ER Mapper Professional

Training Workbook for Mineral Exploration Applications

www.ermapper.com

ER Mapper
Geospatial Imagery Solutions

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Introduction to ER Mapper

This chapter briefly describes the role ER Mapper plays as an important tool for the enhancement, analysis and integration of the wide variety of data used in mineral exploration. This chapter also contains a brief overview of general image processing concepts and terminology, and information about how ER Mapper works compared to traditional image processing software.

This workbook consists of many modules. It is recommended that you work through all the exercises to gain a thorough understanding of ER Mapper.

Structure interpretation from magnetic data dicusses some basic principles of magnetics, common magnetic data processing techniques and interpreting subsurface magnetic structure using ER Mapper. Although magnetic data processing will be of interest primarily to geophysicists, it will be also beneficial to geologists by working through the examples.

Mapping surface geology from radiometric data dicusses some basic principles of radiometrics, the limitations of mapping surface geology (regolith mapping) using radiometric data and mapping high anomaly classes of radiometric elements. This is primarily of interest to geophysicists, but will also be pertinent to geologists for regolith mapping using radiometric data with the aid of existing geological maps of the area of interest.

Mapping surface cover types using satellite images explain how to process Landsat satellite images and apply common enhancement techniques such as RGB band combinations, filtering, band ratios, and advanced techniques such as directed Principal Component Analysis, Abrams and Crosta algorithms for geological applications. Although intended primarily for geologists, geophysicists can benefit from working through the examples as well.

Geophysical filters and map composition explains the basic use of ER Mapper's geophysical spatial and frequency Fourier Transformation filters. This is primarily of interest to geophysicists, and may not be pertinent to geologists unless they are using geophysical data. It also covers ER Mapper's functionality on map composition and printing hard copies for presentation and reports.

Satellite, radiometrics, magnetics and vector integration explains the basic techniques for integrating satellite, radiometrics, magnetics and vector datasets, and 3D visualization of data. These use both geophysical and geological datasets in the examples, and so will be of direct interest to both geophysicists and geologists

Image processing for mineral exploration

Effective mineral exploration programs require analysis and synthesis of many different types of geophysical, geochemical and geological data. These include geophysical data such as magnetics, gravity and radiometrics, Landsat and other satellite images, airphotos, geological maps, geochemical samples, and vector data stored in Geographic Information Systems.

Image processing of geophysical data

For geophysicists, it is essential that interpretation of geophysical survey data be both effective and efficient to ensure that maximum information is derived. Image processing has now become an important tool for mining geophysicists to analyze gridded potential fields, geophysical, and geochemical datasets. ER Mapper provides unique capabilities for interactively enhancing and integrating all types of geophysical data, and can lower exploration costs by aiding detection of subtle anomalies and structural features not readily discernible by other means.

Image processing of satellite and airborne imagery

For geologists, image processing of satellite imagery has been used for many years to aid logistics, mapping of structure and lithology, and location of alteration zones. ER Mapper provides all the tools necessary to interactively create all the common enhancements of Landsat and other satellite data, radar imagery, and aerial photography. It also lets geologists easily integrate collateral data such as geological maps, vector GIS data, and geophysical and geochemical data.

ER Mapper features for mineral exploration

Among the many features ER Mapper provides to aid in mineral exploration:

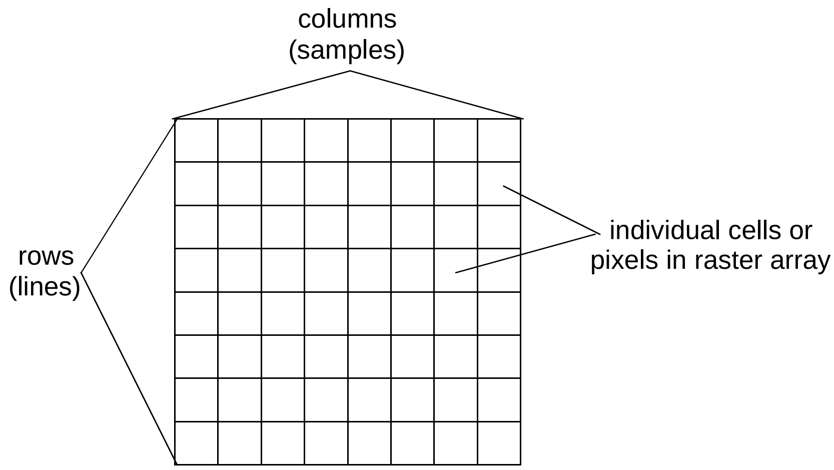
- import data in common geophysical formats (including Geosoft, Gridpro, and more) and satellite image formats (Landsat, SPOT, etc), TIFF files, and more;
- process and integrate geophysical, geochemical, satellite, digital terrain, radar, airphotos, scanned maps, vector GIS, and other data for combined analysis
- apply sophisticated illumination and shading effects to geophysical data to rapidly identify gradients and trends, subtle geological features, and processing artifacts;
- interactively combine structure and other images into a single display by showing data as both color and brightness (“colordraping”);
- view and print any data in 3D perspective, with controls over viewpoint, real-time 3D flythrough, stacking of multiple surfaces with transparency, and more;
- use math functions to generate vertical derivatives and continuations of potential fields data, Landsat band ratios and Principal Components, and other common transforms;
- use Fourier transforms (FFTs) to apply processing in the frequency domain, such as reduction to pole of magnetic data
- register and overlay satellite images and airphotos with geophysical datatsets;
- combine different types of raster, vector, and tabular data into a single visualization;
- render top quality, annotated image maps to over 230 hardcopy devices and standard graphics file formats.

Best of all, ER Mapper is also easy to learn and use, so you do not have to be an image processing expert to use it! You can be performing useful work within hours rather than the days or weeks required for learning conventional image processing software.

Image processing concepts

The term *digital image processing* refers to the use of a computer to manipulate image data stored in a digital format. The goal of image processing for earth science applications is to enhance geographic data to make it more meaningful to the user, extract quantitative information, and solve problems.

A digital image is stored as a two-dimensional array (or grid) of small areas called *pixels* (picture elements) or cells, and each pixel corresponds spatially to an area on the earth’s surface. This array or grid structure is also called a *raster*, so image data is often referred to as raster or gridded data. The raster data is arranged in horizontal rows called *lines*, and vertical columns called *samples*. Each pixel in the image raster is represented by a *digital number* (or DN).

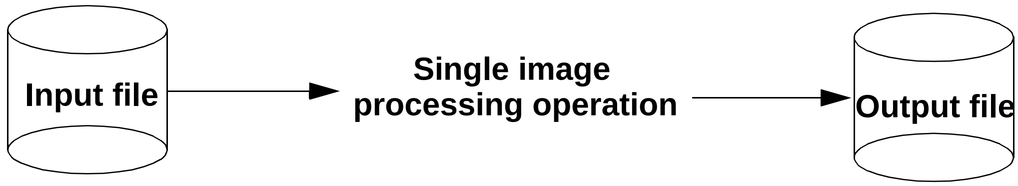


For geophysical data, the DNs may represent total magnetic intensity, radiometric counts, gravity, or other types of data. For remote sensing data such as Landsat, DNs represent composite reflected light (of objects within a pixel) in various wavelengths of the electromagnetic spectrum. By applying mathematical transformations to the digital numbers, ER Mapper can enhance image data to highlight and extract very subtle information that would be impossible using traditional manual interpretation techniques. *This is why image processing has become such a powerful tool for all types of earth science applications.* The exercises in this workbook provide many examples that illustrate how image processing is typically used to enhance and visualize geophysical and remote sensing datasets.

Image datasets can also have multiple *bands* (or layers) of data covering the same geographic area, each containing a different type of information. For example, a radiometric dataset may contain potassium, thorium, uranium, and total count bands. Or, a satellite image may contain several spectral bands such as reflectance in the visible or infrared wavelengths of light.

Traditional image processing

Image processing was first developed on large mainframe computers in the 1960's to process images from planetary satellites. To process an image, you specified the name of the file to process, the type of operation you wanted to perform, then waited for the system to process the data and write the results to a new image file on disk (shown in the diagram below). You then used a separate display program to view the output file and evaluate your results.

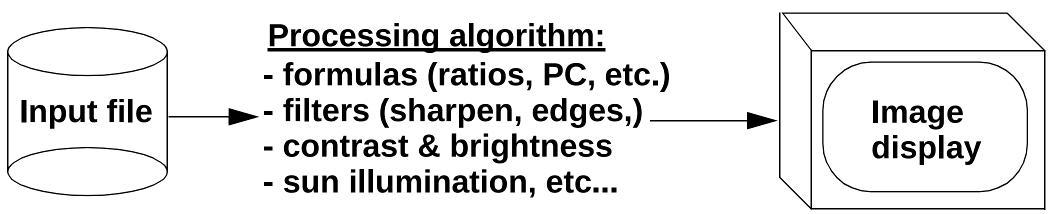


With traditional systems, the changes resulting from the image processing operation are saved in a *separate output raster file*.

With the introduction of powerful workstations in the 1980's, processing of large images could now be performed on the desktop. Surprisingly, nearly all image processing products on the market today are still designed around this "disk-to-disk" approach from the 1960's. This means that to perform a processing operation that requires several steps, you need to write an intermediate file to disk for each step. Only when the final file is created can you view your desired results. This approach can consume tremendous amounts of time and disk space, and if the result is not what you intended, you must often start all over again.

ER Mapper image processing

Recognizing the restrictions inherent in traditional image processing software, the creators of ER Mapper developed an entirely new approach. Instead of writing a file to disk for each processing step, ER Mapper lets you combine many processing operations into a single step, and render the results directly to your screen display in near real-time. (In most cases, no processed copies of your original data are written to disk unless you request to do so.) The set of processing steps you apply to your data is called an "algorithm" in ER Mapper.

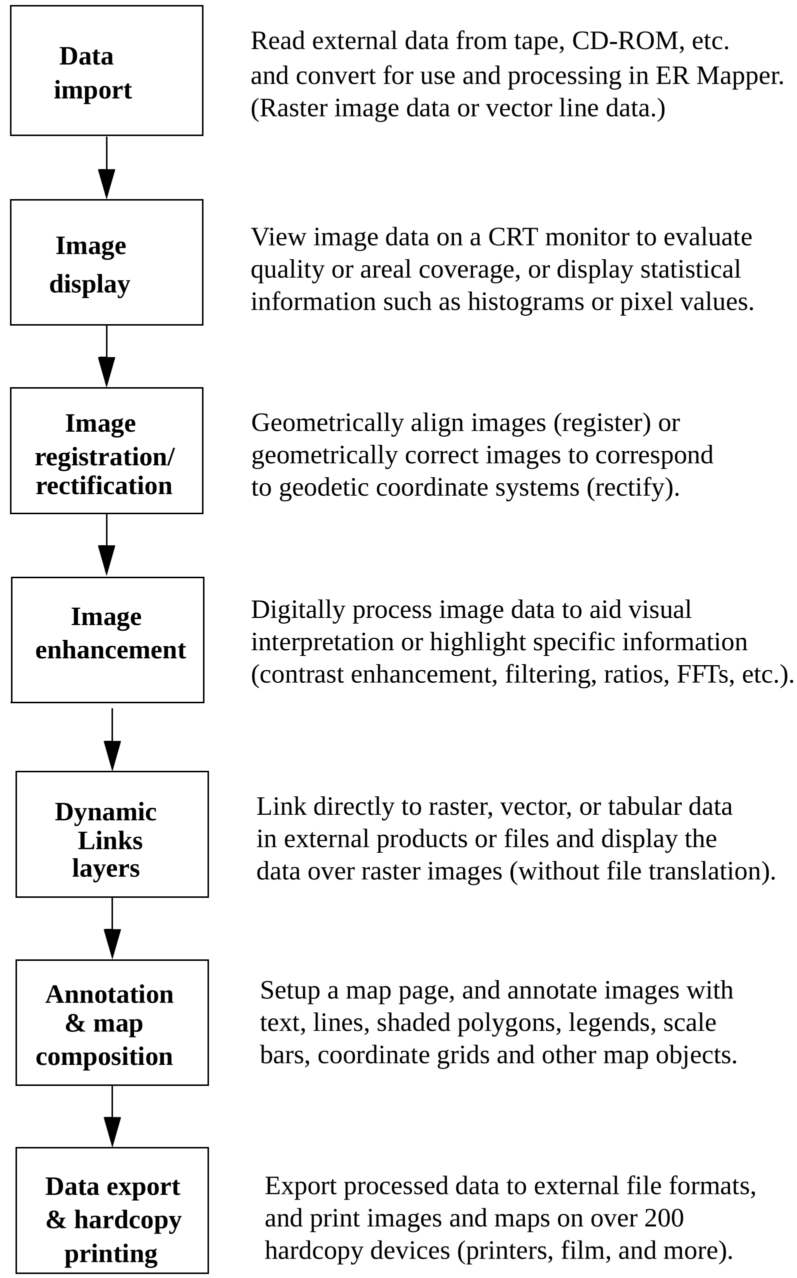


With ER Mapper, you save only a *description of the processing steps* you wish to apply to the data (the algorithm), *not* separate processed copies of the original raster data file. By storing the processing steps separately from the actual data, image processing becomes faster, easier to learn, and more interactive.

In ER Mapper, algorithms can be used for simple viewing of data, or for very complex processing and modelling operations involving many images, transformations of the data, and overlays of other types of data.

Image processing tasks

A flowchart of typical image processing tasks is summarized in the following diagram, from data import through processing to final output. You may or may not need to perform some of these tasks for your application, but it is helpful to have a general idea of a typical procedure:



Data import

The first step in image processing is importing the data you want to use into ER Mapper. Typically the data might be stored on magnetic tape, CD-ROM, or other media. For mineral exploration applications, raster datasets are usually preprocessed and gridded geophysical datasets or digital satellite images, airphotos or other raster datasets used for geological analysis. These datasets are then imported into ER Mapper for enhancement, integration and analysis. There are two primary types of data you may want to import into ER Mapper: raster and vector.

Raster image data is the type used as input to image processing operations. When you import a raster image file (using ER Mapper's import utility programs), ER Mapper converts the data and creates two files:

- a binary data file containing the raster data, in band interleaved by line (BIL) format
- a corresponding ASCII header file with an ".ers" file extension

Vector data is stored as lines, points, and polygons. Many geographic information system (GIS) products use vector data structures because it is more efficient for representing discrete spatial objects like faults (lines), mine locations (points), or lease boundaries (polygons). In an image processing product, it is often helpful to overlay vector data on top of a raster image backdrop, for example to overlay lease boundaries on a seismic horizon. When you import a vector file (using ER Mapper's import utility programs), ER Mapper converts the data and creates two files:

- an ASCII data file containing the vector data
- a corresponding ASCII header file with an ".erv" file extension

Image display

After importing the data, the next step is usually to display the image on your CRT monitor to evaluate the data quality and geographic area of coverage. There are several ways in which data can be viewed, including simple black and white or pseudocolor displays, and red-green-blue (RGB) or hue-saturation-intensity (HSI) color composite displays. The way in which you choose to display your raster data is called the "Color Mode" in ER Mapper.

In addition to displaying the data, you may want to view statistical information about it. Statistics are often good indicators of image quality. You may want to calculate statistics for the image, such as the mean value in each band, and view them in a tabular format. Or you may want to view statistical information in a graphical format using tools like histograms, scattergrams, and traverse profiles.

Image rectification

Raster image data is sometimes supplied in a "raw" state where the true earth coordinates are not known. Although this is usually not the case with geophysical datasets, it is sometimes the case with satellite images and scanned airphotos or maps. Whenever accurate area, direction, and distance measurements are required, raw image data must usually be processed to remove geometric errors and/or rectify the image to a real world coordinate system.

- *Registration* is the process of geometrically aligning two or more images to allow them to be superimposed or overlaid.
- *Rectification* is the process of geometrically correcting raster images so they correspond to real world map projections and coordinate systems (such as Latitude/Longitude or Eastings/Northings).

  If your application requires that your images be registered to one another or rectified to a map projection, you can use ER Mapper's Rectification utilities.

Image enhancement

Image enhancement refers to any one of many types of image processing operations used to digitally process image data to aid visual interpretation or extract quantitative information meaningful to the user. Image enhancement is what many people commonly think of as "image processing."

In ER Mapper, most image enhancement operations are greatly simplified by the "algorithms" processing concept. Multiple-step image enhancement operations can be applied and displayed in real time to provide truly interactive control without writing temporary files to disk.

Typical image enhancement operations include:

- *Colordraping*–Drape one type of data over another to create a combined display allowing analysis of two or three variables. For example, draping radiometric data in color over a shaded magnetic image highlighting structural features.
- *Contrast enhancements*–Improve image presentation by maximizing the contrast between light and dark portions (or high and low data values) in an image. Or, highlight a specific data range or spatial area in an image.
- *Filtering*–Enhance edges, smooth noise, or highlight or suppress specific linear or spatial features in images. For example, apply a smoothing filter to suppress noise in a radiometric dataset, or an edge enhancement filter to highlight lineaments in a satellite image.
- *Formula processing*–Apply mathematical operations to transform data for analysis or derive specific thematic information. In ER Mapper, formulas are used for creating derivatives and continuation of geophysical data, and band ratios, Principal Components, or other transformations of satellite image data. ER Mapper also includes Fourier Transformations for processing in frequency domain space.
- *Real-time 3D visualization*–View and manipulate geophysical and remote sensing data sets in 3D perspective or 3D flythrough modes. ER Mapper lets you stack multiple datasets as different surfaces in a single view, and manipulate the viewpoint, transparency, and other parameters of the surfaces in real-time.

Dynamic Link layers

Dynamic Links are a special ER Mapper feature that let you link to data in external products or file formats, and display the data on top of raster images without the need for importing the files. Dynamic Links can link to raster, vector, or tabular (point) datasets, so you can access and integrate *all* your geographic information. ER Mapper provides Dynamic Links to several popular products and file formats, and the procedure is fully documented so you can also create your own links to any other product or format you desire.

Types of Dynamic Links include:

- *Links to GIS products*–Extract and display vector data from GIS products such as ARC/INFO or vector data from geophysical products such as Intrepid. GIS links are often used to overlay vector data such as lease boundaries, interpreted geology, contours, and so on.

Tip: You can display, edit, and save ARC/INFO coverage files directly in ER Mapper. See the *ER Mapper Reference Manual* for details.

- *Links to database products*–Extract and display tabular (point location) data from database products such Oracle. Tabular links are often used to overlay georeferenced point location symbols such as mine locations.
- *Links to external file formats*–Display specialized annotation, vector data, or other data stored in PostScript, DXF, DGN, or other standard vector file formats.

Map composition

You can use ER Mapper's built-in annotation and map composition tools to create top quality image maps combining raster, vector, and tabular data. Annotation lets you draw directly on-screen using text, line, polygon, and other annotation tools, and specify fill color, shading, line styles, and group, resize and move objects. Vector annotation files can also be exported to external file formats for use in other products (for example exporting faults interpreted in ER Mapper to other seismic processing products).

ER Mapper's map composition tools let you create top quality image maps by adding coordinate grids, map collars, scale bars, legends, north arrows, and many other map objects. You can layout and compose maps comprised of multiple processed images, and size and scale map output as desired. All map objects are defined as full color PostScript, and you can easily add custom map objects such as company logos or special north arrows.

Data export and hardcopy

Once you have completed processing your data, ER Mapper lets you translate raster and vector data to external standard file formats or print to over 200 different hardcopy devices.

Data export is used to export the processed version of your raster images for use in another product that handles gridded data. Or, you may want export vector annotation or vectorized thematic data to another product.

Hardcopy printing is often the final goal of processing and annotating images, and ER Mapper provides unsurpassed hardcopy support and output to standard graphics file formats. ER Mapper also includes a built-in PostScript-compatible rendering engine, so you get PostScript-quality output (such as beautiful, smooth text) on any supported device, whether the device supports PostScript or not.

You can also easily print at exact sizes and map scales, and automatically print images in strips for mosaicking large image displays. Supported hardcopy devices include film recorders, dye sublimation printers, inkjet printers, and electrostatic plotters. Graphics file formats include PostScript, TIFF, CGM, and CMYK and RGB color separations.

2

User interface basics

This chapter introduces the basic use of the ER Mapper graphical user interface. It gives you practice using menus, toolbars, dialog boxes, and image windows, and loading and displaying image processing algorithms.

Note: In order to complete the exercises in this manual, you will need to access the example images and algorithms supplied with ER Mapper. If needed, ask your system manager for the location of the ER Mapper software directory at your site.

User interface components

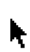
This section provides a brief introduction to the main components of ER Mapper's graphical user interface (GUI). You can perform nearly all operations by pointing and clicking with the mouse, and very little typing on the keyboard is required. The GUI is part of ER Mapper's original design, so it is well integrated and easy to learn and use.

Using mouse buttons

When using ER Mapper, use the left button on your mouse to perform operations like selecting items from menus, manipulating image windows, and drawing annotation. In this manual, all actions are performed with the left mouse button unless otherwise indicated. The following table explains terms used in this manual to describe actions you perform with the mouse.

Term	Meaning
Point	Position the mouse pointer on an item.
Click	Point to an item, then quickly push and release the left mouse button.
Right-click	Point to an item, then quickly push and release the right mouse button.
Double-click	Point to an item, then quickly click the left mouse button twice.
Drag	Point to an item. Then press and hold down the left mouse button as you move the pointer to a new location, then release the button.
Shift-click or Ctrl-click	Hold down the Shift key or Ctrl key on your keyboard, then click.
Shift-drag or Ctrl-drag	Hold down the Shift key or Ctrl key on your keyboard, then drag the mouse.

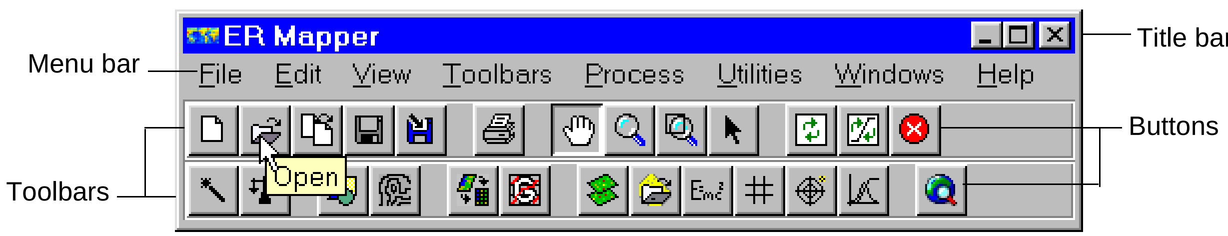
The symbol representing the mouse pointer on the screen changes shape depending on what you are pointing to and the task you are performing.

Pointer	Location on the screen	Function
	Menu bars and buttons; or inside image window	Choose menu commands and click buttons; point to the image to see data values or coordinates.
	Text fields	Type or select text, or reposition the insertion point.
	Inside the current image window	Zoom the image within the image window.
	Inside the current image window	Drag a box over an area to fill image window.

	Inside the current image window	Pan the image within the image window.
	Inside inactive image windows	Select an inactive window to become the current window.
	In image windows when annotation tools are selected	Draw annotation and map composition objects.

The ER Mapper main menu

When you start ER Mapper, the main menu appears. The main menu has two primary components–the menu bar and rows of toolbar buttons.



Menu bar	Lets you select commands used to carry out actions in ER Mapper. To select a command from the menu bar, click on the name of the menu to open it, then click the desired command name.
Toolbar buttons	Shows groups of buttons to let you carry out common tasks quickly. To choose a function from a toolbar, click on the desired button.
Tool tips	Place the cursor on any toolbar button and within a couple of seconds the function of that toolbar button is displayed in a small text window just below the cursor

Using ER Mapper toolbars

Toolbars give you quick access to many common functions, such as saving an image processing algorithm or printing a hardcopy. ER Mapper also provides optional toolbars for specific tasks and image processing applications. To hide or display various toolbars, use the **Toolbar** menu. To get short help for any toolbar function, point to the button and read the tool tips.

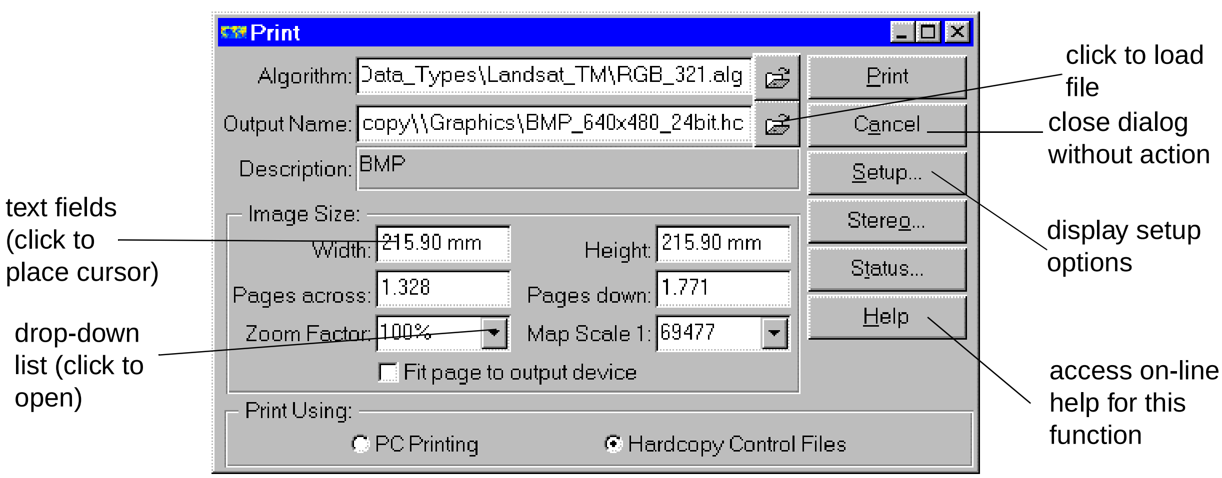
ER Mapper provides toolbars for many common tasks, and also toolbars for building processing algorithms commonly used in remote sensing applications such as forestry, geophysics, and map generation. The functions of the Standard, and Common Functions toolbars are summarized below.

Standard	Provides quick access to standard commands for opening and saving algorithms, printing, starting and stopping algorithm processing, and changing the mouse pointer. Most functions are also available from the menu bar.
Common Functions	Provides quick access to commonly used functions, such as creating general types of algorithms, viewing and editing components of an algorithm.

Using ER Mapper's scripting language, you can also create your own customized toolbars for specific tasks and functions. For more information on creating custom toolbars, see the *ER Mapper User Guide*.

Using dialog boxes

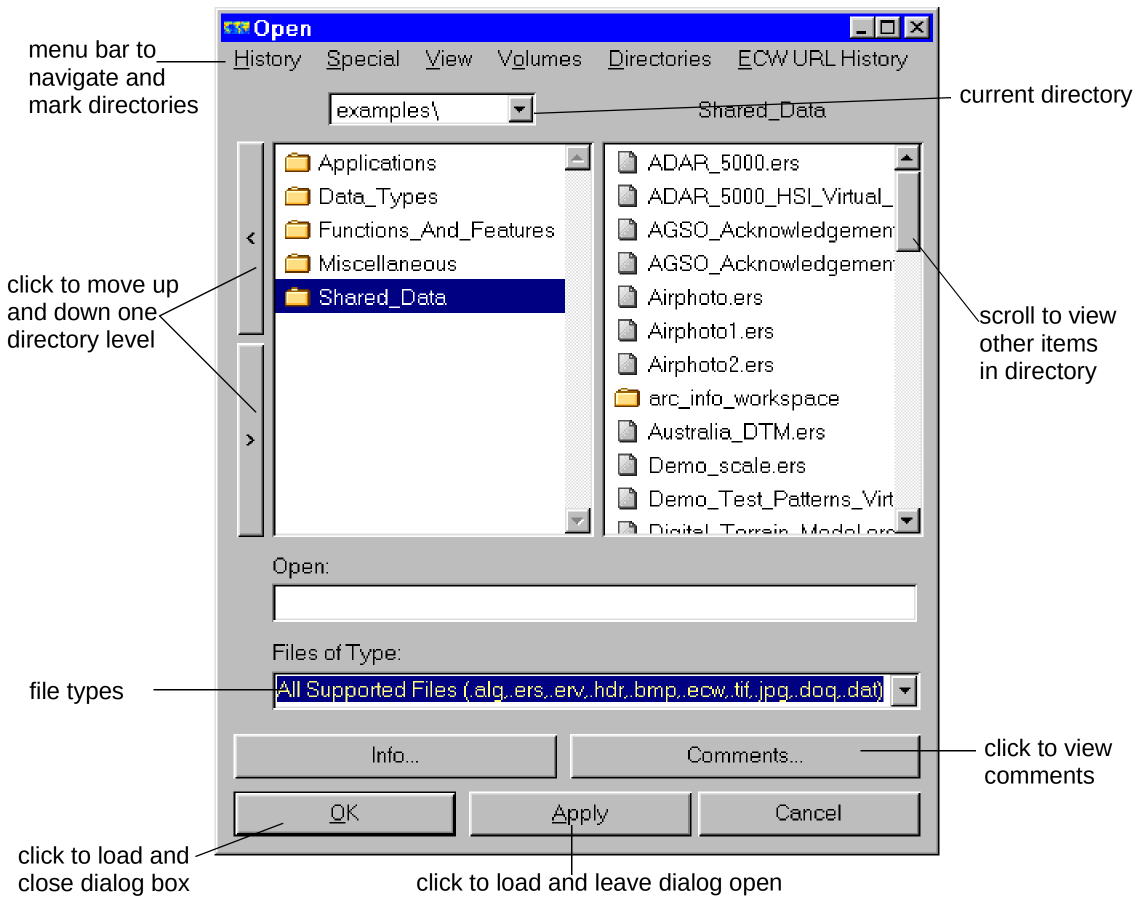
When you select menu commands or click toolbar buttons, dialog boxes often appear for you to choose options to control your image processing tasks. Some dialog boxes, such as the File Chooser, can disappear when you make your selection. Other dialogs can remain open for setting options for as long as you want to use them.



To resize a dialog box, drag one of its corners or edges to the desired size. ER Mapper automatically resizes the dialog box intelligently, so that any central display areas are enlarged, and the layout of buttons remains the same. After resizing, the dialog retains your new size for the current ER Mapper session.

Using the File Chooser dialog boxes

When you choose to open or save a dataset, algorithm, or other file, ER Mapper displays a File Chooser dialog box. The central window contains a list of directories, or files in the current directory.



To open a file or directory displayed in the scroll list window, either double-click on it, or click once to select it and click the **OK** or **Apply** button to open it.

Tip: You can see two levels of directories and/or files by widening the file chooser dialog box (drag one of the sides).

The File Chooser menus at the top have the following functions:

History menu	Use to change the File Chooser's current directory. The menu has two parts: the upper portion lists most recently visited directories, and the lower portion lists marked directories.
Special menu	Use to change to your home directory, or to mark or unmark a directory (any directory may be marked for fast access using the History menu).
View menu	Use to sort the contents of the current directory by name, date modified, or date created.
Volumes menu	Use to access volumes or disk drives on your network.
Directories menu	Use to change to any directory defined by your preferences settings.
ECW URL History	List of the URLs of the most recently accessed image files from an Image Web Server.

Using the on-line help system

ER Mapper provides an extensive on-line help system with both simple overviews and detailed descriptions of all features and functions. There are two ways to access help:

Help menu	Lets you browse all the standard ER Mapper manuals on-line, and go between manuals and topics using hypertext links.
Help buttons	The **Help** button inside dialog boxes gives you context-sensitive help. If needed, you can navigate to view more detailed information using the hypertext links.

Typing text in text fields

To enter text for naming files or changing values in dialog boxes, ER Mapper provides text fields. When you point to a text field, the pointer shape changes to an I-beam. To enter text, click anywhere inside the text field to place the text cursor.

To select existing text, you can drag through the desired portion, or double-click on a word or numeric value to select it. Text that is selected become reverse highlighted, and any subsequent typing replaces it.

Hands-on exercises

The following hands-on exercises introduce you to the basic concepts of using menus and dialog boxes and managing image windows.

What you will learn...

After completing these exercises, you will know how to perform the following tasks in ER Mapper:

- Choose options from menus and toolbar buttons
- Display and hide toolbars
- Open an empty image window
- Open an image processing algorithm into a window
- Move and resize an image window
- Zoom and pan the image within the window
- Manipulate multiple image windows on the screen
- Close image windows

1: Using menus and toolbars

Objectives

Learn to open and make selections from menus, use toolbars, and access on-line help.

Move the ER Mapper main menu around the screen

1 Position the mouse pointer on the ER Mapper main menu title bar, then drag it to the lower-left part of the screen.

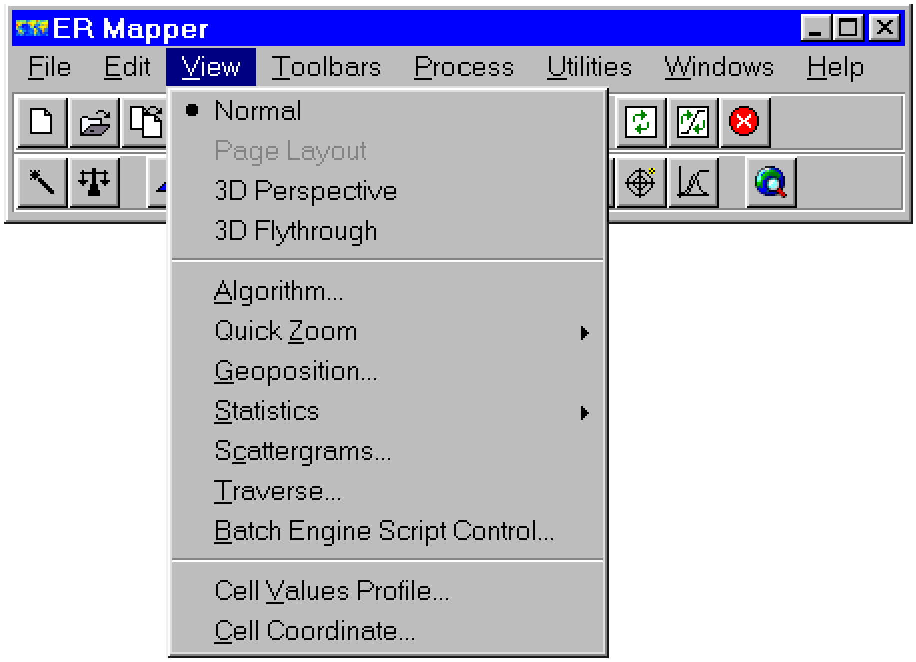
Pointing to the title bar and dragging is how you move dialog boxes and image windows around the screen.

2 Drag the main menu to the upper-right corner of the screen.

This is the recommended position for the main menu for the exercises in this tutorial.

Open a menu to display its commands, then close the menu

1 Click on the **View** menu button; a list of commands under the menu displays.



The small arrows next to **Quick Zoom** and **Statistics** indicate that they have additional commands under them.

2 Click on the **Statistics** command to display its submenu.

3 Click anywhere outside the main menu to close the open menus without making a selection.

Note: In the rest of this manual, selecting commands from menus is indicated as follows: "From the **Edit** menu, select **Preferences...**" (which means click on Edit in the menu bar, then click on the Preferences command).

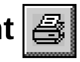
Select the Print command from the menu bar

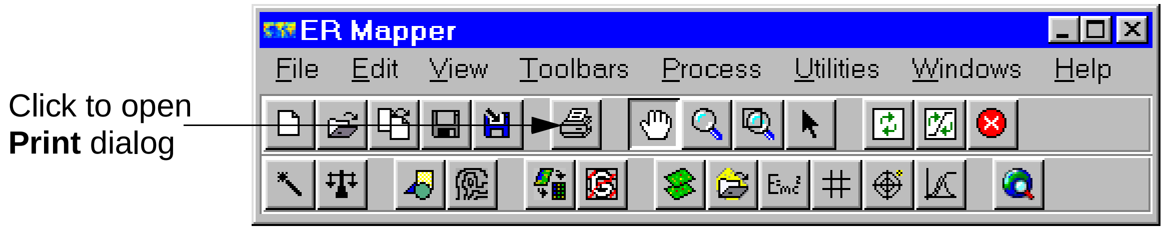
1 From the **File** menu, select **Print**.

The **Print** dialog box appears with options for printing hardcopy.

2 Click the **Cancel** button to close the dialog box.

Select the Print command from the Standard toolbar

1 On the Standard toolbar, click the **Print**  button.



The same **Print** dialog box appears again. Using toolbar buttons is often a faster way to access many commands in ER Mapper.

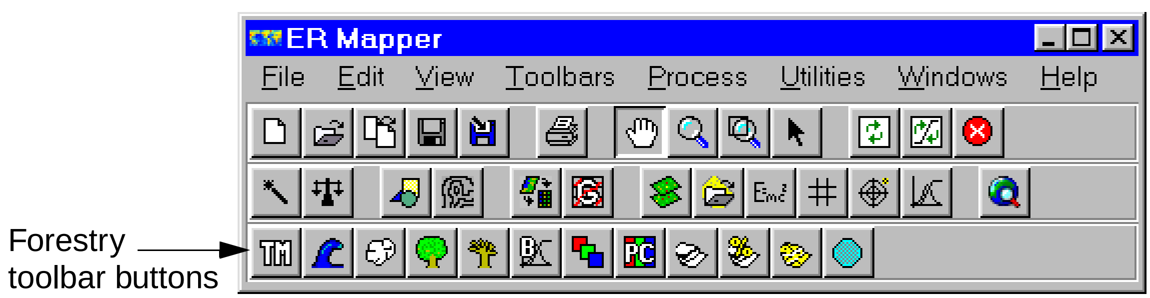
2 Click the **Cancel** button to close the dialog box.

Tip: Many common commands on the menu bar, such as Print, are also available on the Standard toolbar. Use whichever is fastest or most comfortable.

Display and hide a toolbar

1 From the **Toolbar** menu, select **Forestry**.

A third row of toolbar buttons appears on the main menu below the Standard and Common Functions toolbars. This toolbar has buttons for common image processing techniques used in forestry applications.



2 Point the cursor to any button on the toolbar.

A description of the button function displays in the small text field just below the cursor.

3 From the **Toolbar** menu, select **Forestry** again.

The Forestry toolbar buttons disappear from the main menu. Use the **Toolbar** menu to display or hide any toolbar. (It is recommended that you always display the Standard and Common Functions toolbars.)

2: Opening windows and algorithms

To display an image in ER Mapper, you first open an empty image window, then load and display an image processing algorithm. The algorithm references a raster data file on disk, and the processing steps ER Mapper uses to enhance and render the data on the screen display. (You will learn more about algorithms later.) You can have as many different image windows open on the screen as you need.

Objectives Learn to open image windows on your computer display, and open and run an image processing algorithm stored on disk.

Open a new empty image window

1 From the **File** menu, select **New**.

An empty image window opens in the upper left corner of the screen. The window title bar reads “Algorithm Not Yet Saved” because no processing algorithm is associated with this image window yet.

Open and display an image processing algorithm

1 From the **File** menu, select **Open...**.

The **Open** file chooser dialog box opens.

2 From the **Directories** menu, select the path ending with the text **\examples** (The portion of the path name preceding it is specific to your site.)

3 Double-click on the directory named ‘Data_Types’ to open it.

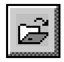
4 Double-click on the directory named ‘Landsat_TM’ to open it. (Scroll if needed to view it first.)

The list of example algorithms for processing Landsat Thematic Mapper (TM) satellite imagery displays.

5 Double-click on the algorithm named ‘RGB_321.alg.’ (Scroll down if needed to view it first.)

ER Mapper runs the algorithm and displays an enhanced Landsat TM image of San Diego, California in the image window. This algorithm displays bands 3, 2, and 1 of the Landsat image as an RGB color composite image, with band 3 in the red display channel, band 2 in the green, and band 1 in the blue. Notice also that the algorithm filename ‘RGB_321’ now appears in the title bar of the image window.

Use the toolbar to open a different processing algorithm

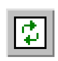
1 Click the **Open**  button on the Standard toolbar.

The **Open** file chooser dialog box appears. (This toolbar button has the same function as selecting **Open...** from the **File** menu.)

The algorithm named 'RGB_321' in the 'Data_Types\Landsat_TM' directory is already highlighted since it is currently loaded into the image window.

2 Double-click on the algorithm named 'RGB_541.alg.'

ER Mapper runs the algorithm and displays a color composite of the same Landsat image, this time using bands 5, 4, and 1. Notice that the title bar also changes to show the filename of the new algorithm.

Note: By default, ER Mapper runs the algorithm automatically for you when you open it from disk. You can also reprocess the data at any time by clicking the **Refresh**  button.

3: Resizing windows and zooming/panning

Objectives Learn to move and resize image windows, zoom (magnify) part of an image, and pan (scroll) to other parts of an image.

Move the image window on the screen

1 Point the mouse at the image window title bar, then drag it to another part of the screen.

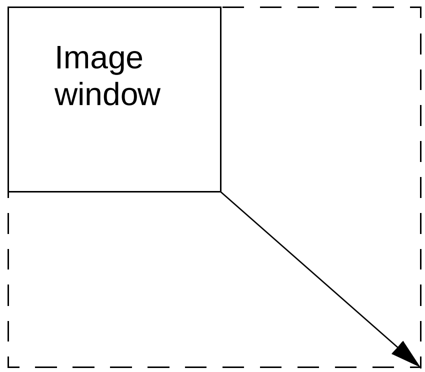
2 Drag the image back to the upper-left part of the screen.

Like dialog boxes, dragging images by the title bar is how you move them around the screen.

Resize the image window

1 Move the mouse pointer directly over the lower-right corner of the image window–the pointer shape changes to a double ended arrow.

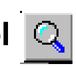
2 Drag the lower-right corner to make the window about twice its original size, then release.



Dragging any side or corner of an image window lets you change the default window size as you desire.

Note: When you resize a window, ER Mapper maintains the size of the image inside the window. Empty areas on the sides are filled with a cross-hatch pattern to indicate that no data is displayed there.

Set the mouse pointer to Zoom mode

1 On the Common Functions toolbar, click the **Zoom Tool**  button.

This tells ER Mapper to use the mouse pointer for zooming when it is positioned inside an image window. Also notice that the **Zoom Tool** button becomes depressed to indicate that it is the active pointer mode.

2 Move the pointer inside the image window.

The mouse pointer displays as a magnifying glass icon.

Zoom in and out of the image with the mouse

1 Position the pointer in the center of the image, and click the left mouse button.

The image zooms in by 50%.

2 Position the pointer in the center of the image, hold down the Ctrl. key while clicking the left mouse button.

The image zooms out by 50%.

3 Position the pointer in the image, and then drag it up and down.

As you drag the pointer down the image is magnified, i.e you zoom into it. When you drag the pointer upwards, the image gets smaller, i.e you zoom out.

Set the mouse pointer to ZoomBox mode

1 On the Common Functions toolbar, click the **ZoomBox Tool**  button.

This tells ER Mapper to use the mouse pointer for creating a zoom box when it is positioned inside an image window. Also notice that the **ZoomBox Tool** button becomes depressed to indicate that it is the active pointer mode.

2 Move the pointer inside the image window.

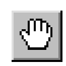
The mouse pointer displays as a magnifying glass and box icon.

Zoom in (magnify) an area of the image with the mouse

1 Position the pointer near the upper-left center of the image, then drag to the lower-right to define a box.

When you release the mouse, ER Mapper runs the algorithm again and magnifies (or “zooms in”) on the area of the image you defined with the box. Dragging a zoom box is a fast way to magnify an area of interest. (There are other zooming functions you will learn about later.

Set the mouse pointer to Hand mode

1 On the Common Functions toolbar, click the **Hand Tool**  button.

This tells ER Mapper to use the mouse pointer for panning when it is positioned inside an image window. Also notice that the **Hand Tool** button becomes depressed to indicate that it is the active pointer mode.

2 Move the pointer inside the image window.

The mouse pointer displays as a hand icon.

Pan (scroll) the image within the window with the mouse

1 Click on the image. and drag it to a new position in the image window.

The hand pointer will grab the image and move it (pan) to the new location.

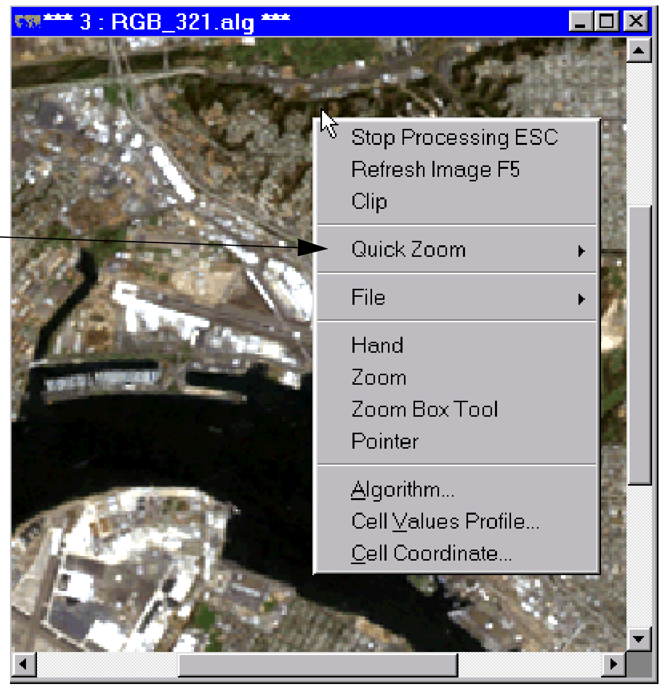
Zoom back out to view the full image extents

1 From the **View** menu, select **Quick Zoom** and then select **Zoom to All Datasets**.

ER Mapper runs the algorithm again and zooms back out to display the full extents of the Landsat image data. The **Quick Zoom** submenu provides many options for zooming in or out to specific datasets, setting window geolinking, and other options you will learn more about later.

2 Right-click inside the image window to open the shortcut menu, then select **Quick Zoom** and then **Zoom to All Datasets**.

Right-click inside image window to open shortcut menu

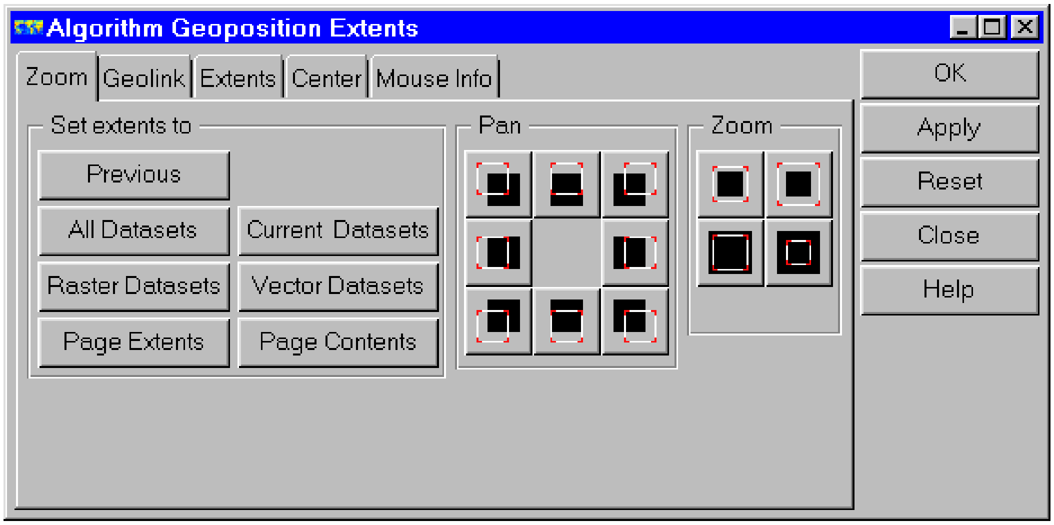


Zoom and pan using buttons for predefined options

In addition to using the mouse, ER Mapper also lets you zoom and pan using buttons to invoke predefined zoom and pan functions.

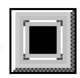
1 From the **View** menu, select **Geoposition...**.

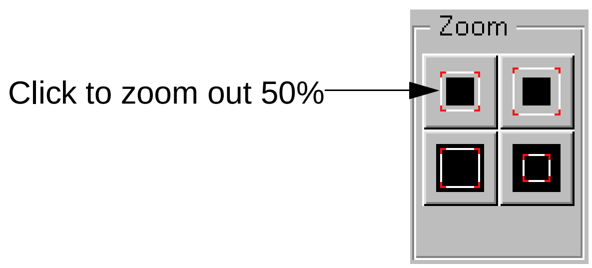
The **Algorithm Geoposition Extents** dialog box appears.



2 Click on the **Zoom** tab at the top to display zoom and pan options.

The **Zoom** tab options show sets of buttons for zooming and panning the image within the window.

3 In the buttons labelled 'Zoom,' click the **Zoom out 50%**  button.



ER Mapper runs the algorithm and zooms out to 50% of the previous display resolution.

Tip: For all icons on buttons under 'Zoom' and 'Pan,' the black square represents the current image, and the white box represents how the size or position of the image will change after the button is clicked.

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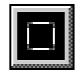
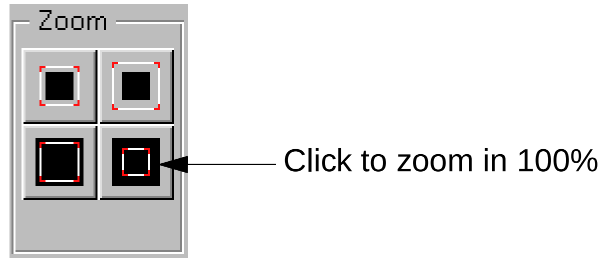
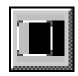
4 In the buttons labelled 'Set Extents To,' click **Previous**.

ER Mapper zooms out to the previous image display extents.

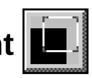
5 Under ‘Zoom,’ click on the **Zoom in 100%**  button.



ER Mapper magnifies the images to two times (100%) of the previous display resolution (and keeps the image center point constant).

6 Under ‘Pan,’ click on the **Pan left**  button.

ER Mapper pans or scrolls the image 50% to the left (the previous center point is now on the far right side of the image).

7 Under ‘Pan,’ click on the **Pan upper-right**  button.

ER Mapper pans the image 50% to the upper-right (the previous center point is now on the lower-left corner of the image).

8 Experiment with other buttons under Zoom and Pan to see their effect.

9 Under ‘Set Extents To,’ click the **All Datasets** button.

ER Mapper resets the image extents to fit the entire dataset in the image window.

10 Click **Close** on the **Algorithm Geoposition Extents** dialog to close it.

4: Managing multiple image windows

Objectives Learn to open a second image window, specify overlap priority between windows, activate an image window, and close image windows.

Open a second image window

1 From the **File** menu, select **New**.

ER Mapper opens a new image window. As with all new image windows, it has no algorithm associated with it yet.

Open and display a processing algorithm in the new window

1 From the **File** menu, select **Open...**.

The **Open** file chooser dialog box appears.

2 From the **Directories** menu, select the path ending with the text **\examples**.

3 Double-click on the directory named ‘Data_Types’ to open it.

4 Double-click on the directory named ‘SPOT_Panchromatic’ to open it.

The list of example algorithms for processing SPOT Panchromatic satellite imagery displays.

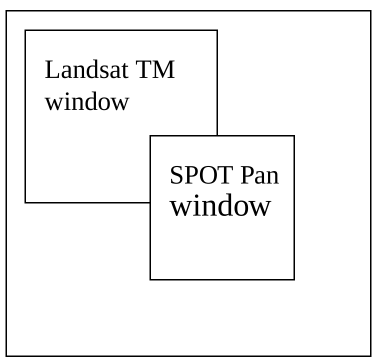
5 Double-click on the algorithm named ‘Greyscale.alg.’

ER Mapper runs the algorithm and displays a SPOT Panchromatic satellite image the San Diego (the same geographic area covered by the Landsat image in the other window). The SPOT Pan data provides greater spatial detail than the Landsat data, but has only one spectral band which is displayed in greyscale.

Move the SPOT window to overlap with the Landsat window

1 Drag the image window titled ‘Greyscale’ to the center of the screen until it partially overlaps with the Landsat ‘RGB_541’ image window.

Your windows should be similar to the following diagram:



Move one window in front of the other

1 Click on the title bar of the window with the algorithm description titled ‘RGB_541.’

The Landsat window moves in front of the SPOT window where there is overlap.

2 Click on the title bar of the window with the algorithm description ‘Greyscale.’

The SPOT window now moves in front of the Landsat window where there is overlap. Clicking on the title bar of a window or dialog box bar lets you choose which window or dialog box to display on top of others.

Select a window to be the active window

The “active” image window is the one you want to currently work with, such as zooming, loading a new processing algorithm, or editing the current algorithm. (You can have many image windows open on the screen, but only one can be active.)

1 Look at the title bar of the SPOT Panchromatic window and notice the three asterisks (***) on either side of the window title.

The three asterisks indicate that this is the active (or current) window of the two.

2 Move the pointer inside the image area of the window with the algorithm description titled “RGB_541.”

The pointer shape changes to a pointing hand. (This happens whenever you move from the active window to any inactive image window.)

3 Click anywhere inside the Landsat image window or on the Title Bar.

It now becomes the active window and three asterisks appear next to the title.

4 Click inside the SPOT window or on the Title Bar again to make it active.

Note: A window can be active and still be covered by another “inactive” window. To move the active window to the front, click on its title bar.

Close both image windows

1 Close one image window using the window system controls:

- For Windows, select **Close** from the window control-menu.

The window closes and disappears from the screen.

2 Close the other image window by repeating Step 1.

The window closes and disappears from the screen. Only the ER Mapper main menu is now open.

What you learned

After completing these exercises, you know how to perform the following tasks in ER Mapper:

- Choose options from menus and toolbar buttons

- Display and hide toolbars
- Open an empty image window
- Open an image processing algorithm into a window
- Move and resize an image window
- Zoom and pan the image within the window
- Manipulate multiple image windows on the screen
- Close image windows

3

Pseudocolor algorithms

This chapter introduces the basic concepts involved in creating a simple image processing algorithm that displays a gridded radiometrics dataset in greyscale or color. You learn about the interface ER Mapper provides for creating and editing algorithms (the **Algorithm** dialog), and how to control the color mapping and contrast enhancements used to display the image.

About the algorithms concept

The goal of all image processing is to enhance your data to make it more meaningful and help you extract the type of information that interests you. To make this procedure faster and easier, Earth Resource Mapping developed a new image processing technique called "algorithm data views." Understanding how to use algorithms is the key to understanding how to use ER Mapper effectively.

What is an algorithm data view?

An algorithm is a list of processing steps or instructions ER Mapper uses to transform raw datasets on disk into a final, enhanced image on your screen display. In this sense, algorithms let you define "views" into your data that you can save, reload, and modify at any time.

You use ER Mapper's graphical user interface to define your list of processing steps, and you can save the steps in an algorithm file on disk. An algorithm file can store any of the following information about your processing:

- Names of dataset(s) to be processed and displayed
- Subsets of the dataset(s) to be processed (zoomed areas)
- Bands (layers of data) in the dataset(s) to be processed
- Color mapping and contrast enhancements (Transforms)
- Filtering to be applied to the data (Filters)
- Equations and combinations of bands or datasets used to create the image (Formulae)
- Color mode used to display the data (Pseudocolor, Red Green Blue, or Hue Saturation Intensity)
- Any vector datasets, thematic color, or map composition layers to be displayed over the raster image data
- Definition of a page size and margins (used for positioning the image on a page for creating maps and printing)
- Viewpoint and other parameters when viewing the image in 3D perspective

By being able to apply a set of processing steps as a single entity, the complexity often associated with image processing is greatly simplified. In addition, you gain tremendous savings in disk space, since you do not need to store intermediate processed copies of your original data on disk.

Building Algorithms in ER Mapper

There are three primary ways to build a processing algorithm in ER Mapper:

- Open a dataset directly (**File Open**) and have ER Mapper automatically display the image using a simple default algorithm
- Use the **Algorithm** dialog options to build an algorithm by adding the desired types of layers, loading datasets, and specify processing steps for each layer.
- Use image wizards to have ER Mapper automatically create any of several types of specialized algorithms for you. In this case, ER Mapper adds the appropriate layers to the **Algorithm** dialog, prompts you to load a dataset, and possibly other options as well.

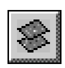
The majority of exercises in this workbook ask you to build algorithms from scratch so you become familiar with and thoroughly understand the basic concepts. However, you will also use the automatic algorithm creation wizards from time to time to understand how they can save time.

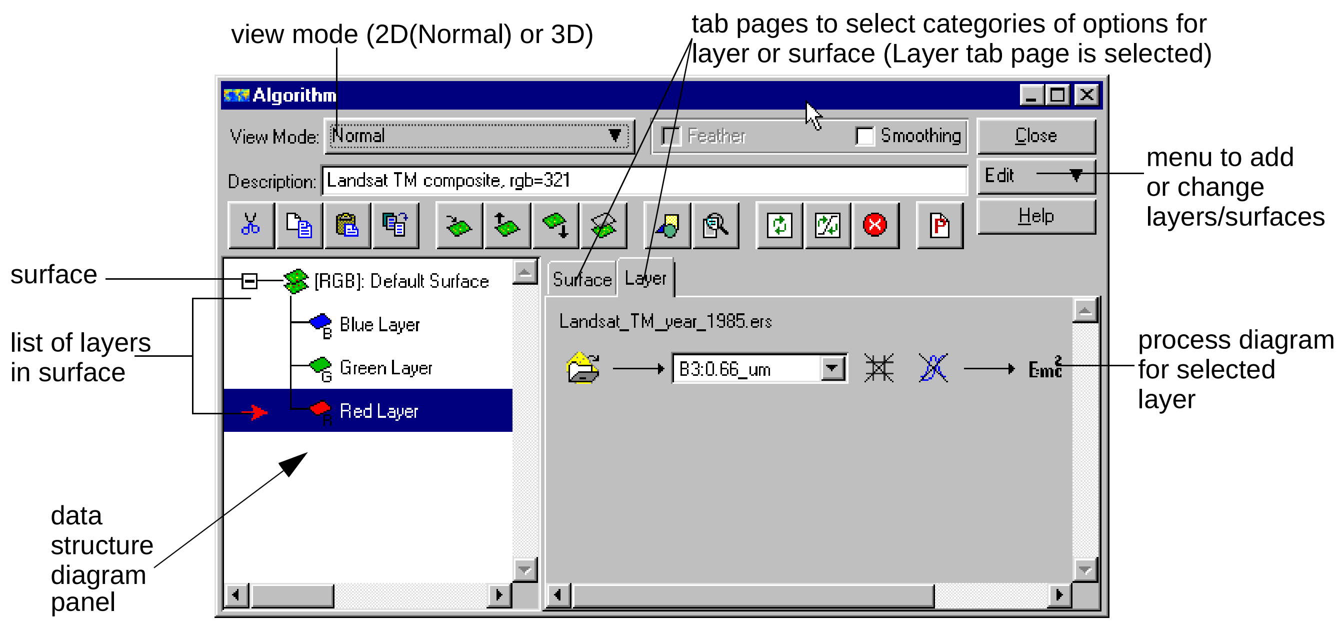
Using Algorithms as Templates

Once you have saved your processing instructions as an algorithm file, you can use the algorithm as a “template” to easily apply the same processing to other datasets. To use an algorithm as a template, simply load the desired dataset(s) to replace the default dataset(s) saved with the algorithm to apply the same processing to the new dataset(s). You may also need to adjust the transforms (color mapping) for the new datasets.

Any algorithm can be used as a template, and ER Mapper also provides many template algorithms for common tasks. These include common display techniques (pseudocolor, colordrape, etc.), writing processed image files to disk, and saving algorithms as “Virtual Datasets.”

The Algorithm dialog

The **Algorithm** dialog is a special dialog box that serves as your “command center” for creating and editing algorithms in ER Mapper. To open the **Algorithm** dialog, you can select **Algorithm...** from the **View** menu or click the **Edit Algorithm**  toolbar button. The key components of the **Algorithm** dialog are labelled in the diagram below and described in the table that follows.



Data structure diagram Shows a list of surfaces and layers contained in the current algorithm using a hierarchy or “tree” structure. Select (click on) a surface or layer to change its options using the Tab pages.

Surface A group of raster and/or vector data layers that combine to create a view or image. Algorithms can have multiple surfaces that become independent entities when viewed in 3D mode.

Layers Components of a surface that contain data used to construct an image. Different layer types can contain raster or vector data, and processing for each overlay is controlled independently from the others.

View Mode Sets the manner in which data is displayed as two dimensions (2D) or three dimensions (3D).

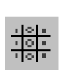
Tab pages Display categories of options for controlling the image display and processing techniques, such as Layer for options for current layer, or Surface for options that apply to an entire surface.

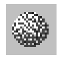
Process diagram Used to control the processing operations applied to dataset(s) in the currently selected layer (displayed when Layer tab is selected).

The Process Diagram

When the Layer tab is selected, the horizontal row of buttons in the right-hand panel of the **Algorithm** dialog are called the *process diagram*. They are used to define your image processing operations for the currently selected data layer. Each button in the diagram controls a specific image processing function.

As the arrows indicate, the processing stream flows from left to right. Typically, you may specify an image to be used, the bands within the image to be processed, then apply processing using formulae, filters, transforms or other options to create your desired image. ER Mapper compiles all the processing steps you specified and renders the resulting image to the screen display. The name and function of the main processing stream buttons are as follows.

Button	Function
Dataset 	Use to load an image from disk, or edit or view information or comments about an image.
Band Selection 	Use to select one or more bands in the image for use in generating an image (a drop-down list).
Formula 	Use to enter, load, or save a formula to perform image algebra and other arithmetic operations.
Filter 	Use to add or delete one or more spatial filters. (There are both pre- and post-formula Filter buttons.)

Button	Function
Transform 	Use to adjust image contrast and brightness. (There are both pre- and post-formula Transform buttons.)
Sunshade 	Use to specify artificial illumination of the image to create shaded relief effects.

Note: A cross or “X” through the button indicates that the function is not active in the current data layer. In addition, there are other buttons for some layer types that you will learn about later in this manual.

Hands-on exercises

These exercises show you how to initially display an dataset, use transforms to control color mapping, and save and reload a simple image processing algorithm.

Note: These exercises briefly introduce concepts and procedures that are explained in more detail later in this workbook.

What you will learn...

After completing these exercises, you will know how to perform the following tasks in ER Mapper:

- Load a new dataset for display and processing
- Change the color lookup table used to display the image
- View different bands or layers of data in a dataset
- Use transforms to adjust the image contrast and color mapping
- Add text labels and comments to an algorithm
- Save the processing algorithm to disk
- Reload and view the saved algorithm
- View the algorithm in 3D perspective

Before you begin...

Before beginning these exercises, make sure all ER Mapper image windows are closed. Only the ER Mapper main menu should be open on the screen.

1: Loading and displaying images

Objectives Learn to open an image window and the **Algorithm** window, load a raster dataset, and display the dataset on-screen. You will also learn to change the contrast (color mapping) of the image.

(Part 1 shows you how to load a sample dataset from disk and display it on-screen. The sample dataset was previously imported from a magnetic tape or other media and now resides on the computer's hard disk. Available import formats and details on importing data are discussed in the ER Mapper manual set.)

Open an image window and the Algorithm window

1 From the **View** menu, select **Algorithm...**.

A new empty image window opens in the upper-left corner of the screen, and the **Algorithm** dialog box opens.

Note that the **Algorithm** dialog shows one Pseudocolor layer (labelled “Pseudo Layer”) in the left-hand panel, and a process diagram for that layer in the right-hand panel. The words “No Dataset” above the process diagram indicate that no dataset is currently loaded into the layer.

Note: If you open the Algorithm window when no image windows are currently open (as in this case), ER Mapper opens an empty image window for you automatically. This shortcut saves you the step of opening a window.

Load a raster dataset into the Pseudocolor layer

1 In the **Algorithm** dialog, click the **Load Dataset**  button.

The **Raster Dataset** file chooser dialog box appears.

2 From the **Directories** menu, select the path ending with **\examples**.

The scrolling list in the center now shows a list of directories containing example images supplied with ER Mapper (such as 'Application...' and others).

3 Double-click on the directory named 'Shared_Data.'

A list of raster images is displayed. Note that each has a ".ers" file extension. This is the file extension associated with raster files in ER Mapper format.

4 Double-click on the dataset named 'Newcastle_Radiometrics.ers' to load it (scroll down to view if needed).

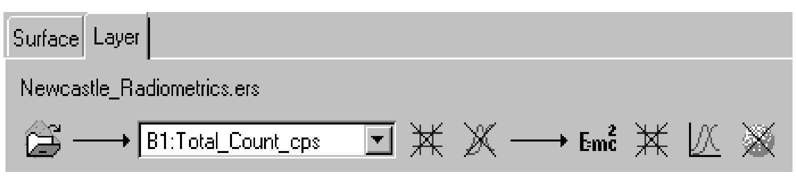
The file chooser dialog box closes, and the dataset is loaded into the Pseudocolor layer. Note that the dataset name ('Newcastle_Radiometrics.ers') now appears above the process diagram.

The image initially displays as red in the image window–*this is expected* since the range of data values in this dataset is different than the default range ER Mapper initially uses for display. (All data is mapped to the color red.) You will adjust this next.

Note: If the image does not appear red, click on the **Surface** tab, select **pseudocolor** from the 'Color Table' list, then click the **Layer** tab again.

Resize the Algorithm dialog to view all process stream icons

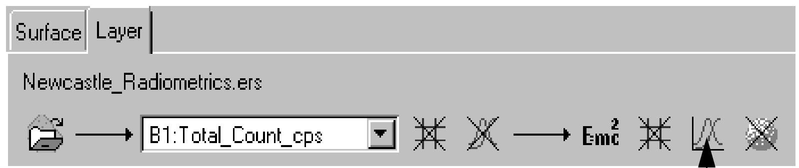
1 Drag one side of the **Algorithm** dialog to widen it until you can see all the option icons below in the process diagram:



Tip: When you resize or reposition a dialog box, ER Mapper automatically remembers this the next time you open it. This lets you setup your work environment as you like.

Adjust the contrast to use the entire range of colors

1 In the **Algorithm** dialog, click on the right-hand **Edit Transform Limits**  button (blue) in the process diagram.



Edit Transform Limits button

The **Transform** dialog box opens. Note that the field 'Actual Input Limits' at the bottom shows a data range of about 178 to 2922. This is the actual range of total count values in the radiometrics dataset. You need to tell ER Mapper to map the colors in the lookup table to *this* range instead of the default 0 to 255 range currently shown on the X-axis below.

2 Drag the **Transform** dialog under the image window (so the two dialogs and window do not overlap).

3 From the **Limits** menu (on the **Transform** dialog), select **Limits to Actual**.

The X axis data range changes to match the Actual Input Limits.

ER Mapper renders the image again, this time using the full range of colors to display the image. This dataset shows total count radiometrics values, so low values are shown as blues transitioning through cyan-green-yellow-orange to red for the highest values.

(This dataset is from the Newcastle area of Australia and also contains bands for Potassium, Uranium and Thorium measurements you will view later. Radiometrics data measures the total radioactivity of specific elements in the the upper 1-2 meters of rock over an area. Radiometrics data can be useful for near surface geological and soil mapping.)

In addition, a histogram showing the relative frequency of data values for the dataset appears in the center of the **Transform** dialog.

Note: After loading and displaying a geophysical dataset, you should **always** perform step 3 to match the input data range used for the transform to the actual range of values in the dataset. (There are automated toolbar functions that make this easier, and you will learn about them later.)

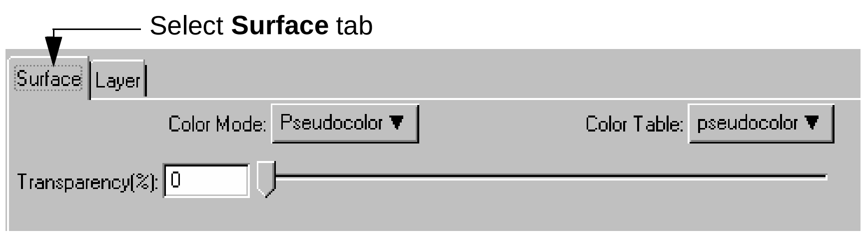
2: Changing color tables and dataset bands

Objectives Learn to display an image in color, change the color lookup table (LUT) used to display the image, and view different bands in a dataset.

Change the color table to view the image in greyscale

When you are using the Color Mode named Pseudocolor (as you are in this example), the color lookup table controls the set of colors ER Mapper uses to display the image. Each lookup table contains a set of 255 colors that ER Mapper uses to display the image on-screen.

1 In the **Algorithm** dialog, select the **Surface** tab.



Options for Color Mode, Color Table, and Transparency now appear in the panel.

Color Mode is set to "Pseudocolor" meaning that a color lookup table (LUT) is used to control the image colors. The current color table is named "pseudocolor" (because it is the default color set), and it's set of colors is shown in the color bar on the left side of the **Transform** dialog.

2 Click on the **Color Table** drop-down list button.

A menu listing available color lookup tables appears.

3 Click on the color table named **greyscale**.

ER Mapper renders the image using the greyscale color range (dark greys correspond to low total count values and light greys to high values).

Tip: Notice that when you change the color lookup table, the new set of colors is also shown in the Y-axis color bar on the **Transform** dialog box.

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4 From the **Color Table** drop-down list, select **rainbow1**.

This lookup table has colors similar to 'pseudocolor,' but also adds magenta at the low end and white at the high end.

5 From the **Color Table** list, select **red_blue**.

ER Mapper renders the image using a lookup table that contains only the colors red (for low values) transitioning into blues for high values.

6 From the **Color Table** list, select **pseudocolor** again.

7 In the **Algorithm** dialog, select the **Layer** tab again.

The process diagram is now displayed in the right-hand panel.

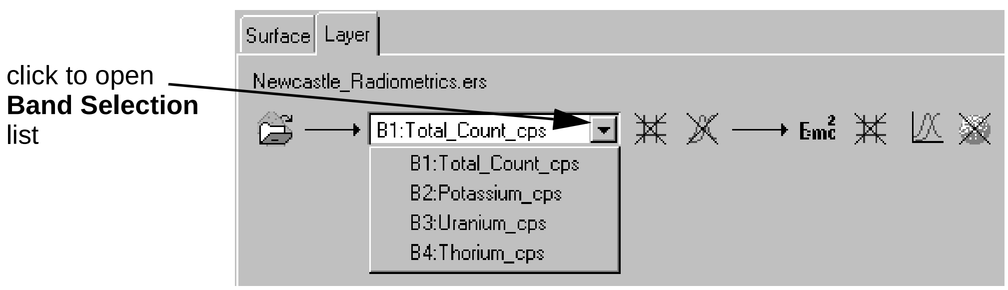
Display the Potassium band and adjust color mapping

Geophysical datasets (and other types of data) sometimes contain multiple layers or "bands" of data. This dataset, for example, contains four bands: Total_Count, Potassium, Uranium and Thorium. You can choose to display any band (or a combination of bands) in a raster data layer.

1 In the **Algorithm** dialog, click on the **Band Selection** 

drop-down list in the process stream diagram.

A menu listing the four different bands in the radiometrics dataset displays.



2 Click on the band labelled **B2:Potassium_cps**.

The menu closes and the new band appears in the **Band Selection** list button.

ER Mapper renders band 2 of the radiometrics dataset (Potassium) in the image window. The image appears only in shades of blue because the range of Potassium values is different than the previous range of Total Count values. (You can see this in the Actual Input Limits field on the Transform dialog box.)

3 On the **Transform** dialog box, select **Limits to Actual** from the **Limits** menu.

The X axis data range changes to match the Actual Input Limits (-12.8 to 502).

ER Mapper renders the image again, this time using the full range of colors to display the Potassium image.

Note: Since the range of data values is nearly always different for each band of geophysical datasets, you must usually select **Limits to Actual** as shown here to adjust the color mapping. (Typically you select the new band, determine the new data range, and select **Limits to Actual**.)

Display the Uranium band and adjust color mapping

1 In the **Algorithm** dialog, select **B3:Uranium_cps** from the **Band Selection** drop-down list.

ER Mapper renders band 3 of the radiometrics dataset (Uranium) in the image window. You must again adjust the transform color mapping to use the full range of display colors.

2 From the **Limits** menu (on the **Transform** dialog), select **Limits to Actual**.

The X axis data range changes to match the Actual Input Limits (-0.05 to 145).

ER Mapper renders the Uranium data again using the full range of colors.

Display the Thorium band

1 In the **Algorithm** dialog, select **B4:Thorium_cps** from the **Band Selection** drop-down list.

ER Mapper renders band 4 (Thorium) in the image window.

2 From the **Limits** menu (on the **Transform** dialog), select **Limits to Actual**.

The X axis data range changes to match the Actual Input Limits (8 to 397).

ER Mapper renders the Thorium data again using the full range of colors.

Display the Total Count band again

1 In the **Algorithm** dialog, select **B1:Total_Count_cps** from the **Band Selection** drop-down list.

2 From the **Limits** menu (on the **Transform** dialog), select **Limits to Actual**.

ER Mapper renders the Total Count data again using the full range of colors.

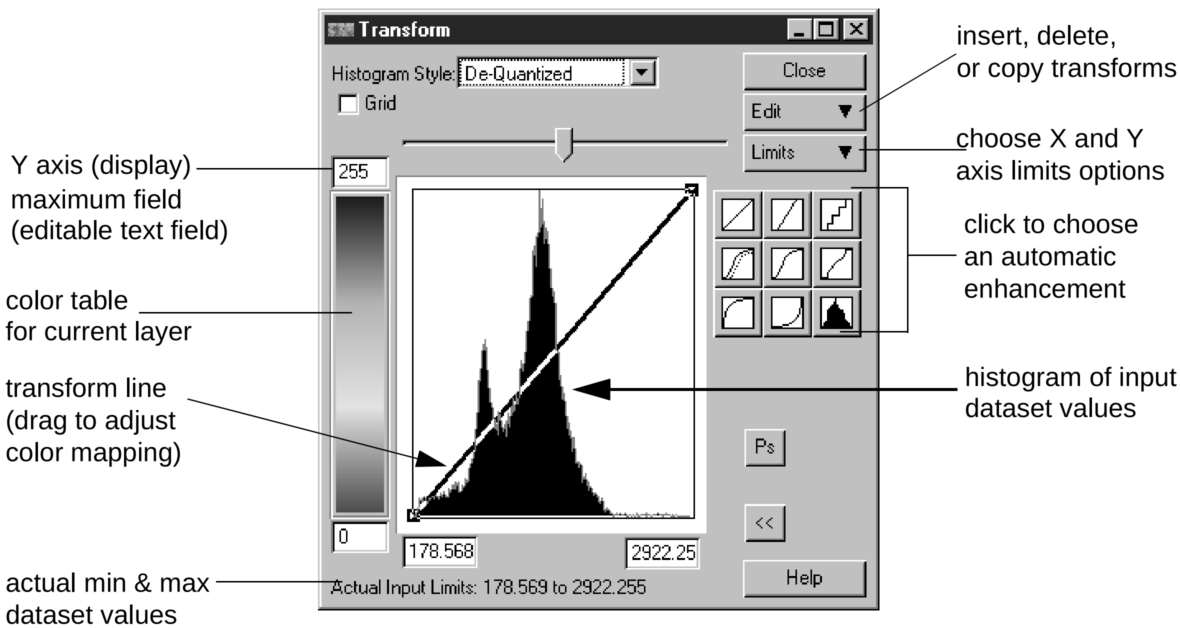
3: Modifying color mapping transforms

Objectives Learn to manually adjust color mapping by moving the transform line, and use automatic transform options. ER Mapper provides many features to let you create the best contrast between colors to aid analysis of your data.

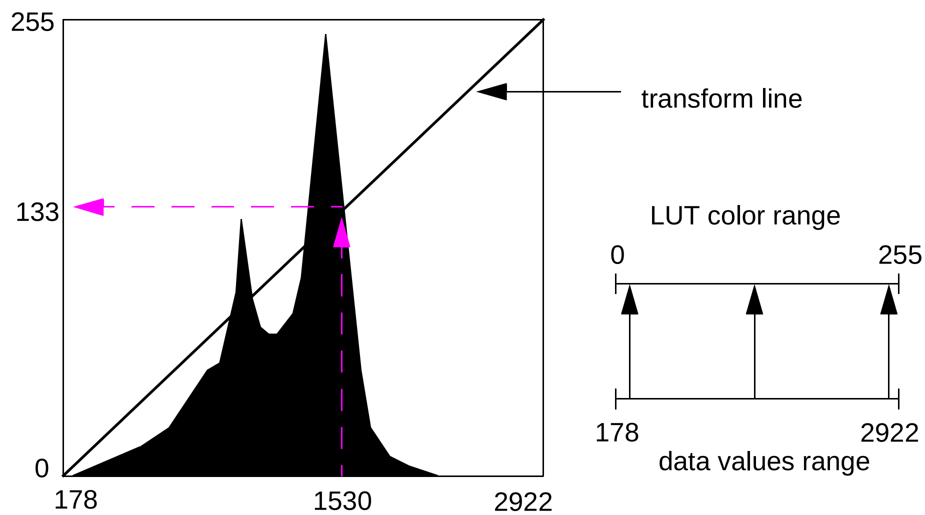
Manually adjust the image contrast (color mapping)

1 Examine the contents of the **Transform** dialog box.

This dialog box lets you control how ranges of data values are mapped to display colors on the screen. The transform line controls how data values are mapped to display colors, and the color bar along the Y axis shows the colors contained in the current color table (‘pseudocolor’ in this case).



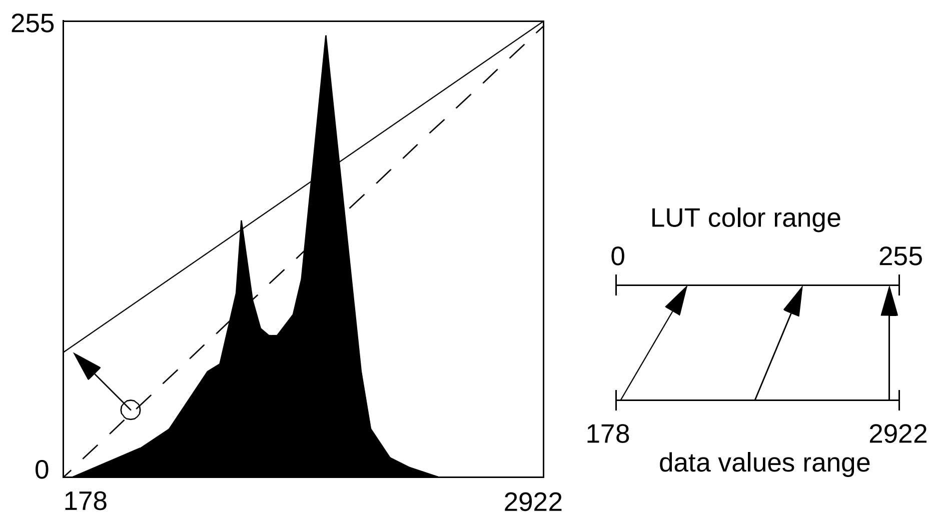
Up until now, you have displayed the dataset using a simple linear transform (shown above), where a straight 45 degree line defines a linear mapping between data values and display colors. For example, the data value 1530 on the X axis is mapped to color number 133 (light green) in the ‘pseudocolor’ lookup table:



2 Move the mouse pointer into the area containing the histogram.

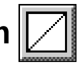
The X-Y location of the current pointer position is shown in the upper-left part of the **Transform** dialog (under 'Histogram Style'). The X value is the total count value from the radiometrics dataset, and the Y value is the position in the set of lookup table colors (ranging from 0-255).

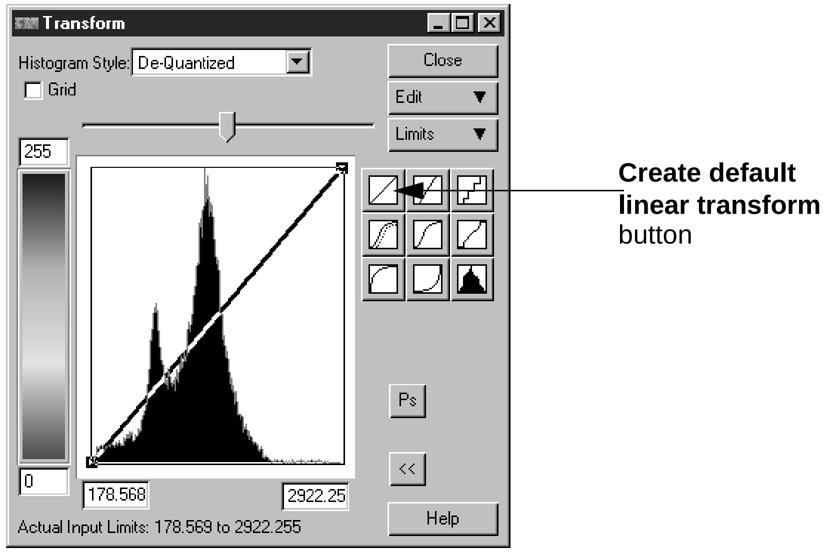
3 Drag the transform line up along the Y axis to exclude the blues from the image display (see diagram below).



ER Mapper updates the color mapping interactively, so the lower colors in the lookup table (blues) are no longer used to display the image. (Only colors about 80-255 are used to display the image, or cyan-green-yellow-red in this case).

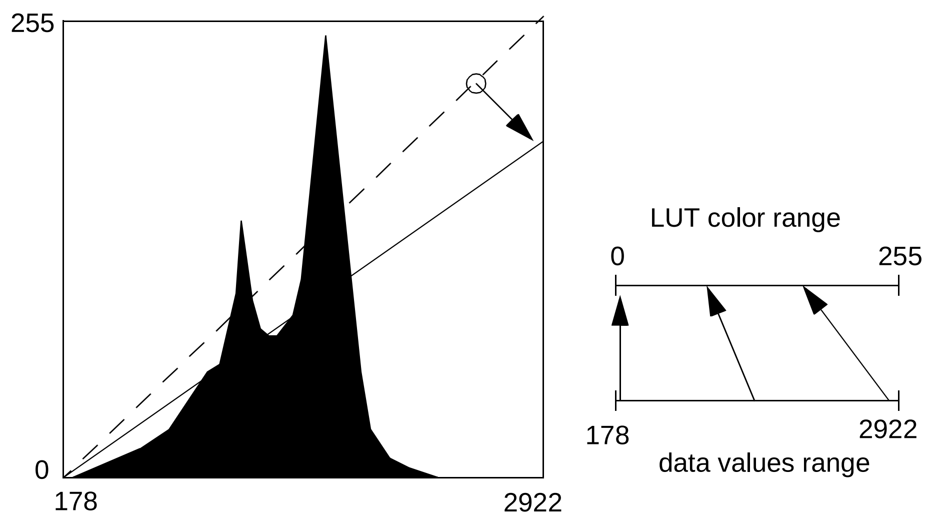
Notice also that a second grey outline histogram appears–this is the *output histogram* showing how data values are distributed *after* being transformed (or the distribution of colors in the image).

4 On the **Transform** dialog, click the **Create default linear transform**  button (upper-left of the nine buttons together).

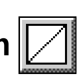


ER Mapper resets the transform line back to a straight linear default and the image colors update interactively.

5 Drag the transform line down along the right-hand Y axis to exclude the reds from the image display (see diagram below).



Now higher colors in the lookup table (reds) are no longer used to display the image. (Only colors about 0-200 are used to display the image, or blue-cyan-green-yellow in this case).

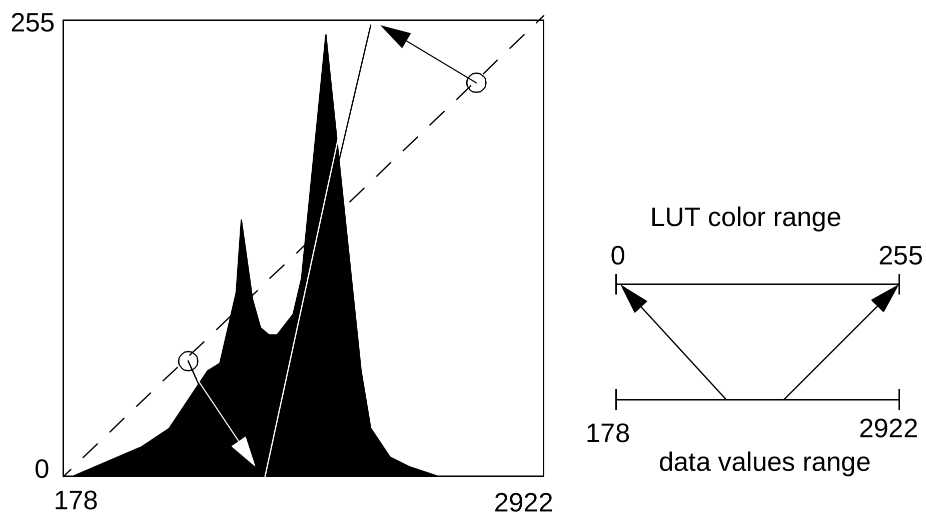
6 On the **Transform** dialog, click the **Create default linear transform**  button again.

ER Mapper resets the transform line back to a straight linear default.

Highlight a range of values in the dataset

By adjusting the transform line, you can map any range of data values to any desired range of colors, for example to maximize color contrast in a specific range or feature in your histogram.

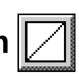
1 Drag the transform line at two points to map the central peak of data values in the histogram to all the display colors (see diagram below).



Now all colors are used to display only the total count values from about 1000 to 2000 cps. Values less than 1000 are all mapped to blue, and values greater than 2000 are all mapped to red.

Note: This technique is called *histogram clipping*. Although it causes loss of detail in lower and/or higher ranges of values, it can be effective for maximizing contrast and detail in specific data ranges of interest as shown here.

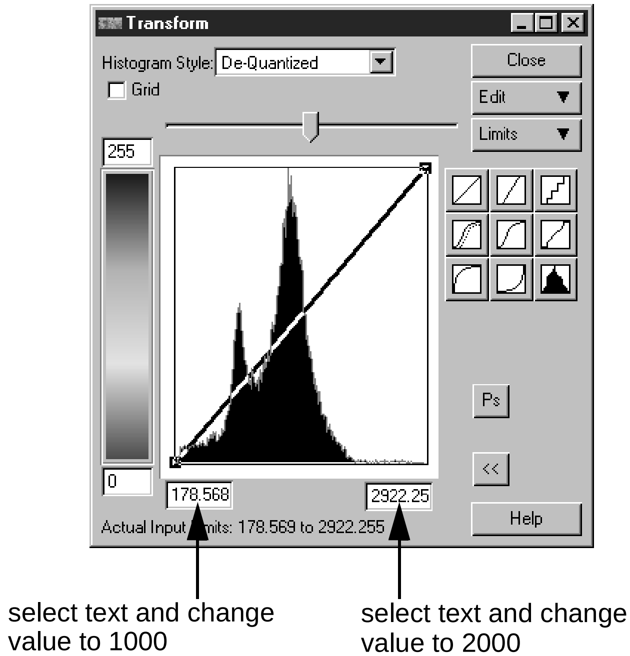
---

2 On the **Transform** dialog, click the **Create default linear transform**  button again.

Set exact input limits to highlight a specific data range

The text boxes next to the X and Y axes of the histogram window can be edited to change the minimum and maximum values. This offers another way to display exact ranges of data or use only specific colors for the image display.

1 Select the text in the X axis minimum text box (currently about 178), and enter a value of **1000**.



2 Select the text in the X axis maximum text box (currently about 2922), and enter a value of **2000**.

Again, all colors are used to display only the data range from 1000 to 2000 cps. Values less than 1000 are all mapped to blue, and values greater than 2000 are all mapped to red. The histogram you see is only for the data values between 1000 and 2000.

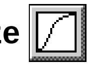
This is another method to map a specific range of data to the entire display range. In this case, you are choosing to display only a specific data range, rather than moving the transform line to accomplish this task as you did earlier.

3 From the **Limits** menu (on the **Transform** dialog), select **Limits to Actual**.

The X axis data range changes back to match the Actual Input Limits (so all data values will again be displayed).

ER Mapper renders the full image again with the default linear color mapping.

Apply a Histogram equalize transform to the data

1 On the **Transform** dialog, click the **Histogram equalize**  button..

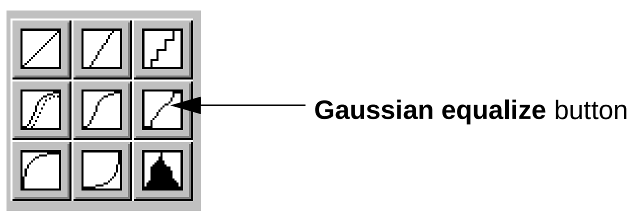
Tip: Pass the mouse over the buttons to see their names and functions.

ER Mapper creates a complex piecewise linear transform line and updates the image. Contrast is maximized in the range of mid-level values, and detail is slightly obscured in the highs and lows.

Histogram equalization (also called uniform distribution stretching) automatically adjusts the transform line so that image values are assigned to display levels based on their frequency of occurrence. More display values are assigned to the most frequently occurring portion of the histogram, so the greatest contrast enhancement occurs in the data range with the most values (peaks in the histogram). Histogram equalization usually creates an image with very strong contrast. In some cases, it can also saturate areas which can obscure detail.

Apply a Gaussian equalize transform to the data

1 On the **Transform** dialog, click the **Gaussian equalize**  button.



ER Mapper creates a complex piecewise linear transform line (sometimes with slight stair steps) and updates the image.

Gaussian equalization automatically adjusts the transform line so that image values are assigned as needed to make the output (display) values occur with a Gaussian distribution. A Gaussian, or “normal” distribution, is characterized as producing a bell-shaped histogram (shown in the output histogram).

Gaussian equalization is useful when data is skewed in such a way that features could be abnormally saturated if stretched linearly. This technique tends to bring out more detail in areas with less frequently occurring data values so it is good for emphasizing subtle features. (In this case it emphasizes the detail in the highs and lows of the data range, and suppresses detail in the mid-range).

Tip: You can set the number of standard deviations used for the Gaussian equalize function by double-clicking on the button. Smaller values produce more contrast and higher values less contrast. The default is 3 standard deviations.

---

2 On the **Transform** dialog, click the **Create default linear transform** button.

ER Mapper resets the transform line back to the straight linear default.

Tip: Other types of transforms can also be useful for displaying geophysical data. **Logarithmic** and **Exponential** transforms create a smooth curve transform line that can be useful for highlighting subtle features. The **Level-Slice** transform creates a “stepped” transform line that displays the data using contours of solid color instead of transitional color gradations.

Zoom in to view the data range within a specific area

It is sometimes helpful to view the range of values in a specific area of the image. You can easily do this by zooming in on the area.

1 If needed, click the **Zoom Box Tool** button on the main menu.

This tells ER Mapper to use the mouse pointer for zooming and panning functions.

2 Inside the image window, drag a box to zoom in on an area of interest.

ER Mapper zooms into area.

3 Examine the ‘Actual Input Limits’ fields on the **Transform** dialog.

The ‘Actual Input Limits’ fields have changed to show the range of data *only within the zoomed area* currently displayed in the image window.

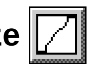
4 Click in the image window to pan the image to an adjacent area.

The ‘Actual Input Limits’ fields update again to show the new range. Zooming into areas of interest and examining the Actual Input Limits is a fast way to view the range of values in different parts of an image.

Zoom back out to view the full image extents

1. From the **View** menu, select **Quick Zoom** and then select **Zoom to All Datasets**.

   ER Mapper zooms back out to display the full extents of the radiometrics dataset. (You could also do this by right-clicking in the image window.)

2. On the **Transform** dialog, click the **Gaussian equalize**  button.

   ER Mapper applies a Gaussian Equalization enhancement to the data.

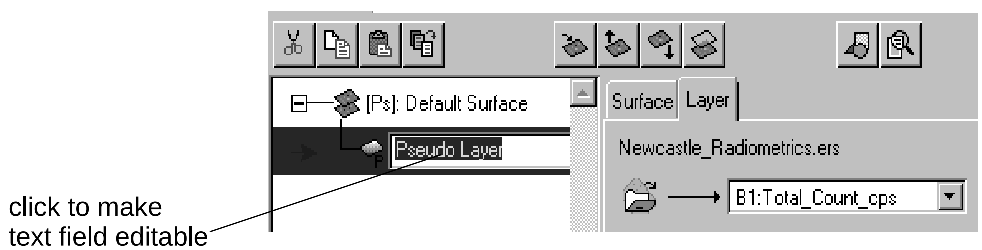
3. Click **Close** on the **Transform** dialog to close it.

4: Labelling and saving the algorithm

Objectives Learn to specify description labels, titles, and comments for an algorithm, and save the algorithm processing steps to a file on disk for later use.

Enter a description for the Pseudocolor layer

1. In the **Algorithm** dialog, click on the text 'Pseudo Layer' in the left-hand panel.



   the text becomes reverse highlighted (shown above) indicating the text is editable..

2. Type **`total count`** in the field. Then press the Enter or Return key on the keyboard.

   This text now becomes a visual description for the layer.

Enter a description for the entire algorithm

1. In the **Algorithm** dialog, select the text in the **Description** text field (it currently reads 'No Description').

   (To select the text, either drag through it, or triple-click to select the entire line.)

2. Type the following text, then press Enter or Return on your keyboard:

`Newcastle radiometrics total count`

This text now becomes a brief description for the entire algorithm.

Save the processing steps to an algorithm file on disk

1 From the **File** menu (on the main menu), select **Save As...**.

The **Save As...** file chooser dialog box appears.

2 In the Files of Type field, choose ‘ER Mapper Algorithm (.alg).

3 From the **Directories** menu, select the path ending with the text **\examples**.

4 Double-click on the directory named ‘miscellaneous\tutorial’ to open it.

5 In the **Save As:** text field, click to place the cursor, then type in a name for the algorithm file. Use your initials at the beginning, followed by the text ‘Newcastle_Radiometrics,’ and separate each word with an underscore (_). For example, if your initials are “JC,” type in the name:

`JC_Newcastle_Radiometrics`

(You will be asked to add your initials to all practice algorithm names to keep them separate from other students.)

6 Click the **Apply** button to save the algorithm and leave the dialog open.

Your pseudocolor algorithm is now saved to an algorithm file on disk.

Add comments to the algorithm

1 On the **Save As...** dialog, Click the **Comments...** button.

A dialog box appears titled with the file name, and a text area for you to type comments about your algorithm. The cursor is already active.

2 In the comments dialog, type the following information to describe your algorithm:

```
This algorithm displays radiometric total counts using the
‘pseudocolor’ lookup table. Low values are shown as blue
colors and high values as red colors. Gaussian equalization
contrast enhancement is used.
```

3 Click **OK** on the comments dialog to save your comments.

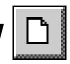
4 Click **Cancel** on the **Save...** dialog close it.

(If you accidentally click **OK**, click **Cancel** when asked to overwrite the file. Otherwise your comments will not be saved with the algorithm file.)

5: Reloading and viewing the algorithm

Objectives Learn to reload and display the algorithm you just created, and to view the text file on disk that defines the algorithm processing steps.

Open a second image window

1 On the main menu, click the **New**  button.

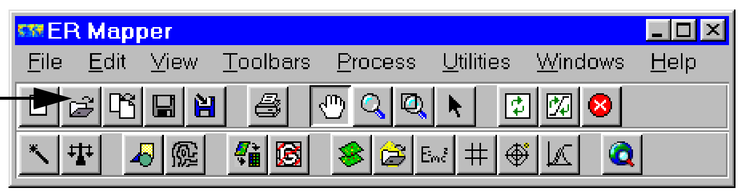
New button

ER Mapper opens a new image window (this is a shortcut for selecting **New** from the **File** menu). Drag the new window to the lower left part of the screen (so you can see all or part of the other image window).

Open the processing algorithm you created earlier

1 On the Standard toolbar, click on the **Open**  button.

Open button



The **Open** file chooser appears. (This is a shortcut for selecting **Open...** from the **File** menu.)

2 From the **Directories** menu, select the path ending with the text **\examples**.

3 Double-click on the ‘miscellaneous\tutorial’ directory to open it.

Your ‘Newcastle_Radiometrics’ algorithm name should appear in the list.

4 Click once on your algorithm name to highlight it (do not double-click).

5 Click the **Apply** button to load and process the algorithm without closing the **Open** dialog.

ER Mapper runs the algorithm and displays the processed radiometrics dataset in the image window. It looks identical to the other image since they both use the same algorithm and dataset.

View the algorithm comments

1 On the **Open** dialog, click the **Comments...** button.

The dialog box opens showing the comments you entered for your algorithm. These comments can be very helpful to others who use or display your algorithm, and they are a good way to document the procedures you used to create it.

2 Click **Cancel** to on the comments dialog box to close it.

3 Click **Cancel** to on the **Open** dialog box to close it.

6: Viewing the image in 3D perspective

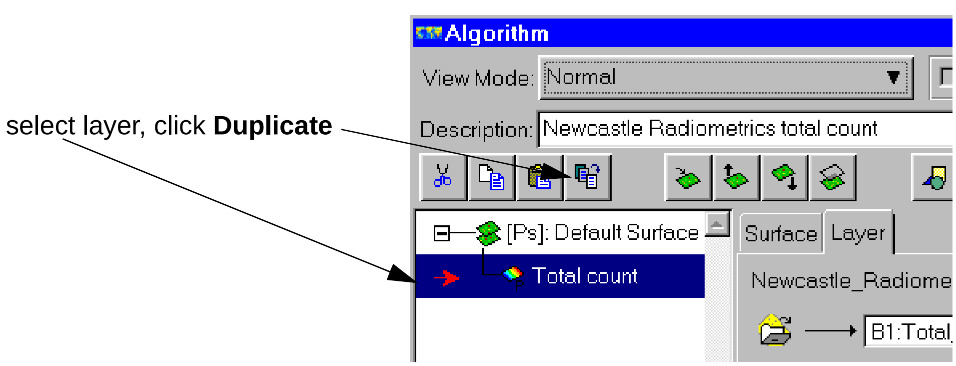
Objectives Learn to modify the algorithm you just created to view the image in 3D perspective.

About 3D perspective viewing

Up until now you have viewed your images using conventional 2D planimetric views. ER Mapper makes it very easy to view images in 3D perspective by simply adding a height (or elevation) component to your algorithm. The following is a very simple introduction to the 3D viewing features, and you will learn more about them in later chapters.

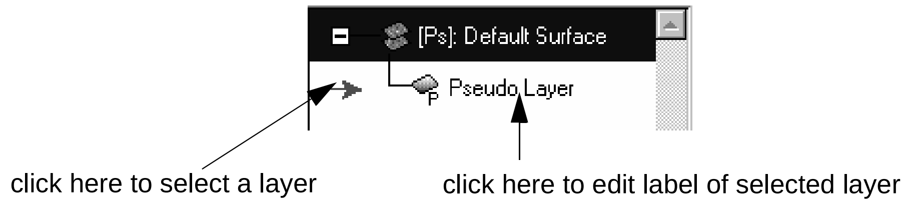
Duplicate (copy) the Pseudo layer of the algorithm

1 On the **Algorithm** dialog, click once on the layer 'total count' to select it, then click the **Duplicate**  button.



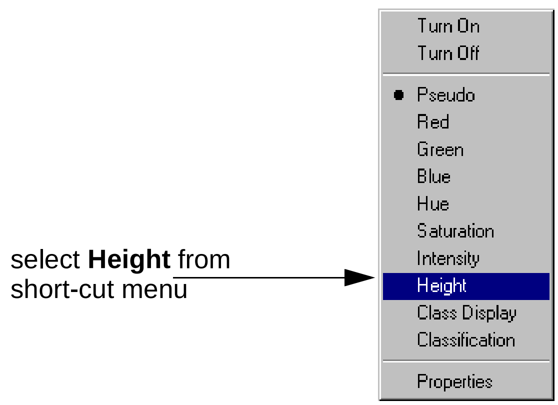
ER Mapper makes an exact copy of the layer below the original. (For example, this layer contains the same dataset and transform as the original.)

Tip: To *select* a layer, click once on the left side. To change the layer's text label, select it first (if needed), then click once on the text label to make it editable.



Change the copied layer to a Height layer

1 Point to the copied (lower) layer, click the right mouse button, and select **Height** from the short-cut menu:



The Pseudo layer changes to a Height layer. Note that the layer is currently crossed out–this indicates that it is not active until you switch to 3D perspective View Mode.

You have now duplicated the radiometrics total count layer and changed the layer type to create a elevation component for your algorithm. Your algorithm now contains two types of layers (Pseudo and Height), shown in the layer list on the **Algorithm** dialog.

Select 3D perspective View Mode to view the image in 3D

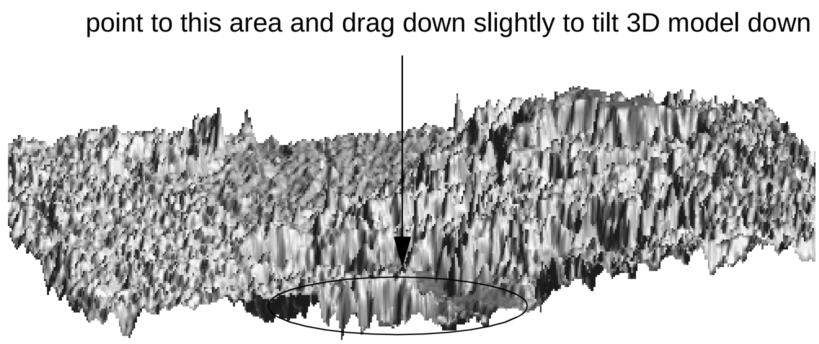
1 From the **View Mode** menu (on the **Algorithm** dialog), select **3D perspective**.

ER Mapper displays a message that the image is being processed, then displays a 3D perspective view of the image in color. The message “Regenerating Terrain” appears in the image window as ER Mapper performs iterations to increase the resolution (detail) in the 3D image.

This 3D image uses color to denote magnitude of the radiometric total count values, and also uses the total count data as the height (elevation) component. Therefore, peaks in the 3D surface are high values, and valleys are low values. The right-hand panel in the **Algorithm** dialog now has two additional tabs–**3D View** and **3D Properties**. These contain controls specifically for 3D viewing of images.

Change the perspective viewing angle

1 Point to the lower part of the 3D image (the cursor changes to a hand), and drag down slightly to tilt the 3D view (see following diagram).



The 3D image tilts downward, so you are now looking more from an overhead viewpoint. You can use the mouse to manipulate the viewpoint, zoom in and out, rotate the image, and other controls (to be discussed later).

This a simple 3D algorithm that contains only one surface (radiometrics in this case). You can also build algorithms that let you view and manipulate multiple surfaces simultaneously.

Select Normal Mode to view the image in 2D again

1 From the **View Mode** menu, select **Normal**.

ER Mapper redisplays the image in a two-dimensional planimetric view again.

Note: This 3D exercise was a simple introduction to show how easy it can be to view data in 3D perspective in ER Mapper. You will learn more about the 3D capabilities and controls later.

Close both image windows and the Algorithm dialog

1 Close one image window using the window system controls:

- For Windows, click the ☒ **Close** button in the upper-right window corner.

2 Close the other image window by repeating Step 1.

3 On the **Algorithm** dialog, click the **Close** button to it.

Only the ER Mapper main menu is now open on the screen.

What you learned...

After completing these exercises, you know how to perform the following tasks in ER Mapper:

- Load a new dataset for display and processing
- Change the color lookup table used to display the image
- View different bands or layers of data in a dataset
- Use transforms to adjust the image contrast and color mapping
- Add text labels and comments to an algorithm
- Save the processing algorithm to disk
- Reload and view the saved algorithm
- View the algorithm in 3D perspective

4

Colordrape algorithms

This chapter explains how to apply shaded relief effects to a dataset and create "colordrape" algorithms that combine color information with intensity (brightness) information. Shading and colordraping are two of the most powerful techniques for presentation and analysis of geophysical datasets.

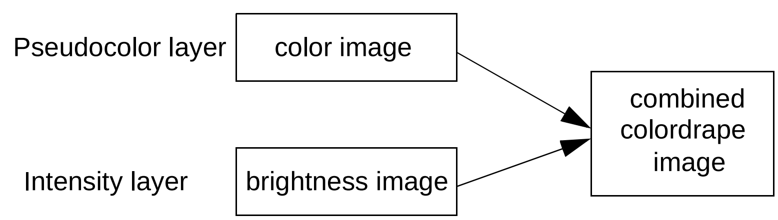
About colordraping

The term *colordraping* refers to the technique of draping one set of image data in color over another set of data that controls the color brightness or intensity. This allows you to effectively view two (or more) different types of data or methods of processing simultaneously in a *combined display.* Colordraping is usually difficult and time consuming using traditional image processing products, but ER Mapper makes it very fast and interactive by providing the special Intensity layer type.

The colordraping technique has become a very popular and powerful tool for visualization of geophysical datasets. For example, a magnetics dataset shown as both color and as structure lets you create a shaded relief image that enhances subtle structural trends and gradients while also showing absolute values as various colors. You can also combine different types of data, for example shade the magnetics data to highlight structures, then drape radiometrics data in color to highlights associations between the two datasets. From these types of combined images, far more useful information can be derived than from conventional visualization techniques.

The Intensity Layer Type

ER Mapper provides a special type of layer named Intensity that is the key to the colordraping technique. When you add an Intensity layer to an algorithm, the *brightness* (or intensity) of the image colors are automatically controlled by the data loaded into the Intensity layer. Low data values in the Intensity layer produce dark colors in the image, and high data values produce bright colors.



The diagram above shows how algorithm Pseudocolor and Intensity layers are combined to create a single colordrape image. You will see for yourself how these techniques work in the following exercises.

Hands-on exercises

These exercises give you practice creating colordrape algorithms to display aeromagnetics as both shaded relief and color. You will also learn to drape data such as radiometrics over a shaded relief image to enhance analysis.

What you will learn...

After completing these exercises, you will know how to perform the following tasks in ER Mapper:

- Use Intensity layers to create shaded relief images that highlight structure
- Combine Pseudocolor and Intensity layers to create colordrape images
- Control the color and intensity components to modify image displays
- Add new layers to display other datasets in the same algorithm
- Turn layers on (to process them) and off (to ignore them)
- Collapse/expand the data structure diagram and change layer priority

Before you begin...

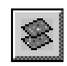
Before beginning these exercises, make sure all ER Mapper image windows are closed. Only the ER Mapper main menu should be open on the screen.

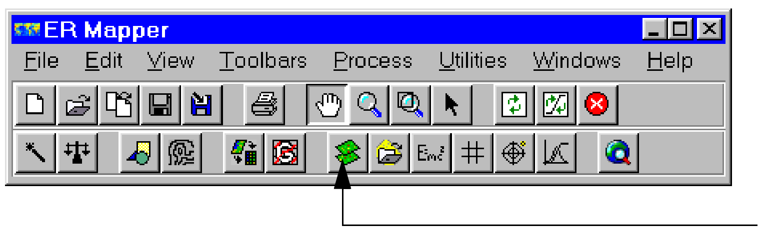
Note: Some of the following exercises repeat steps from the previous exercise to emphasize understanding of the fundamental concepts.

1: Using shading to highlight structure

Objectives Learn how to display a magnetics dataset in an Intensity layer and apply sun angle shading to create shaded relief effects to highlight subtle trends and geological structures.

Open an image window and the Algorithm dialog

1 On the main menu, click the **Edit Algorithm**  button.

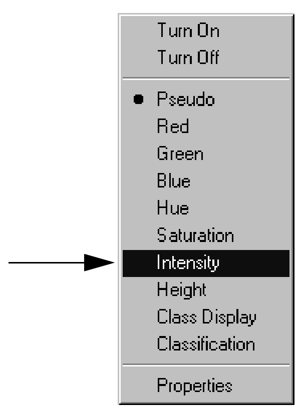


Edit Algorithm button

An image window and the **Algorithm** dialog open. (This is a shortcut for selecting **Algorithm** from the **View** menu.)

2 Point to the layer labelled "Pseudo Layer", click the right mouse button, and select **Intensity** from the short-cut menu:

select **Intensity** from short-cut menu

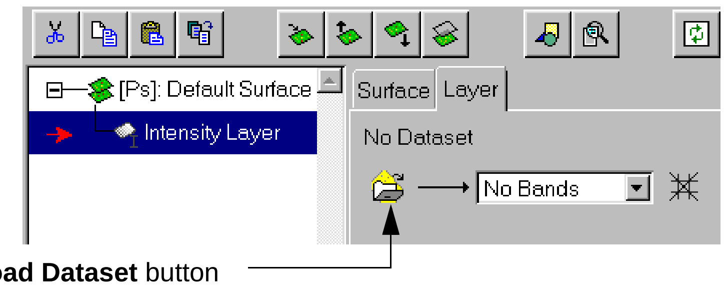


The Pseudo layer changes to an Intensity layer and ER Mapper sets the layer description to "Intensity Layer."

Tip: Right-clicking any layer opens the short-cut menu that lets you quickly change the layer’s type, and turn it on or off.

Load a sample magnetics dataset into the Intensity layer

1 In the **Algorithm** dialog, click the **Load Dataset**  button in the process diagram (be sure the **Layer** tab is selected first).



The **Raster Dataset** file chooser dialog box appears.

2 From the **Directories** menu, select the path ending with **\examples**.

3 Double-click on the directory named ‘Shared_Data’

A list of raster datasets and algorithms is displayed.

4 Scroll down to view the dataset named ‘Newcastle_Magnetics.ers,’ then double-click on it to load it.

The dataset is loaded into the Intensity layer.

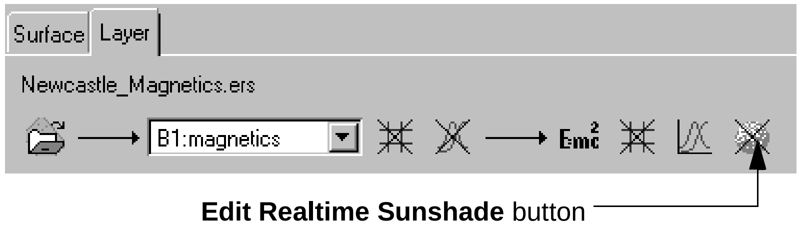
A greyscale image of aeromagnetics dataset from the Newcastle area of Australia displays. This dataset covers approximately the same area as the radiometrics dataset you used earlier.

Magnetics datasets measure the strength of the magnetic field over an area, and is usually measured in terms of total magnetic intensity (TMI) in units of nanoteslas. Variations in the magnetic composition of rocks produce variations in the magnetic field, which can be interpreted in terms of geology to aid subsurface geological mapping to depths of several kilometers.

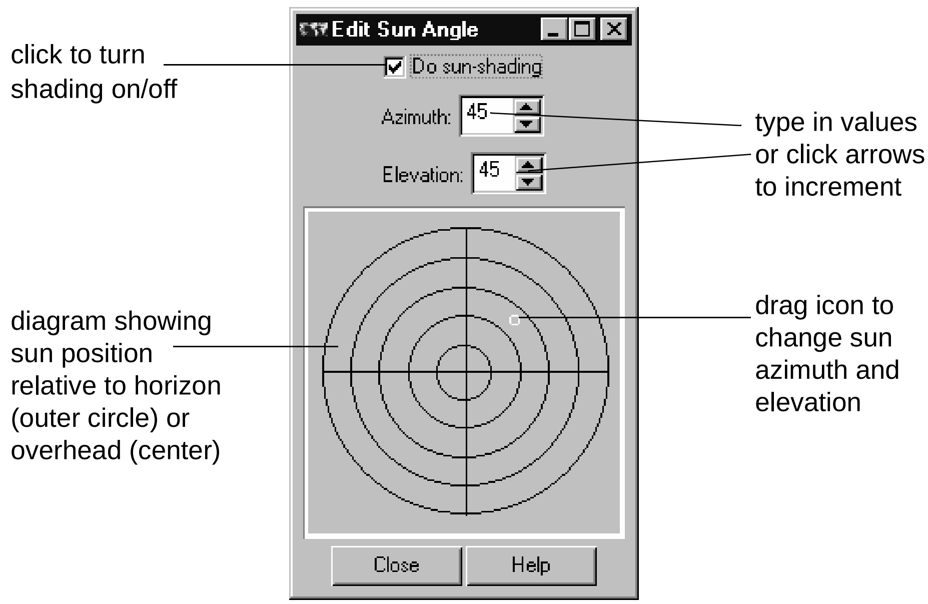
Note: This sample dataset has been rescaled into an 8-bit (0-255) data range. (The data values are therefore not actual TMI values.) When using your own datasets, you will typically need to adjust the color mapping using the **Limits to Actual** option on the **Transform** dialog.

Turn on sun shading and display the shaded relief image

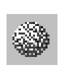
1 On the **Algorithm** dialog, click the **Edit Realtime Sunshade**  button in the process diagram.



The **Edit Sun Angle** dialog box opens to let you specify shaded relief effects for the Intensity layer.



2 Turn on the **Do sun-shading** option.

Also notice that the **Edit Realtime Sunshade** icon in the process diagram is now a yellow sun  to indicate that shading is active for the Intensity layer.

Now the gradients and trends in the magnetics dataset are clearly defined due to the sun angle shading. This feature allows you to apply artificial illumination from any direction to highlight very subtle trends and features.

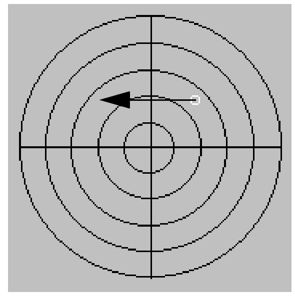
3 Make the image window larger by dragging lower-right corner of the window border.

4 Right-click on the image and select **Zoom to All Datasets** from the **Quick Zoom** menu.

ER Mapper redisplays the image to show more detail.

Change the sun azimuth

1 In the **Edit Sun Angle** dialog, drag the small sun icon (the circle) to the upper-left quadrant of the circular grid.



The shading angle of the image changes in real time to show the shading effect as if the sun were shining from the northwest.

The *azimuth* (compass direction) from which the sun shines highlights structural features normal to the sun angle. In this case, features trending in a northeast to southwest direction are now highlighted (since they are normal to the northwest sun angle).

2 Drag the sun icon to shade from different compass directions (azimuths).

Structural features normal to your new sun azimuths are highlighted. Sun angle shading is also useful for highlighting gridding artifacts in geophysical datasets.

Change the sun elevation

1 In the **Edit Sun Angle** dialog, drag the sun icon near the outer rim of the circular grid.

The image becomes darker overall and with larger areas of shadows.

The *elevation* from which the sun shines determines the length of shadows in the shaded relief image. In this case, the sun is shining from a very low sun angle (near the horizon), so you get longer shadows just as you would see right after sunrise or before sunset. Low sun angles can sometimes be useful for highlighting subtle trends in areas without strong gradients.

2 Drag the sun icon to the center of the circular grid.

Now the entire image has very little shadow, as if the sun is shining directly overhead during midday. This allows you to see terrain features without directional shadowing introduced by shading from a specific azimuth. (For example, you can see both sides of a structural boundary.)

3 Experiment by dragging the sun icon until you create an image that highlights structural features of interest. (Setting the sun elevation at 45 degrees or greater is usually recommended to reduce shadowing.)

Tip: The “best” shade angle for a dataset depends on the directional alignment of major features of interest. Typically positioning the sun normal to the features of interest produces good results. Real-time shading is also very useful for highlighting gridding artifacts in magnetics, radiometrics, and gravity datasets.

---

4 Click **Close** on the **Edit Sun Angle** dialog to close it.

2: Draping color on the image

Objectives Learn how to duplicate and modify the Intensity layer to create a Pseudocolor layer, and how to combine the two layers to create a colordrape image.

Duplicate the Intensity layer and change it to Pseudocolor

1 On the **Algorithm** dialog, select the Intensity layer (if needed), then click the **Duplicate** button.

ER Mapper creates a copy of the Intensity layer below the original.

2 Right-click on the new duplicate layer, and select **Pseudo**.

The Intensity layer changes to a Pseudo layer. You will use this layer to display the magnetics data in color over the shaded relief image.

Turn off sun shading for the Pseudo layer

1 With the Pseudo layer selected, click the yellow **Edit Realtime Sunshade** button in the process diagram.

The **Edit Sun Angle** dialog box opens. Since the layer was duplicated from the Intensity layer, sun angle shading is still turned on.

2 On the **Edit Sun Angle** dialog, turn off the **Do sun-shading** option.

Sun angle shading is now turned off, and the **Edit Realtime Sunshade** icon in the process diagram shows a cross through it to indicate this.

Note: Sun angle shading is usually applied only to Intensity layers, and not other layer types (such as Pseudo) that are designed to displayed color.

---

3 Click **Close** on the **Edit Sun Angle** dialog to close it.

Note that by combining the two processing techniques into one image, you can simultaneously see structure as brightness and geomagnetic field strength as color. In this case blues represent low values, and reds high values.

Tip: The colordrape technique you used here is one of the most important ER Mapper processing techniques used to visualize magnetics and other geophysical data. You should therefore practice and become comfortable with the steps used to create colordrape algorithms.

Try different color mapping transforms for the color layer

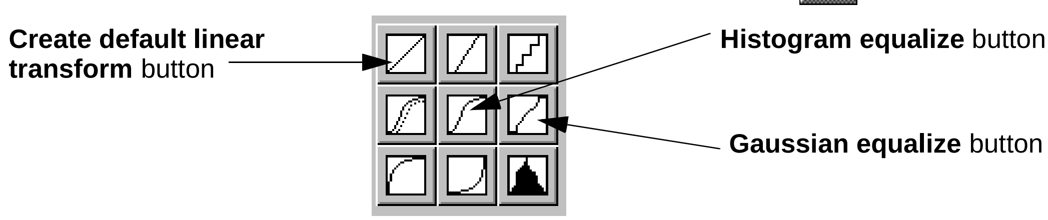
1 In the **Algorithm** dialog, select the Pseudo layer.

By selecting the Pseudo layer, you can now use the process diagram options in the right-hand panel to control it separately from the Intensity layer.

2 Click on the right-hand **Edit Transform Limits** button in the process diagram.

The **Transform** dialog opens showing the current color table and color mapping.

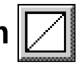
3 On the **Transform** dialog, click the **Histogram equalize** button.



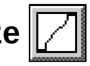
ER Mapper applies a histogram equalization transform to the data. Histogram equalization maximizes overall color contrast in the image.

Note: Notice that the color mapping changes without affecting the shaded relief image in the Intensity layer. This shows how layers in an algorithm are independent of each other, and can be modified individually to affect to overall image they combine to create.

---

4 On the **Transform** dialog, click the **Create default linear transform**  button.

ER Mapper resets the color mapping back to a straight linear default.

5 On the **Transform** dialog, click the **Gaussian equalize**  button.

ER Mapper applies a gaussian equalization contrast stretch to the data. This maximizes color contrast in the structural highs and lows, but tends to flatten out contrast in other parts of the image.

6 Click **Close** on the **Transform** dialog to close it.

Display the shaded relief and color images separately

1 Turn off the Pseudo layer by right-clicking the the layer and selecting **Turn Off** from the short-cut menu.

Only the structural component of the image displays since the color component of the algorithm (the Pseudo layer) is turned off.

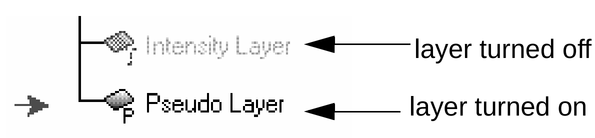
2 Turn the Pseudocolor layer on again (right-click and select **Turn On**).

3 Turn the Intensity layer off (right-click and select **Turn Off**).

By turning layers on and off, you can see them independently of each other to fine tune adjustments before adding them together again.

4 Turn the Intensity layer on again (right-click and select **Turn On**).

Note: When a layer is turned off, the the layer label becomes dim and the icon next to it changes to a question mark (?). If the layer is on, the icon displays a letter corresponding to the layer type, such as “P” for a Pseudo layer.



3: Draping radiometrics data in color

Objectives Learn how to add a second Pseudocolor layer to drape a different dataset (radiometrics in this case) as color over the shaded magnetics data. Also learn to use multiple Pseudocolor layers in the same algorithm.

Add a second Pseudocolor layer to the algorithm

1. Select the Pseudo layer in the layer list.
2. From the **Edit** menu (on the **Algorithm** dialog), select **Add Raster Layer**, then select **Pseudo**.

   ER Mapper adds a second Pseudo layer to the layer list. New added layers contain no dataset (shown by “No Dataset” above the process diagram).

Load the sample radiometrics dataset into the new layer

1. In the **Algorithm** dialog, click the **Load Dataset**  button on the left side of the process diagram.

   The **Raster Dataset** file chooser dialog box appears.
2. From the **Directories** menu, select the path ending with **\examples**.
3. Double-click on the directory named ‘Shared_Data’ to open it.
4. Select the dataset named ‘Newcastle_Radiometrics.ers’ and click on **OK this layer only** to load it into the Pseudo layer.

   The dataset is loaded into the new Pseudocolor layer. You now have one Pseudo layer containing the “Newcastle_Magnetics’ dataset and another Pseudo layer containing the ‘Newcastle_Radiometrics’ dataset.

Tip: The **OK this layer only** or **Apply this layer only** button on the **Raster Dataset** dialog are designed to let you load a dataset into *only* the currently selected layer. This is useful when you want several layers of the same type with different datasets in them. Double-clicking on the dataset name is the same as clicking the **OK** button.

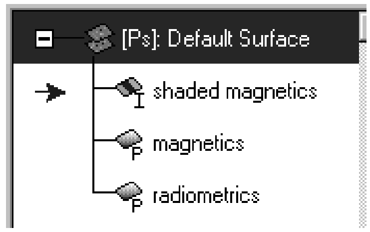
Label the three algorithm layers to distinguish them

Since you now have more than one Pseudocolor layer, it is helpful to add text labels to each so you can quickly distinguish between them.

1 Change the label of the lower Pseudo layer containing the ‘Newcastle_Radiometrics’ dataset to **`radiometrics`**.

2 Change the label of the upper Pseudo layer containing the ‘Newcastle_Magnetics’ dataset to **`magnetics`**.

3 Change the label of the Intensity layer to **`shaded magnetics`**. Your algorithm layers should look like this:



Turn off the ‘magnetics’ Pseudo layer

1 Turn off the Pseudo layer labelled ‘magnetics’ (right-click and select **Turn Off**).

The layer is now turned off and will be ignored during processing.

The radiometrics data initially displays as red over the shaded magnetics image (it covers only part of the geographic area of the magnetics dataset). You need to adjust the transform limits for the radiometrics data to improve the color contrast.

Adjust the transform for the ‘radiometrics’ color layer

1 Click on the Pseudo layer labelled ‘radiometrics’ to select it.

2 Click the right-hand **Edit Transform Limits**  button in the process diagram.

The **Transform** dialog box opens.

3 From the **Limits** menu, select **Limits to Actual**.

The total count data now displays as various colors over the shaded magnetics data.

4 On the **Transform** dialog, click the **Gaussian equalize**  button.

Guassian equalization increases the overall color contrast in the radiometrics total count data. Areas of high counts are shown as reds, and low count areas are shown in blues.

This colordrape image lets you easily associate variations and anomalies in total count radiometrics with structural features and trends shown in the shaded magnetics data. Using this technique, you can drape virtually any type of data in color over the shaded relief image to aid interpretation of subtle relationships.

5 Click **Close** on the **Transform** dialog box to close it.

Drape the magnetics data in color again

1 Turn on the Pseudo layer labelled ‘magnetics.’

2 Turn off the Pseudo layer labelled ‘radiometrics.’

The magnetics data again displays in color over the shaded relief data. You can now easily display either the magnetics or radiometrics data simply by turning on the desired Pseudo layer.

Note: If you have more than one layer of the same type turned on, the layer on top has display priority over layers below it. In this case, for example, you would see the ‘magnetics’ data if both the ‘magnetics’ and ‘radiometrics’ layers were turned on. (Data in lower priority layers is only displayed where they do not spatially overlap with layers of the same type above them.)

4: Saving the colordrape algorithm

Objectives Learn to save and add comments to the colordrape algorithm.

Enter a description for the algorithm

1 In the **Algorithm** dialog, change the text in the **Algorithm Description** field to read:

`Magnetics and radiometrics colordrape`

This text now becomes a brief description for the entire algorithm.

Save the processing steps to an algorithm file on disk

1 From the **File** menu (on the main menu), select **Save As...**.

The **Save Algorithm** file chooser dialog box appears.

2 In the **Files of Type:** field, select ‘ER Mapper Algorithm (.alg)’.

3 From the **Directories** menu, select the path ending with the text **\examples**.

4 Double-click on the directory named ‘miscellaneous\tutorial’ to open it.

5 In the **Save As:** text field, enter your initials followed by the text **`magnetics_radiometrics_colordrape`**.

6 Click the **Apply** button to save the algorithm and leave the dialog open.

Your pseudocolor algorithm is now saved to an algorithm file on disk.

Add comments to the algorithm

1 Click the **Comments...** button.

A dialog box opens allowing you to type comments about your algorithm.

2 In the comments dialog, type the following description information:

```
This algorithm drapes either magnetics or radiometrics data
in color over shaded magnetics. Sun angle shading is applied to
the magnetics data in the Intensity layer to highlight structural
features. Two Pseudocolor layers are added to display either
magnetics or total count radiometrics to create a combined
color/shaded relief image.
```

3 Click the **OK** button to save your comments with the algorithm and close the dialog.

4 Click **Cancel** on the **Save Algorithm** dialog to close it.

Your algorithm is now commented for future users.

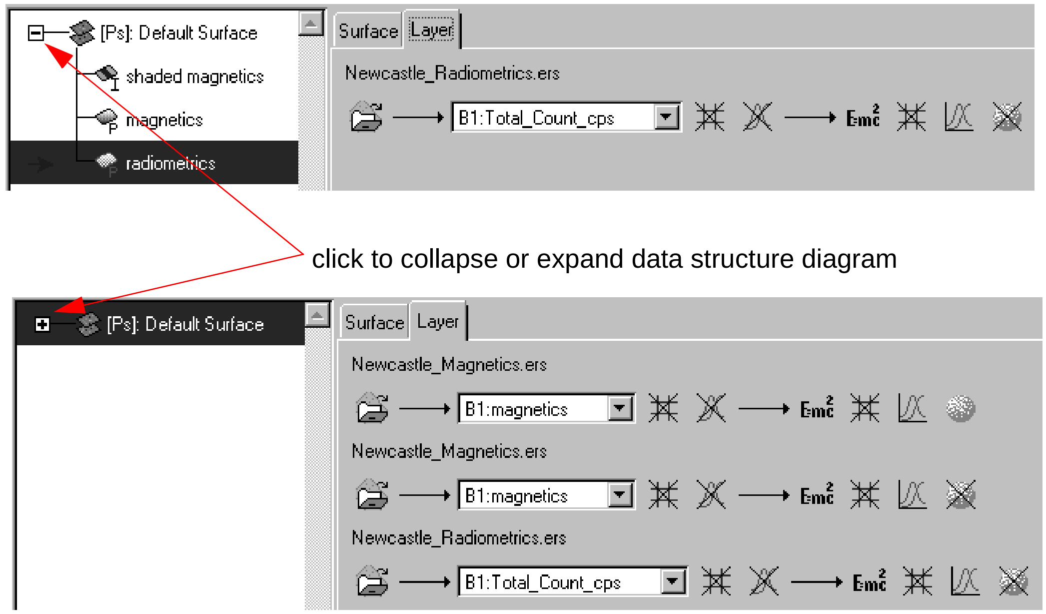
5: Working with layers

Objectives Learn how to collapse and expand the tree structure view of the algorithm. Also learn to view the process diagram for any desired layers, and change layer priority by moving layers up or down in the layer list.

Collapse the data structure view of the surface

This algorithm data view is composed of a single surface that has three layers. Currently this surface is displayed in expanded mode so all the layers are listed in the data structure diagram in the left-hand panel.

1 In the data structure (left-hand) panel, click once on the small “-” button left of the surface name.



The tree structure diagram collapses to show only the surface, and process diagrams for all three layers in the surface are now displayed in the Layer page on the right. Notice, for example, that you can easily see that sun shading is turned on for the Intensity layer and off for the two Pseudo layers. Collapsing surfaces can also be helpful for navigating around in algorithms that contain several surfaces.

2 Click once on the small “+” button left of the surface name.

The data structure diagram expands again to show all three layers.

3 Click once on the layer labelled ‘shaded magnetics’ to select it.

The Layer tab page in the right-hand panel changes to show only the process diagram for the selected layer.

Choose to show process diagrams for two layers

If you have more than one layer in your surface, you can choose to display the process diagram for any combination of them.

1 Ctrl-click once on the icon for the ‘radiometrics’ layer to select it. (Hold down the Ctrl key and click on the layer icon.)

Process diagrams for both layers are now displayed.

2 Ctrl-click once on icon for the ‘radiometrics’ layer to de-select it.

Use Ctrl-click also to remove process diagrams for highlighted layers.

Note: Notice that one layer always has a red arrow pointing to it–this indicates that it is the *active* layer. You may select several layers and view their process diagrams, but only one layer is active at a time. For example, if you have a number of layers selected and open the **Transform** dialog, the dialog contents apply only to the active layer.

Move the radiometrics layer up change its priority

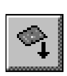
Right now, if both Pseudo layers were turned on, you would see the magnetics data because it has a higher priority than the radiometrics data layer (it is above it in the layer list).

1 Right-click the ‘radiometrics’ layer and select **Turn On**.

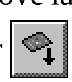
You see the magnetics data draped over the shaded magnetics because the ‘magnetics’ layer is higher than the ‘radiometrics’ layer in the layer list.

2 Point to the icon for the ‘radiometrics’ layer and drag it above the ‘magnetics’ layer.

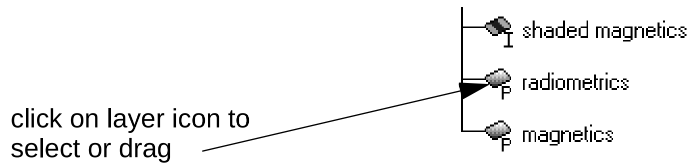
Now the radiometrics data is draped in color over the shaded magnetics data because its layer now has display priority over the ‘magnetics’ layer below it. (Since the radiometrics data only covers part of the area of the mag dataset, you still see the mag data where it is not covered by the radiometrics data.)

3 Click once on the ‘radiometrics’ layer to highlight it, then click the **Move Down**  button (in the row of buttons above the tabs).

The selected layer moves down below the ‘magnetics’ layer.

You can move layers either by dragging them or selecting the layer and using using the  or  buttons.

Tip: When selecting or dragging layers, always click on the layer's icon, *not* on the label text field.



Close the image window and Algorithm dialog

1 Close the image windows using the window system controls:

- For Windows, click the **Close** button in the upper-right window corner.

2 Click **Close** on the **Algorithm** dialog to close it.

Only the ER Mapper main menu should be open on the screen.

What you learned...

After completing these exercises, you know how to perform the following tasks in ER Mapper:

- Use Intensity layers to create shaded relief images that highlight structure
- Combine Pseudocolor and Intensity layers to create colordrape images
- Control the color and intensity components to modify image displays
- Add new layers to display other datasets in the same algorithm
- Turn layers on (to process them) and off (to ignore them)
- Collapse/expand the data structure diagram and change layer priority

Tips for colordrape algorithms

Generally the Intensity layer of a colordrape algorithm is used to show structural features and gradients derived from magnetics data, and the color layers are used to show magnetics, radiometrics, gravity, satellite images, or any other datasets you feel are useful. To use an existing algorithm as a "template" algorithm to apply the same processing to different datasets, simply load new datasets into the Intensity and Pseudocolor layers and adjust the transforms to account for the new data ranges.

Using algorithms with multiple layers

As you have seen in this exercise, a single algorithm can contain several layers that can be used to view the data in different ways. In this example, you had two Pseudocolor layers–one to display the magnetics data in color and another to display the radiometrics data in color. The ability to have access to many different views of the data in a single algorithm is a very powerful feature that lets you quickly visualize a wide variety of processing techniques and enhancements.

As you learn to use ER Mapper, you may build algorithms that contain many layers that process or integrate several different datasets. For example, a single algorithm can contain geophysical data, satellite images, scanned maps, and vector GIS data. You simply turn on the layers that give you the dataset combinations you desire.

5

HSI algorithms

This chapter explains how to create algorithms that allow you to display and manipulate data in Hue Saturation Intensity (HSI) color space. The HSI enhancement is an innovative analysis technique that goes one step beyond a colordrape display, so you can visualize three variables simultaneously. (HSI is also referred to as IHS, or Intensity Hue Saturation, in some circles.)

About the HSI Color System

In the Hue Saturation Intensity (HSI) color system, different colors are characterized by three measurable characteristics of a color:

- **Hue**–The main attribute of a color that distinguishes it from other colors in the spectrum. Hues are what you see in a rainbow, and are what we commonly think of as “color” (red, yellow, green, and so on).
- **Saturation**–The amount of grey in a color or color “purity.” Colors with high saturation (little grey) are said to be pure or vivid. Colors with low saturation (much grey) are pastel or dull colors. Completely desaturated colors are grey, no matter what the hue.
- **Intensity**–The relative brightness of a color. Colors with high intensity are bright, and colors with low intensity are dark.

The HSI color system is characterized as an “perceptual” color system because it provides a more intuitive means of manipulating color than the RGB (electronic) color system. ER Mapper implements the HSI color system by means of the Color Mode named Hue Saturation Intensity, and separate algorithm layer types for Hue, Saturation, and Intensity.

HSI Color Mode

To display data in HSI, you set the algorithm Color Mode to Hue Saturation Intensity, then load data into Hue, Saturation, and Intensity layers. In order to produce color, all three layers types must be used and turned on. ER Mapper provides HSI template algorithms that let you quickly load and display data using the HSI color system.

Note: Computer monitors use the RGB color system to actually display data, so ER Mapper automatically performs an internal translation of colors specified in HSI to colors specified in RGB for the monitor.

The Hue Layer

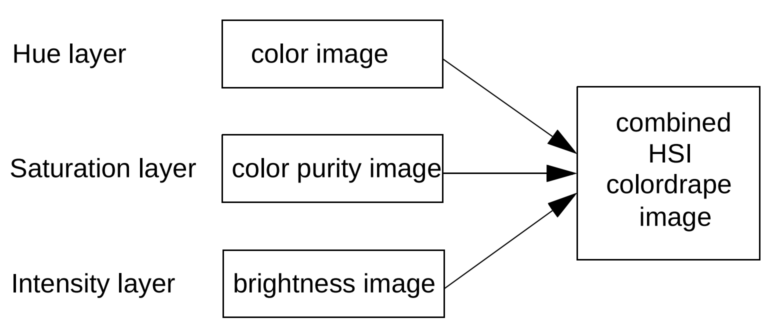
In an HSI image display, The Hue layer controls the mapping of data values to colors in the spectrum. In a typical display, the range of data values from low to high is mapped through the progression of hues: red-yellow-green-cyan-blue-magenta.

The Saturation Layer

In an HSI image display, The Saturation layer controls the mapping of data to the purity of colors in the image display (that is, the amount of grey in the colors). Low data values produce pastel or dull colors (much grey), and high data values produce pure or vivid colors (little grey).

The Intensity Layer

In an HSI image display, The Intensity layer controls the mapping of data to the brightness of colors in the image display. Low data values produce dark colors, and high data values produce bright colors.



The previous diagram shows how algorithm Hue, Saturation and Intensity layers are combined to create a single HSI colordrape image. You will see for yourself how these techniques work in the following exercises.

Hands-on exercises

These exercises give you practice creating HSI colordrape algorithms and manipulating image display in HSI color space.

What you will learn...

After completing these exercises, you will know how to perform the following tasks in ER Mapper:

- Use the algorithm Color Mode named Hue Saturation Intensity
- Combine Hue, Saturation and Intensity layers to create HSI images
- Understand the basics for interpreting data displayed in HSI
- Control the hue, saturation and intensity components to modify image displays
- Create special effect “wet look” images using HSI algorithms

Before you begin...

Before beginning these exercises, make sure all ER Mapper image windows are closed. Only the ER Mapper main menu should be open on the screen.

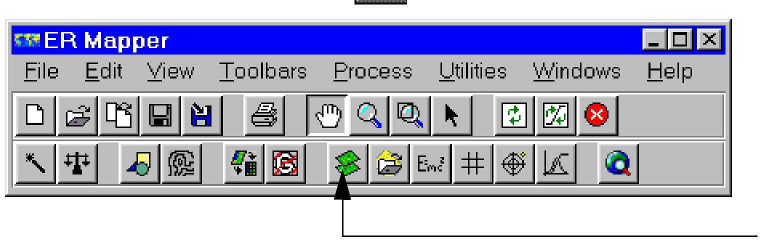
1: Creating the shaded relief image

Objectives

Learn how create an HSI algorithm by opening a new image window, creating Hue, Saturation, and Intensity layers, and loading data into the H, S, and I layers. (The sample algorithm you will create displays radiometrics as hues (color), magnetics as color saturation, and shaded magnetics as intensity.)

Open an image window and the Algorithm window

1 Click the **Edit Algorithm**  button.



Edit Algorithm button

An image window and the **Algorithm** dialog appear.

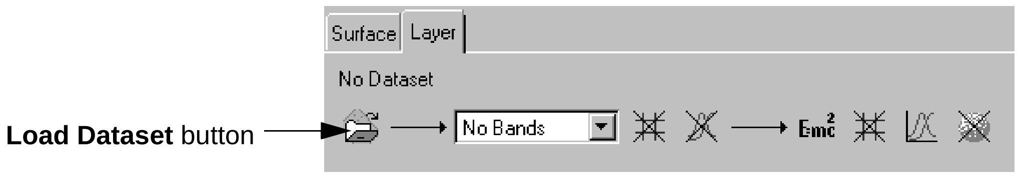
Change the Pseudocolor layer to an Intensity layer

1 Right-click the Pseudo layer and select **Intensity** from the short-cut menu.

The Pseudocolor layer changes to an Intensity layer. You will use this layer to create a greyscale shaded relief image.

Load the sample magnetics dataset into the Intensity layer

1 On the **Algorithm** dialog, click the **Load Dataset**  button.



The **Raster Dataset** file chooser dialog opens.

2 From the **Directories** menu (on the **Raster Dataset** dialog), select the path ending with **\examples**.

3 Double-click on the directory ‘Shared_Data’ to open it.

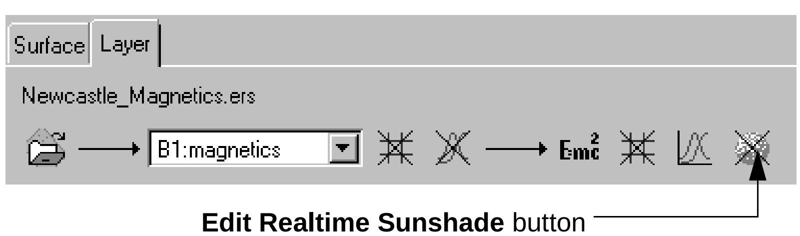
4 Double-click on the dataset named ‘Newcastle_Magnetics.ers’ to load it.

The magnetics dataset is loaded into the Intensity layer and displayed in greyscale.

Note: Data displayed in an Intensity layer always appears in greyscale unless other layers are used to add color (colordraping).

Turn on sun shading and display the shaded relief image

1 On the **Algorithm** dialog, click the **Edit Realtime Sunshade**  button in the process diagram.



The **Edit Sun Angle** dialog box opens to let you specify shaded relief effects for the Intensity layer.

2 Turn on the **Do sun-shading** option to turn on shading.

The structural features and trends of the magnetics dataset are clearly defined due to the sun angle shading.

3 Drag the small sun icon (the circle) around the circular grid until you find a shade angle that highlights structural features of interest. (Keep the sun elevation above 45 degrees to reduce shadowing.)

4 Click **Close** on the **Edit Sun Angle** dialog to close it.

Label the Intensity layer to identify it

1 Change the Intensity layer's text label to **`shaded magnetics`**.

(If desired, you could also add the shading angle, for example "NE shaded magnetics".)

2 Make the image window about 50% larger by dragging lower-right corner of the window border.

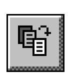
3 Right-click on the image and select **Zoom to All Datasets** from the **Quick Zoom** menu.

You have now created the shaded relief image to highlight structure. Next you will add Hue and Saturation layers to drape other data in color.

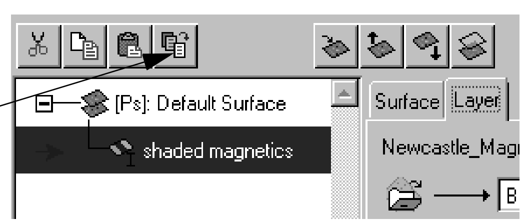
2: Adding data in Hue and Saturation layers

Objectives Learn how to build on your shaded relief Intensity image to create an HSI algorithm by adding Hue and Saturation layers.

Duplicate the Intensity layer and change it to Saturation

1 On the **Algorithm** dialog, select the Intensity layer (if needed), then click the **Duplicate**  button.

Duplicate button



ER Mapper creates a copy of the Intensity layer below the original.

2 Right-click on the new duplicate layer, and select **Saturation**.

The Intensity layer changes to a Saturation layer. You will use this layer to display the magnetics data as color saturation for the entire image.

Note: Notice that the Saturation layer has a red “X” through it. This indicates that the layer type in *not valid* with the current algorithm Color Mode. (In order to use Saturation or Hue layers in an algorithm, you must also select the Color Mode named Hue Saturation Intensity).

Change the Color Mode to Hue Saturation Intensity

1 Click the **Surface** tab in the **Algorithm** dialog.

Options for Color Mode, Color Table and Transparency display.

2 From the **Color Mode** drop-down menu, select **Hue Saturation Intensity**.

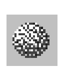
The Saturation layer now becomes active, and the HSI color mode is also shown in brackets next to surface name ([HSI]:Default Surface). Also notice that the Color Table option disappears from the Surface tab (because a color lookup table is not used to control image colors when HSI color mode is used).

Tip: You can also change the Color Mode for a surface by right-clicking the surface name and selecting from the short-cut menu.

Turn off sun shading and label the Saturation layer

1 Click the **Layer** tab in the **Algorithm** dialog.

The process diagram for the Saturation layer again displays.

2 With the Saturation layer selected, click the yellow **Edit Realtime Sunshade**  button in the process diagram.

The **Edit Sun Angle** dialog box opens. Since the layer was duplicated from the Intensity layer, sun angle shading is still turned on.

3 On the **Edit Sun Angle** dialog, turn off the **Do sun-shading** option.

Sun angle shading is now turned off.

4 Click **Close** on the **Edit Sun Angle** dialog to close it.

5 Change the label for the Saturation layer to `magnetics`.

Add a Hue layer and load the sample radiometrics dataset

1 From the **Edit** menu (on the **Algorithm** dialog), select **Add Raster Layer**, then select **Hue**.

ER Mapper adds a new Hue layer to the layer list. New added layers contain no dataset (shown by "No Dataset" above the process diagram). You will use this layer to display the radiometrics data in color.

2 On the **Algorithm** dialog, click the **Load Dataset** button.

The **Raster Dataset** file chooser dialog opens.

3 From the **Directories** menu, select the path ending with **\examples**.

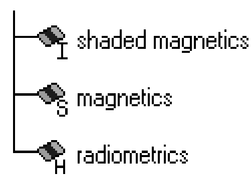
4 Double-click on the directory 'Shared_Data' to open it.

5 Double-click on the dataset named 'Newcastle_Radiometrics.ers' to load it.

The radiometrics dataset is loaded into the new Hue layer. Band 1 of the dataset (total count data) will be displayed by default.

6 Change the label for the Hue layer to **`radiometrics`**.

You should now have Intensity, Saturation and Hue layers with these labels:



Zoom to the extents of the radiometrics dataset

1 Right-click in the image window, select **Quick Zoom**, then **Zoom to Current Dataset**.

ER Mapper zooms in to the extents of the radiometrics dataset (it only covers part of the larger area covered by the magnetics dataset). You now have a reddish image similar to the colordrape, but you need to adjust the transforms of the Hue and Saturation layers to complete the HSI enhancement.

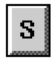
Adjust transforms of the Hue and Saturation layers

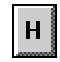
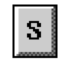
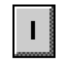
1 With the Hue layer selected, click the right-hand **Edit Transform Limits** button in the process diagram.

The **Transform** dialog box opens.

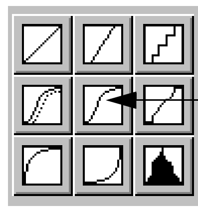
2 On the **Transform** dialog, select **Limits to Actual** from the **Limits** menu.

The X-axis transform limits change to match the actual limits of the total count radiometrics data.

3 On the **Transform** dialog, click the **Move to next saturation layer in surface**  button.

ER Mapper automatically selects the Saturation layer of the algorithm and shows the histogram of the magnetics data in that layer. (The ,  and  buttons are used to move between layers in a surface from within the **Transform** dialog as an alternative to selecting the layer in the **Algorithm** dialog.)

4 On the **Transform** dialog, click the **Histogram equalize**  button.



Histogram equalize button

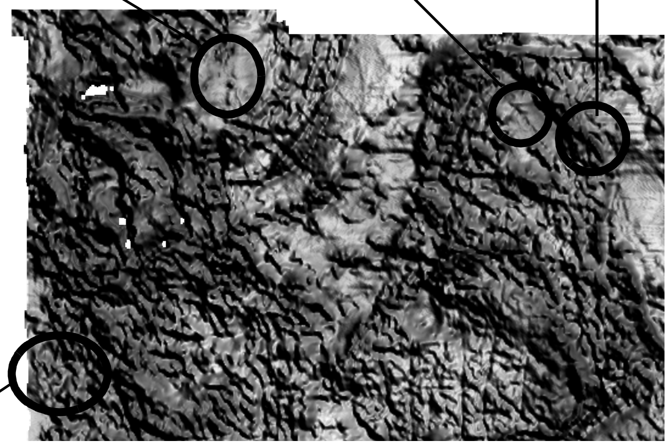
ER Mapper applies a histogram equalization transform line to the magnetics data.

5 Click **Close** on the **Transform** dialog to close it.

The combined magnetics and radiometrics image appears as a color shaded relief. You now have an image that shows three variables at once:

- Structure is shown as intensity (brightness) by applying sun angle shading to the magnetics data.
- Radiometrics total count data is shown as color (hues), where red indicates low values progressing through yellow, green, cyan, and blue to magenta for the highest total count values.

- The amplitude of the magnetics data is shown by variations in the *saturation* of colors, where greyish or pastel colors indicate low magnetic values progressing through to vivid or rich colors that indicate high magnetic values.



This type of display has become a popular ER Mapper processing technique for combined analysis of different types of geophysical datasets.

Tip: See the section “Tips for HSI algorithms” at the end of this chapter for more information on creating and interpreting HSI images.

Zoom in on upper-right portion of the image

1 On the Main Menu, click the **Zoom Box Tool** button.

You can now use the mouse for zooming and panning functions.

2 Inside the image window, drag a zoom box around the upper-right portion of the image.

ER Mapper zooms in on the defined area. Notice that the image takes on a slightly jagged or blocky look when you zoom in closely. (You can begin to see the limits of the geophysical data resolution, or the actual pixels that comprise the datasets.)

3 On the **Algorithm** dialog, turn on the **Smoothing** option.

Notice that the jagged look is reduced and overall features are easier to interpret.

Tip: The **Smoothing** option applies a bilinear interpolation to the data, and is most useful when you zoom in very closely on an area of interest. It usually has little noticeable effect until you zoom in close to the pixel resolution. This option also effects printing to help reduce the jagged look of large prints.

---

4 Select the ‘radiometrics’ layer of the algorithm.

5 Right-click in the image window, select **Quick Zoom**, then **Zoom to Current Dataset**.

ER Mapper zooms back out to the full extents of the radiometrics dataset.

3: Saving the HSI colordrape algorithm

Objectives Learn to save and add comments to the HSI colordrape algorithm.

Enter a description for the surface

1 Change the surface description text to **`mag & total count`** (it currently reads ‘Default Surface’).

It is often helpful to label each surface in an algorithm, as well as the individual layers that comprise the surface. (This is especially true for multi-surface algorithms that you will learn about later).

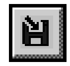
Enter a description for the entire algorithm

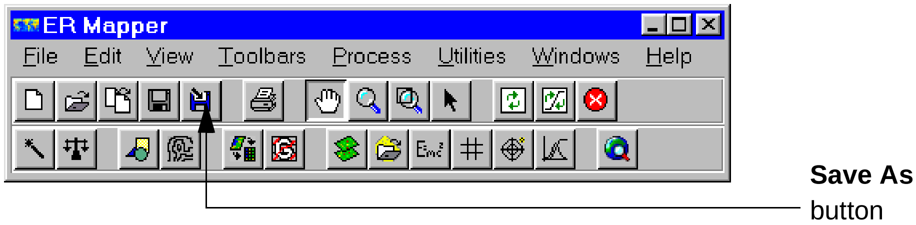
1 In the **Algorithm** dialog, change the text in the **Description** field to the following:

`Magnetics and Radiometrics HSI colordrape`

This text now becomes a brief description for the entire algorithm.

Save the algorithm to disk

1 On the main menu, click the **Save As**  button.



The **Save As** file chooser dialog box appears.

2 From the **Directories** menu, select the path ending with the text **\examples**.

3 Double-click on the ‘miscellaneous\tutorial’ directory to open it.

4 In the **Save As:** text field, enter your initials followed by the text **`HSI_colordrape`**.

5 Click the **Apply** button to save the algorithm and leave the dialog open.

Your HSI algorithm is now saved to an algorithm file on disk.

Add comments to the algorithm

1 Click the **Comments...** button to add comments.

2 In the comments dialog, type the following description information:

```
This algorithm displays magnetics and radiometrics data in hue
saturation intensity (HSI) color space. Sun angle shading is
applied to the mag data in the Intensity layer to highlight
structure. Radiometrics is displayed as color in the Hue layer,
and magnetics is displayed as variations in color saturation
in the Saturation layer.
```

3 Click the **OK** button to save your comments with the algorithm and close the dialog.

4 Click **Cancel** on the **Save As** dialog to close it.

Your algorithm is now commented for future users.

4: Creating a “wet look” HSI image

Objectives

Learn to create an HSI algorithm that creates a special shiny look similar to a plastic raised relief map. This type of image is very popular for presentations and hardcopy map prints.

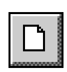
Note: The following technique uses a fast method to build the “wet look” algorithm using already existing algorithms. It is a good example of using existing algorithms as templates to save time when creating your own.

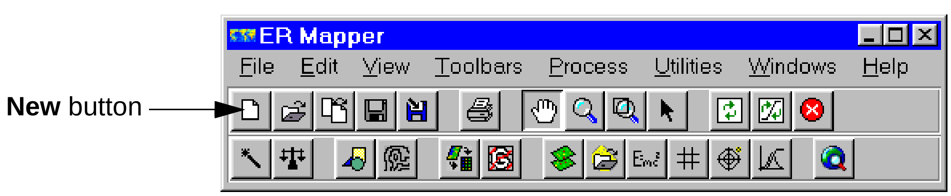
Open an existing colordrape algorithm

1. On the main menu, click on the **Open**  button.
2. From the **Directories** menu, select the path ending with the text **\examples**.
3. Double-click on the directory named ‘Data_Types’ to open it, then double click on the ‘Magnetics_And_Radiometrics’ directory.
4. Double-click on the algorithm ‘Magnetics_Colordrape.alg’ to open it.

   ER Mapper displays a magnetics colordrape image similar to the one you created in a previous lesson. (Magnetics is draped in color over shaded magnetics.)

Open a second image window

1. On the main menu, click the **New**  button.



A second image window appears. Drag it down below the ‘Magnetics_Colordrape’ image window.

Open an existing “wet look” algorithm

1 On the main menu, click on the **Open** button.

2 From the **Directories** menu, select the path ending with the text **\examples**.

3 Double-click on the directory named ‘Data_Types’ to open it, then double-click on the ‘Magnetics_And_Radiometrics’ directory.

4 In the **Files of Type:** field, select “ER Mapper Algorithm (.alg)”

5 Double-click on the algorithm ‘Magnetics_Colordrape_wet_look.alg’ to open it.

This colordrape shows the same data as the other image window (magnetics in color over shaded magnetics), but with a special enhancement that creates the illusion of a reflected light source. (The shiny surface is created by removing all saturation from the brightest sun shaded areas of the image so they look bright white.) This specialized enhancement technique is often used to make fancy images for presentations.

A short-cut way to create a “wet look” image with your own data (a complete explanation is beyond the scope of this workbook):

- Create and save a colordrape algorithm with one Intensity and one Pseudocolor layer (use the ‘Magnetics_Colordrape’ algorithm as an example).
- Open the existing wet look algorithm ‘Magnetics_Colordrape_wet_look.’
- Load your colordrape algorithm as if it were a dataset into the ‘Magnetics_Colordrape_wet_look’ algorithm. (Load the colordrape algorithm just like a dataset using the **Load Dataset** button on the **Algorithm** dialog. You will need to select “Algorithm Data View (.alg)” from the Files of Type menu on the **Raster Dataset** dialog to see the algorithm files.)
- Using the **Band Selection** list, make sure you have the Pseudo (color) band selected for the Hue layer, and the Intensity (shaded) band selected for the Saturation and Intensity layers.

Close all image windows and dialog boxes

1 Close all image windows using the window system controls:

- For Windows, click the **Close** button in the upper-right window corner.

2 Click **Close** on the **Algorithm** dialog to close it.

Only the ER Mapper main menu should be open on the screen.

What you learned...

After completing these exercises, you know how to perform the following tasks in ER Mapper:

- Use the algorithm Color Mode named Hue Saturation Intensity
- Combine Hue, Saturation and Intensity layers to create HSI images
- Understand the basics for interpreting data displayed in HSI
- Control the hue, saturation and intensity components to modify image displays
- Create special effect “wet look” images using HSI algorithms

Tips for HSI algorithms

Displaying data in Hue Saturation Intensity color space is one of the newer techniques in the analysis of geophysical datasets. It is helpful to have basic understanding of the way the HSI color system works to help you interpret data presented in this way.

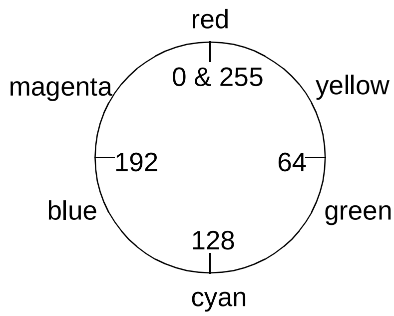
Using the magnetics-radiometrics HSI image you created here as an example, color is used to indicate radiometrics total count values. The magnetics values are not related to any specific color or hue (red, yellow, blue, etc.), but to the *saturation* of the color. For example, areas of the image with similar magnetic amplitudes may have completely different colors (because of the radiometrics), but will have the *same degree of color saturation or purity.*

This example used radiometrics in the hue layer and magnetics in the saturation layer, but you could just as easily substitute any other types of data instead. Shaded magnetics data is commonly used in the intensity layer to highlight geological structures.

The steps you followed in this exercise showed how to create an HSI algorithm from scratch, in part to illustrate the use of certain features in ER Mapper. When you learn to use ER Mapper, you can create these types of algorithms more quickly by using an existing algorithm as a template, or using a toolbar button to automatically create certain types of commonly used algorithms.

Modifying color mapping in HSI mode

The set of hues used to display data in HSI can be envisioned as color wheel, where the output data range 0-255 is mapped to the cycle of hues as shown in the following diagram. (The normal 0-360 azimuth range is compressed to 0-255 to simplify mapping to computer displays.):



For example, input data values that are mapped to the output value 128 (by the transform) are displayed using a cyan hue in the image. This is a fixed set of colors, but you can exclude colors either at the bottom or top of the range to modify the colors in the displayed image.

Since the color wheel wraps around on itself, both the very lowest values and very highest values are assigned the color red in the image by default. (You can see this in the sample HSI algorithm you created in this chapter.) You can avoid this by opening the **Transform** dialog and changing the output maximum field to 240. This tells ER Mapper not to use the red hues (240-255) for high data values, and instead map the highest values to the hue magenta. (As another example, the HSI “wet look” algorithm also excludes some hues using this method.)

Tip: To see the progression of colors used in HSI mode, display a dataset in Pseudocolor mode and select the color table named “hue.” Then open the **Transform** dialog and view the color progression of hues on the Y axis color bar.

6

Magnetic Anomalies and Structure

This chapter explains how to highlight magnetic anomalies and structure from processed Total Magnetic Intensity (TMI) data using ER Mapper.

Data quality and magnetic properties of rocks

Data quality

- Caesium or helium vapour magnetometers commonly used in standard aeromagnetics surveys have a resolution of 0.01 nT (nano-Tesla) or better and along line sampling rate of every 0.1s (4 -7 m sampling interval).

- Flight-line spacing depends on the request of client. Narrow line spacing will achieve higher resolution. For an aeromagnetics survey with a line spacing of 400 m it is generally gridded with a grid spacing of 80 - 100 m (0.2 - 0.25 x line spacing). Tie lines are usually flown with a tie spacing of ten times the flight line spacing. It is desirable to fly flight lines at right angles to the regional geological strike direction.
- Diurnal, levelling and International Geomagnetic Reference Field (IGRF) corrections are generally done by the Geophysical Data Acquisition Company or Processing company before passing on the processed, georeferenced and gridded data to the client.

Note: Diurnal variation is temporal variation in magnetic intensity and is monitored with a base station magnetometer.

Note: Levelling is correcting the discrepancies between readings at each crossover point between flight lines and tie lines.

Note: International Geomagnetic Reference Field (IGRF) correction is to remove Earth's regional magnetic field from the data.

Magnetic properties of rocks

- **Ferromagnetic** materials such as iron, cobalt and nickel have parallel dipoles and very strong spontaneous magnetization and a very high susceptibility which can exist even in the absence of an external magnetic field. **Antiferromagnetic** materials such as haematite have antiparallel dipole coupling with equal numbers of dipoles in each direction, hence self-cancelling its magnetization. **Ferrimagnetic** materials such as magnetite also have antiparallel dipole coupling but the number of dipoles in each direction are unequal provoking strong spontaneous magnetization and a high susceptibility.
- Magnetic susceptibility of common rocks depends on the small proportion of magnetic minerals that they contain. The iron-titanium-oxygen group possesses a solid solution series of magnetic minerals from magnetite (Fe3O4) to ulvospinel (Fe2TiO4). The other common iron oxide, haematite (Fe2O3) is antiferrromagnetic and does not give rise to magnetic anomalies. The iron-sulphur group provides the magnetic mineral pyrrhotite (FeS1+x, $0<x<0.15$) whose magnetic susceptibility is dependent upon the actual composition. However, the most common magnetic mineral is magnetite. Hence, it is reasonable to classify the magnetic behaviour of common rocks according to the overall magnetite content.

- Basic igneous rocks are usually highly magnetic due to their high magnetite content. With increasing acidity in igneous rocks, magnetite content generally decreases and hence reduces magnetization in acidic rocks. Metamorphic rocks are also variable in their magnetization but usually lower than igneous rocks. When metamorphic rocks are serpentinized it produces magnetite which gives rise to magnetization. Sedimentary rocks are generally weakly magnetic except for sand with heavy minerals containing significant concentrations of magnetite. Where magnetic anomalies are observed over sedimentary areas the major anomalies are generally caused by an underlying igneous or metamorphic basement, or by intrusions into the sediments. Magnetic anomalies may range from a few tens of nT over deep metamorphic basement to several hundred nT over basic intrusions and may reach an amplitude of several thousand nT over magnetic ores.
- Magnetic anomalies are commonly caused by dykes, faults, folds or truncated sills and lava flows, massive basic intrusions, metamorphic basement rocks and magnetite bearing orebodies.

Highlighting structure/lineaments from Total Magnetic Intensity (TMI)

- Total Magnetic Intensity (TMI) images show composite magnetic intensity which can yield useful information on broad lithological units.

Note: Structural interpretation using first vertical derivative, continuations and reduction to pole images are discussed in a later chapter.

- When interpreting magnetic data it is important to have some knowledge of the geology of the area.
- If there is a deep magnetic source such as a metamorphic basement or an igneous intrusion lying beneath a shallow/surface magnetic source such as maghemite the two magnetic responses add together.
- In interpreting magnetic images look for magnetic highs, magnetic lows, magnetic gradients, discontinuities in patterns and textures.
- Changes in texture, subtle changes in frequency content, usually indicate a contact.
- Displacement or offsets of magnetic anomalies may indicate faulting or folding.
- Draw lineaments only where you can see them.
- Look for broad gradients which may indicate dip or plunge.
- Apply directional filters and observe structure/lineaments of different orientation.

Hands-on exercises

These exercises show you how to effectively use artificial sun illumination through sun angle dialog box and highlight structure/lineaments of different directions on colordrape HSI magnetic images.

What you will learn...

After completing these exercises, you will know how to perform the following tasks in ER Mapper:

- Create Total Magnetic Intensity (TMI) colordrape images with different artificial sun angle illumination and save them as virtual datasets (VDS)
- Use the Shiny Look algorithm to create HSI Shiny Look TMI images and highlight lineaments of different directions
- Improve the overall brightness of HSI images by adjusting the transform of the Intensity layer
- Compare lineaments of different orientation
- Correlate structure with magnetics highs and lows.

Before you begin...

Before beginning these exercises, make sure all ER Mapper image windows are closed. Only the ER Mapper main menu should be open on the screen.

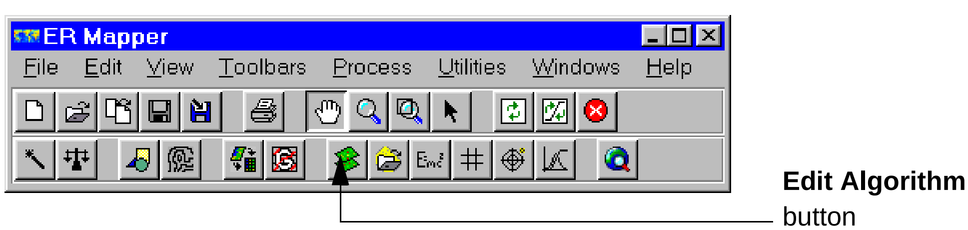
1: Creating Sun shaded relief image

Objectives

Learn to apply artificial sun angle illumination on TMI colordrape images and save them as VDS datasets.

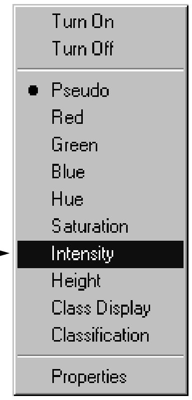
Open an image window and the Algorithm dialog

1 In the main menu window, click the **Edit Algorithm** button.



An image window and the **Algorithm** dialog open.

2 Point to the layer labelled “Pseudo Layer”, click the right mouse button, and select **Intensity** from the short-cut menu:



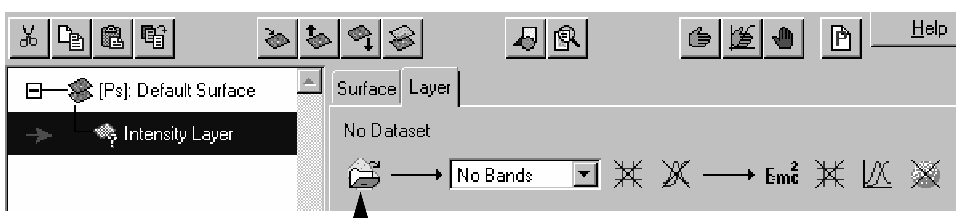
select **Intensity** from short-cut menu

The Pseudo layer changes to an Intensity layer and ER Mapper sets the layer description to “Intensity Layer.”

Tip: Right-clicking any layer opens the short-cut menu that lets you quickly change the layer’s type, and turn it on or off.

Load a sample magnetic dataset into the Intensity layer

1 In the **Algorithm** dialog, click the **Load Dataset**  button in the process diagram (be sure the **Layer** tab is selected first).



Load Dataset button

The **Raster Dataset** file chooser dialog box appears.

2 From the **Directories** menu, select the path ending with **\examples\Shared_Data**.

3 Double-click on the directory named ‘\examples\Shared_Data’

A list of raster datasets and algorithms is displayed.

4 In the **Files of Type:** field, select ER Mapper Raster Dataset (.ers)

5 Scroll down to view the dataset named ‘Newcastle_Magnetics.ers,’ then double-click on it to load it.

The dataset is loaded into the Intensity layer.

A greyscale image of aeromagnetics dataset from the Newcastle area of Australia displays.

Note: This sample dataset has been rescaled into an 8-bit (0-255) data range. (The data values are therefore not actual TMI values.) When using your own datasets, you will typically need to adjust the color mapping using the **Limits to Actual** option in the **Transform** dialog.

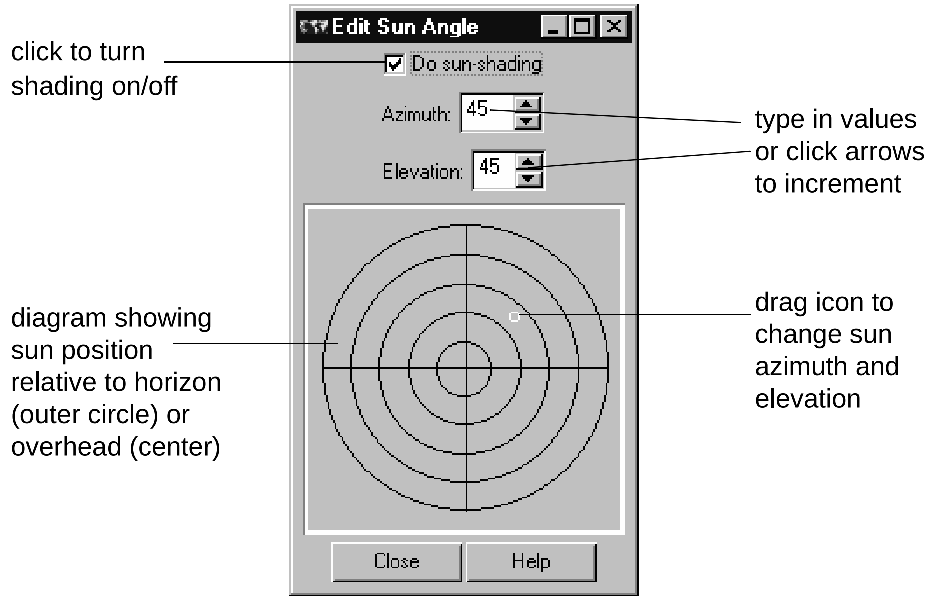
Tip: Do not clip the transform of the Intensity Layer if you are applying sun shading on it. You need the full dynamic range to display the full magnetic intensities (or height extent of DTM if you are using a DTM image) and highlight the structure. If you clip the transform you will have the upper and lower limits of the dynamic range cut off and the high relief areas will be displayed as flat tops.

Turn on sun shading and display the sun shaded relief image

1 In the **Algorithm** dialog, click the **Edit Realtime Sunshade**  button in the process diagram.

Edit Realtime Sunshade button

The **Edit Sun Angle** dialog box opens to let you specify shaded relief effects for the Intensity layer.



2 Turn on the **Do sun-shading** option.

Also notice that the **Edit Realtime Sunshade** icon in the process diagram is now a yellow sun  to indicate that shading is active for the Intensity layer.

Now the gradients and trends in the magnetic dataset are clearly defined due to the sun angle shading. This feature allows you to apply artificial illumination from any direction to highlight very subtle trends and features.

3 Make the image window larger by dragging lower-right corner of the window border.

ER Mapper redisplays the image to show more detail.

Change the sun azimuth and elevation to highlight structure of different orientation

1 In the **Edit Sun Angle** dialog, set both the azimuth and elevation to 45 degree.

The shading angle of the image changes in real time to show the shading effect as if the sun was shining from the northeast from an elevation of 45 degree.

Note: Structural features normal to NE sun illumination direction are highlighted. Sun angle shading is also useful for highlighting gridding artifacts in geophysical datasets. In fact on the Newcastle_Magnetics colordrape image there are some horizontal and vertical stripes which are gridding effects that becomes obvious when you enlarge the image or zoom in to the top-right corner of the image. Precaution should be taken in interpreting images with regular artifact horizontal or vertical stripes.

Note: The *elevation* from which the sun shines determines the length of shadows in the shaded relief image. Low sun angles can sometimes be useful for highlighting subtle trends in areas without strong gradients. Sun shining directly overhead during midday allows you to see terrain features without directional shadowing introduced by shading from a specific azimuth.

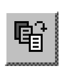
---

2 Click **Close** in the **Edit Sun Angle** dialog to close it.

2: Creating a colordrape image

Objectives Learn how to duplicate and modify the Intensity layer to create a Pseudocolor layer, and how to combine the two layers to create a colordrape image.

Duplicate the Intensity layer and change it to Pseudocolor

1 In the **Algorithm** dialog, select the Intensity layer (if needed), then click the **Duplicate**  button.

ER Mapper creates a copy of the Intensity layer below the original.

2 Right-click on the new duplicate Intensity layer, and from the short-cut menu select **Pseudo**.

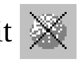
The Intensity layer changes to a Pseudo layer. You will use this layer to display the magnetic data in color over the shaded relief image.

Turn off sun shading for the Pseudo layer

1 With the Pseudo layer selected, click the yellow **Edit Realtime Sunshade**  button in the process diagram.

The **Edit Sun Angle** dialog box opens. Since the layer was duplicated from the Intensity layer, sun angle shading is still turned on.

2 In the **Edit Sun Angle** dialog, turn off the **Do sun-shading** option.

Sun angle shading is now turned off, and the **Edit Realtime Sunshade** icon in the process diagram shows a cross through it  to indicate this.

Note: Sun angle shading is usually applied only to the Intensity layer, and not other layer types (such as Pseudo) that are designed to display color.

---

3 Click **Close** in the **Edit Sun Angle** dialog to close it.

Note: From the colordrape image you can simultaneously see structure as brightness and geomagnetic field strength as color. In this case blues represent low values, and reds high values.

3: Saving the colordrape image as a VDS

Objectives Learn to save the colordrape TMI image with specific sunangle illumination as a VDS

Enter a description for the algorithm

1 Change the label of the Pseudo layer containing the ‘Newcastle_Magnetics’ dataset to **`magnetics`**.

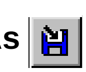
2 Change the label of the Intensity layer to **`NE shaded magnetics`**.

3 In the **Algorithm** dialog, change the text in the **Algorithm Description** field to read:

`Magnetics colordrape with NE illumination`

This text now becomes a brief description for the entire algorithm.

Save the colordrape TMI image as a VDS on disk

1 On the Standard toolbar, click the **Save As**  button.

2 The **Save As** dialog box appears.

3 From the **Directories** menu, select the path ending with the text **\examples\Miscellaneous\Tutorial**.

4 In the **Files of Type:** field, select “ER Mapper Virtual Dataset (.ers)”.

5 In the **Save As:** text field, enter your initials followed by the text `magnetics_NE_colordrape`.

6 Click the **OK** button to save the colordrape image as a VDS.

7 A message “ Delete output transform for virtual dataset ?” will appear.

8 Click “Yes“ and delete the transforms

Note: Your colordrape image with sun illumination from NE is now saved as a VDS file on disk with the transforms deleted. Deleting the transforms will maintain the original dynamic range of the dataset without being clipped.

4: Creating a “shiny look” HSI image

Objectives Learn to create an HSI algorithm that creates a special shiny look similar to a plastic raised relief map. This type of image is very popular for presentations and hardcopy map prints.

Note: The following technique uses a fast method to build the “shiny look” algorithm using already existing algorithms. It is a good example of using existing algorithms as templates to save time when creating your own.

Open an existing colordrape algorithm

1 In the main menu window, click on the **Open**  button.

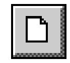
2 From the **Directories** menu, select the path ending with the text **\examples\Data_Types\Magnetics_And_Radiometrics**.

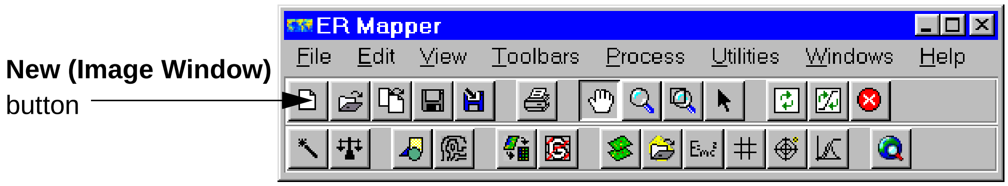
3 In the **Files of Type:** field, select “ER Mapper Algorithm (.alg)”.

4 Double-click on the algorithm ‘Magnetics_Colordrape.alg’ to open it.

ER Mapper displays a magnetic colordrape image similar to the one you created in a previous lesson. (Magnetics is draped in color over shaded magnetics.)

Open a second image window

1 In the main menu window, click the **New (Image Window)**  button.



A second image window appears. Drag it down below the ‘Magnetics_Colordrape’ image window.

Open an existing “shiny look” algorithm

1 In the main menu window, click on the **Open**  button.

2 From the **Directories** menu, select the path ending with the text **\examples\Data_Types\Magnetics_And_Radiometrics**

3 In the **Files of Type:** field, select “ER Mapper Algorithm (.alg)”.

4 Double-click on the algorithm ‘Magnetics_Colordrape_shiny_look.alg’ to display it.

This colordrape shows the same data as the other image window (magnetics in color over shaded magnetics), but with a special enhancement that creates the illusion of a reflected light source. (The shiny surface is created by removing all saturation from the brightest sun shaded areas of the image so they look bright white.) This specialized enhancement technique is often used to make fancy images for presentations.

Note: This colordrape shows the same data as the other image window (magnetics in color over shaded magnetics), but with HSI color combination and manually enhanced the saturation layer to give the shiny look.

5: Creating a HSI “shiny look” image using the NE illuminated colordrape VDS dataset

1 In the main menu window click the **Copy Window** button and duplicate the shiny look image.

2 Click the **Load Dataset**  button in the duplicated **Algorithm** dialog.

3 The **Raster Dataset** file chooser dialog box appears.

4 From the **Directories** menu, select the path ending with **\examples\Miscellaneous\Tutorial**.

5 Double-click on the directory named ‘Tutorial.’

A list of raster datasets is displayed.

6 In the **Files of Type:** field, select “ER Mapper Raster Dataset (.ers)”

7 Scroll down to view the dataset named

‘`magnetics_NE_colordrape`.ers,’ then double-click to load it.

The dataset is loaded into the HSI layers of the shiny look image.Your colordrape data with the “shiny look” is displayed.

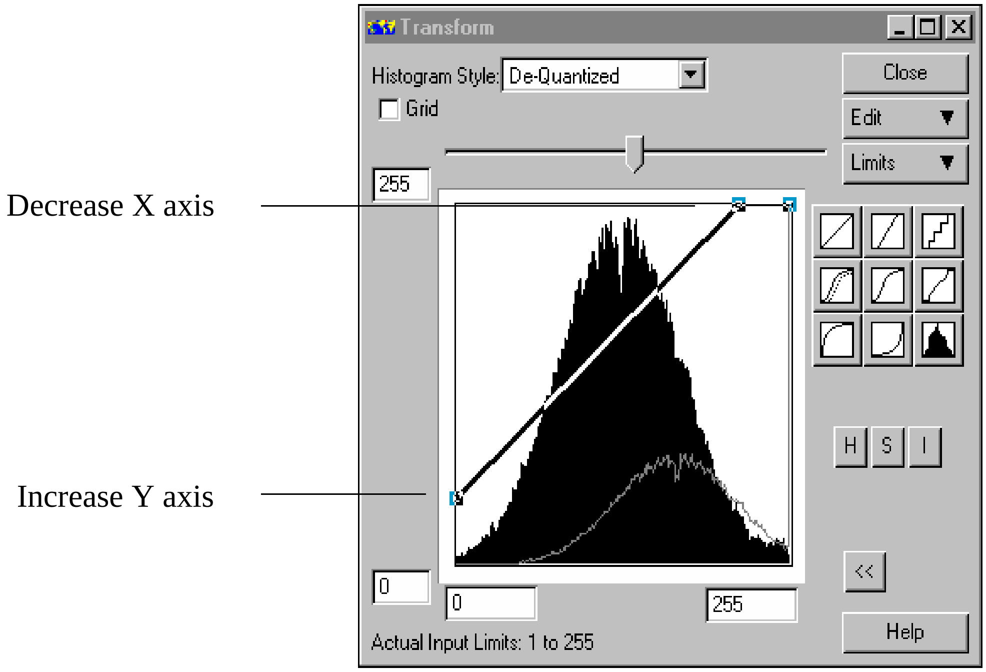
6: Enhancing the “shiny look” image by adjusting the transformation of the Intensity layer

1 Click the Transform button of the Intensity layer

2 The Transform dialog appears.

3 Manually increase the lower left point of the linear transform along the Y axis and decrease the upper right point of the linear transform along the X axis. Adjust the transform to the optimum overall brightness of the image.

Note: The Shiny Look image now is brighten overall because the intensity of the magnetics in the Intensity layer has been brighten.



Note: If the current Intensity layer is applying artificial illumination through the sun angle button you should not clip the transformation. However, if the artificial sun illuminated intensity layer has been saved as a band in a VDS, you can change the transformation of the Intensity layer from the VDS to brighten the image.

7: Creating “shiny look” images with different sun angles illumination and compare lineaments of various orientations

1 Repeat the procedures mentioned above and create colordrape images with EW, NS and NW sun angles illumination.

2 Save those colordrape images with EW, NS and NW sun angles illumination as VDS and save them as magnetics_EW(or)NS(or)NW_colordrape.ers in the **\examples\Miscellaneous\Tutorial** directory.

Note: Depending on your dataset you can adjust the elevation to highlight lineaments of different directions. Low elevation will highlight lineaments with subtle height difference whereas high elevation will reduce shadow effects.

---

3 Display the ‘Magnetics_Colordrape_shiny_look.alg’ from the **\examples\Data_Types\Magnetics_And_Radiometrics** directory.

4 Load each of your colordrape VDS with EW, NS and NW sun angles illumination saved them as magnetics_EW(or)NS(or)NW_colordrape.ers in the \examples\Miscellaneous\Tutorial directory into the layers of the displayed Magnetics_Colordrape_shiny_look image.

5 Click the Transform button of the Intensity layer

6 The Transform dialog appears.

7 Manually increase the lower left point of the linear transform along the Y axis and decrease the upper right point of the linear transform along the X axis. Adjust the transform to the optimum overall brightness of the image.

8 Geolink all the windows with shiny look images that have applied EW, NS, NE and NS sun angles illumination. Compare lineaments of different directions.

Tip: Creating a HSI shiny look image with vertical sun angle illumination will allow you to see an image without shadow effects. It will also enable you to compare it with images that have applied artificial sun illumination from different azimuth and elevations.

8: Correlating structure and magnetic highs and lows

Create a colordrape image

1 Follow steps 1 and 2 and create a colordrape image with sun angle illumination of 45 degree for azimuth and 85 degree for elevation.

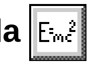
Note: Use high elevation (85 degree) to reduce the shadow effects on the colordrape image.

---

2 Enhance the overall brightness of the image by adjusting the transformation of the Intensity layer as mentioned in step 7.

Highlight the magnetics highs and lows

1 Duplicate the Pseudo layer of the colordrape image

2 Highlight the first Pseudo layer and click the **Edit Formula**  button from the process stream in the Algorithm window.

The **Formula Editor** dialog box opens.

Note: Note that the generic formula window contains the text “I1” by default, and that I1 (Input 1) is assigned to dataset band 1 in the Relations window.

---

3 In the **Generic** formula window, edit the formula text to read:

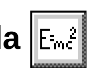
```
if i1 > threshold then i1 else null
```

4 Click the **Apply changes** button to accept the formula.

5 Select the **Variables** in the **Formula Editor** dialog box and type in 180 for the value of threshold and press enter.

Note: You are going to highlight all magnetics that have dynamic range (DN) higher than 180 from an 8-bit (0-255DN) data.

---

6 Highlight the second Pseudo layer and click the **Edit Formula**  button from the process stream in the Algorithm window.

The **Formula Editor** dialog box opens.

7 In the **Generic** formula window, edit the formula text to read:

```
if i1 < threshold then i1 else null
```

8 Click the **Apply changes** button to accept the formula.

9 Select the **Variables** in the **Formula Editor** dialog box and type in 80 for the value of threshold and press enter.

Note: You are going to highlight all magnetics that have dynamic range (DN) lower than 80 from an 8-bit (0-255DN) data.

---

10 The image displays magnetics highs in the top range of pseudo color (a variation of yellow - red) and the magnetics lows in the low range of pseudo color (a variation of cyan-blue) draped over the structure image of Newcastle_Magnetics.

Tip: If you want to display the magnetics highs and lows in solid colors instead of a range of color variation do the following. Instead of using the formula “if i1 > threshold then i1 else null” use “if i1 > threshold then 255 else null” to highlight high magnetics in red. Similarly instead of using the formula “if i1 <threshold then i1 else null” use “if i1 > threshold then 1 else null” to highlight low magnetics in blue. If you want to highlight magnetics lows in yellow instead of blue choose 170 instead of 1. In fact you can choose any number (level) that corresponds to the color from the color lookup table that you choose to display the magnetics in the **Pseudo** layer. Check the corresponding number for a particular color from the Y-axis of the **Transform** dialog.

Tip: Instead of using **Pseudo** layer you can use **Classification** layer and use the formula “if i1 > threshold then 1 else null” to highlight high magnetics and “ if i1 < threshold then 1 else null” to highlight low magnetics and assign colors from the **Edit Layer Color** button in the Process stream diagram.

Note: Observe whether magnetics highs and/or lows are related to the structure of the area of interest. In some areas of the Newcastle_Magnetics image magnetics highs and lows are related to the rims of igneous bodies.

Close the image window and the Algorithm dialog

1 Close the image windows using the window system controls:

- For Windows, click the **Close** button in the upper-right window corner.
- For Unix systems, select **Close** or **Quit** from the window control menu in the upper-left corner (for systems with both options, select **Quit**).

2 Click **Close** in the **Algorithm** dialog.

Only the ER Mapper main menu is now open.

What you learned...

After completing these exercises, you know how to perform the following tasks in ER Mapper:

- Create colordrape images with specific sun angle illumination and save them as VDS
- Use an existing HSI shiny look algorithm and create your own HSI shiny look algorithms highlighting lineaments of different directions

- Enhance the overall brightness of the HSI shiny look images by adjusting the transformation of the Intensity layer
- Compare the highlighted lineaments of different orientation
- Correlate structure with magnetics highs and lows

7

Structure Interpretation and Vector files Creation

This chapter explains some techniques in interpreting structure from processed Total Magnetic Intensity data using ER Mapper and create vector files of the interpreted structure.

Structure interpretation from Total Magnetic Intensity (TMI) images

In interpreting lithological boundaries, structure such as folds, faults, and lineaments from magnetics you should be aware of the following facts.

- Magnetic susceptibility reflected from rocks is mostly due to the abundance of accessory minerals, particularly magnetite and thus is too broad to be used for lithological classification. In magnetic petrological classification you should know the characteristic and contents of ferrous and ferric iron content of the whole rocks and all the minerals in the rocks as a function of the geological variable being studied. Due to conditions of metamorphism, degree and type of hydrothermal alteration, bulk composition, degree of differentiation and conditions of emplacement, meta-igneous rocks will vary in magnetic susceptibility. Even within one type of rock magnetic anomaly pattern may vary due to the above-mentioned conditions.
- Magnetic anomalies are commonly caused by dykes, faults, folds or truncated sills and lava flows, massive basic intrusions, serpentinization, magnetic felsic intrusion into potassic alteration zones, contact metamorphism, metamorphic basement rocks, Banded Iron Formation (BIF), maghemite (alteration product) and magnetite ore bodies.
- Generally sedimentary rocks have insignificant magnetic susceptibility. Magnetic anomalies are strongly influenced by the depth of magnetic bodies. Shallow magnetic bodies show high spatial frequencies whereas deep magnetic bodies exhibit low spatial frequencies.
- Total Magnetic Intensity (TMI) image shows composite magnetic intensity which can yield useful information on broad lithological groupings. However, interpreting magnetic data should be carried out with the aid and knowledge of local geology.
- Magnetic anomalies may range from a few nT over deep metamorphic basement to several hundred nT over basic intrusion and may reach several thousand nT over a magnetite ore body.
- Magnetic susceptibility of rocks may vary considerably and hence there maybe overlap between different lithologies.
- An area where a deep magnetic body lies beneath a shallow magnetic body the two magnetic response add together.
- In interpreting magnetic images look for magnetic highs, magnetic lows, magnetic gradients, discontinuities in patterns and textures.
- Changes in texture, subtle changes in frequency content, usually indicate a contact.
- Displacement or offsets of magnetic anomalies may mean faulting or folding.
- Draw lineaments only where you can see them.

- Look for broad gradients which may indicate dip or plunge.
- Apply different artificial sun angles illumination on colordrape images to observe and interpret structure/lineaments of different orientation.

Hands-on exercises

These exercises show you how to extract geological structure/lineaments from colordrape Magnetic images which are artificially illuminated from different directions.

What you will learn...

After completing these exercises, you will know how to perform the following tasks in ER Mapper:

- Extract lineaments from Total Magnetic Intensity (TMI) colordrape images with different artificial sun angle illumination and save them as virtual datasets (VDS)
- Create vector files of structure/lineaments of different orientation extracted from TMI color drape images.

Before you begin...

Before beginning these exercises, make sure all ER Mapper image windows are closed. Only the ER Mapper main menu should be open on the screen.

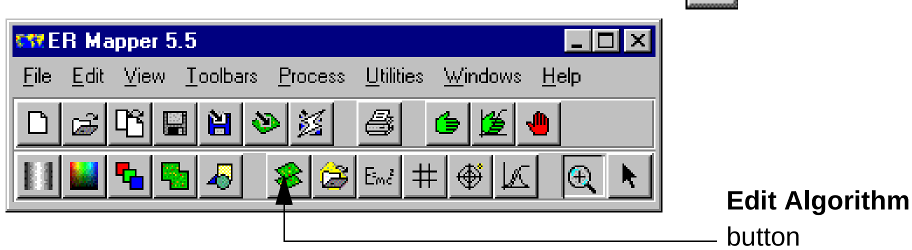
1: Creating sun shaded magnetic image

Objectives

Learn to apply artificial sun angle illumination on a TMI image and save it as a VDS dataset.

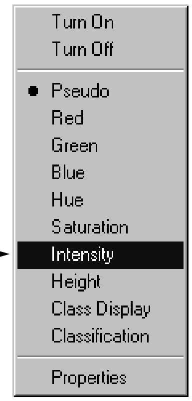
Open an image window and the Algorithm dialog

1 In the main menu window, click the **Edit Algorithm**  button.



An image window and the **Algorithm** dialog open.

2 Point to the layer labelled “Pseudo Layer”, click the right mouse button, and select **Intensity** from the short-cut menu:



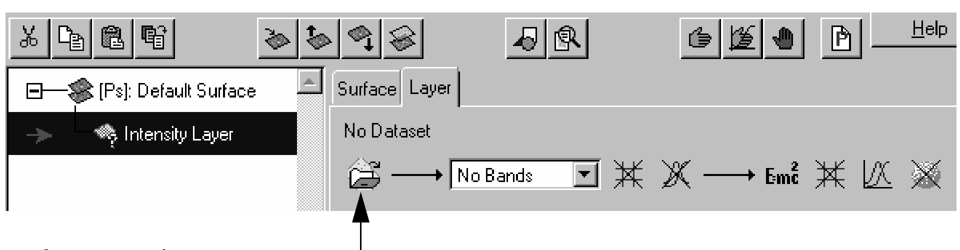
select **Intensity** from short-cut menu

The Pseudo layer changes to an Intensity layer and ER Mapper sets the layer description to “Intensity layer.”

Tip: Right-clicking any layer opens the short-cut menu that lets you quickly change the layer’s type, and turn it on or off.

Load a sample magnetic dataset into the Intensity layer

1 In the **Algorithm** dialog, click the **Load Dataset**  button in the process diagram (be sure the **Layer** tab is selected first).



Load Dataset button

The **Raster Dataset** file chooser dialog box appears.

2 From the **Directories** menu, select the path ending with **\examples**.

3 Double-click on the directory named ‘Shared_Data.’

4 In the **Files of Type**: field, select “ER Mapper Raster Dataset (.ers)”

A list of raster datasets and algorithms is displayed.

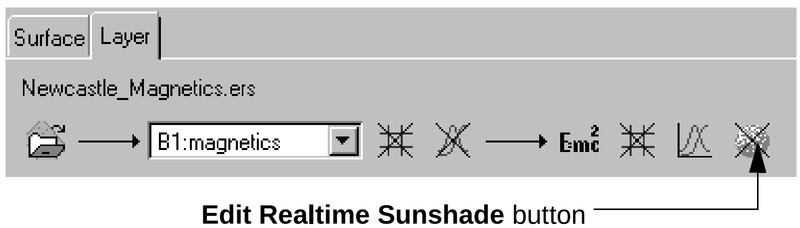
5 Scroll down to view the dataset named ‘Newcastle_Magnetics.ers,’ then double-click on it to load and display it.

The dataset is loaded into the Intensity layer.A greyscale image of aeromagnetic dataset from the Newcastle area of Australia displays.

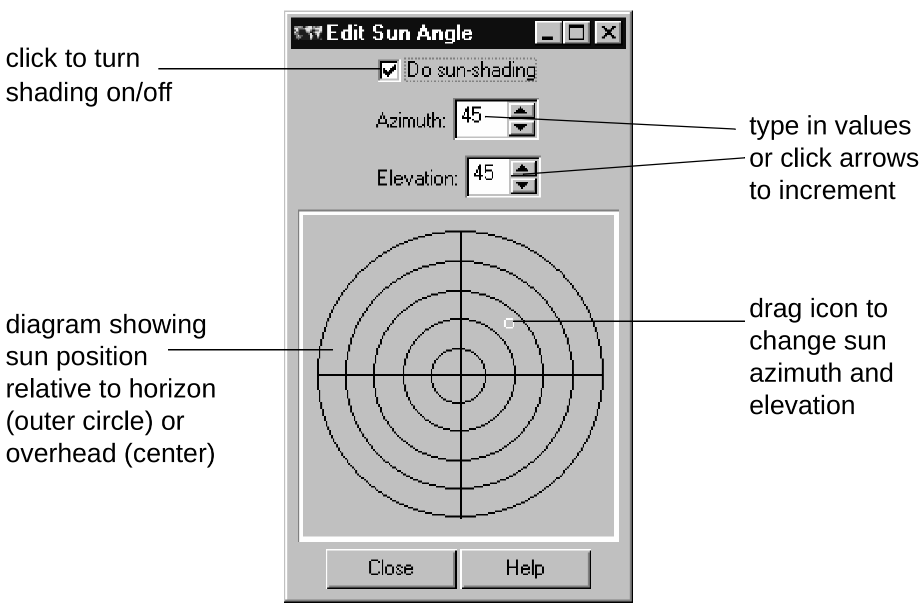
Note: This sample dataset has been rescaled into an 8-bit (0-255) data range. (The data values are therefore not actual TMI values.) When using your own datasets, you will typically need to adjust the color mapping using the **Limits to Actual** option in the **Transform** dialog.

Turn on sun shading and display the shaded relief image

1 In the **Algorithm** dialog, click the **Edit Realtime Sunshade**  button in the process diagram.



The **Edit Sun Angle** dialog box opens to let you specify shaded relief effects for the Intensity layer.



2 Turn on the **Do sun-shading** option.

Also notice that the **Edit Realtime Sunshade** icon in the process diagram is now a yellow sun  to indicate that shading is active for the Intensity layer.

Now the gradients and trends in the magnetic dataset are clearly defined due to the sun angle shading. This feature allows you to apply artificial illumination from any direction to highlight very subtle trends and features.

3 Make the image window larger by dragging lower-right corner of the window border.

ER Mapper redisplays the image to show more detail.

Change the sun azimuth and elevation to highlight structure of different orientation

1 In the **Edit Sun Angle** dialog, set both the azimuth and elevation to 85 degree.

The shading angle of the image changes in real time to show the shading effect as if the sun was shining from the northeast from an elevation of 85 degree.

Note: Structural features normal to NE sun illumination direction are highlighted. Precaution should be taken in interpreting images with horizontal or vertical stripes. The sun *elevation* at 85 degree will minimize shadow effects on the image.

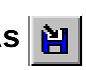
---

2 Click **Close** in the **Edit Sun Angle** dialog to close it.

2: Highlighting lineaments of sun shaded magnetic image using formula

Objectives Learn how to save artificial sun angle illumination applied magnetics and using formula to automatically highlight lineaments.

Save the Sun Shaded Magnetics as a VDS

1 On the Standard toolbar, click the **Save As**  button.

2 The **Save As** dialog box appears.

3 From the **Directories** menu, select the path ending with the text **\examples\Miscellaneous\Tutorial**.

4 In the **Files of Type:** field, select “ER Mapper Virtual Dataset (.ers)”.

5 In the **Save As:** text field, enter your initials followed by the text **`magnetics_NE_colordrape_vds`**.

Note: It is a good practice to include _vds as part of your virtual dataset file name to differentiate VDS from Dataset as both types have .ers extension.

---

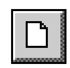
6 Click the **OK** button to save the colordrape image as a VDS.

7 A message “ Delete output transform for virtual dataset ?” will appear.

8 Click “Yes“ and delete the transforms

Note: Your colordrape image with sun illumination from NE is now saved as a VDS file on disk with the transforms deleted. Deleting the transforms will maintain the original dynamic range of the dataset without being clipped.

Display the VDS (Sun Shaded Magnetics)

1 In the main menu window, click the **New (Image Window)**  button

A second image window appears.

2 In the main menu window, click on the **Open**  button.

3 From the **Directories** menu, select the path ending with the text **\examples\Miscellaneous\Tutorial**

4 In the **Files of Type:** field, select “ER Mapper Raster Dataset (.ers)”.

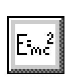
5 Double-click on the Virtual Dataset ‘**`magnetics_NE_colordrape_vds`**.ers’ to display it.

Automatic lineaments extraction

1 If the image is displayed in pseudocolor, change the Layer type to Intensity.

Note: The image will be displayed as greyscale

---

2 Click the **Edit Formula**  button from the process stream in the Algorithm window.

The **Formula Editor** dialog box opens.

Note: Note that the generic formula window contains the text “I1” by default, and that I1 (Input 1) is assigned to dataset band 1 in the Relations window.

---

3 In the **Generic** formula window, edit the formula text to read:

```
if i1 < threshold then 1 else 255
```

4 Click the **Apply changes** button to accept the formula.

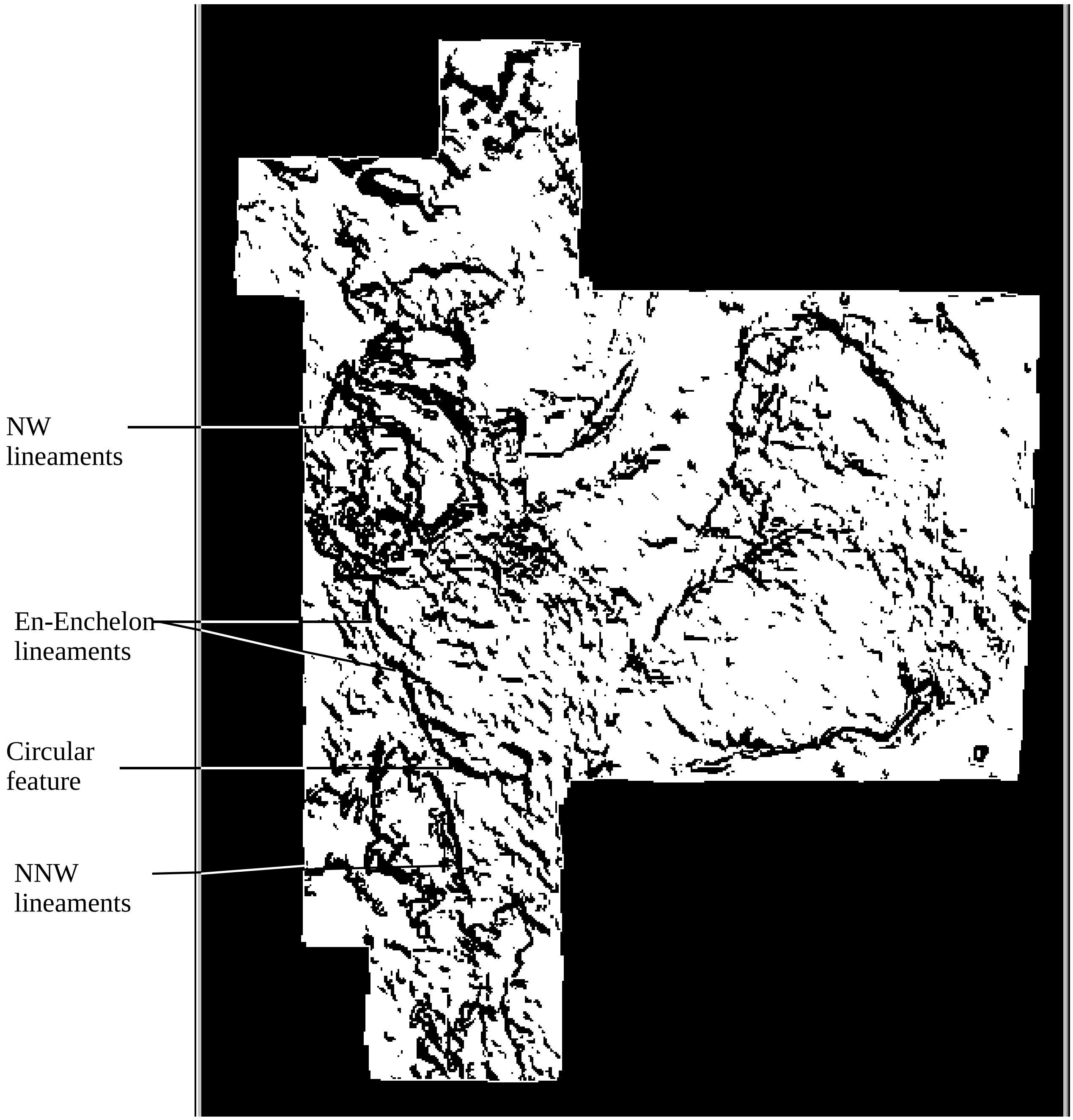
5 Select the **Variables** in the **Formula Editor** dialog box and type in 35 for the value of threshold and press enter.

Note: You are going to highlight lineaments that correspond to Magnetic Intensity that have dynamic range (DN) lessthan 35 from an 8-bit (0-255DN) data.The lineaments are actually highlighted using the NE Sun Angle Illumination. It is assumed that shadows (DN < 35) have highlighted lineaments.

---

6 Boundaries of igneous bodies and lineaments are displayed as black lines and narrow areas.

Note: Notice the circular features of igneous bodies. Lineaments and en-echelon lineaments cutting the rims of the igneous bodies indicate that lineaments are later stage tectonic events.


NW
lineaments
En-Enchelon
lineaments
Circular
feature
NNW
lineaments

3: Creating vector files of the highlighted lineaments

Objectives Learn to save the sun shaded TMI image with highlighted lineaments and circular features as a VDS

Open a new image window and the Algorithm dialog

1 In the main menu window, click the **New** button.

A new image window appears.

2 Click on the **Edit Algorithm** button in the main menu window.

3 The **Algorithm** window open.

4 In the **Algorithm** window click the **Load Dataset** button in the **Algorithm** window.

5 From the **Directories** menu, select the path ending with the text **\examples\Miscellaneous\Tutorial**

6 In the **Files of Type:** field, select “ER Mapper Raster Dataset (.ers)”.

A list of raster datasets is displayed.

7 Scroll down to view the dataset named ‘Newcastle_Magnetics_NE_sunshaded_VDS.ers,’ then double-click to load it.

Note: Newcastle_Magnetics_NE_sunshaded_VDS.ers Virtual dataset is displayed.

Highlight lineaments using formula and save it as a binary image

1 Click the **Edit Formula** button in the process stream diagram.

2 In the Generic formula window, edit the formula text to read:

```
if input1 < 35 then 1 else 2
```

This formula tells ER Mapper “if pixels in the NE illuminated sun shaded image have a value less than 35, assign them a value of 1, else assign all other a value of 2.” After this formula each pixel in the image will be reassigned a data value of 1 or 2 (a binary image).

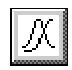
3 Click the **Apply changes** button to validate the formula.

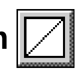
Note: The threshold value of 35 for this dataset was determined in an earlier exercise in highlighting the NW oriented lineaments using the NE sun illumination. This threshold value may differ from dataset to dataset. Initially the image appears black because the Transform limits need to be adjusted.

---

4 Click **Close** to close the **Formula Editor** dialog.

Adjust the Transform for the binary image

1 Click the post-formula **Edit Transform Limits**  button to open the **Transform** dialog box.

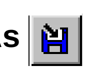
2 In the **Transform** dialog, click the **Create default linear transform**  button to reset the transform line.

3 From the **Limits** menu, select **Limits to Actual**.

The image is displayed in black for the lineaments (a value of 1) and white for the remaining areas (a value of 2).

Note: You adjusted the transform so the binary image could be displayed onscreen. Before vectorizing the binary image, you need to delete the transform as described following so the 1-2 data range is not scaled to 0-255.

Save the binary algorithm as a Virtual Dataset

1 On the Standard toolbar, click the **Save As**  button.

2 The **Save As** dialog box appears.

3 From the **Directories** menu, select the path ending with the text **\examples\Miscellaneous\Tutorial**.

4 In the **Files of Type:** field, select “ER Mapper Virtual Dataset (.ers)”.

5 In the **Save As:** text field, type a name using your initials at the beginning, followed by the text ‘binary_NW_Lineaments_image_VDS,’ and separate

each word with an underscore (_). For example, if your initials are “BP,” type in the name:

BP_binary_NW_Lineaments_image_VDS

6 Click the **OK** button to save the binary image as a VDS.

7 A message “ Delete output transform for virtual dataset ?” will appear.

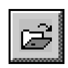
8 Click “Yes“ and delete the transforms

Note: Your binary lineament image is now saved as a VDS file on disk with the transforms deleted. Deleting the transforms will maintain the original dynamic range of the dataset without being clipped.

Convert the raster cells to vector polylines

1 From the **Process** menu, select **Raster Cells to Vector Polygons...**.

The **Raster to Vector Conversion** dialog box opens.

2 Click the **Input Raster Dataset**  chooser button.

3 From the **Directories** menu, select the path ending with the text **\examples\Miscellaneous\Tutorial**. Then open the ‘binary_NW_Lineaments_image_VDS.ers’ dataset you just created.

4 Click the **Output Vector Dataset**  chooser button.

5 From the **Directories** menu, select the path ending with the text **\examples\Miscellaneous\Tutorial**. In the **Save As:** text field as follows, then click **OK** to close the chooser. For example, if your initials are “MJ,” type in the name:

`MJ_Polylines_NW_Lineaments_Low_DN`

6 Edit the value in the **Cell Value** field to read **`1`** then press Enter or Return.

This tells ER Mapper to vectorize all pixels (cells) with the value 1 in the Virtual Dataset (the NW lineaments in the image).

7 Turn on the **Polylines** option (to create polylines instead of polygons).

8 Click **OK** to start the raster to vector conversion.

ER Mapper displays a status dialog indicating the progress, then displays a confirmation dialog when the conversion is complete.

9 Click **OK** to close the confirmation dialog, then click **Close** and **Cancel** to close the other two raster to vector dialogs.

You have now created a vector file containing polylines representing the NW Lineaments and ring features of the NE illuminated Newcastle Magnetic image.

Display the vector polylines over the Newcastle Magnetic image

1 In the main menu window, click the **New** button.

A new image window appears.

2 Click on the **Edit Algorithm** button in the main menu window.

3 The **Algorithm** window appears.

4 In the **Algorithm** window click the **Load Dataset** button in the **Algorithm** window.

5 The **Raster Dataset** file chooser dialog box appears.

6 From the **Directories** menu, select the path ending with **\examples**

7 In the directory 'Shared_Data,' open the dataset 'Newcastle_Magnetics.ers'

This is the same magnetic image you used to create the binary VDS.

8 In the Algorithm window, select **Annotation/Map Composition** from the **Edit/Add Vector Layer** menu.

A new annotation layer is added to the algorithm.

9 Click the **Edit Layer Color** button in the process stream diagram to choose a color for displaying the vectors.

10 Select a yellow color, and click **OK** to close the **Color Chooser**.

11 Click the **Load Dataset** button in the process stream diagram.

12 From the **Directories** menu, select the path ending with the text **\examples\Miscellaneous**.

13 In the directory 'tutorial,' double-click on the 'Polylines_NW_Lineaments_Low_DN.erv' dataset you created to load it.

ER Mapper first processes the raster data, then draws the vector polylines in yellow.

Convert the raster cells to vector polygons

1 Repeat the steps in **Convert the raster cells to vector polylines**.

2 However, in the **Raster to Vector Conversion** dialog instead of turning on the **Polylines** option turn on the **Fill Polygons** (to create polygons instead of polylines).

3 Save the vector file as '`Polygons_NW_Lineaments_Low_DN`.erv' in the \examples\Miscellaneous\Tutorial directory.

4 Display the lineaments filled with solid color (polygons) choosing a color (red) other than yellow which you have assigned it for the polylines of the lineaments on top of the Newcastle_Magnetics raster image.

Note: Lineaments may also coincide with magnetic highs such as dykes intruded into weak fault zones, contact metamorphism. Hence you can also highlight lineaments of high DN magnetics. Invert the dynamic range of the magnetics by inserting minus (-) in front of the INPUT1 in the formula of the magnetics and save it as either a dataset or a VDS and follow the above-mentioned procedures to automatically extract lineaments of high DNs and create vector files. Compare the lineaments extracted from the magnetic highs and lows.

Note: Similar to what you can create lineaments of magnetic highs and lows for a sun shaded TMI image with NE sun illumination you can also automatically extract lineaments of different orientation from sun shaded images with sun angle illumination of specific directions such as EW, NS, NW etc. You can create vector files of lineaments of different orientation from those sunshaded TMI images following the procedures mentioned above. Compare the lineaments and structural features extracted from sunshaded TMI images with different sun illuminations.

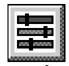
5: Annotating lineaments and structural features of sunshaded magnetic images and creating *.erv vector files.

1 Display the sun shaded TMI image or pseudo color drape or HSI colordrape with NE sun angle illumination. Choose the one that is best for visual interpretation. HSI colordrape seems to be the best.

2 Also display the algorithm with the lineaments and structural features highlighted from the NE sun shaded TMI image (Newcastle_Magnetics_NW_Lineaments.alg) to compare and use it as a guide in drawing lineaments and structural features from the HSI colordrape image.

3 In the Algorithm window, select **Annotation/Map Composition** from the **Edit/Add Vector Layer** menu.

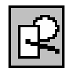
A new annotation layer is added to the algorithm.

4 Click the **Edit Layer Color**  button in the process stream diagram to choose a color for displaying the vectors.

5 Select a red color (red) , and click **OK** to close the **Color Chooser**.

6 Click the right-hand mouse button on the Annotation layer.

7 From the short-cut menu click Turn On.

8 **Annotate Vector Layer** button  appears on the process stream diagram.

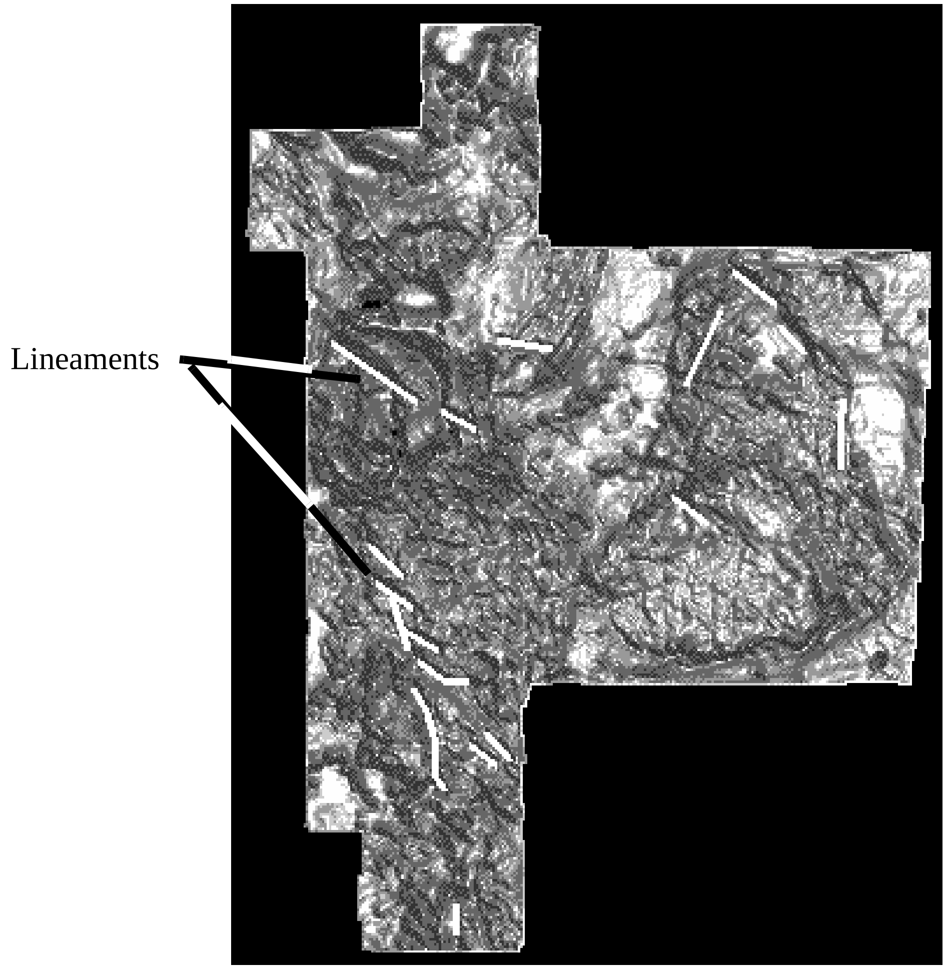
9 Click on the **Annotate Vector Layer** button.

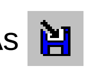
An **ER Mapper** warning dialog and the annotation **Tools** palette dialog appear. You will use the vector annotation tools to draw lineaments and structural features on the image.

10 Click **Close** in the **ER Mapper** warning dialog to close it. (When using annotation tools for other purposes the default Fixed Page mode is not recommended, but it is fine for this exercise.)

11 In the **Tools** dialog, click the **Annotation: Poly Line**  button.

12 As shown in the following diagram, define lineaments and structural features starting from the beginning of an obvious lineament or structural features and extending through to the end. (Click once at the start point, click once at the end point, then double-click to end the line definition.)



13 When you have completed drawing the lineaments and structural features on the HSI colordrape image in the **Tools** dialog click on the Save As  button.

14 **Map Composition Save As** dialog appears.

15 Select **Vector File** option and click **Save to File:** button .

16 **Save Map Composition File** dialog appears.

17 In the **Save Map Composition File** dialog select the \examples\Miscellaneous\Tutorial directory and type in NE_illuminated_Lineaments.erv at **Save As:** text field and click **OK.**

18 The vector name NE_illunimated_Lineaments.erv is loaded in the **Save To File:** text field in the **Map Composition Save As** dialog.

19 Click OK button in the **Map Composition Save As** dialog and save the vector file.

Note: Vector files can also be created for lineaments with different orientation highlighted using different sun angles illumination. The vector files can also be saved as ARCINFO or DXF formats and use them as GIS layers in a GIS software.

Close the image window and the Algorithm dialog

1 Close the image windows using the window system controls:

- For Windows, click the  **Close** button in the upper-right window corner.
- For Unix systems, select **Close** or **Quit** from the window control menu in the upper-left corner (for systems with both options, select **Quit**).

2 Click **Close** in the **Algorithm** dialog.

Only the ER Mapper main menu is now open.

What you learned...

After completing these exercises, you know how to perform the following tasks in ER Mapper:

- Create colordrape images with specific sun angle illumination and save them as VDS
- Use an existing HSI shiny look algorithm and create your own HSI shiny look algorithms highlighting lineaments of different directions
- Compare highlighted lineaments of different orientational
- Create vector files of lineaments with different orientation

8

Viewing image data values

This chapter shows you the tools ER Mapper provides for viewing dataset values and coordinate locations. These include cell (pixel) values, neighborhoods, signatures, and traverse extraction. You also learn how to measure distances between two points on an image.

About viewing data values

Viewing image data values is one of the fundamental ways to assess data quality and the particular characteristics of features in an image. Options for viewing data values and geographic locations in ER Mapper include:

Cell values	The data value associated with each cell or pixel in the dataset, or the data values of that cell in each band of a multi-band dataset.
Neighborhoods	An array of data values surrounding a pixel.
Signatures	The data values of a pixel in all bands shown in a line graph format.
Traverse extraction	A profile of data values occurring along a line or polygon drawn on the image.

Scattergrams — An X-Y plot showing the relationship between data values in two bands of an image (covered in a later chapter)

Histograms — A plot showing the range of data values on the X axis and their relative frequency on the Y axis

Hands-on exercises

These exercises show you various ways of viewing data values, coordinate locations, and geographic distances between two points on an image.

What you will learn... After completing these exercises, you will know how to perform the following tasks in ER Mapper:

- View image data values in text and line graph (signature) format
- View distances between any two points on an image
- View image data values along a transect profile line

Before you begin... Before beginning these exercises, make sure all ER Mapper image windows are closed. Only the ER Mapper main menu should be open on the screen.

1: Viewing cell values and signatures

Objectives Learn to view image data values in a text format, neighborhood format, and signature (line graph) format.

Open and display a sample radiometrics algorithm

1 On the main menu, click the **Open**  button.

An empty image window and the **Open** dialog box appear.

2 From the **View** menu, select **Algorithm**.

The **Algorithm** dialog opens.

3 From the **Directories** menu, select the path ending with the text **\examples**.

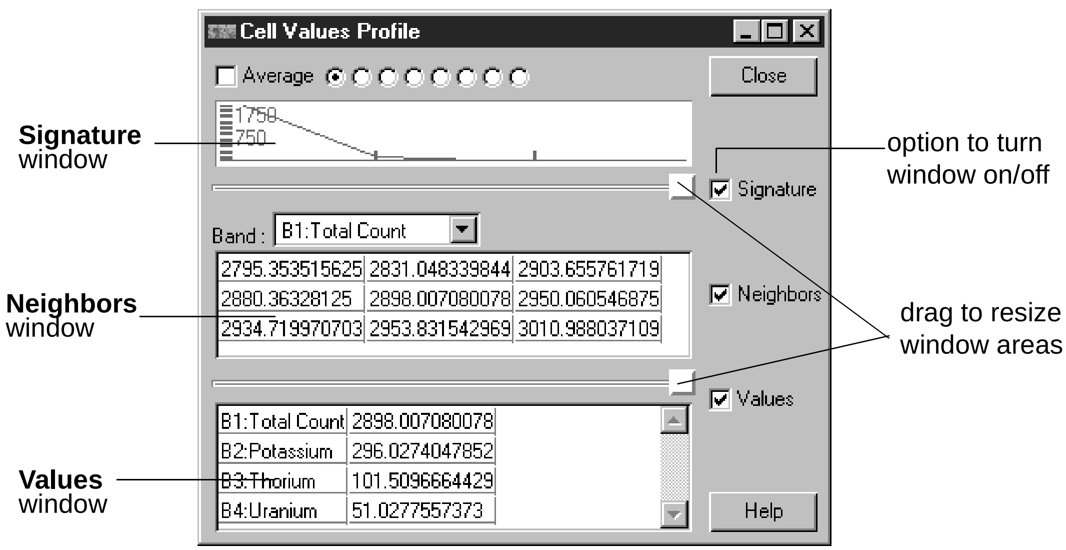
4 Open the ‘Data_Types\Magnetics_And_Radiometrics’ directory, then double-click on the algorithm ‘Radiometrics_Magnetics_RGBI.alg’ to display it.

This algorithm drapes three channels of radiometrics data in (potassium, uranium and thorium) in RGB color over shaded magnetics to provide structure (similar to one you created in an earlier chapter using the Newcastle dataset). This dataset is from the Cape York peninsula area of northeastern Australia.

View cell values for the magnetics dataset

1 From the **View** menu, select **Cell Values Profile...**.

The **Cell Values Profile** dialog box appears. Drag it by its title bar next to the image window. This dialog has three display windows, any of which can be turned on or off at any time.

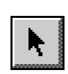


By default, all three options are turned on (**Values**, **Signature** and **Neighbors**.)

2 If needed, resize the dialog until all fields are visible as shown above.

3 Turn off the **Signature** and **Neighbors** options by deselecting their option buttons.

Those windows disappear from the **Cell Values Profile** dialog.

4 On the main menu, click the **Pointer Tool**  button

This tells ER Mapper that you want to use the mouse pointer to view data values.

5 In the algorithm dialog, select the Intensity layer containing the 'Magnetics_Grid' dataset.

6 Point inside the image window, and press and drag the mouse pointer through the image (or just click on any pixel).

The **Cell Values Profile** dialog displays the data values for the magnetics dataset for the current cell (pixel) location in the image (this is a total magnetic intensity dataset, so values are in nanoteslas). The data values are updated as you drag the mouse through new locations.

The sun angle shading emphasizes the steep gradient associated with the magnetic high running diagonally through the image. You can see the change in data values by dragging the mouse slowly through that area.

View cell values for the radiometrics dataset

When two or more datasets are displayed in a single algorithm, you need to select the layer containing the desired dataset to view its data values.

1 In the **Algorithm** dialog, select any of the three layers (Red, Green or Blue) containing the ‘Radiometrics_Grid’ dataset.

2 Point inside the image window, and press and drag the mouse pointer through the image (or just click on any pixel).

The **Cell Values Profile** dialog displays the data values for the radiometrics dataset for the current cell (pixel) location in the image. This dataset has four bands (Total Count, Potassium, Uranium and Thorium), so you see the value in each band at the current cell location.

View a neighborhood of cell values

1 In the **Cell Values Profile** dialog, turn on the **Neighbors** option.

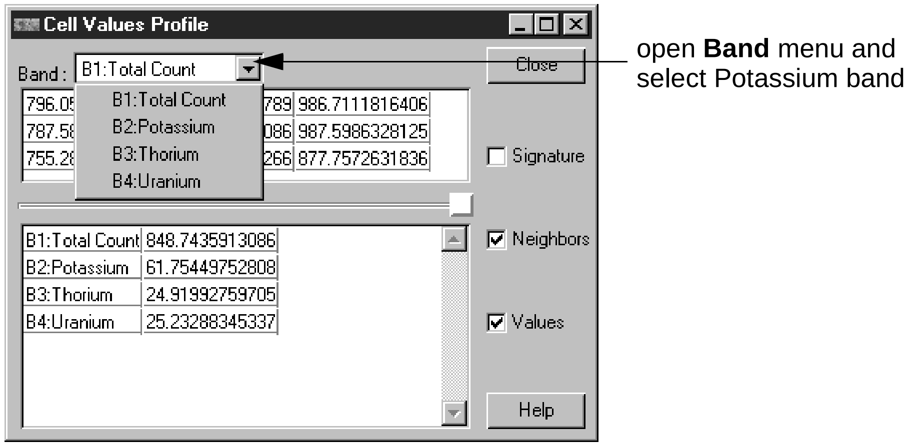
A second window is added to the **Cell Values Profile** dialog, with a drop-down menu to select a dataset band.

2 If needed, resize the dialog box to make it wider until you can see the full nine cell matrix of data values in the Neighbors window.

3 Point inside the image window, and drag the mouse pointer through the image (or just click on any pixel).

A three-by-three neighborhood of cell values displays as you drag the mouse. The center pixel in the three-by-three array is the current pixel, and the surrounding eight pixels are its neighbors. By default, the band 1 (Total Count) values are displayed. This feature is useful to viewing the local variance or gradients in various parts of an image.

4 From the **Band** drop-down list, select **B2:Potassium** then drag again in the image.



The data values for band 2 of the radiometrics dataset (Potassium) display in the three-by-three neighborhood.

View a signature of cell values

1 In the **Cell Values Profile** dialog, turn on the **Signature** option.

A third window is added to the **Cell Values Profile** dialog, with a row of buttons on top. This option shows the same data as displayed in the Values window, but in line graph format.

The Signature option is designed for use with datasets that contain multiple bands, and would not normally be used with datasets that contain a single band such as the magnetics dataset. It can be very useful to see graphically how the data values in various bands relate to each other in different parts of an image. Following are general procedures for using the Signature feature:

- To view a signature, click on one of the option buttons above the Signature window, and drag through the image or click on a feature. The data values for all bands in the dataset will appear as a line graph (a “signature”) in the Signature window. (This is the same data shown in the Values window but displayed in line graph format.)
- The buttons above the Signature window set a color for the graph line(s). To see a second signature in a different color, click on another button above the Signature window. A second graph line in a different color will appear. (Each of the buttons starts a new color graph line that appears after you drag or click in the image.)
- To view a signature showing the *accumulated average* of all the data values over the area where you dragged, click on the Average option before dragging. A thickened graph line will appear to indicate that this signature is an average, and you can add to the average signature by continuing to drag. (This allows you to view the average signature over a broad feature area instead of a single pixel at a time.)

2 Click the **Close** button on the **Cell Values Profile** dialog box to close it.

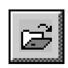
3 Click **Close** on the **Algorithm** window to close it.

Note: The data values shown in the **Cell Values Profile** dialog are taken directly from the dataset on disk. Therefore, any processing you apply in your display algorithm (such as a formula or filter) do not affect the data values you see here.

2: Viewing locations and distances

Objectives Learn to view the geographic location of features in a dataset, and to measure the distance between two points in an image (mensuration).

Open a magnetics Pseudocolor algorithm

1 On the main menu, click the **Open**  button.

2 From the **Directories** menu (on the **Open** dialog), select the path ending with the text **\examples**.

3 Open the ‘Data_Types\Magnetics_And_Radiometrics’ directory, then double-click on the algorithm ‘Magnetics_Colordrape.alg’ to display it.

This algorithm colordrapes total magnetic intensity (TMI) data in color over shaded magnetics. Mag highs display as orange and red colors. This dataset is from the Cape York peninsula area of northeastern Australia.

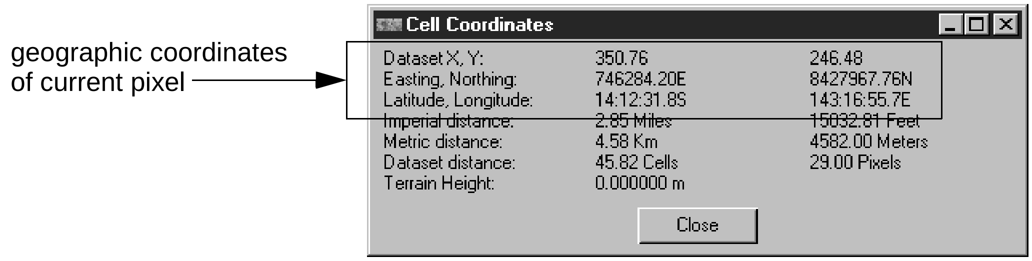
View geographic coordinates in the image

1 From the **View** menu, select **Cell Coordinate...**.

The **Cell Coordinates** dialog appears. Drag it next to the image window.

2 Point to the image window, and drag the pointer through the image.

The dataset and geographic location of the current cell appear, and are updated as you drag the mouse. The upper three fields of this dialog show the location of the current pixel in dataset column (X) and row (Y) coordinates, and the Eastings/ Northings and Latitude/Longitude coordinate systems.



Note: The Easting Northing and Latitude Longitude fields only display values if the dataset is georeferenced to a map projection. Unregistered (raw) datasets display zero values in these fields.

View distances between points in the image

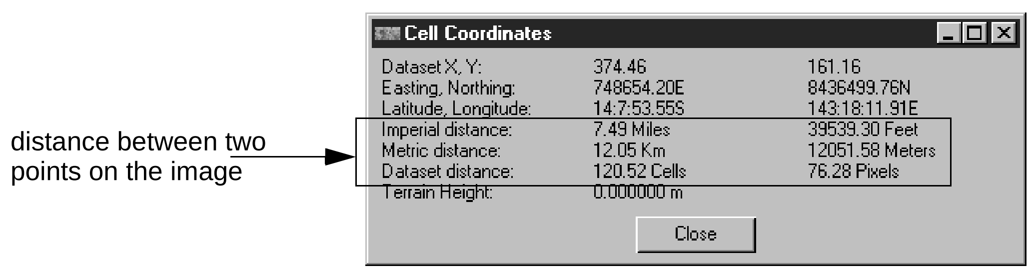
The lower three fields of the **Cell Coordinate** dialog show distance between the point where you first depress the mouse button and the point where you release it. Distances are shown as Imperial distance (feet and miles), Metric distance (meters and kilometers), and Dataset distance (number of cells in the X and Y directions).

1 Point to the image window, and click on any point in the image.

The Imperial, Metric, and Dataset distance fields are cleared to zero values.

2 Pick out two features in the image, then drag the mouse between them.

The distance between those two points is displayed when you release the mouse button. Measuring the distance between two points is called *mensuration*.



(The Terrain Height field is only active when the image is viewed in 3D.)

View the magnetics dataset in 3D perspective

1 From the **View** menu, select **Algorithm**.

The **Algorithm** dialog opens.

2 From the **View Mode** menu (on the **Algorithm** dialog), select **3D Perspective**.

ER Mapper renders the magnetics dataset in 3D perspective. The “topography” in the image is the strength of the magnetic field, so mag highs appear as higher features in the 3D surface (also shown by color).

Query cell values and coordinates on the 3D image

1 From the **View** menu, select **Cell Values Profile...**.

Both the **Cell Values Profile** and **Cell Coordinates** dialog should be open.

2 Drag inside the image window, and view the cell values and coordinates.

Notice that the mouse cursor becomes a cross that conforms to the 3D surface as you drag on the image. The arrow on the cursor points north. Querying cell values and coordinates works essentially the same in 3D view mode as it does in 2D.

3 Click **Close** on the **Cell Values Profile** and **Cell Coordinates** dialogs to close them.

4 From the **View Mode** menu (on the **Algorithm** dialog), select **Normal** to display the image in 2D.

5 Click **Close** on the **Algorithm** dialog.

3: Viewing traverse profiles

Objectives Learn to view image data values for as a profile or transect along a line or polygon drawn on the image (called *traverse extraction*). Also learn to view profiles for multiple band datasets such as radiometrics..

Set up to draw traverse profile lines

1 From the **View** menu, select **Traverse...**.

The **New Map Composition** and **Traverse** dialogs open.

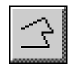
2 On the **New Map Composition** dialog, be sure the **Vector File** option is selected, then click **OK**.

The annotation **Tools** dialog appears, along with an **ER Mapper** warning dialog box.

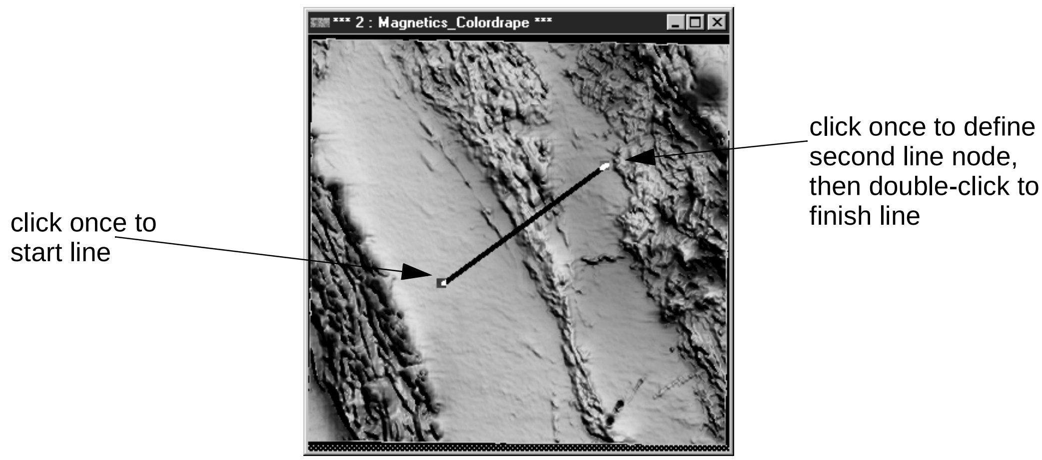
3 Click **Close** on the **ER Mapper** warning dialog to close it. (When using annotation tools for other purposes Page Setup is recommended, but it is not important for this exercise.)

You will use the vector annotation tools in the **Tools** dialog to draw traverse lines on the image.

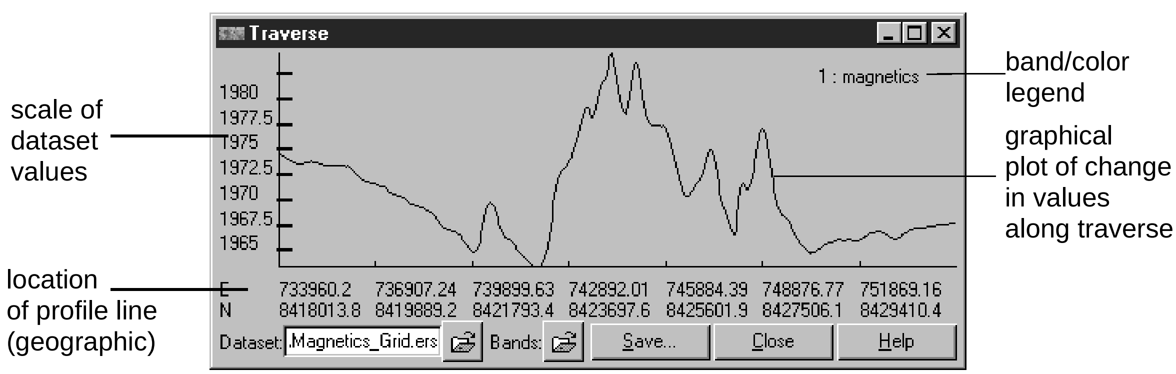
Draw a traverse line on the image

1 On the **Tools** dialog, click the **Poly Line**  button.

2 Inside the image window, define a straight line across the mag high in the center. Click once at the start point, click once at the end point, then double-click to end the line definition.



A profile line appears inside the **Traverse** dialog. This line displays the change in the values of pixels underneath the traverse line you drew. The traverse line lets you clearly see the gradient and change in TMI values over the magnetic high..



Draw a second traverse line on the image

1 Inside the image window, define a second line in a different area by again clicking once at the start point, click once at the end point, then double-click to end the line definition.

The new profile line appears inside the **Traverse** dialog. You can draw as many different traverse lines on the image as you desire.

Tip: You can also drawn polylines (lines with multiple nodes) that, for example, zig-zag back and forth across a feature like a magnetic high. (Just click once at each node, then double-click to end the line.)

Alternate between the two traverse lines

1 On the **Tools** dialog, click the **Select/Edit Points Mode** button.

2 Inside the image window, click on the first traverse line you drew.

The line becomes selected and its corresponding profile again appears in the **Traverse** dialog. You can view the profiles for any traverse line you've drawn by simply selecting it as shown here.

Revise the location of a traverse line

1 Drag one of the endpoints of the selected line to a new location on the image.

When you release the mouse button, the profile is automatically updated in the **Traverse** dialog. You can modify the location and length of any traverse line by following these steps.

Close Traverse Extraction

1 Click **Close** on the **Traverse** dialog.

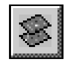
2 Click **Close** on the **Tools** dialog. When asked to save the current annotation, click **No**.

Open a radiometrics RGB algorithm

1 On the main menu, click the **Open** button.

2 On the **Open** dialog, double-click on the algorithm ‘Radiometrics_RGB.alg’ to display it.

This is the radiometrics dataset associated with a portion of the magnetics dataset used earlier. In this RGB algorithm, Potassium data is displayed in red, Thorium in green, and Uranium in blue.

3 On the main menu, click the **Edit Algorithm**  toolbar button to open the **Algorithm** dialog.

4 On the **Algorithm** dialog, select the Red, Green or Blue layer containing the ‘Radiometrics_Grid’ dataset.

Set up to draw traverse profile lines

1 From the **View** menu, select **Traverse...**.

2 On the **New Map Composition** dialog, be sure the **Vector File** option is selected, then click **OK**.

The annotation **Tools** dialog and **ER Mapper** warning dialogs open.

3 Click **Close** on the **ER Mapper** warning dialog.

Draw a traverse line on the image

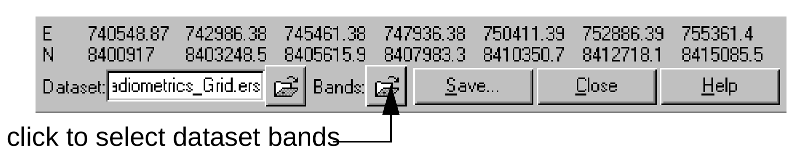
1 On the **Tools** dialog, click the **Poly Line**  button.

2 Inside the image window, define a traverse line by clicking once at the start point, once at the end point, then double-click to end the line definition.

The profile line for displays in the **Traverse** dialog. By default, the band 1 (Total Count) data values are displayed.

View traverse lines for three dataset bands at once

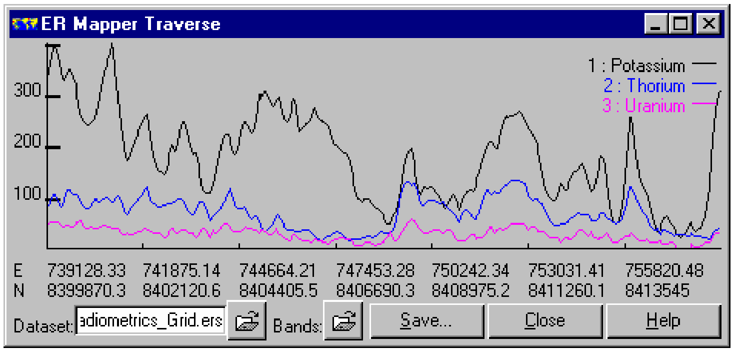
1 On the lower part of the **Traverse** dialog, click the **Bands:**  button.



The **Traverse Band Selection** dialog appears showing the four bands in this radiometrics dataset.

2 Hold down the Ctrl key on your keyboard, then click on the Potassium, Thorium and Uranium bands in the list to select them. (They should become reverse highlighted.)

3 Click **OK** on the **Traverse Band Selection** dialog.



Profiles for the three bands appear together in different colors in the **Traverse** dialog. This lets you graphically see the relationships between the change in the values for each band along the traverse line on the image.

Note: As with the Cell Profiles, traverse profiles show the data values actually stored in the dataset on disk. Therefore algorithm formulas, transforms, and so on do not affect the data values shown in traverse profiles.

Close Traverse Extraction

1 Click **Close** on the **Traverse** dialog to close it.

2 Click **Close** on the **Tools** dialog. When asked to save the current annotation, click **No**.

Tip: If desired, you could save the current annotation layer and reload it later, and you can also save the traverse profiles to an XYZ format dataset on disk for export to other analysis software if desired. See the *ER Mapper User Guide* for more information.

Close the image window and the Algorithm dialog

1 Close the image window using the window system controls:

- For Windows, click the [X] **Close** button in the upper-right window corner.

2 Click **Close** on the **Algorithm** window to close it.

Only the ER Mapper main menu is now open.

What you learned...

After completing these exercises, you know how to perform the following tasks in ER Mapper:

- View image data values in text format
- View distances between any two points on an image
- View image data values along a transect profile line

9

Highlighting Radiometric Anomalies

This chapter discusses briefly the basic principles of radiometrics and remote sensing methods. It also shows you how to highlight Radiometric anomalies of K, Th and U both individual elements and combined in Red Green Blue (RGB) color composite and use of ratios.

About Radiometric data

Radiometrics is airborne geochemistry of K, Th and U and their decay series. These are the only naturally occurring elements with isotopes that produce gamma rays with sufficient energy and intensity to be measured at airborne survey heights. Radiometric data are usually collected using gamma-ray spectrometers with 33 litre Sodium Iodide crystal detectors. These record gamma rays in 256 energy channels. Samples are normally taken every second which corresponds to 40 - 70 metres along line intervals. Processed radiometric data normally has four bands : Total Counts (gamma-ray radiation total count per second), and three other bands with gamma-ray radiation count per second of K, Th and U. Average crustal abundances are K - 2%, Th - 8.5 ppm and U - 2.7 ppm.

Quality of radiometric data

Certain corrections have to be made before meaningful analysis of radiometric data. These include:

- **Dead time correction:** To correct the finite time that the Spectrometer requires to process each pulse from the detector. A typical dead time would be in the order of 5-15 microseconds per pulse.
- **Energy drift correction:** To correct for changes in the gain of the photomultiplier tubes because of drift in the high-voltage supply and changes in temperature. A gain drift of just 2 % can change the processed data by several percent.
- **Aircraft and cosmic background correction:** Aircraft background spectrum is due to the radioactivity of the aircraft and its content. Cosmic background component arises from the reaction of primary cosmic radiation with atoms and molecules in the upper atmosphere. Both have to be corrected.
- **Radon background correction:** Radon gas (Rn 222) which has a very similar spectrum shape to that of U is very mobile and can escape into the atmosphere from soils and rock fissures. Up to 50% of the U window count rate can arise from Rn daughter products in the atmosphere. This has to be corrected. This is usually done with the use of "upward looking detectors", or 256 channel methods using high and low energy "uranium" channels.
- **Channel interaction correction:** This is to correct K, Th and U window count rates for gamma-rays not originating from radioelement or decay series being monitored.
- **Height correction:** This is to correct the effect of variation in height of the detector. Radiation from narrow source attenuates more rapidly with distance than that from broad source and low-energy radiation falls off more rapidly with distance than high-energy radiation.
- **Background radioelement concentration correction:** Count rates of the radioelements should have a direct geological significant. Hence effects from instrument and survey parameters such as crystal volume, detector efficiency and window widths should be corrected and count rates should be converted to mean-ground-level abundances of the radioelements.
- **Levelling:** Due to variations in soil moisture, vegetation thickness and Rn content of rocks and soils during the radiometric data acquisition, unwanted radiations are measured both along and between lines. These can be corrected using Levelling using Crossover Ties, Between-Channel correlation Information and Microlevelling.
- **Error propagation correction:** Statistical counting error in gamma-ray spectrometry that occur during the radiometric data acquisition should also be corrected.
- Attempts have been made in Australia to standardize data from radiometric surveys between different aircraft and survey specifications, to units of equivalent ppm K, Th, U based on Canadian experience.

Distribution of radioelements in rocks and soils

Aerial gamma-ray surveying reflects the geochemical variations of K, Th and U in the upper 30-40 cm of the Earth's surface. To be able to interpret radiometric data and relate them to mineralization it is important to understand the distributions of radioelements in rocks and soils.

Distribution of radioelements in rocks: There is a trend of increasing radioelement content with increasing Si content. Felsic rocks have higher radioelement content than ultrabasic and mafic rocks. Generally, Th shows much larger increase than U and ratio such as Th/U can be used to investigate the degree of differentiation within igneous suites. However, there is a wide range of radioelements values within any given rock types. Hence no global classification of rock type is possible based on radioelements content. For example: A rock with low radioelement content (<1% K, < 5 ppm Th, < 1 ppm U) could be anything except felsic intrusive or shale. Nevertheless, within a small region, different rock types can often be identified on the basis of the relative concentration of radioelements.

Metamorphism does not effect radioelement content. Hence, metamorphic rocks such as gneiss derived from granite, amphibolite derived from dolerite, will have similar radioelements as those of granite and dolerite igneous rocks.

Sedimentary rocks generally reflect radioelement content of the parent source rocks. Immature sedimentary rocks will have higher radioelement content whereas mature sedimentary rocks will have low values. However, there are cases which show that mature sedimentary rocks have high radioelement contents such as Archean shale in Australia.

Distribution of radioelements in soils: To do geological mapping using radiometrics it is important to understand the relationship between radioelement contents detected in soils and underlying rocks.

In situ soils over granite may have high K content (from phenocryst K-feldspar) due to its resistance to weathering and the removal of more easily weathered minerals such as plagioclase - mafic minerals in the early stage of weathering. On the other hand under lateritic weathering condition (oxidation environment) granitoid may be kaolinised, resulting in substantial loss of K, but apparent retention of 60-80 % of the Th and U. U is more mobile and can be distributed along grain boundaries and microfissures.

There is no major change in radioelement content on the weathering of intermediate intrusives. Weathered dolerites are often contaminated with transported materials from adjacent, radioelement-rich rocks. Freshly weathered dolerites do not show changes in radioelement contents. Weathering of felsic volcanics generally produces soil showing loss of all three elements (20-30%). Soils over mafic volcanics have remarkable changes. They have major losses in K (up to 50%) but gain Th and U content. In areas of basalt of various ages, different flows can be distinguished by the way their K and Th changes with weathering.

Soils over Archean shale contain an average of 0.8% K, 3 ppm Th and 1.2 ppm U, very close to the composition of unweathered shale. However, lateritic weathering of shales can result in almost complete lost of K but retain Th and U.

Clay eluviation, colluvial and aeolian transport, and soil movement which are geological processes other than in-situ weathering can effect the radioelement content of soils. These effect the concentration of radioelements in the thin 30 cm layer measured in the airborne radiometric surveys.

Calcrete - a surficial chemical weathering product has low radioelement concentrations and can mask the radiometric signatures of underlying rocks. However, calcrete formed over high radioelement rocks (siltstones, schists, gneiss) may have slightly higher radioelements. Iron-rich surface materials (ferricrete, pisoliths) contain high Th (24-43 ppm). Gossans are variable in radioelement contents.

Generally in situ soils can be good indicators of the underlying rocks.

Some examples of radiometric applications :

- **Geological mapping (regolith)** using radiometrics is essentially correlation between radioelements and the groundtruthed geology of the area of investigation and extension to unknown areas with similar signatures. It is particularly good where there are in-situ soils with radioelements representing the underlying rocks. In areas with thick overburden you should be careful of whether the radiometric signatures are true representation of the underlying geology. Thick overburden reduces radiometric signatures and soil in the thick overburden may have been transported from distant sources.
- **Uranium exploration:** Uranium mineralization would have high concentration of Uranium. To reduce the common radiometric signatures of soils in the three radioelements, K, Th and U, ratios such as U/Th and U/K and U*U/TH are useful to locate high Uranium areas.
- **Bauxite exploration:** Bauxites derived from nepheline syenites tend to have unusually high Uranium and Thorium whereas bauxites derived from basic igneous rocks have very low radioelement contents.
- **Phosphate exploration:** Phosphate deposits have high Uranium and high U/Th ratio.
- **Heavy minerals sand exploration:** Monazite and zircon are heavy sand minerals and have anomalous radioactivity due to Thorium, sometimes Uranium but rarely Potassium.
- **Porphyry Copper exploration:** Potassium concentration has been found to be higher in the porphyry copper mineralization. Uranium and Thorium are irregular and have little value for porphyry copper exploration.

- **Hydrothermal alteration related mineralization:** Potassium is found to have increased in zones of alteration whereas Thorium concentration remains unchanged. Hence, K/Th ratio is indicative of hydrothermally altered zones. Some hydrothermal mineralizations in Canada and Australia have high U/Th and K/U ratios.
- **Sedimentary depositional environment:** There are some indications that sediments that have Th/U ratio higher than 7 may have deposited in oxidized continental environment whereas those that have Th/U ratio less than 7 may have deposited in marine environment.
- **Epithermal gold mineralization at Newcastle Range, Australia:** The Newcastle Range has a Carboniferous acid volcanic sequence.The classic target signature is magnetic lows and high potassium anomaly indicating possible hydrothermal alteration of the volcanics.

Hands-on exercises

These exercises show you how to highlight individual radioelement, ratioing and creating RGB color composites.

What you will learn...

After completing these exercises, you can perform the following tasks in ER Mapper:

- Highlighting soils that contain high anomaly of K, Th, U radioelements
- Display and analyze radioelements and their ratios in Red Green Blue (RGB) color space

Before you begin...

Before beginning these exercises, make sure all ER Mapper image windows are closed. Only the ER Mapper main menu should be open on the screen.

1: Highlighting soils with high anomaly of K, Th and U

Objectives

Learn to highlight and display each components of a radiometric element and adjust the color mapping (transform).

Open an image window and Algorithm window

1 Click the **Edit Algorithm**  button in the main menu window.

ER Mapper opens a new image window and the **Algorithm** dialog.

Load a raster dataset into the Pseudocolor layer

1 In the Algorithm dialog, click the **Load Dataset**  button.

The **Raster Dataset** file chooser dialog box appears.

2 In the **Files of Type:** field, select “ER Mapper Raster Data (.ers)”

3 From the **Directories** menu, select the path ending with **\examples**.

4 Double-click on the directory named ‘Shared_Data’

5 Double-click on the dataset named ‘Newcastle_Radiometrics.ers’ to load it (scroll down to view if needed).

The file chooser dialog box closes, and the dataset is loaded into the Pseudocolor layer. Note that the dataset name (‘Newcastle_Radiometrics.ers’) now appears above the process diagram.

6 Change the lookup table color to Pseudocolor (if required)

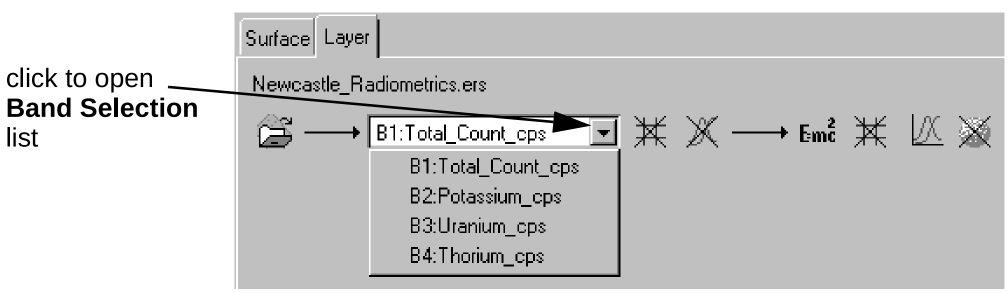
Display the Potassium band and adjust color mapping

Geophysical datasets (and other types of data) sometimes contain multiple layers or “bands” of data. This dataset, for example, contains four bands: Total_Count, Potassium, Uranium and Thorium. You can choose to display any band (or a combination of bands) in a raster data layer.

1 In the **Algorithm** dialog, click on the **Band Selection** 

drop-down list in the process stream diagram.

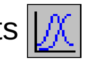
A menu listing the four different bands in the radiometric dataset displays.



2 Click on the band labelled **B2:Potassium_cps**.

The menu closes and the new band appears in the **Band Selection** list button.

ER Mapper renders band 2 of the radiometric dataset (Potassium) in the image window. High K anomaly areas are displayed as red and low K anomaly areas are displayed as blue (for Pseudcolor).

3 In the Algorithm window click the Edit Transform Limits  button. The Transform window appears.

Note: In the **Transform** dialog box, you'll notice that the dynamic range of Potassium image is between -13 to 502.

Apply a threshold to map high anomalies of Potassium

1 In the Transform window manually adjust the X-axis to about 340 (vertical).

Note: You have selected 340 as the threshold to map high K anomalies above 340 DN as red and less than 340 DN as blue

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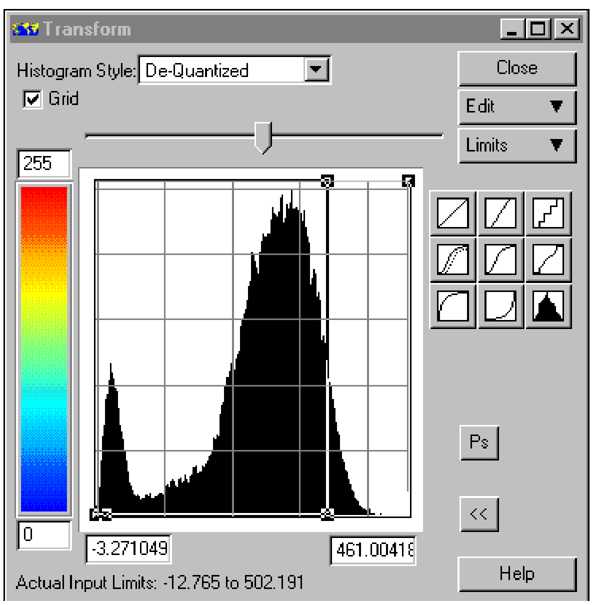


ER Mapper renders the image again, this time K anomalies higher than 340 DN is displayed as red and DN less than 340 is displayed as blue.

Dark Pixel Correction of the K image for proper evaluation

1 In the Main Menu window click on the **Copy Window**  button and duplicate the K image.

2 A new window with K high anomalies (>340 DN) in red and low anomalies (<340 DN) in blue is displayed.

3 In the Algorithm dialog, select **Edit Formula** button.

4 **Formula Editor** dialog appears.

5 In the **Formula Editor** dialog type in “ (i1 - rmin(, r1,i1))” in the generic formula window area.

Note: Radiometric data are recorded number of counts of radiometric elements (K, Th, K) and properly recorded radiometric data with the necessary corrections made should not have negative counts. You are adjusting the lowest negative number of count (dynamic range) of the K image so the count starts from zero(0) rather than negative.

Note: The Dark Pixel Correction formula is applied to reduce the negative minimum response of the radioelement K. It is similar to dark pixel correction in Landsat atmospheric correction.

---

6 Click the **Apply changes** button in the **Formula Editor** dialog.

7 The Dark Pixel Correction formula applied K image is displayed

---

Note: Notice the actual input now is between 0 to 514.9 not as -12.76 to 502.19 before dark pixel correction.

Display the Thorium band and highlight high anomaly areas

1 In the Main Menu window click on the **Copy Window** button

2 In the **Algorithm** dialog, select **B4:Thorium_cps** from the **Band Selection** drop-down list.

ER Mapper renders band 4 (Thorium) in the new image window.

3 Follow the steps mentioned above in highlighting high anomaly areas for K band and highlight high anomaly areas for Th band

---

Note: The **Th** band of the Newcastle_Radiometrics.ers data has a dynamic range of 8.79644 to 397.645752. It starts from positive 8.79644 DN value. You should be careful in applying the Dark Pixel Correction to images of radiometric elements that start with positive values. If the lowest DN is positive and represents the actual lower limit of Th values of soils than you should not apply the Dark Pixel Correction.

Display the Uranium band and highlight high anomaly areas

1 In the Main Menu window click on the **Copy Window** button

2 In the **Algorithm** dialog, select B3:**Uranium_cps** from the **Band Selection** drop-down list.

ER Mapper renders band 3 of the radiometric dataset (Uranium) in the new image window.

3 Follow the steps mentioned above in highlighting high anomaly areas for K band and highlight high anomaly areas for U band

---

Note: The U band of the Newcastle_Radiometrics.ers data has a dynamic range of -0.056 to 144.621. Applying the formula (i1 - rmin(,r1,i1)) will give you the dynamic range of 0 to 144.677.

2: Creating an RGB algorithm

Objectives Learn to display three components of a radiometric dataset as an RGB color composite image and adjust the color mapping (transform) for each layer.

Note: Close all the image windows and the Algorithm window. Only the main menu window should be opened.

Open an image window and Algorithm window

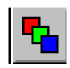
1 Click the **Edit Algorithm** button in the main menu window.

ER Mapper opens a new image window and the **Algorithm** dialog.

Load and display the radiometric dataset

1. In the Algorithm dialog, click the **Load Dataset**  button.
2. In the **Files of Type:** field, select “ER Mapper Raster Data (.ers)”
3. From the **Directories** menu, select the path ending with the text **\examples**.
4. Open the ‘**Shared_Data**’ directory, then double-click on the dataset named ‘Newcastle_Radiometrics.ers’ to load it.

   Band 1 (B1:Total_Count_cps) of the dataset is loaded into the Pseudo Layer.

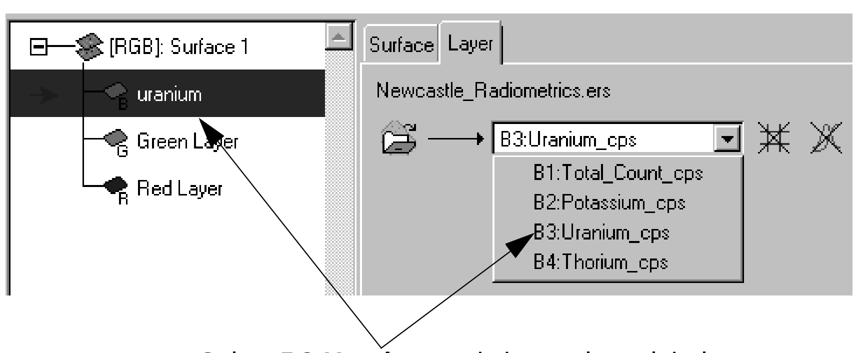
5. Click the **Create RGB Algorithm**  button in the Forestry Toolbar of the main menu.

   ER Mapper displays three bands of the radiometric dataset as an RGB image. You need to choose the desired bands to display and adjust the contrast (transform) of each layer next to create an enhanced color image.

Select appropriate bands and enter labels for the RGB layers

Radiometric data is often displayed in RGB by selecting the potassium data as the red component, thorium as the green component, and uranium as the blue component.

1. Highlight the inactive Pseudo Layer  and remove it from the Data-Structure using the cut  button in the Algorithm window.
2. Select the Blue layer in **Algorithm** dialog, then choose **B3:Uranium_cps** from the **Band Selection**  drop-down list, and change the layer label to **`uranium`**.



Select **B3:Uranium** and change layer label

3. Select the Green layer, choose the band **B4:Thorium_cps**, and enter the layer label **`thorium`**.

4 Select the Red layer, choose the band **B2:Potassium_cps**, and enter the layer label `potassium`.

5 A potassium, thorium and uranium RGB image is displayed.

Next you need to adjust the contrast (transform) of each layer next to create a contrast-enhanced color image.

Adjust the transforms for the RGB layers to increase contrast

1 With the 'potassium' (red) layer selected, click on the post-formula **Edit Transform Limits** button in the process diagram.

The **Transform** dialog box opens showing the histogram for the potassium data.

2 From the **Limits** menu (in the **Transform** dialog), select **Limits to Actual**.

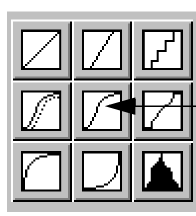
The X axis (input) limits are changed to match the range of the potassium data.

3 Click the **Move to next Green layer** G button, and select **Limits to Actual** from the **Limits** menu for the 'thorium' (green) layer.

4 Click the **Move to next Blue layer** B button, and select **Limits to Actual** from the **Limits** menu for the 'uranium' (blue) layer.

You now have a presentable image, but you can increase the contrast between the red (potassium), green (Thorium) and blue (uranium) components further by applying a histogram equalization transform to each layer.

5 For each layer, click the **Histogram equalize** button. (Move between them using the R, G and B buttons.)



The resulting RGB color composite image shows information about the relationships and relative strengths of each component. Radiometrics RGB displays can also be useful in geological mapping because different rocks types can often be recognized by their distinctive radioactive signatures.

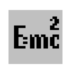
Following are some general rules for interpreting colors in RGB images:

- Black, grey or white colors indicate that the proportional response from each component is relatively equal, i.e., one is not dominant. Black indicates very low values for all three components, grey colors are mid-level values for all three, and white are high values for all three.
- Red, green, or blue colors indicate that one of the three components has a much higher value relative to the other two. For example, where you see red colors potassium has a high value relative to the thorium (green) and uranium (blue) components.
- Cyan, magenta or yellow colors indicate that two of the components have relatively high values and the third has a low value. (The colors of two components combine to create a third color.) For example, magenta colors are produced in areas with high potassium (red) and uranium (blue) values, and low thorium (green) values. Cyan (light blue) colors indicate high uranium (blue and thorium (green), and yellow indicates high potassium (red) and thorium (green).

6 Click **Close** to close the **Transform** dialog box.

3: Creating a ratio RGB algorithm

Objectives Learn to apply ratio with dark pixel corrected radiometric bands K, Th and U and create RGB color composite image.

1 With the RGB color composite of radiometrics displayed, highlight the Red layer and click on the Edit Formula  button in the Algorithm window.

2 **Formula Editor** dialog appears.

3 In the **Formula Editor** dialog type in “ (i1 - rmin(,r1,i1))/((i1 - rmin(,r1,i1)) + (i2) + (i3 - rmin(,r1,i3)))” in the generic formula window area.

4 Select INPUT1: (i1) to be Potassium_cps, INPUT2: (i2) to be Thorium_cps and INPUT3: to be Uranium_cps in the relation window area.

Note: i1 = current (Red) band which is K band; rmin(,r1,i1) = the minimum value for a particular band within a region. Syntax:RMIN(dataset, region, band)

Note: The generic formula “(i1 - rmin(,r1,i1))/((i1 - rmin(,r1,i1)) + (i2) + (i3 - rmin(,r1,i3)))” is applied to adjust the dynamic range of the radioelements K and U to starts from zero(0) rather than negative DN values. The dynamic range of Th starts with positive values hence the Dark Pixel Correction is not applied.

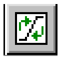
---

5 Click the **Apply changes** button in the **Formula Editor** dialog.

6 Applied the same formula to Green (Thorium) and Blue (Uranium) layers.

Note: Apply the Dark Pixel Correction to K and U bands only which have negative DN values. For example for the Green (Th) layer use the formula "(i1)/((i1) + (i2- rmin(,r1,i2)) + (i3 - rmin(,r1,i3)))" where i1 = Th, i2 = K and i3 = U; and for the Blue (U) layer use the formula "(i1 - rmin(,r1,i1))/((i1 - rmin(,r1,i1)) + (i2) + (i3 - rmin(,r1,i3)))" where i1 = U, i2 = Th and i3 = K.

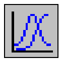
---

7 Click the **99% Contrast Enhancement**  button in the main menu (or **Algorithm** dialog).

8 The ratio RGB color composite image with normalized Th and Dark Pixel Corrected radioelements K and U is displayed.

Apply a threshold to map high anomalies of Potassium

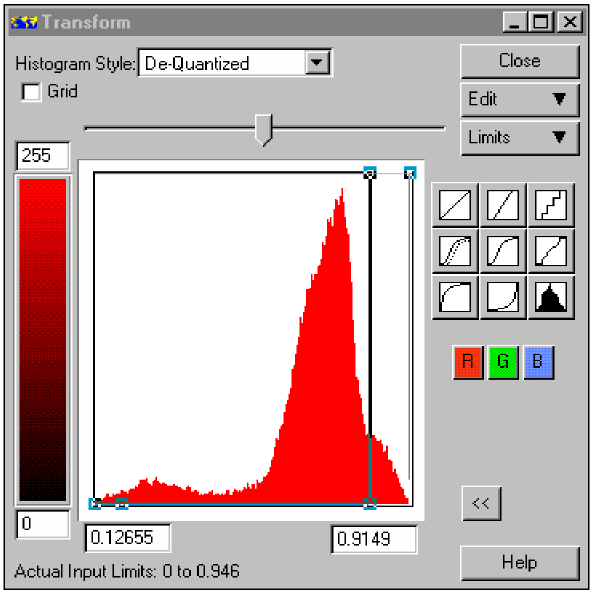
1 Highlight the Red Layer.

2 In the Algorithm window click the **Edit Transform Limits**  button.

3 The Transform window appears.

4 In the Transform window manually adjust the X-axis to about 0.8 (vertical).

Note: You have selected 0.8 as the threshold to map high K anomalies above 0.8 DN as red. Normalized ratio image has a dynamic range of 0-1. The Actual Input Limits of normalized K image is 0 to 0.916.



5 Highlight the Green Layer.

6 In the Transform window manually adjust the X-axis to about 0.36 (vertical).

Note: You have selected 0.36 as the threshold to map high Th anomalies above 0.36 DN as green. Normalized ratio image falls in a dynamic range of 0-1. The Actual Input Limits of normalized Th image is 0.04 to 0.813.

---

7 Highlight the Blue Layer.

8 In the Transform window manually adjust the X-axis to about 0.18 (vertical).

Note: You have selected 0.18 as the threshold to map high U anomalies above 0.18 DN as blue. Normalized ratio image falls in a dynamic range of 0-1. The Actual Input Limits of normalized U image is 0.0 to 0.637.

ER Mapper renders the image again.

Note: Red covers areas of high K anomalies, green covers areas of high Th anomalies and blue covers areas of high U anomalies. Cyan color covers areas of common areas consist of both Th and U.

Note: Common areas between red and green will display yellow, common areas between red and blue will display magenta and common areas between red, green and blue will display white color.

Note: Create a RGB composite image of Red = K, Green = Th and Blue = U and apply thresholds for each radioelement and compare with the threshold applied ratio RGB composite of Th and Dark Pixel Corrected K and U. You will notice significant difference between the two RGB composites.

Close the image window and the Algorithm dialog

1 Close both image windows using the window system controls:

- For Windows 95, click the  **Close** button in the upper-right corner.
- For Windows NT, select **Close** from the window control-menu.
- For Unix systems, select **Close** or **Quit** from the window control menu in the upper-left corner (for systems with both options, select **Quit**).

2 Click **Close** in the Algorithm window and **Edit Sun Angle** dialog box to close them.

Only the ER Mapper main menu is now open.

What you learned...

After completing these exercises, you know how to perform the following tasks in ER Mapper:

- Highlight high anomalies of radioelements K, Th and U using thresholds in transformation
- Reduce negative minimum response of radiometrics by applying Dark Pixel Correction formula
- Create RGB algorithm (RGB) of radiometrics
- Create ratio RGB algorithm (RGB) of Dark Pixel Corrections applied radiometrics

10

Unsupervised classification

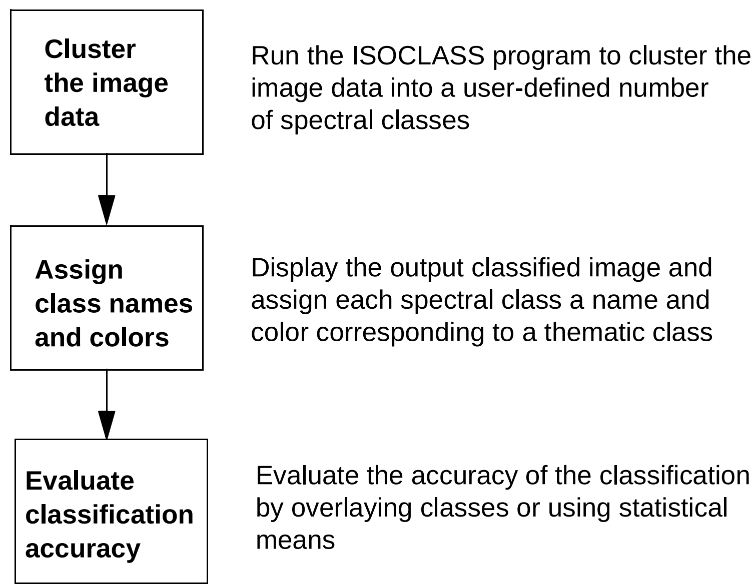
This chapter explains how use ER Mapper's ISOCLASS unsupervised classification feature to group multispectral image data into thematic information classes. You will learn to define clustering parameters, perform an actual unsupervised classification, and assign feature categories to the classes.

About unsupervised classification

Unsupervised classification is one of two methods used to transform multispectral image data into thematic information classes (supervised classification being the other). This procedure typically assumes that imagery of a specific geographic are gathered in multiple regions of the electromagnetic spectrum, for example Landsat TM or SPOT XS multispectral satellite imagery. (Classification can also be effective for other types of imagery. Please refer to an appropriate reference text for complete information on classification.)

In unsupervised classification, the classification program automatically searches for natural groupings or clusters of the spectral properties of pixels, and assigns each pixel to a class based on initial clustering parameters you define. Typically, you ask ER Mapper to group the image data into a specific number of spectral classes and give it parameters for when classes are to be split or merged as it searches for groupings in the image data. After the classification is completed, you assign each "spectral" class to a thematic information or feature class (such as water, urban, etc.) and a color for the class display. ER Mapper uses the ISOCLASS algorithm to perform clustering of the image data during an unsupervised classification. For information on how the ISOCLASS program works, refer to the chapter on Supervised and Unsupervised Classification in the *ER Mapper Reference*.

A typical procedure for performing an unsupervised classification is as follows:



Hands-on exercises

These exercises give you practice using ER Mapper's ISOCLASS Unsupervised Classification feature.

What you will learn...

After completing these exercises, you will know how to perform the following tasks in ER Mapper:

- Specify clustering parameters and perform an unsupervised classification
- Assign colors and feature class names to the classified image
- Display a classified image using a Class Display layer
- Display individual classes over a backdrop image using a Classification layer

Before you begin...

Before beginning these exercises, make sure all ER Mapper image windows are closed. Only the ER Mapper main menu should be open on the screen.

1: Clustering the image data

Objectives Learn how to use ER Mapper's ISOCLASS unsupervised classification feature to group or cluster multispectral image data into several spectral classes in an output dataset.

Display the Radiometric image to be classified

1 Click the **Edit Algorithm** button in the main menu window.

ER Mapper opens a new image window and the **Algorithm** dialog.

Load and display the radiometric dataset

1 In the Algorithm dialog, click the **Load Dataset** button.

2 From the **Directories** menu, select the path ending with the text **\examples**.

3 Select **ER Mapper Raster Dataset (.ers)** from the "Files of Type:" dropdown list in the **Raster Dataset** dialog.

4 Open the 'Shared_Data' directory, then double-click on the dataset named 'Newcastle_Radiometrics.ers' to load it.

Band 1 (B1:Total_Count_cps) of the dataset is loaded into the Pseudo Layer.

5 Click the **Create RGB Algorithm** button from the Forestry Toolbar in the main menu window.

ER Mapper displays three bands of the radiometric dataset as an RGB image. You need to choose the desired bands to display and adjust the contrast (transform) of each layer next to create an enhanced color image.

Select appropriate bands and enter labels for the RGB layers

Radiometric data is often displayed in RGB by selecting the potassium data as the red component, thorium as the green component, and uranium as the blue component.

1 Highlight the inactive Pseudo Layer Pseudo Layer and remove it from the Data-Structure using the cut button in the Algorithm window.

2 Select the Blue layer in **Algorithm** dialog, then choose **B3:Uranium_cps** from the **Band Selection** drop-down list, and change the layer label to **`uranium`**.

3 Select the Green layer, choose the band **B4:Thorium_cps**, and enter the layer label **`thorium`**.

4 Select the Red layer, choose the band **B2:Potassium_cps**, and enter the layer label **`potassium`**.

5 Click the **99% Contrast Enhancement** button to display the potassium, thorium and uranium data as an RGB image.

Open the Unsupervised Classification dialog box

1 From the **Process** menu, select **Classification**, then select **ISOCLASS Unsupervised Classification**.

The **Unsupervised Classification** dialog box appears.

This dialog lets you specify the input raster dataset and dataset bands to be used, the output dataset name, starting classes to be used, and parameters for clustering the image data.

Specify the input dataset and bands to be used

1 Click the **Input Dataset** chooser button.

2 From the **Directories** menu in the **Open Dataset** dialog, select the path ending with the text **\examples**.

3 Open the ‘Shared_Data’ directory, then double-click on the dataset named ‘Newcastle_Radiometrics.ers’ to load it.

4 Click the **Bands to use** chooser button.

The **Band Selection** dialog box appears to let you choose which bands in the dataset to use during the clustering.

5 Drag through all four bands listed to select them.

Note: You will use all four bands; Total_Count_cps, Potassium_cps, Thorium_cps and Uranium_cps of the Newcastle_Magnetics.ers dataset.

---

6 Click **OK** to close the **Band Selection** dialog.

Specify a dataset name for the output classified image

1 Click the **Output Dataset**  chooser button.

2 From the **Directories** menu, select the path ending with the text **\examples\Miscellaneous**.

3 Double-click on the ‘Tutorial’ directory to open it.

4 In the **Save As** field, type a name using your initials at the beginning followed by the text ‘10_class_ISOCLASS,’ and separate each word with an underscore (_). For example, if your initials are “DH,” type in the name:

```
DH_10_class_ISOCLASS
```

5 Click **OK** or **Save** to validate the name and close the file chooser dialog.

Specify the ISOCLASS clustering parameters

1 In the **Maximum number of classes** field, enter the value **`10`** and press the Return or Enter key.

This tells ER Mapper to cluster the image data into a maximum of 10 spectral classes. (Note that this example is simplified, and you would typically choose a larger number of classes.)

All other default values in the dialog are appropriate for this simple exercise. ER Mapper will use bands 1-4 in the dataset, and will generate one starting class automatically (you could also use classes from another classified image to start with if desired). The clustering will finish when a maximum of 10 classes are created and 98% of the clusters remain unchanged.

Perform the unsupervised classification

1 Click **OK** in the **Unsupervised Classification** dialog to start the clustering process.

The **Processing Status** dialog box appears to show the progress. ER Mapper runs through several iterations to cluster the image data into classes, and splits and merges classes as specified by the parameters you entered.

When the 98% unchanged parameter has been reached, the classification finishes with 10 classes. ER Mapper then generates dataset statistics for the 10 classes.

2 When the dialog appears indicating successful completion, click **OK**.

3 Click **Close** in the **Processing Status** dialog, and click **Cancel** in the **Unsupervised Classification** dialog.

The output of the classification is a single band dataset. Each pixel in the dataset has a value ranging from 1 to 10 (the number of classes you specified). Next you will display the output image and assign class colors and names.

2: Assigning colors and class names

Objectives Learn how to view a classified image in a Classification Display layer, and assign colors and feature names to class numbers.

Display the classified image you created earlier

1 Click the **New** toolbar button.

An image window appears.

2 Click the **Edit Algorithm** toolbar button.

3 The Algorithm window appears.

4 Click your right mouse button on the Pseudo Layer

5 A short-cut menu appears.

6 On the Short-Cut menu click on Class Layer and change the Pseudo Layer to Class Layer.

Note: The Class Display layer is designed to display images created with ER Mapper's classification functions.

---

7 In the process diagram, click the **Load Dataset** button.

8 From the **Directories** menu, select the path ending with the text **\examples\Miscellaneous**.

9 In the directory 'Tutorial,' double-click on the dataset '10_class_ISOCLASS' with your initials to load it.

The image initially displays in various shades of grey by default. Next you will create a color scheme for the classified image.

10 Click **Close** in the **Algorithm** window to close it.

Auto-generate a color scheme for the classes

1 From the **Process** menu, select **Classification**, then select **Edit Class/ Region Color and Name...**.

The **Edit Class/Region Detail** dialog box appears. This dialog lists each class in the classified dataset by number, and provides text fields for assigning names and a button to choose colors.

2 Enlarge the dialog by dragging the top or bottom edge until all 10 classes can be viewed at once.

3 Click the **Auto-gen colors...** button.

The **Auto-generate colors** dialog box appears. This dialog lets you automatically generate a color scheme for the classified image that simulates the colors of an RGB image display. By default, an RGB=321 band combination is chosen, but you will change it to an RGB=431 band combination.

4 Change the **Red Band** value to **4**, and the **Green Band** value to **3**.

5 Click the **Auto-gen** button.

The new color assignments for each class appear in the **Set color...** buttons next to the class number in the **Edit Class/Region Details** dialog.

6 Click **Save** on the **Edit Class/Region Details** dialog to save the color scheme for the classified image (stored in the dataset header file).

7 Reload the classified image from the **Load Dataset**  button in the Algorithm window.

The classified image with autogenerated colors for the classes is displayed

8 Click **Close** in the **Auto-generate colors** dialog to close it.

Assign appropriate colors to known classes

1 From the **Process** menu, select **Classification**, then select **Edit Class/ Region Color and Name...**.

2 The **Edit Class/Region Detail** dialog box appears.

3 In the **Name** field for class 1 in the **Edit Class/Region Details** dialog, select the text ‘1: unlabelled,’ and type in `High Uranium`.

4 Click the **Set color...** button for class 1 to open the color chooser.

5 Choose blue color, then click **OK** to close the dialog.

6 Click **Save** in the **Edit Class/Region Details** dialog to save the color change.

The pixels assigned to class 1 are colored blue.

7 Similarly if you know the classes then type in appropriate names and assign colors for each of the class.

3: Overlaying a class on an image

Objectives Learn how to use a Classification layer to display class from a classified image on top of the original image displayed as an RGB color composite.

Add a Classification layer to the radiometrics RGB composite

1 In the Algorithm dialog, click the **Load Dataset** button.

2 From the **Directories** menu, select the path ending with the text **\examples**.

3 Open the 'Shared_Data' directory, then double-click on the dataset named 'Newcastle_Radiometrics.ers' to load it.

Band 1 (B1:Total_Count_cps) of the dataset is loaded into the Pseudo Layer.

4 Click the **Create RGB Algorithm** button from the Forestry Toolbar in the main menu.

ER Mapper displays three bands of the radiometric dataset as an RGB image. You need to choose the desired bands to display and adjust the contrast (transform) of each layer next to create an enhanced color image.

5 Highlight the inactive Pseudo Layer and remove it from the Data-Structure using the cut button in the Algorithm window.

6 Select the Blue layer in **Algorithm** dialog, then choose **B3:Uranium_cps** from the **Band Selection** drop-down list, and change the layer label to **`uranium`**.

7 Select the Green layer, choose the band **B4:Thorium_cps**, and enter the layer label **`thorium`**.

8 Select the Red layer, choose the band **B2:Potassium_cps**, and enter the layer label **`potassium`**.

9 Click the **99% Contrast Enhancement** button to display the potassium, thorium and uranium data as an RGB image.

10 Click on the Red layer to select it (if it is not already).

11 From the **Edit/Add Raster Layer** menu, select **Classification**.

A new Classification layer is added to the layer list in the algorithm. You will use this layer to display one the classes from your classified image on top of the RGB backdrop image.

Load the classified image you created earlier

1 With the Classification layer selected, click the **Load Dataset** button in the process stream diagram.

2 From the **Directories** menu, select the path ending with the text **\examples\Miscellaneous**.

3 In the directory 'Tutorial,' double-click on the '10_class_ISOCLASS' filename you created earlier to load it.

Enter a formula to overlay a single class

1 Click on the **Edit Formula** button in the process stream diagram.

The **Formula** dialog box opens and shows the default formula "INPUT1."

2 In the Generic formula window, edit the formula text to read:

```
if input1=1 then 1 else null
```

This formula tells ER Mapper "if pixels have a value of 1 (class 1) in the dataset, assign them a value of 1 for display, else assign them a value of null" (so the backdrop image shows through).

Tip: This formula can also be loaded from the **Standard** menu in the **Formula Editor** dialog box.

---

3 Click the **Apply changes** button to validate the formula.

4 Click **Close** to close the **Formula Editor** dialog.

Choose a color for the class overlay

1 With the Classification layer selected, click the **Edit Layer Color** button in the process stream diagram. (It is on the far right side, scroll the process stream if needed to view it.)

The **Color Chooser** dialog box appears.

2 Select a blue color, and click **OK** to close the **Color Chooser**.

Display the class over the backdrop image

The high Uranium areas (class 1) display in blue over the backdrop RGB image. This is one way to overlay thematic data, and help analyze and assess the accuracy of a classification.

1 (Optional.) If desired, edit the formula to display other thematic classes by changing the text input1=1 to **`input1=2`** (for class 2) or any other class number 1 through 10. Choose any color desired.

Close all image windows and dialog boxes

1 Close all image windows using the window system controls:

- For Windows, select **Close** from the window control-menu.
- For Unix systems, press right mouse button on the window title bar, and select **Close** or **Quit** (for systems with both options, select **Quit**).

2 Click **Close** in the **Algorithm** window to close it.

Only the ER Mapper main menu should be open on the screen.

What you learned...

After completing these exercises, you know how to perform the following tasks in ER Mapper:

- Specify clustering parameters and perform an unsupervised classification
- Assign colors and feature class names to the classified image
- Display a classified image using a Class Display layer
- Display individual classes over a backdrop image using a Classification layer

11

Supervised classification

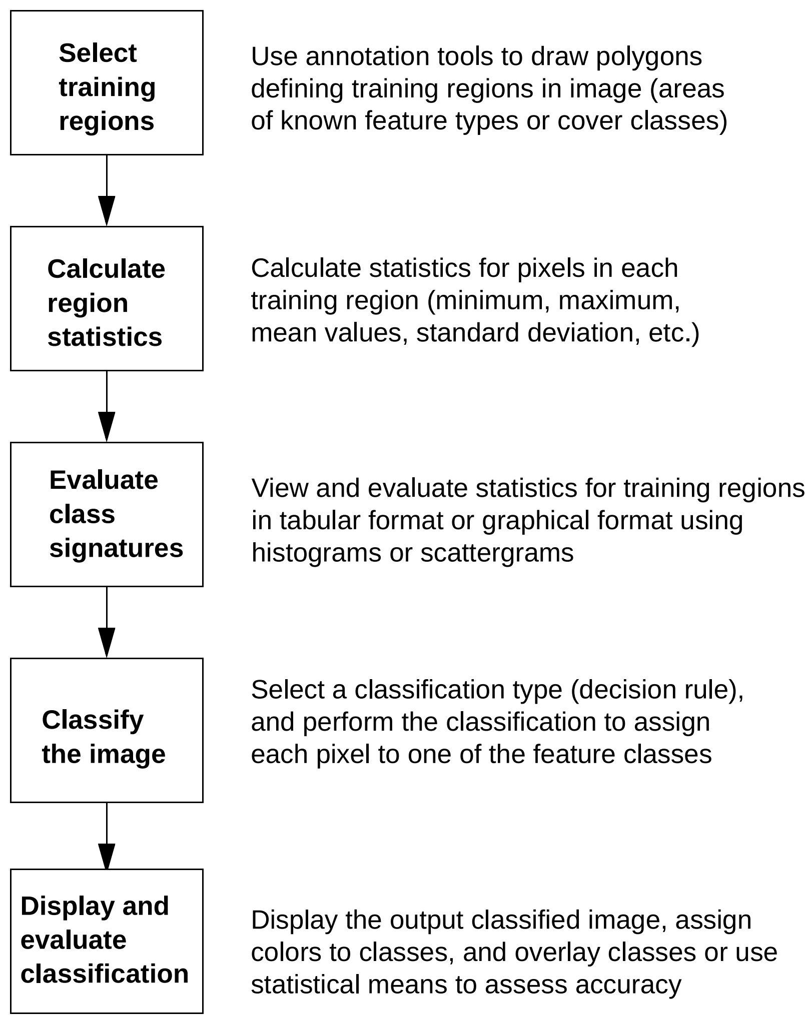
This chapter explains how to use ER Mapper's supervised classification features to transform multispectral image data into user-defined thematic information classes. You will learn to choose define training regions, perform a supervised classification, and assign colors to the classes.

Note: To perform the following exercise as written, you will need to have a practice copy of the dataset 'Newcastle_Radiometrics.ers' in the 'Tutorial' directory. The practice dataset is referred to as 'Radiometrics_Practice' in the exercise. You will create the 'Radiometrics_practice.ers' dataset and save it in the '\examples\Miscellaneous\Tutorial' directory in the following exercise.

About supervised classification

Supervised classification is one of two methods used to transform multiradioelements image data into thematic information classes (unsupervised classification being the other). In supervised classification, the identity and location of feature classes or cover types (granite, shale, etc.) are known beforehand through field work, geological mapping, or other means. You typically identify specific areas on the multiradioelements imagery that represent the desired known feature types, and use the signature characteristics of these known areas to “train” the classification program to assign each pixel in the image to one of these classes. Multivariate statistical parameters such as means, standard deviations, and correlation matrices are calculated for each training region, and each pixel is evaluated and assigned to the class to which it has the most likelihood of being a member (according to rules of the classification method chosen).

A simplified procedure for performing a supervised classification is as follows:



Hands-on exercises

These exercises give you practice defining training regions and using ER Mapper’s Supervised Classification features to perform a classification.

What you will learn...

After completing these exercises, you will know how to perform these tasks in ER Mapper:

- Draw polygons to define training regions for a supervised classification
- View statistics, histograms, and scattergrams for each training region
- Perform a supervised classification
- Display a classified image using a Class Display layer type

Before you begin...

Before beginning these exercises, make sure all ER Mapper image windows are closed. Only the ER Mapper main menu should be open on the screen.

1: Defining training regions

Objectives

Learn to use ER Mapper's vector annotation tools to define training regions (polygons) representing feature or land cover classes in an image.

About regions: Regions are vector polygons that define an area of interest in an image. Regions can be used to process or display parts of an image separately from others, mask out parts of an image for mosaicing, define training sites as you will do here, and other purposes. The definition of each region is stored in the header file for the raster dataset.

Create a practice dataset

1. Click the **Edit Algorithm** toolbar button.

   An image window and the **Algorithm** window appear.

2. In the **Algorithm** window, click the **Load Dataset** button in the process stream diagram to open the file chooser. The **Raster Dataset** dialog box which is the file chooser appears.
3. In the **Files of Type:** field, select "ER Mapper Raster Dataset (.ers)"
4. From the **Directories** menu, select the path ending with the text **\examples**.
5. In the directory '**\Shared_Data**' load the dataset named 'Newcastle_Radiometrics.ers.'
6. Total_Count_cps band 1 will be loaded into the Pseudo Layer. The Total_Count_cps image is displayed.
7. In the Algorithm window click the duplicate button three times and duplicate the Pseudo Layer with Total_Count_cps three times. You have now 4 Pseudo Layers with Total_Count_cps band.

8 From the dropdown list of the **Band Selection** 

button in the **Algorithm** window, load Total_Count_cps in the first Pseudo Layer, Potassium_cps in the second Pseudo Layer , Uranium_cps in the third Pseudo Layer and Thorium_cps in the fourth Pseudo Layer .

9 By turning off three layers at a time, display each band individually.

10 Edit the band descriptions and type in for band 1 (Total_count_cps), for band 2 (Potassium_cps), for band 3 (Uranium_cps) and for band 4 (Thorium_cps).

11 Turn on all the four Pseudo layers.

12 From the File menu in the main menu window select **Save As ..** and save it in the \examples\Miscellaneous\Tutorial directory as 'Radiometrics_practice.ers'.

13 In the **Files of Type:** field, select "ER Mapper Raster Dataset (.ers)"

Tip: To maintain the original dynamic range of the dataset, delete the transforms before saving it

---

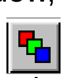
Note: Click the Default button in the **Save As** window and take the default values which are Output Data Type: IEEE 4ByteReal; Output Null Value: -10000; Cells Across (width): 268; Cells Down (height): 177. Click OK and save the file as Radiometrics_Practise.ers" file.

Load the practice dataset and display it as a RGB composite

1 In the **Algorithm** window, click the **Load Dataset**  button in the process stream diagram to open the file chooser.

2 From the **Directories** menu, select the path ending with the text **\examples\Miscellaneous**.

3 In the directory 'Tutorial,' double-click on the dataset named 'Radiometrics_practice.ers'.

4 In the main menu window, from the Forestry Toolbar, click on the Create RGB Algorithm button  to display the 'Radiometrics_practice.ers' dataset as RGB composite.

5 Drag the image window by the lower-right corner to make it about 50% larger.

You will next draw polygons to define several feature classes in the image.

Add a vector layer for region definition to your algorithm

1 From the **Edit** menu, select **Edit/Create Regions...**.

The **New Map Composition** dialog box opens.

2 In the **New Map Composition** dialog, notice that the **Raster Region** option is selected.

Note: The **Raster Region** option tells ER Mapper that the annotation layer will be used to create regions for a raster dataset (for use in training site selection in this case).

---

3 Click **OK** in the **New Map Composition** dialog box.

4 ER Mapper opens the **Tools** palette dialog box containing your vector annotation tools. Also notice that a new vector layer titled ‘Region Layer’ has been added to the layer list in the **Algorithm** window.

5 From the **File** menu (in the main menu window), select **Save As...** to save the algorithm under your own name with the new page extents information.

6 From the **Directories** menu, select the path ending with the text **\examples\Miscellaneous**.

7 Double-click on the directory ‘Tutorial’ to open it.

8 In the **Save As:** text field, type a name using your initials at the beginning, followed by the text ‘land_use_regions.’ Separate each word with an underscore (_). For example, if your initials are “KA,” type in the name:

```
KA_radioelements_regions
```

9 Click **OK** or **Save** to save the algorithm, which now includes your Page Setup parameters.

10 Click **Close** in the **Algorithm** window to close it.

Open the Geoposition dialog box

1 From the **View** menu, select **Geoposition...**.

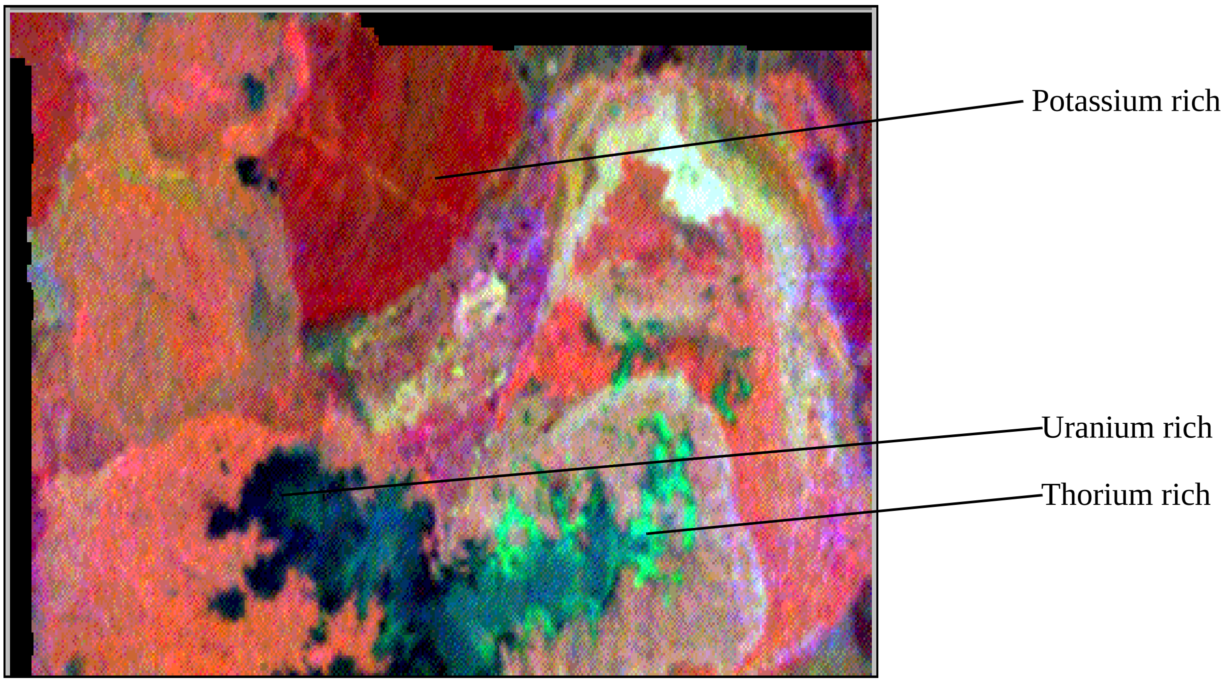
The **Algorithm Geoposition Extents** dialog box opens. Move it to the right side of the screen.

2 Select the **Zoom** option to display buttons for zooming and panning.

You will use these options to help zoom in and out of areas as you define your training region polygons.

Define training regions on the image

1. Use the following diagram as a guide to help locate training regions in the image. You are asked to define these regions in the next steps.



Define a region to represent with high anomalies in Uranium

1. In the **Tools** palette dialog, click the **Zoom Box mode**  button.
2. Zoom in on the lower-left quarter of the image by dragging a zoom box.

   The dark blue areas at the lower-left of the image have high Uranium anomalies.
3. Click on the **Polygon**  button.
4. Draw a polygon to define an area with high Uranium anomalies (click once at each point, then double-click to close the polygon).

   The polygon becomes selected when you close it.
5. In the **Line Style** dialog, click **Set Color**, choose a dark blue color, and click **OK** to close the color chooser.

6 In the **Map Composition Attribute** dialog, enter the text **`High Uranium`** in the text field at the bottom, then click the **Apply** button.

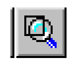
7 Zoom in to the High Uranium region and define a few training areas (if necessary) and save them with the same name (High Uranium) and color (dark blue).

The text “High Uranium” is now defined as a the name or text attribute of the polygon.

You have now defined a training region representing areas with high Uranium anomalies in the image. When you calculate statistics for this image later, the statistics for pixels inside this region will be used as a “signature” to classify other areas with high Uranium anomalies in the image.

Define a region to represent with high anomalies in Thorium

1 In the **Geoposition** dialog, click **All Datasets** to zoom to all dataset.

2 In the **Tools** palette dialog, click the **ZoomBox mode**  button.

3 Zoom in on the lower-right quarter of the image by dragging a zoom box.

The green areas at the lower-right of the image have high Thorium anomalies.

4 Click on the **Polygon**  button.

5 Draw a polygon to define an area with high Thorium anomalies (click once at each point, then double-click to close the polygon).

The polygon becomes selected when you close it.

6 In the **Line Style** dialog, click **Set Color**, choose a yellow color, and click **OK** to close the color chooser.

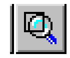
7 In the **Map Composition Attribute** dialog, enter the text **`High Thorium`** in the text field at the bottom, then click the **Apply** button.

You have now defined a training region representing areas with high Thorium anomalies.

8 Zoom in to the High Thorium region and define a few training areas (if necessary) and save them with the same name (High Thorium) and color (yellow).

Define a region to represent areas with high anomalies in Potassium

1 In the **Geoposition** dialog, click **All Datasets** to zoom to all dataset.

2 In the **Tools** palette dialog, click the **Zoom Box mode**  button.

3 Zoom in on the middle-upper quarter of the image by dragging a zoom box.

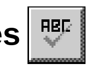
The large portion of red area has high anomalies in Potassium.

4 In the **Tools** palette dialog, click on the **Polygon**  button.

5 Point to an area with high Potassium anomalies and draw a polygon by clicking once at each point, then double-clicking to close the polygon.

The polygon is selected by default when you close it. Since it is selected, you can now add a color and text attribute to give the polygon a name.

6 In the **Tools** dialog, double-click the **Polygon**  button to open the **Line Style** dialog box.

7 In the **Tools** dialog, click the **Display/Edit Object Attributes**  button to open the **Map Composition Attribute** dialog box

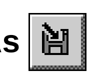
Position the **Line Style** and **Map Composition Attribute** dialogs in a convenient position on the screen. You will leave these dialogs open while you define regions so you can assign a color and name to each region as you go. (The colors you assign becomes the default class colors in the output classified image.)

8 In the **Line Style** dialog, click the **Set Color** button, choose a red color, and click **OK** to close the color chooser.

9 In the **Map Composition Attribute** dialog, enter the text **`High Potassium`** in the text field at the bottom, then click the **Apply** button.

You have now defined a training region representing areas with high Potassium anomalies.

Save the regions to the Radiometrics_Practice dataset

1 In the **Tools** palette dialog, click the **Save As**  button.

The **Map Composition Save As** chooser dialog appears.

2 From the **Directories** menu, select the path ending with the text **\examples\Miscellaneous**.

3 Double-click on the directory ‘Tutorial’ to open it.

4 Click on the dataset named ‘Radiometrics_Practice’ to select it, then click **OK**.

5 When asked to confirm the overwrite, click **OK** to proceed. After the next dialog indicates all your new regions were added, click **Close** to close it.

The regions definitions and names are saved to the header file of the ‘Radiometrics_Practice’ dataset. You can now calculate statistics for the pixels in each region.

6 Click **Close** on the **Tools** palette and **Geoposition** dialogs to close them.

Calculate statistics for the new regions

1 From the **Process** menu, select the **Calculate Statistics**.

The **Calculate Statistics** dialog box appears.

The ‘Radiometrics_Practice’ dataset should be chosen by default because it is the dataset used in the current algorithm. (If it is not chosen, load it from the ‘tutorial’ directory).

2 Set the **Subsampling Interval** to **1**.

3 Select the **Force Recalculate stats** option (to calculate statistics again in case they have previously been calculated).

4 Click **OK** to start the statistics calculation.

5 When the calculation is finished, click **OK** in the dialog indicating successful completion, then close the other statistics dialogs with **Close** or **Cancel**.

2: Viewing training statistics

Objectives Learn to view statistics for training regions in tabular format, view histograms of data values in the training class regions, and view class means and 95% probability ellipses over a scattergram.

View tabular statistics for the training regions

1 From the **View** menu, select the **Statistics**, then select **Show Statistics**.

The **Statistics Report** dialog box appears. The ‘Radiometrics_Practice’ dataset should be selected by default. You can choose to view statistics for selected regions or bands in the dataset, or for all regions and bands.

2 Click **OK** to display statistics for the all the regions you defined.

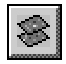
The display dataset Statistics dialog opens showing statistics for all your regions in all four Radiometrics_Practice dataset bands.

3 Scroll through the list to view statistics for your training regions (make the dialog larger if needed).

(The last region listed named ‘All’ is the entire dataset. This region is present in every dataset header file.)

4 When finished viewing statistics, click **Cancel** in the **Statistics Report** dialog to close both dialogs.

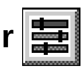
Add a Classification layer and load the Radiometric dataset

1 Click the **Edit Algorithm**  toolbar button to open the **Algorithm** window.

2 Click on the ‘Region Layer’ layer to select it, then click **Delete** to delete the layer. (You no longer need it for this exercise.)

3 From the **Edit/Add Raster Layer** menu, select **Classification**.

A Classification layer is added to the algorithm layer list.

4 In the process diagram, click the **Edit Layer Color**  button.

5 Choose a bright yellow color, then click **OK** to close the color chooser.

6 In the process diagram, click the **Load Dataset**  button.

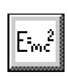
7 From the **Directories** menu, select the path ending with the text **\examples\Miscellaneous**.

8 Double-click on the ‘Tutorial’ directory to open it.

9 Double-click on the dataset ‘Radiometrics_Practice’ to load it.

You can now use the Classification layer to display a training region in yellow on the image and show its histogram in any band.

Enter a formula to display a region

1 Click the **Edit Formula**  button in the process diagram to open the **Formula Editor** dialog.

2 In the Generic formula window, edit the formula text to read:

```
if inregion(region1) then input1 else null
```

This formula tells ER Mapper to process and display the data inside the region chosen as region 1 in yellow on the image.

3 Click the **Apply changes** button.

Notice that the **Inputs** and **Regions** buttons above the Relations window are now active. Dataset band 1 is assigned to generic input1 by default.

4 Click the **Regions** button, select **High Potassium** from the drop-down list next to ‘REGION1.’

Your **High Potassium** region is displayed in yellow over the RGB image.

View the histograms for the High Potassium region

1 Click on the post-formula **Edit Transform Limits**  button to open the **Transform** dialog box. Move it so it does not overlap with the image window or Formula dialog.

2 From the **Limits** menu, select **Limits to Actual**.

The histogram for the pixels in band 1 of the training region ‘High Potassium’ appears in the histogram window.

3 In the **Formula** dialog, click the **Inputs** button, then select **B2:Potassium_cps** from the ‘INPUT1’ drop-down list.

4 From the **Limits** menu, select **Limits to Actual**.

Note: Since the data range is different for each band and region, you need to use **Limits to Actual** each time you change the band or region. Otherwise the new histogram may not fully display due to the limits set for the previous one.

The histogram for the pixels in band 2 of the training region ‘High Potassium’ appears in the histogram window. By changing the assignments in the Relations window, you can view a histogram for any band and region combination in the dataset. The histogram provides important information about the distribution and range of data values in your training regions.

5 If desired, view histograms for other region and/or band combinations using the steps listed previously.

6 When finished, click **Close** in the **Formula Editor** dialog, and **Close** in the **Algorithm** window.

View a scattergram for the Radiometrics_Practice dataset

1 From the **View** menu, select **Scattergrams...**.

The **Scattergram** dialog box and **New Map Composition** dialog boxes open. Notice that the **New Map Composition** dialog already has **Raster Regions** selected and the name of your dataset entered.

2 Click **OK** in the **New Map Composition** dialog.

The annotation **Tools** dialog opens and the **Scattergram** dialog automatically references the dataset in the active image window (‘Radiometrics_Practice’). Notice also that your region polygons are shown on the image in their assigned color.

Set the scattergram bands and limits

1. In the **Scattergram** dialog, click the **Setup...** button.
2. In the **Scattergram Setup** dialog, select band 2 for the **X Axis** field, and band 4 for the **Y Axis** field.
3. Click the **Limits to Actual** button to set the X and Y axis limits to the actual data ranges of bands 2 and 4.

   The scattergram for dataset bands 2 (Potassium_cps) and 4 (Thorium_cps) is redisplayed to fill the window. The wide dispersion of points in the scattergram indicates that the information in these two bands is not strongly correlated.

Display mean and probability ellipses for training regions

1. In the **Scattergram Setup** dialog, turn on the **From current selection** option.

   This tells ER Mapper that you want to display the mean value and 95% probability ellipse for the currently selected region polygons in the image.

2. In the **Tools** dialog, click the **PSelect / Edit Points Mode**  button.
3. In the image, select the red polygon defining your ‘High Potassium’ class training region (click on a line segment).

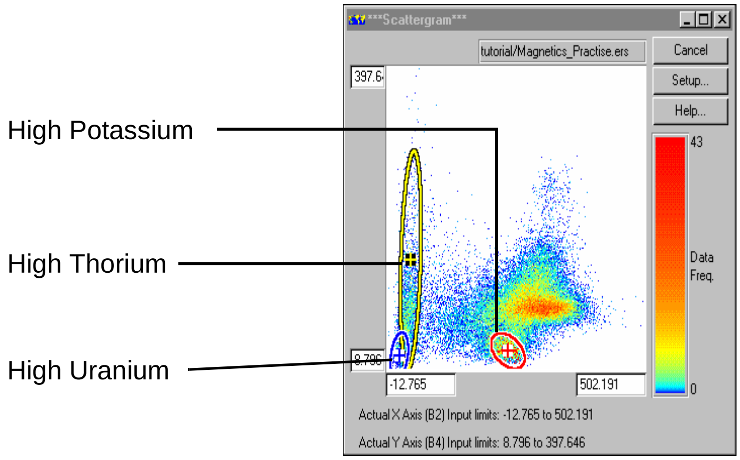
   A red ellipse appears over the scattergram showing the 95% probability threshold and mean value (the ellipse center point) for the ‘High Potassium’ class in bands 2 and 4. (The ellipse extents represent the probability that an unknown pixel is a member of that class at the 95% confidence level.)

4. In the image, select the yellow polygon defining your ‘High Thorium’ class training region.

   A yellow ellipse appears on the scattergram.

5. Hold down the Shift key, then click on the dark blue ‘High Uranium’ polygon in the image.

   Ellipses for the ‘High Potassium’, ‘High Thorium’ and ‘High Uranium’ regions appear on the scattergram, so you can easily compare them. Comparing region means and ellipses in an excellent way to evaluate the separability of your class signatures.



Tip: To select multiple polygons, hold down the Shift key while clicking.

Close the scattergram dialogs

1. Click **Close** in the annotation **Tools** dialog to close it.
2. Click **Cancel** in the **Scattergram Setup** dialog to close it, then click **Cancel** to close the **Scattergram** dialog.

3: Classifying the image

Objectives Learn how to use the training region statistics to perform a supervised classification on the entire image that assigns each pixel to one of the six feature classes you defined.

Open the Supervised Classification dialog box

1. From the **Process** menu, select **Classification**, then select **Supervised Classification**.

   The **Supervised Classification** dialog box opens. The ‘Radiometrics_Practice’ dataset is already chosen as the default input dataset.The dialog also lets you choose which bands of the dataset to use for the classification, and the type of classification (or decision rule) to use.

2. Click the **Output Dataset**  chooser button.

3 From the **Directories** menu, select the path ending with the text **\examples\Miscellaneous**.

4 Double-click on the 'Tutorial' directory to open it.

5 In the **Save As** field, type a name using your initials at the beginning followed by the text 'max_like_class,' and separate each word with an underscore (_). For example, if your initials are "SC," type in the name:

```
SC_max_like_class
```

6 Click **OK** or **Save** to validate the name and close the file chooser dialog.

Setup the classification type and parameters

1 Click the **Classification Type** drop-down to see the list.

ER Mapper provides Maximum Likelihood Enhanced, Minimum Distance, Minimum Distance with a standard deviation, Parallelopiped, and Mahalanobis classifiers.

2 From the **Classification Type/Maximum Likelihood Enhanced** menu, select **Maximum Likelihood Standard**.

3 Click the **Setup** button.

The **Supervised Classification Setup** dialog box opens. This dialog allows you to setup the options used for the classification, including which training regions to use (from this or other datasets), assigning class probabilities, and other options. By default, the three regions in your practice dataset are displayed.

4 In the **Supervised Classification Setup** dialog click the Add New.. button and load in classes you generated from the ISOCLASSIFICATION by selecting the '10_class_ISOCLASS.ers' in the \examples\Miscellaneous\Tutorial directory.

5 The 10 ISO_classes are loaded into the Training Area Information text field in the **Supervised Classification Setup** dialog.

6 Delete the first four classes from the ISO_class classes which are Uranium, Thorium, Potassium and an unlabelled classes generated from Unsupervised classification.

Note: You are going to use supervised training areas for Uranium, Thorium and Potassium for the Supervised classification. In addition you are using 6 Unsupervised classes as training areas for the Supervised classification.

---

7 In the **Supervised Classification Setup** dialog adjust the Baysian Prior Probability as necessary. For example if your estimation for High Uranium class will cover only 5% of the entire image area extent, click the left mouse button on

the 0.10000 text field of the High Uranium class/region layer and change it to 0.05000. You can also make area percent estimation of other classes and change the Baysian Prior Probability.

8 Click the **Close** button to close the **Supervised Classification Setup** dialog box.

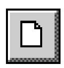
Classify the image

1 Click the **OK** button to start the classification.

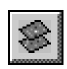
2 When asked to confirm the successful completion, click **OK**. Then click **Close** and **Cancel** in the other two dialogs to close them.

The output of the classification is a single band dataset. Each pixel in the dataset is has a value ranging from 1 to 9 (the number of training regions you specified).

Open a second window and display the classified image you created earlier

1 Click the **New**  toolbar button.

An image window appears.

2 Click the **Edit Algorithm**  toolbar button.

An Algorithm window appears.

3 In the Algorithm window click right mouse button on the Pseudo Layer and from the Short-Cut menu change the layer type to Class Display.

Note: The Class Display layer is designed to display images created with ER Mapper's classification functions.

---

4 In the process diagram, click the **Load Dataset**  button.

5 From the **Directories** menu, select the path ending with the text **\examples\Miscellaneous**.

6 In the directory 'Tutorial,' double-click on the dataset 'max_like_class' you created earlier to load it.

Each pixel in the original Landsat image is assigned to one of the nine training classes (three from the supervised training areas and 6 from the Unsupervised classes) you defined earlier. The class colors are those you defined for the training region polygons and those that you defined for the unsupervised classes.

7 From the **Edit** menu (in the main menu window), select **Edit Class/Region Color and Name**.

The Edit Class/Region Details dialog opens showing the name and color assigned to each class. If desired, you could change them here.

8 Click Cancel in the **Edit Class/Region Details** dialog to close it.

Close all image windows and dialog boxes

1 Click **Close** in the **Algorithm** window to close it.

2 Close all image windows using the window system controls:

- For Windows, select **Close** from the window control-menu.
- For Unix systems, press right mouse button in the window title bar, and select **Close** or **Quit** (for systems with both options, select **Quit**).

3 Click **Close** in the **Algorithm** window to close it.

Only the ER Mapper main menu should be open on the screen.

What you learned...

After completing these exercises, you know how to perform the following tasks in ER Mapper:

- Draw polygons to define training regions for a supervised classification
- Add classes from the Unsupervised Classification and use them as training areas in the Supervised classification
- View statistics, histograms, and scattergrams for each training region
- Perform a supervised classification
- Display a classified image using a Class Display layer type

12

Creating Radiometric Vector Classes

This chapter introduces you to the concept of raster to vector conversion and gives you practice using ER Mapper's raster to vector conversion features.

About raster to vector conversion

Raster to vector conversion, sometimes called vectorization, allows you to convert data from a raster data structure to a vector data structure. For example, features or thematic classes defined by processing a radiometric image can be converted to polylines and polygons, and then imported directly into a vector-based GIS product or used for further processing of raster data. In raster to vector conversion, ER Mapper analyzes the boundaries of the features you specify in a raster image, then traces polylines or closed polygons around the features. Typically you first need to perform some type of image processing to extract the features you are interested in, such as classification or thresholding to mask or highlight a particular feature. After vectorizing the features of interest, the output polylines or polygons can be saved to an ER Mapper format vector file, regions in a raster file, an ARC/INFO GIS coverage, or exported to other vector formats such as DXF.

Hands-on exercises

These exercises give you practice creating algorithms to highlight a feature in a raster image, and then converting the feature to a vector representation. In this case, you will create vector polygons from classes in a previously classified image, and generate a binary High Potassium/remaining areas image and create a vector representation of the areas with high Potassium anomalies.

What you will learn...

After completing these exercises, you will know how to perform these tasks in ER Mapper:

- Apply smoothing to a classified image to remove isolated pixels
- Extract classes from a classified image and convert them to vector polygons
- Process a radiometric image to create a binary high/low anomaly areas
- Vectorize the binary image to extract polylines tracing the boundaries between the chosen radiometric classes (ex: High and Low Potassium areas)

Before you begin...

Before beginning these exercises, make sure all ER Mapper image windows are closed. Only the ER Mapper main menu should be open on the screen.

1: Vectorizing a feature class

Objectives

Learn to prepare an algorithm displaying a classified image to extract and vectorize a feature class of interest, and perform the raster to vector conversion.

Display a classified Radiometric image

1. On the Standard toolbar, click on the **Edit Algorithm**  button.

   An image window and the **Algorithm** window appear.

2. Click on the **Layer tab** to view the settings for the layer.

3. In the **Algorithm** window, click the **Load Dataset** button  on the left side of the process stream diagram.

The **Raster Dataset** file chooser dialog box appears.

4 From the **Directories** menu, select the path ending with \examples\Miscellaneous.

5 Double-click on the directory ‘Tutorial’ to open it.

6 In **Files of Type:** field, select “ER Mapper Raster Dataset (.ers)”

7 Double-click on the dataset named ‘max_like_class’ to load the classified dataset.

The classified Radiometric dataset which you created previously is loaded into the Pseudo layer.

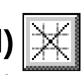
8 In the Algorithm window click the right mouse button on the Pseudo Layer and change the layer type to Class Display.

Note: Class Display layer is designed to display classified image.

ER Mapper displays the classified image which was previously generated from the Radiometrics_Practice dataset. There are 9 feature classes in this image representing High Potassium, High Thorium, High Uranium, and other feature classes.

Apply a median filter to generalize the classification

Notice that the classification contains many small, isolated groups of pixels within the larger single color areas. It is generally a good idea to incorporate these isolated pixels into the larger feature classes before performing a raster to vector conversion. That way, you vectorize only the major features in the image and minimize the number of very small polygons that will be created.

1 In the process diagram, click the pre-formula **Edit Filter (Kernel)**  button. (Be sure to choose the button left of the **Formula** button.)

2 In the **Filter** dialog, click the **Filter filename**  chooser button.

3 From the **Directories** menu, select the path ending with the text **\kernel**.

4 In the directory ‘filters_ranking,’ load the filter ‘median_5x5.ker.’

This is a 5 by 5 filter that assigns the center pixel the median values of all pixels in the 5 by 5 window. This and other filters such as ‘majority.ker’ are commonly used to generalize classified images.

Notice that most of the smaller, isolated pixels or clusters are merged into the surrounding dominant feature classes, giving the image smoother look.

5 Click **Close** in the **Filter** dialog to close it.

Enter a formula to aggregate the two unlabelled classes

Notice that there are two unlabelled classes that are represented in green and light green. For this exercise, you will aggregate these into one common class. (You could also vectorize each into its own polygons if desired.)

1 Click the **Edit Formula** button in the process stream diagram.

2 In the Generic formula window, edit the formula text to read:

```
if input1=6 or input1=7 then 6 else input1
```

This formula tells ER Mapper “if pixels have a value of 6 (unlabelled class 6) or 7 (unlabelled class 7) in the dataset, assign them both a value of 6, else do not change them.”

3 Click the **Apply changes** button to validate the formula.

Both the unlabelled classes with green and light green are assigned the same value (6), so they both appear in the light green color.

4 Click **Close** to close the **Formula Editor** dialog.

Save the algorithm as a Virtual Dataset

To run the raster to vector conversion, you need to save the algorithm as a Virtual Dataset (VDS). The VDS will contain all your processing, including the zoomed area, the smoothing filter, and the class aggregation formula.

1 From the **File** menu, select **Save as ...**.

2 From the **Directories** menu, select the path ending with the text **\examples\Miscellaneous**.

3 Double-click on the directory named ‘Tutorial’ to open it.

4 In the **Files of Type:** field, select “ER Mapper Virtual Dataset (.ers)”

5 In the **Save As:** text field, type a name using your initials at the beginning, followed by the text ‘raster_classes_VDS,’ and separate each word with an underscore (_). For example, if your initials are "CJ," type in the name:

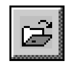
```
CJ_raster_classes_VDS
```

6 Click **OK** to save the Virtual Dataset.

Convert the raster cells to vector polygons

1 From the **Process** menu, select **Raster Cells to Vector Polygons...**.

The **Raster to Vector Conversion** dialog box opens. This dialog contains options to vectorize specific bands or cells values in a dataset, to create polygons, polylines, or filled polygons, and to smooth (interpolate) vectors.

2 Click the **Input Raster Dataset**  chooser button.

3 From the **Directories** menu, select the path ending with the text **\examples\Miscellaneous**. Then open the ‘Tutorial’ directory and load the ‘raster_classes_VDS.ers’ dataset you just created.

4 Turn on the **Fill Polygons** option (to create polygons instead of polylines)

Tip: To smooth rugged edges of the ploygons turn on **Smooth** option.

---

5 Click the **Output Vector Dataset**  chooser button.

6 From the **Directories** menu, select the path ending with the text **\examples\Miscellaneous**. Then open the ‘Tutorial’ directory and type a name in the **Save As:** text field as follows, then click **OK** to close the chooser. For example, if your initials are "JT," type in the name:

```
JT_High_Potassium_polygons
```

7 Edit the value in the **Cell Value** field to read `1` then press Enter or Return.

This tells ER Mapper to vectorize all pixels (cells) with the value 1 in the Virtual Dataset (the High Potassium areas from the classification). By default, ER Mapper will create vector polygons.

8 Click **OK** to start the raster to vector conversion.

ER Mapper displays a status dialog indicating the progress, then displays a confirmation dialog when the conversion is complete.

9 Click **OK** to close the confirmation dialog, then click **Close** and **Cancel** to close the other two raster to vector dialogs.

You have now created a vector file containing polygons representing the areas of High Potassium on the classified image.

Display the vector polygons over the classified image

1 In the Algorithm window, select **Annotation/Map Composition** from the **Edit/Add Vector Layer** menu.

A new annotation layer is added to the algorithm.

2 Click the **Edit Layer Color** button in the process stream diagram to choose a color for displaying the vectors.

3 Select a red color, and click **OK** to close the **Color Chooser**.

4 Click the **Load Dataset** button in the process steam diagram.

5 From the **Directories** menu, select the path ending with the text **\examples\Miscellaneous**.

6 In the directory ‘Tutorial,’ double-click on the ‘High_Potassium_polygons.erv’ dataset you created to load it.

ER Mapper first processes the raster data, then draws the vector polygons in red.

Display the vector polygons alone

1 Turn off the Class Display layer containing the max_like_class dataset.

ER Mapper draws the vector polygons in red over an empty (black) backdrop image so your can see them more clearly. As you can see, vectorizing raster data in this way can save hours or days of digitizing feature outlines by hand, so it is especially valuable for updating vector information for use in GIS products.

2: Vectorizing a binary image

Objectives Learn to prepare an algorithm that creates a binary image (High Potassium and remaining areas in this case), and perform the raster to vector polygons and to extract a polyline defining the boundaries between the High Potassium and the rest of the areas.

Create a ratio image

1 On the Standard toolbar, click on the **Edit Algorithm** button.

An image window and the **Algorithm** window appear.

2 Click on the **Layer tab** to view the settings for the layer.

3 In the **Algorithm** window, click the **Load Dataset** button on the left side of the process stream diagram.

The **Raster Dataset** file chooser dialog box appears.

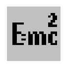
4 From the **Directories** menu, select the path ending with \examples\Miscellaneous.

5 Double-click on the directory ‘Tutorial’ to open it.

6 Double-click on the dataset named ‘Radiometrics_Practice.ers’ to load the Newcastle_Radiometrics dataset in the Pseudo Layer.

Note: If the color of the Pseudo Layer is other than pseudocolor change it to pseudocolor from the Color Table on the Surface Tab.

---

7 Click on the Edit Formula  button in the Algorithm window.

8 **Formula Editor** dialog appears.

9 In the **Formula Editor** dialog type in “ (i1 - rmin(,r1,i1))/(i2)” in the generic formula window area.

10 Select INPUT1: (i1) to be Potassium_cps and INPUT2: (i2) to be Thorium_cps in the relation window area.

Note: i1 = K band; i2 = Th band; rmin(,r1,i1) = the minimum value for a particular band within a region. Syntax:RMIN(dataset, region, band).

Note: The generic formula “(i1 - rmin(,r1,i1))/ (i2) ” is applied to adjust the dynamic range of the radioelements K to start from zero (0). Th band has a dynamic range of 8.796 to 397.646. Since there is no negative values for the Th dynamic range the Dark Pixel Correction is not applied. The ratio is an indicative of hydrothermally altered zones where K is found to have increased but Th concentration remains unchanged.

---

11 Click the **Apply changes** button in the **Formula Editor** dialog.

12 Click the **99% Contrast Enhancement**  button in the main menu (or **Algorithm** dialog).

13 The ratio (K - K min) / (Th) image is displayed.

Apply a median filter and a threshold to map high anomalies of K/Th ratio image

1 In the process diagram, click the pre-formula **Edit Filter (Kernel)** button. (Be sure to choose the button right of the **Formula** button.)

2 In the **Filter** dialog, click the **Filter filename** chooser button.

3 From the **Directories** menu, select the path ending with the text **\kernel**.

4 In the directory ‘filters_ranking,’ load the filter ‘median_5x5.ker.’

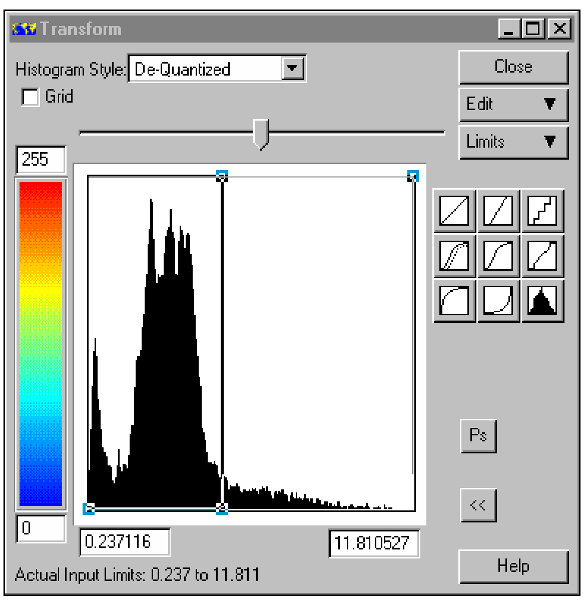
This is a 5 by 5 filter that assigns the center pixel the median values of all pixels in the 5 by 5 window. This and other filters such as ‘majority.ker’ are commonly used to generalize classified images.

5 In the Algorithm window click the **Edit Transform Limits** button.

6 The Transform window appears.

7 In the Transform window manually adjust the X-axis to about 5 (vertical).

Note: You have selected 5 as the threshold to map high K anomalies above 5 DN as red. The Actual Input Limits of K/Th image is 0.237 to 11.811.



Notice that most of the smaller, isolated pixels or clusters are merged into the surrounding dominant feature classes, giving the image smoother look.

8 Click **Close** in the **Filter** dialog to close it.

Save the ratio image as a Virtual Dataset

Save the algorithm as a Virtual Dataset (VDS). The VDS will contain all your processing, including the smoothing filter, and the formula.

1 Delete the transform of the ratio image.

Note: It is necessary to delete the transform so that ratioed image information, will be maintained and not scaled or clipped.

---

2 From the **File** menu, select **Save as ...**.

3 From the **Directories** menu, select the path ending with the text **\examples\Miscellaneous**.

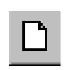
4 Double-click on the directory named ‘Tutorial’ to open it.

5 In the **Save As:** text field, type a name using your initials at the beginning, followed by the text ‘K_by_Th_VDS,’ and separate each word with an underscore (_). For example, if your initials are "CJ," type in the name:

`CJ_K_by_Th_VDS`

6 Click **OK** to save the Virtual Dataset.

Create a binary image using a formula

1 In the main menu window click on the **New**  button.

2 A new image window appears.

3 On the Standard toolbar, click on the **Edit Algorithm**  button.

An image window and the **Algorithm** window appear.

4 Click on the **Layer tab** to view the settings for the layer.

5 In the **Algorithm** window, click the **Load Dataset** button  on the left side of the process stream diagram.

The **Raster Dataset** file chooser dialog box appears.

6 From the **Directories** menu, select the path ending with \examples\Miscellaneous.

7 Double-click on the directory ‘Tutorial’ to open it.

8 Double-click on the dataset named ‘K_by_Th_VDS’ to load the ratio image in the Pseudo Layer.

Note: If the color of the Pseudo Layer is other than pseudocolor change it to pseudocolor from the Color Table on the Surface Tab.

---

9 Click the **Edit Formula** button in the process stream diagram.

10 In the Generic formula window, edit the formula text to read:

```
if input1 < 5 then 1 else 2
```

This formula tells ER Mapper “if pixels in the band selected for input1 have a value less than 5, assign them a value of 1, else assign all other a value of 2.” After this formula each pixel in the image will be reassigned a data value of 1 or 2 (a binary image).

Note: The threshold value 5 is taken from the threshold defining areas of High K anomalies in the Transform of K/Th ratio image in an earlier exercise.

---

11 Click the **Apply changes** button to validate the formula.

Now your formula uses a threshold of 5 to separate areas high in Potassium anomalies from the remaining low Potassium anomaly areas.

Note: The threshold value of 5 for this ratio K/Th image was determined in an earlier exercise. This value would typically be different for each dataset.

Initially the image appears black because the Transform limits need to be adjusted.

12 Click **Close** to close the **Formula Editor** dialog.

Adjust the Color Table and Transform for the binary image

1 From the **Color Table** drop-down list, select **unique**.

‘Unique’ is a special lookup table with widely different colors in slots next to each other (so it is good for emphasizing small differences in data values).

2 Click the post-formula **Edit Transform Limits** button to open the **Transform** dialog box.

3 In the **Transform** dialog, click the **Create default linear transform** button to reset the transform line.

4 From the **Limits** menu, select **Limits to Actual**.

The image is displayed in two colors–grey for the areas with high Potassium anomalies (a value of 1) and red for the remaining areas with low Potassium anomalies (a value of 2).

Note: You have adjusted the transform so the binary image could be displayed onscreen. Before vectorizing the binary image, you need to delete the transform as described below so the 1-2 data range is not transformed to 0-255.

Save the binary algorithm as a Virtual Dataset

1 From the **Edit** menu in the **Transform** dialog, select **Delete this transform**.

The transform you used previously to display the binary image is deleted to prevent rescaling the data in the Virtual Dataset.

2 Click **Close** to close the **Transform** dialog.

3 From the **File** menu, select **Save as...**.

4 From the **Directories** menu, select the path ending with the text **\examples\Miscellaneous**.

5 Double-click on the directory named ‘Tutorial’ to open it.

6 In the **Save As:** text field, type a name using your initials at the beginning, followed by the text ‘binary_image_VDS,’ and separate each word with an underscore (_). For example, if your initials are “BP,” type in the name:

```
BP_binary_image_VDS
```

7 Click **OK** to save the Virtual Dataset.

Convert the raster cells to vector polylines

1 From the **Process** menu, select **Raster Cells to Vector Polygons...**.

The **Raster to Vector Conversion** dialog box opens.

2 Click the **Input Raster Dataset**  chooser button.

3 From the **Directories** menu, select the path ending with the text **\examples\Miscellaneous**. Then open the ‘Tutorial’ directory and load the ‘binary_image_VDS.ers’ dataset you just created.

4 Click the **Output Vector Dataset**  chooser button.

5 From the **Directories** menu, select the path ending with the text **\examples\Miscellaneous**. Then open the 'Tutorial' directory and type a name in the **Save As:** text field as follows, then click **OK** to close the chooser. For example, if your initials are "MJ," type in the name:

```
MJ_vector_high_K_polyline
```

6 Edit the value in the **Cell Value** field to read **1** then press Enter or Return.

This tells ER Mapper to vectorize all pixels (cells) with the value 1 in the Virtual Dataset (areas with high Potassium anomalies in the image).

7 Turn on the **Polylines** option (to create polylines instead of polygons).

8 Click **OK** to start the raster to vector conversion.

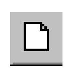
ER Mapper displays a status dialog indicating the progress, then displays a confirmation dialog when the conversion is complete.

9 Click **OK** to close the confirmation dialog, then click **Close** and **Cancel** to close the other two raster to vector dialogs.

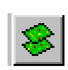
You have now created a vector file containing polylines representing the boundary between areas with high Potassium anomalies and the remaining areas with low Potassium anomalies.

Note: Also create a vector file with areas high in Potassium anomalies as polygon by choosing the Ploygons option in the raster to vector conversion.

Display the vector polylines over the Newcastle_Radiometrics image

1 In the main menu window click on the **New**  button.

2 A new image window appears.

3 Click the **Edit Algorithm**  toolbar button.

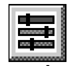
4 Click the **Load Dataset**  button in the process stream diagram.

5 From the **Directories** menu, select the path ending with the text **\examples\Miscellaneous**.

6 In the directory 'Tutorial,' double-click on the 'Radiometrics_Practice.ers' dataset to load it.

7 In the Algorithm window, select **Annotation/Map Composition** from the **Edit/Add Vector Layer** menu.

A new annotation layer is added to the algorithm.

8 Click the **Edit Layer Color**  button in the process stream diagram to choose a color for displaying the vectors.

9 Select a yellow color, and click **OK** to close the **Color Chooser**.

10 Click the **Load Dataset**  button in the process stream diagram.

11 From the **Directories** menu, select the path ending with the text **\examples\Miscellaneous**.

12 In the directory ‘Tutorial,’ double-click on the ‘vector_high_K_ployline.erv’ dataset you created to load it.

ER Mapper first processes the raster data, then draws the vector polylines in yellow. Notice that the vectors closely follow the areas with high Potassium anomalies / the remaining areas with low Potassium anomalies boundary in the image.

Note: You can also create vector polygons for high K anomaly areas and overlay on the raster image.

Close all image windows and dialog boxes

1 Close all image windows using the window system controls:

- For Windows, select **Close** from the window control-menu.
- For Unix systems, press right mouse button on the window title bar, and select **Close** or **Quit** (for systems with both options, select **Quit**).

2 Click **Close** in the **Algorithm** window to close it.

Only the ER Mapper main menu should be open on the screen.

What you learned...

After completing these exercises, you know how to perform the following tasks in ER Mapper:

- Apply smoothing to a classified image to remove isolated pixels
- Extract classes from a classified image and convert them to vector polygons
- Process a Radiometric image to create a binary image with areas of high and low Potassium anomalies
- Vectorize the binary image to extract polylines tracing the boundary of two spectral classes

13

Calibrating Satellite images

This chapter briefly discusses radiometric effects on Satellite images. These are the unwanted radiometric signatures produced by the atmosphere and instruments and contributed to overall signatures recorded in satellite images. The chapter also shows you some techniques on how to reduce those radiometric effects.

Radiometric effects on Satellite imagery

Signatures recorded on Satellite images may contain not only signatures of surface materials but also unwanted signatures from atmosphere and from the instruments. These unwanted radiometric signatures can sometime be very pronounce and can affect the quality of the images. In certain cases it may be necessary to correct the radiometric effects of atmosphere and instruments to have good quality images for digital processing, visual presentation and interpretation.

Atmospheric effects

Atmospheric effects on images are due to scattering or emission of electromagnetic radiation from atmosphere. Scattering of light by particles suspended in the air is the dominant cause of atmospheric effects on images. The scattering is described by Rayleigh's law and increases towards shorter wavelengths. Sun illumination and weather also contribute to the atmospheric effects that affect the quality of images. In hilly terrain, if the sun angle is low there will be increased shadow and not much information can be extracted from those shadow areas. Atmospheric scattering may contribute some signatures to shadow areas which may make them slightly lighter and not completely dark as they are supposed to be. Where there are clouds, visible wavelengths will not be able to penetrate them and also there will be shadow of the clouds on ground. If there is rain the temperature of the air will be cooler and will affect the temperature on images acquired at electromagnetic regions of Thermal Infrared.

Instruments effects

Instruments effects on images include diffraction of optical imaging systems, image detection and recording systems, sensor platform motion, stripping and lines dropouts. As optical sensing systems are not perfect you may get noise induced by sensors, stripping, lines drop out. These instruments effects can be reduced by using spatial and frequency (FFT) filters.

Hands-on exercises

These exercises show you how to rectify radiometric effects on Satellite images.

What you will learn...

After completing these exercises, you can perform the following tasks in ER Mapper:

- Apply Dark Pixel Correction to correct atmospheric effects on Satellite images
- Determine atmospheric effects using bivariate scattergram between longer wavelength (TM band 7) and shorter wavelength (TM band 1, 2, 3, 4 or 5)
- Correct atmospheric affects using “cut-off” information determined through bivariate scattergrams

Before you begin...

Before beginning these exercises, make sure all ER Mapper image windows are closed. Only the ER Mapper main menu should be open on the screen.

1: Dark Pixel Correction

Objectives

Learn to correct atmospheric effects using Dark Pixel Correction.

On any of the Earth’s surface if there is no atmosphere, shadow will be completely black. Hence if a shadow has values above 0 it indicates that atmospheric scattering has contributed to the shadow. One way to correct the atmospheric effects is to identify shadowed pixels, find their DN values adjust them to 0 and set all other pixels accordingly. Assuming the darkest pixel of an image is shadow, the value of the darkest pixel is determined through a formula and the value is subtracted from each pixel of the band to correct the atmospheric effects.

Open an image window and the Algorithm window to load LandsatTM image

Before you begin... Before beginning this exercise, make sure all ER Mapper image windows are closed. Only the ER Mapper main menu should be open on the screen.

1 On the Standard toolbar, click on the **Edit Algorithm** button.

An image window and the **Algorithm** window appear.

2 Click on the **Layer tab** to view the settings for the layer.

3 In the **Algorithm** window, click the **Load Dataset** button on the left side of the process stream diagram.

The **Raster Dataset** file chooser dialog box appears.

4 From the **Directories** menu, select the path ending with \examples.

5 Double-click on the directory 'Shared_Data' to open it.

6 Double-click on the dataset named 'LandsatTM.ers' to load the dataset.

Band one of the dataset is loaded into the Pseudocolor layer.

7 In the **Algorithm** window click on the surface tab. By default the **Color Mode** is in Pseudocolor. If not, change it to Pseudocolor mode. From the **Color Table** drop down list choose 'greyscale'.

8 Click **99% Contrast Enhancement** button to display the band 1 of the dataset.

Apply Dark Pixel Correction on band 1 of the TM image

1 In the Algorithm dialog, select Edit Formula button.

2 **Formula Editor** dialog appears.

3 In the **Formula Editor** dialog type in " INPUT1 - RMIN(,R1,I1)" in the generic formula window area.

Note: INPUT1 = current band which is band 1 of the TM image; RMIN(,R1,I1) = the minimum value for a particular band within a region. Syntax: RMIN(dataset, region, band)

Note: The formula is applied to correct the atmospheric effects by subtracting the darkest pixel value from each pixel of the band. It is called Dark Pixel Correction.

---

4 Click the **Apply changes** button in the **Formula Editor** dialog.

5 Click your left mouse button on the Pseudo Layer. A text field will appear. In the text field change the band description to **TM1_DPC**.

Note: DPC = Dark Pixel Corrected

Apply Dark Pixel Correction on bands 2-5&7of the TM image

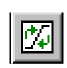
1 In the **Algorithm** window click on the **Duplicate** button  and duplicate Dark Pixel Corrected band 1 of the dataset.

2 Turn off the first **Pseudo Layer**.

3 Click on the second **Pseudo Layer** and make it the active layer.

4 In the **Algorithm** window from the band selector 

, select band 2 of the 'LandsatTM.ers' dataset for the second pseudo layer.

5 Click **99% Contrast Enhancement**  button to display the Dark Pixel Corrected band 2 of the dataset.

Note: You have duplicated the Dark Pixel Corrected band 1. Hence the formula " INPUT1 - RMIN(,R1,I1)" is also duplicated and applied to band 2.

---

6 Click your left mouse button on the **Pseudo Layer**. A text field will appear. In the text field change the band description to **TM2_DPC**.

7 Repeat the process for other bands (3-5&7): duplicate the Pseudo Layer, turn off the second-last Pseudo Layer, activate the last Pseudo Layer, change the last Pseudo Layer to band 3,4,5 or 7 of the dataset from the

band selector in the **Algorithm** window, display it with 99% clip on limits and change the band description to **TM3_DPC, TM4_DPC, TM5_DPC** and **TM7_DPC**.

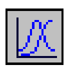
Note: Band 6 is excluded because it is Thermal Infrared and will not be used in the exercise.

---

8 Turn on all the 6 pseudocolor layers of ‘LandsatTM.ers’ which have been corrected for the atmospheric effects using Dark Pixel Correction technique.

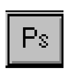
Note: The formula “ INPUT1 - RMIN(,R1,I1)” is applied to all bands 1-5&7.

Delete the transform from each of the 6 layers.

1 In the **Algorithm** window highlight the first Pseudo Layer and click the **Transform**  button.

2 The **Transform** dialog appears.

3 Delete the transform of the first Pseudo Layer.

4 In the **Transform** dialog click on the **Move to next Pseudocolor layer in surface**  button and select the second Pseudo Layer and its Transform.

5 Delete the transform of the second Pseudo Layer.

6 Repeat the process and delete transforms of all six Pseudo Layers.

Note: Deleting the transform from each of the layers maintains the dynamic range of the atmospheric adjusted data value of the 6 bands without scaling or clipping.

---

7 On the **Standard** toolbar, click the **Save As**  button.

The **Save As** dialog box appears. This dialog lets you specify a path and name for your output disk file, and options for creating the new dataset.

In the **Files of Type:** field, select “ER Mapper Raster Dataset (.ers)”

8 In the **Save As** dialog, click the file chooser  button next to **Output Dataset**.

9 From the **Directories** menu, select the path ending with the text **\examples\Miscellaneous**.

10 Double-click on the directory named **‘Tutorial**’ to open it.

11 In the **Save As:** text field, type in a name for the disk file. Use your initials at the beginning, followed by the text ‘Dark_Pixel_Corrected_TM’ and separate each word with an underscore (_). For example, if your initials are "DH," type in the name:

`DH_Dark_Pixel_Corrected_TM`

12 Click **OK** or **Save** to close the file chooser dialog.

The file name appears as the Output Dataset name with a ‘.ers’ extension.

Close the image window

1 In the main menu window, select **Close** from the **File** menu.

Only the ER Mapper main menu and the **Algorithm** dialog should be open on the screen.

2: Atmospheric Correction using “cut-off” information determined from Scattergram

Objectives Learn to correct atmospheric effects using cut-off information determined from Bivariate Scattergram

Another method of correcting atmospheric effects is to use cut-off information determined from bivariate scattergram between longer wavelength (TM 7) and shorter wavelength (either one of the TM 1-5). The longer wavelength (TM7) in Short Wave Infrared (SWIR; 2.215_um) has minimum atmospheric scattering (among the 6 TM bands) whereas shorter wavelengths in Visible range (VIS Blue 0.485_um; VIS Green 0.56_um; VIS Red 0.66_um) Near Infrared range (0.83_um) and SWIR range (1.65_um) have greater effect. A line of best fit drawn through the distribution between the two bands will intercept the shorter wavelength axis at a DN approximating the scattered component. This value is used as the cut-off.

Open an image window and the Algorithm window to load LandsatTM image

Before you begin... Before beginning this exercise, make sure all ER Mapper image windows are closed. Only the ER Mapper main menu should be open on the screen.

1. On the Standard toolbar, click on the **Edit Algorithm** button.

   An image window and the **Algorithm** window appear.

2. Click on the **Layer tab** to view the settings for the layer.

3. In the **Algorithm** window, click the **Load Dataset** button on the left side of the process stream diagram.

   The **Raster Dataset** file chooser dialog box appears.

4. From the **Directories** menu, select the path ending with \examples.

5. Double-click on the directory ‘Shared_Data’ to open it.

6. Double-click on the dataset named ‘LandsatTM.ers’ to load the dataset.

   Band one of the dataset is loaded into the Pseudocolor layer.

7. In the **Algorithm** window click on the surface tab. By default the **Color Mode** is in Pseudocolor. If not, change it to Pseudocolor mode. From the **Color Table** drop down list choose ‘greyscale’.

8. Click **99% Contrast Enhancement** button to display the band 1 of the dataset.

View a scattergram of the image data

1. From the **View** menu, select **Scattergrams...**.

   The **Scattergram** dialog box and **New Map Composition** dialog boxes open.

   (If the algorithm page setup mode is ‘fixed page,’ you may see a third dialog warning about annotation in this mode. If so, click **Close** to close it.)

2. Click **Cancel** in the **New Map Composition** dialog to close it (you do not need it for this exercise).

   The **Scattergram** dialog automatically references the dataset in the active image window (‘LandsatTM’). By default, the band 1 data values are shown on the X axis, and band 2 values on the Y axis.

Revise the scattergram bands and limits

1 In the **Scattergram** dialog, click the **Setup...** button.

The **Scattergram Setup** dialog opens.

2 From the **Y Axis** drop-down list, select **B7:2.215_um**.

3 From the **X Axis** drop-down list, select **B1:0.485_um**.

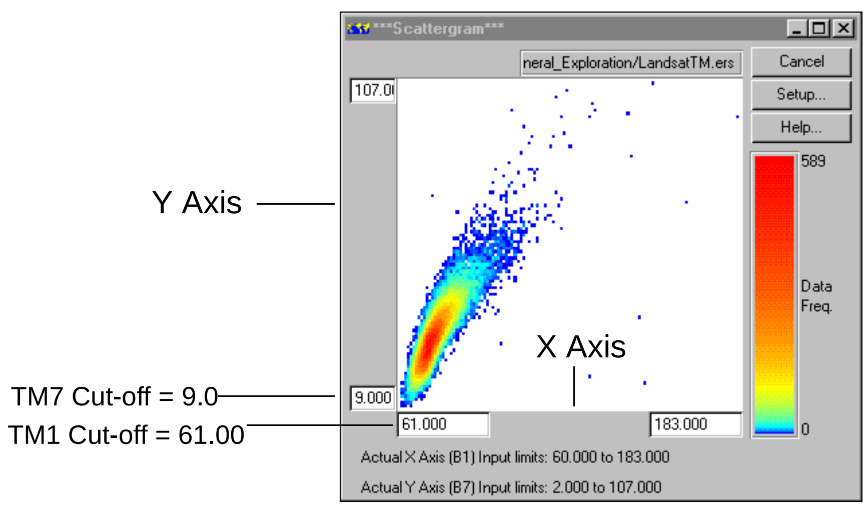
4 Click the **Limits to Actual** button to set the X and Y axis limits to the actual limits of the band 1 and 2 data ranges.

The scattergram is redisplayed to fill the window. TM bands 1 and 7 are not strongly correlated, as indicated by the wide dispersion of points.

Determine the cut-off on the shorter wavelength axis

1 In the **Scattergram** dialog, in the text field of the lower limit of Y axis type in 9.00 and in the text field of the lower limit of X-axis type in 61.00 and press enter.

2 The DN variance between bands TM7 and TM1 now originate from lower left corner of the scattergram. Note down these values. (TM7 = 9.0 and TM1 = 61.0). You will use them as cut-off to correct the atmospheric effects.



3 Change the X axis band to TM 2 and adjust the lower limit to 21 and press enter. The DN variance of the TM7 and TM2 now originate from the lower left corner of the scattergram. These are the cut-off values. (TM7 = 9.00 and TM2 = 21.00). Note down the values.

4 Similarly change the X axis band to TM3, TM4 and TM5 and adjust the lower limits to 18.00, 45.00 and 38.00 respectively. Note down the values.

Atmospheric Correction of band 1 using the cut-off determined from scattergram

1 In the Algorithm dialog, select Edit Formula button.

2 Formula Editor dialog appears.

3 In the **Formula Editor** dialog type in “ INPUT1 - 61” in the generic formula window area.

Note: INPUT1 = current band which is band 1 of the TM image; 61.00 = the cur-off value determined from bivariate scattergram (TM7 vs TM 1) to correct the atmospheric effects for TM band 1)

Note: The formula is applied to correct the atmospheric effects by subtracting the cut-off value from each pixel of the band.

---

4 Click the **Apply changes** button in the **Formula Editor** dialog.

5 Click the **99% Contrast Enhancement** button in the main menu window (or **Algorithm** dialog).

6 Click your left mouse button on the Pseudo Layer. A text field will appear. In the text field change the band description to **TM1_AEC**.

Note: AEC = Atmospheric Effect Corrected

Atmospheric Correction of band 2-5&7 using the cut-off values determined from scattergram

1 In the **Algorithm** window click on the **Duplicate** button and duplicate Dark Pixel Corrected band 1 of the dataset.

2 Turn off the first **Pseudo Layer**.

3 Click on the second **Pseudo Layer** and make it the active layer.

4 In the **Algorithm** window from the band selector B2:0.56_um, select band 2 of the ‘LandsatTM.ers’ dataset for the second pseudo layer.

5 In the **Formula Editor** dialog type in “ INPUT1 - 21” in the generic formula window area.

6 Click the **Apply changes** button in the **Formula Editor** dialog.

7 Click **99% Contrast Enhancement** button to display the Dark Pixel Corrected band 2 of the dataset.

8 Click your left mouse button on the **Pseudo Layer**. A text field will appear. In the text field change the band description to **TM2_AEC**.

9 Repeat the process for other bands (3-5&7) duplicate the Pseudo Layer, turn off the second-last Pseudo Layer, activate the last Pseudo Layer, change the last Pseudo Layer to band 3,4,5 or 7 of the dataset from the band selector in the **Algorithm** window, enter the cut-off values in the formula (18.00, 45.00, 38.00, 9.00 for TM3,4,5,7 respectively), display it with 99% clip on limits and change the band description to **TM3_AEC, TM4_AEC, TM5_AEC** and **TM7_AEC**.

Note: Band 6 is excluded because it is Thermal Infrared and will not be used in the exercise.

---

10 Turn on all the 6 pseudocolor layers of ‘LandsatTM.ers’ which have been corrected for the atmospheric effects using cut-off values determined from bivariate scattergram.

Delete the transform from each of the 6 layers.

1 In the **Algorithm** window highlight the first Pseudo Layer and click the **Transform** button.

2 The **Transform** dialog appears.

3 Delete the transform of the first Pseudo Layer.

4 In the **Transform** dialog click on the **Move to next Pseudocolor layer in surface** button and select the second Pseudo Layer and its Transform.

5 Delete the transform of the second Pseudo Layer.

6 Repeat the process and delete transforms of all six Pseudo Layers.

Note: Deleting the transform from each of the layers maintains the dynamic range of the atmospheric adjusted data value of the 6 bands without scaling or clipping.

---

7 On the **Standard** toolbar, click the **Save As**  button.

The **Save As** dialog box appears. This dialog lets you specify a path and name for your output disk file, and options for creating the new dataset.

8 In the **Save As** dialog, click the file chooser  button next to **Output Dataset**.

9 From the **Directories** menu, select the path ending with the text **\examples\Miscellaneous**.

10 Double-click on the directory named **‘Tutorial**’ to open it.

11 In the **Save As:** text field, type in a name for the disk file. Use your initials at the beginning, followed by the text ‘Dark_Pixel_Corrected_TM’ and separate each word with an underscore (_). For example, if your initials are "DH," type in the name:

`DH_Atmospheric_Effect_Corrected_TM`

12 Click **OK** or **Save** to close the file chooser dialog.

The file name appears as the Output Dataset name with a ‘.ers’ extension.

Other methods in correcting atmospheric effects on Satellite images

- You can also use groundtruthed spectrum of surface materials that were measured at the time the image was acquired to correct atmospheric effects. From the groundtruthed spectrum you can synthesize a spectrum for the wavelength bands of the image type you are using. Force to match the spectrum of the homogeneous and representative same cover type on the image to the synthesized spectrum.
- A rigorous and accurate method to correct atmospheric effects on Satellite images is mentioned by Forster, 1984. (Forster, B. C., (1984); “Deviation of atmospheric correction procedures for Landsat MSS with particular reference to urban data”, Int. J. Remote Sensing, Vol. 5, p 799-817). However, the algorithm requires information such as measured radiance and the aerosol and gaseous absorption optical thickness of the atmosphere at the time the imagery was taken.

Close the image window

1 In the main menu window, select **Close** from the **File** menu.

Only the ER Mapper main menu and the **Algorithm** dialog should be open on the screen.

2 Close the image windows using the window system controls:

- For Windows, click the ☒ **Close** button in the upper-right window corner.
- For Unix systems, select **Close** or **Quit** from the window control menu in the upper-left corner (for systems with both options, select **Quit**).

3 Click **Close** in the **Algorithm** dialog.

Only the ER Mapper main menu is now open.

What you learned...

After completing these exercises, you know how to perform the following tasks in ER Mapper:

- Using Dark Pixel Correction to correct atmospheric effects in TM images
- Determine cut-off values from bivariate scattergrams
- Correct atmospheric effects in TM bands using cut-off values determined from bivariate scattergrams

14

Image Geocoding

This chapter explains how to use ER Mapper to geometrically correct raw image data and rectify it to real world coordinate systems and map projections.

Note: The exercises in this chapter require the ‘Landsat_practice.ers” image file to be in ‘examples\Miscellaneous\Tutorial’ directory. This file was also used Chapter 19, “Supervised classification”.

About image geocoding

Whenever accurate area, direction and distance measurements are required, raw image data must usually be processed to remove geometric errors and rectify the image to a real world coordinate system. With satellite imagery, for example, these errors are introduced by factors such as roll, pitch and yaw of the satellite platform and curvature of the earth. In order to overlay or mosaic two images in ER Mapper, the images must be in the same coordinate system. The common coordinate system can be “raw” (uncorrected), or a real world map projection system.

A *ground control point* (GCP) is a point on the earth’s surface where both *image coordinates* (measured in rows and columns) and *map coordinates* (measured in degrees of latitude and longitude, meters, or feet) can be identified. *Rectification* is the process of using GCPs to transform the geometry of an image so that each pixel corresponds to a position in a real world coordinate system (such as Latitude/ Longitude or Eastings/Northings). This process is sometimes called “warping” or “rubbersheeting” because the image data are stretched or compressed as needed to align with a real world map grid or coordinate system.

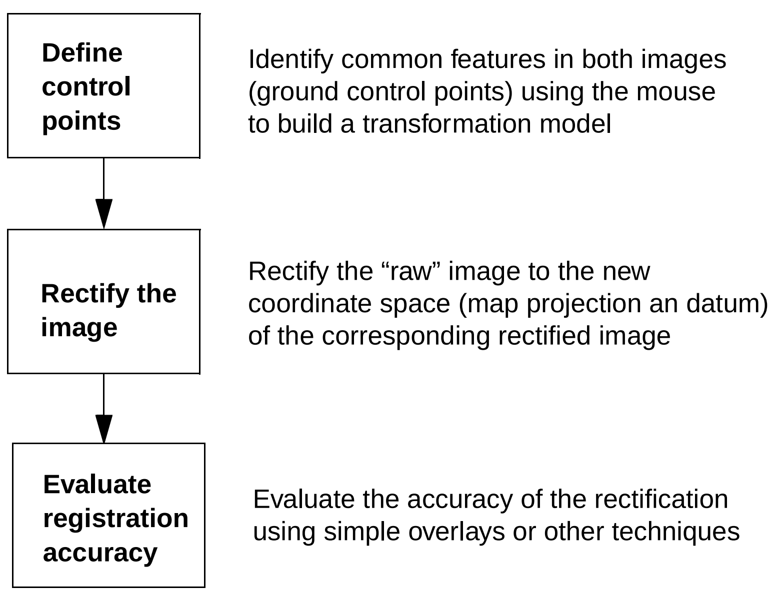
Orthorectification is a more accurate form of rectification because its takes into account sensor (camera) and platform (aircraft) characteristics. It is specifically recommended for airphotos. Orthorectification is covered separately in Chapter 26, “Image orthorectification”.

Registration is simply aligning two images so they can be overlaid or superimposed for comparison. In this case, the images do not have to be rectified to a map projection (they can both be in a “raw” coordinate system).

ER Mapper’s Rectification utilities are commonly used to perform four different types of operations:

- **Image to map rectification**–using polynomial (control point) or linear geocoding to rectify an image to a datum and map projection using GCPs.
- **Image to image rectification**–using polynomial (control point) or linear geocoding to rectify one image to another using GCPs.
- **Map to map transformation**–transforming a rectified image from one datum/map projection to another.
- **Image rotation**–rotating an image any number of degrees.

In this exercise, you will use the Geocoding Wizard to perform an image-to-image rectification. A typical procedure for performing an image-to-image rectification is as follows:



Hands-on exercises

These exercises give you practice using ER Mapper's Geocoding Wizard.

What you will learn...

After completing these exercises, you will know how to perform the following tasks in ER Mapper:

- Choose common ground control points (GCPs) between two images
- Use options to modify the GCP display and edit GCPs
- Rectify a "raw" image to the chosen datum and map projection
- Evaluate registration accuracy using a simple image overlay method

Before you begin...

Before beginning these exercises, make sure all ER Mapper image windows are closed. Only the ER Mapper main menu should be open on the screen.

Note: It is *very important* to adhere to the following procedures exactly as written. Choosing GCPs can be a fairly complex procedure, and you will learn the basics best by following these exact steps the first time.

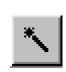
1: Choosing ground control points

Objectives

Learn how to use ER Mapper's Geocoding Wizard to identify common features in the two images, edit the points, and modify the GCP display.

Create the FROM algorithm (the "raw" image)

Before performing an image-to-image rectification, you must first create an algorithm that displays the "raw" image you want to rectify.

1. Click the **Image Display and Mosaicing Wizard**  toolbar button.

   An Image Wizard dialog box appears.

2. In the Image Wizard **Select files to display** window, click the file chooser  button in the **File to display:** field to open the file chooser.

3. In the directory 'examples\Miscellaneous\Tutorial', double-click on the image named 'Landsat_practice.ers'.

Note: You should have created the "Landsat_practice.ers" image in the ‘examples\Miscellaneous\Tutorial’ directory in an earlier exercise. If you have not done so, you can create it now by copying files ‘Landsat_MSS_notwarped’ and Landsat_MSS_notwarped.ers’ from the ‘examples\Shared_Data\’ directory and renaming them to ‘Landsat_practice’ and ‘Landsat_practice.ers’ respectively.

4 Select **Display image in 2D** and **Manually set display method**, and click on the **Next >** button.

5 In the **Select display method** window, select **Red Green Blue**.

6 Check the **Manually select display method properties** box.

7 Click on the **Next >** button.

8 In the display mode properties box **Type:** field, select RGB 321 from the list.

9 Click on the **Next >** button.

10 The RGB composite with MSS1 (Blue), MSS2 (Green) and MSS3 (Red) is displayed.

11 Click on the **Finish** button to close the Image Wizard.

12 Click the **Save As**  toolbar button.

13 In the **Files of Type:** field, select ‘ER Mapper Algorithm (.alg)’.

14 From the **Directories** menu, select the path ending with **\examples**.

15 Open the ‘Miscellaneous\Tutorial’ directory, and save the algorithm with the name ‘Landsat_FROM_algorithm’ (use your initials at the beginning).

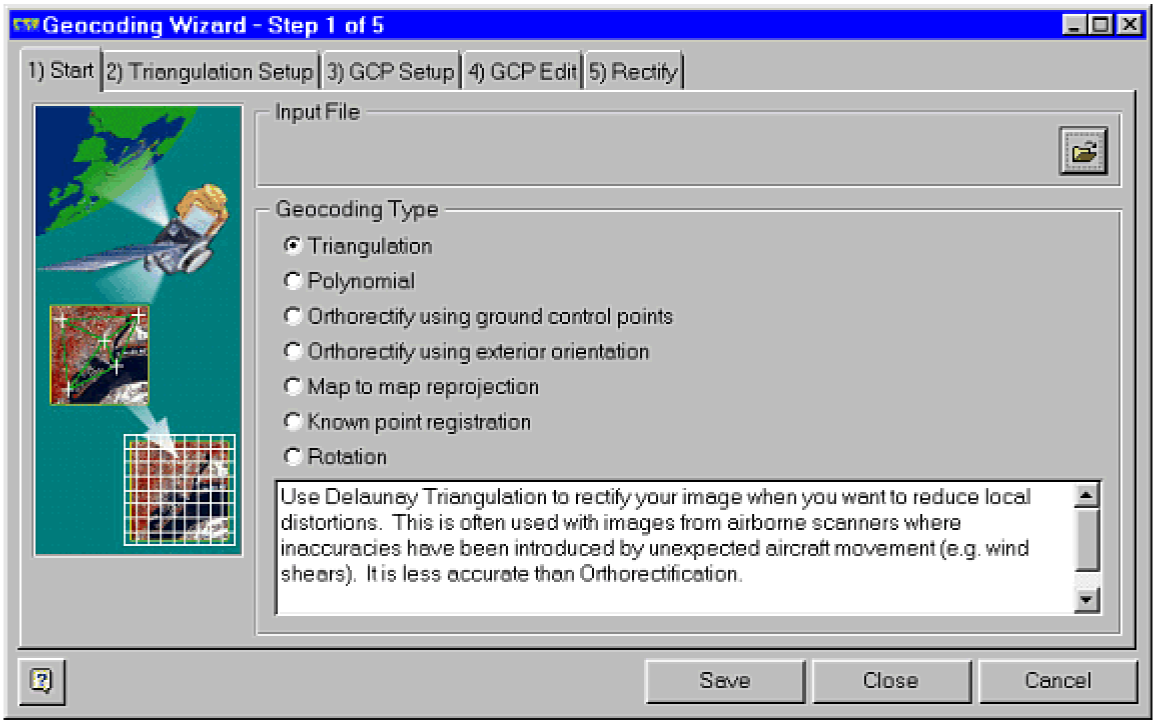
16 Close the image window using the window system controls:

- Select **Close** from the window control-menu.

Remove existing Ground Control Points from the practice image

1 From the **Process** menu (on the main menu), select **Geocoding Wizard**.

The Geocoding Wizard dialog box will open with the **Start** tab selected.



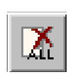
2 Click the **Load Algorithm or Dataset**  button in the **Input file:** field to open the file chooser.

3 From the **Directories** menu, select the path ending with the text **\examples**.

4 In the directory 'Miscellaneous\Tutorial,' double-click on your previously saved algorithm, 'Landsat_FROM_algorithm'.

5 Select **Polynomial** in the **Geocoding Type** box.

6 Select the **GCP Edit** tab.

7 Click the **Delete all GCPs**  button and, when asked to confirm the delete, click **Yes**.

8 Click on the **Save** button to save the changes to the practice image. If asked to confirm saving GCPs to disk click **Yes**.

Set the Polynomial Order

1 Select the Geocoding Wizard **Polynomial Setup** tab.

2 Select **Linear** in the Polynomial Order box.

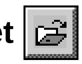
Specify an image-to-image rectification and algorithm name

1 Select the Geocoding Wizard **GCP Setup** tab.

The **GCP Setup** tab lets you specify the name of a geocoded reference image.

2 In the **GCP Picking Method** box, select **Geocoded image, vectors or algorithm** option.

This tells ER Mapper you plan to pick corresponding points between two images on the screen (an “image-to-image” rectification).

3 Click the **Load Corrected Algorithm or Dataset**  button.

4 From the **Directories** menu on the file chooser dialog, select the path ending with the text **\examples**.

5 Double-click on the ‘Data_Types’ directory to open it.

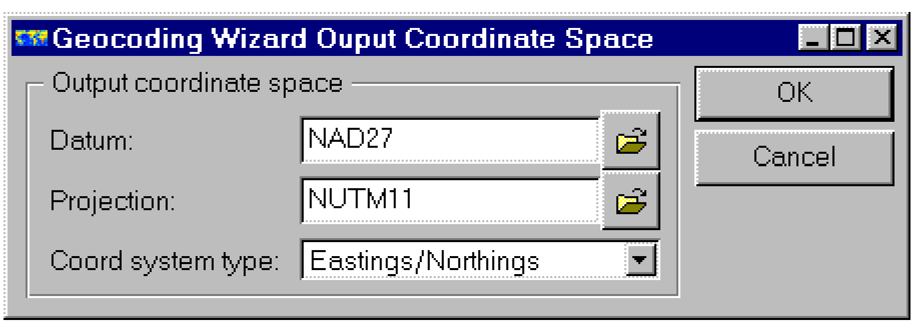
6 Double-click on the ‘Landsat_MSS’ directory to open it, then double-click on the algorithm ‘RGB_321.alg’ to load it.

This algorithm will be used to display the ‘CORRECTED’ image, which is the already rectified image containing coordinate information.

Setup parameters for the image rectification

The **To geodetic datum**, **To geodetic projection** and **To Coordinates**, fields in the Output Coordinate Space box show the datum, projection and coordinate type for the output rectified file you will create. These parameters are included automatically from the ‘CORRECTED’ (rectified) Landsat image.

1 Click on the Change... button to open the **Geocoding Wizard Output Coordinate Space** dialog.



2 Click on the **Projection**  chooser button.

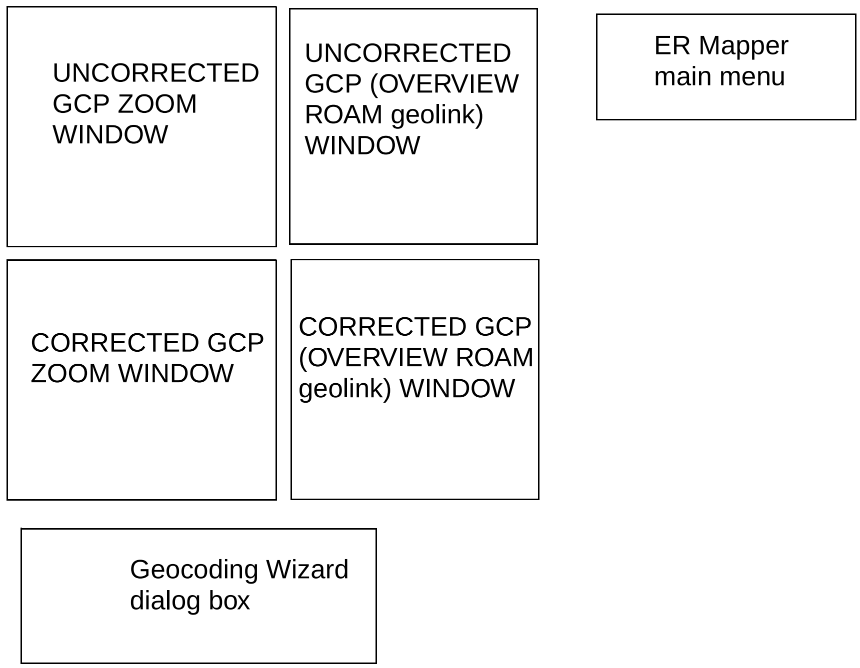
The **Projection Chooser** dialog opens showing available map projections (ER Mapper includes over 700 projections and you can add your own as well).

3 Click **Cancel** on the **Projection Chooser** dialog to close it.

4 Click **Cancel** on the **Geocoding Wizard Output Coordinate Space** dialog to close it.

5 Select the Geocoding Wizard **GCP Edit** tab.

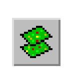
ER Mapper opens several image windows and dialog boxes. You should see a screen setup similar to this one:



Note: If your system does not position the windows automatically, rearrange them as shown above before proceeding.

Setup the image windows to pick the first four GCPs

When you first begin picking GCPs, your “raw” (unrectified) image contains no ground control points. You will begin by picking the first four control points using the CORRECTED and UNCORRECTED image windows. Once you have picked the first four GCPs, you can use the CORRECTED windows to quickly pick the remaining GCPs.

1 On the main menu, click the **Edit Algorithm**  button to open the **Algorithm** window.

2 Click inside the ’CORRECTED GCP ZOOM’ window to activate it.

3 In the **Algorithm** window, turn off the **Smoothing** option.

4 Click your right mouse button inside the ‘CORRECTED GCP ZOOM’ window, and select **Zoom to All Datasets** from the **Quick Zoom** menu.

The ‘CORRECTED GCP ZOOM’ window zooms out to the full image extents.

5 Click inside the ‘UNCORRECTED GCP ZOOM’ image window to activate it.

6 In the **Algorithm** window, turn off the **Smoothing** option.

7 Click your right mouse button inside the ‘UNCORRECTED GCP ZOOM’ window, and select **Zoom to All Datasets** from the **Quick Zoom** menu.

The ‘UNCORRECTED GCP ZOOM’ window zooms out to the full image extents. You are now ready to pick your first GCP.

8 Click **Close** on the **Algorithm** window to close it.

Note: It is a good idea to turn off the **Smoothing** option on algorithms where you will pick ground control points. This makes it easier to see the locations of individual image pixels when you zoom in closely to areas.

Pick a GCP in the upper-left part of both images

Note: Make sure the main ER Mapper menu is not hidden by the image windows–move it slightly if needed so you can easily access the toolbars.

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1 On the main menu, click the **ZoomBox Tool** toolbar button.

2 Point to the ‘UNCORRECTED GCP ZOOM’ image window, and zoom in on a small area in the upper-left part of the image with well defined features (drag a zoom box).

3 Move the pointer over the ‘CORRECTED GCP ZOOM’ image window (notice the pointer is a icon), and click once to activate the window.

4 In the ‘CORRECTED GCP ZOOM’ image window, drag a box to zoom in on the same geographic area you have displayed in the ‘UNCORRECTED’ window.

You have now zoomed to a common area in both images to pick a GCP.

5 On the main menu, click the **Pointer Tool** toolbar button.

6 In the ‘CORRECTED GCP ZOOM’ window (which is active), click on a clearly identifiable feature in the image, such as a sharp boundary between red vegetation and white barren land.

ER Mapper marks the control point with green cross hairs, and the geographic location of that point appears in the Easting and Northing fields on the Geocoding Wizard **GCP Edit** dialog. (This dialog has many options you will learn more about later.)

7 Click once inside the 'UNCORRECTED GCP ZOOM' window to activate it.

8 Click on exactly the same geographic feature in the 'UNCORRECTED GCP ZOOM' window. (It is important to be as accurate as possible).

ER Mapper marks the control point with cross hairs, and the image pixel location of that point in the raw image appears in the Cell X and Cell Y fields on the **GCP Edit** dialog. The location of each point is marked with a white "X" in each image with the number "1." You have now picked the first GCP.

Pick a second GCP in the lower-left of both images

1 On the Geocoding Wizard **GCP Edit** tab, select **Auto zoom**.

The ZOOM windows will now automatically zoom into the point selected in the corresponding OVERVIEW ROAM windows.

2 On the Geocoding Wizard **Edit GCP** dialog, click the **Add new GCP**  button.

3 Click on a well defined feature in the 'UNCORRECTED GCP (OVERVIEW ROAM geolink)' window to select it.

The 'UNCORRECTED GCP ZOOM' window will zoom ito the selected point

4 Click once in the 'CORRECTED GCP (OVERVIEW ROAM geolink)' window to activate it, then click on the same feature to select it as a GCP.

The 'CORRECTED GCP ZOOM' window will zoom ito the selected point

5 Use the two ZOOM windows to adjust the positions of the GCP.

You have now picked a second GCP in the image.

Pick two more GCPs in the upper- and lower-right

1 Following the steps from the previous section, pick a GCP near the upper-right and lower-right corners of the images.

Tip: When picking the first four GCPs, it is best to pick them in the four corners of the image (if this is possible). This will make the **Calculate from point** function you will use next as accurate as possible. (In this case there was ocean in the lower-left, so you picked a point in the closest area possible.)

Pick additional GCPs using the Corrected GCP Overview window

Once you have picked the first four GCPs, notice that ER Mapper now displays values in the 'RMS' field on the **GCP Edit** dialog. The Root Mean Square (RMS) error is a measurement of the accuracy of the GCP in this image expressed in the image's pixel size. (An RMS of 1.00 would be 80 meter positional error in the case of the Landsat MSS data used here.) If you have done an accurate job selecting the first four GCPs, the RMS should be one or less.

When an RMS can be calculated, ER Mapper can now use the coefficients generated from the first four points to "predict" the location of 'UNCORRECTED' (raw) points when you pick additional points in the 'CORRECTED' (rectified) image. This feature makes selection of the remaining points much faster and easier, and you will use it next.

1 On the main menu, click the **Set Pointer mode** button (if needed).

2 If needed, activate the 'CORRECTED GCP (OVERVIEW ROAM geolink)' window by clicking in it.

3 On the Geocoding Wizard **Edit GCP** dialog, click the **Add GCP** button.

4 In the 'CORRECTED GCP (OVERVIEW ROAM geolink)' window, click on a well defined feature near the center of the image.

ER Mapper marks the control point with cross hairs, and enters the geographic location of GCP #5 in the TO Easting and Northing fields. The 'CORRECTED GCP ZOOM' window zooms into the point for you to adjust its position.

5 In the Geocoding Wizard **GCP Edit** dialog, click the **Calculate from point** button.

ER Mapper automatically enters values in Cell X and Cell Y fields–this is the "predicted" location of GCP #5 in the FROM image.

Notice that the new GCP #5 has an RMS error of zero. Since it's location is computed from the existing points, it adds no new information to the rectification model (and is therefore not yet a true GCP). Next you need to "fine tune" the location of the point in the ZOOM windows to make it a true GCP.

6 Click once in one of the ZOOM windows to activate it, then click on the GCP in the image. Adjust its position if necessary.

ER Mapper repositions GCP #5 to the new position, and calculates an RMS value to display in the Geocoding Wizard **GCP Edit** dialog box.

You have now picked a fifth GCP using the "predict FROM points" technique.

Tip: You can keep clicking in the UNCORRECTED AND CORRECTED ZOOM windows as many times as needed to refine the GCP location.

Pick several other points spread throughout the images

1. Using the procedure in steps 2-6 above, pick several other GCPs well spread throughout the image (pick at least 10).

Tip: If the default magnification level in the ZOOM windows is too great or small for your taste, activate each window and use the **Zoom In** or **Zoom Out** options in the Quick Zoom menu to change the zoom factor by a fixed amount in both windows. That zoom factor is retained for subsequent points. (If you make a mistake, you can select **Previous Zoom** to fix it.)

Try some other features on the Geocoding Wizard GCP Edit dialog

1. In the Geocoding Wizard **GCP Edit** dialog, click on any GCP number under the ‘Name’ column.

   ER Mapper moves the crosshairs to highlight that point in all the ‘OVERVIEW ROAM’ and ‘ZOOM’ windows.

2. Turn off the **Auto Zoom** option at the bottom.
3. Click on any GCP number under the ‘Name’ column.

   ER Mapper moves the crosshairs to highlight that point in the ‘OVERVIEW ROAM’ windows, but not the ‘ZOOM’ windows.

4. Click on the **Zoom to current GCP** 

button.

   ER Mapper zooms into the selected GCP in the “ZOOM’ windows.

5. Select the number text for a GCP under the ‘Name’ column, and type a short name.

   You can give GCPs text labels as well as numbers to help identify them.

6. Click on the text ‘On’ in the second column for any GCP.

   The text changes to ‘Off’ and all the RMS errors are recomputed without including that GCP. (This is an easy way to see how the positional error of any GCP influences the RMS of the others. For example, turning off a GCP with a large RMS often reduces the RMS of the others.) This can be important when choosing which GCPs will be used for the final image rectification.

7 Turn off other GCPs to see the effect, but turn all on again when finished.

8 Click on the text ‘Edit’ in the third column for any GCP.

The text changes to ‘No’ and the “X” and number marking it in the image turns green. This effectively “locks” a GCP so it cannot be edited (that is, clicking in the image windows do not redefine it’s position). This is useful when you have several very good GCPs and you to lock them to avoid accidentally changing them.

9 Turn on the **Errors** option.

The magnitude and direction of the calculated positional error are shown graphically by a line for each GCP on the image. (If you have very small RMS errors you may not see the error line, even if you increase the line length by a factor of 10 using the **x10** option.)

10 Turn on the **Grid** option.

A polynomial grid displays over all three image windows. This grid is a simple “preview” of the way in which the FROM (raw) image pixels will be reprojected onto the new coordinate grid of the TO image. (This grid is only an approximation, in reality the lines would be curved.)

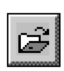
11 Click **Save** on the **Geocoding Wizard** dialog. If asked confirm saving the GCPs to disk, click **Yes**.

2: Perform the image rectification

Objectives Learn how to use the ground control points you selected to rectify the image to the selected datum and map projection.

Specify output (rectified) image file

1 Select the Geocoding Wizard **Rectify** tab.

2 Click the file chooser  button in the Output Info box.

3 From the **Directories** menu, select the path ending with **\examples**.

4 Double-click on the ‘Miscellaneous\Tutorial’ directory to open it.

5 Enter the filename ‘Landsat_MSS_rectified’ (start with your initials), then click **OK**.

6 In the **Resampling:** in the Cell Attributes box select ‘Nearest Neighbour’.

The Cell Attributes box also lets you resample the output image to a different cell size (Output Cell width and height), and specify a null cell value.

7 Select **Display rectified image** to display the image after it is rectified.

Create the output rectified image on disk

1 Click on the **Save file and start rectification** button.

ER Mapper opens a status dialog to indicate the progress of the rectification.

2 When the operation finishes, click **OK** of the successful completion dialog.

3 Click on the **Close** button to exit the Geocoding Wizard.

You have now rectified the uncorrected Landsat MSS image to correspond to the 1927 North American Datum (NAD27) and UTM zone 11 (NUTM11) map projection.

Close all image windows and dialog boxes

1 Click on the Geocoding Wizard **Close** button.

2 Close all image windows using the window system controls:

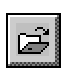
- For Windows, select **Close** from the window control-menu.
- For Unix systems, press right mouse button on the window title bar, and select **Close** or **Quit** (for systems with both options, select **Quit**).

3 Click **Close** on the **Algorithm** window to close it.

3: Evaluating image registration

Objectives Learn a simple way to visually evaluate the registration of two images using an overlay technique. In this case, you will evaluate the registration of the raw image you rectified and the rectified MSS image supplied with ER Mapper.

Load an existing RGB algorithm

1 Click the **Open**  toolbar button.

2 From the **Directories** menu, select the path ending with the text **\examples**

3 Double-click on the 'Data_Types' directory to open it.

4 In the directory 'Landsat_MSS,' load the algorithm named 'RGB_321.alg.'

This algorithm displays the rectified Landsat MSS image of San Diego provided with ER Mapper as an RGB image. You will use only the Red and Green layers for the comparison with your rectified image.

5 On the main menu, click the **Edit Algorithm**  button to open the **Algorithm** window.

Load your rectified image into the Green layer

1. In the **Algorithm** window, click on the Blue layer to select it.
2. Click the **Cut** button to delete the Blue layer.
3. Click on the Green layer to select it.
4. Click the **Load Dataset** button in the algorithm process diagram.
5. From the **Directories** menu, select the path ending with **\examples**.
6. Double-click on the ‘Miscellaneous’ directory to open it.
7. Double-click on the ‘Tutorial’ directory to open it.
8. Click once on the image ‘Landsat_MSS_rectified.ers’ to select it, then click **OK this layer only** button to load it into the Green layer. (The Red layer should still have the ‘Landsat_MSS_27Aug91’ image.)
9. Select **B3:0.75_um** from the Green layer’s **Band Selection** drop-down list.

   (Band 3 is also loaded in the Red layer for the other image for direct comparison.)

Display the two images to evaluate registration

1. Click the **99% Contrast Enhancement** toolbar button.

   This image combines two different images–one in the Red layer and one in the Green layer. If your images are well aligned the image appears yellow. If you see areas that are dominantly red or green, this indicates poor registration.
2. On the **Algorithm** window, turn off the **Smoothing** option.
3. On the main menu, click the **ZoomBox tool** toolbar button.
4. Drag a zoom box over a very small area of the image that contains land and water.

   Errors in registration appear as either red or green pixels because this is where the two image do not align perfectly. This is a very simple way to evaluate the registration of two images. If the RMS errors of your GCPs were generally less than one, you should not see more that one pixel offsets or registration errors.

Close all image windows and dialog boxes

1 Close all image windows using the window system controls:

- Select **Close** from the window control-menu.

2 Click **Close** on the **Algorithm** window to close it.

Only the ER Mapper main menu should be open on the screen.

What you learned...

After completing these exercises, you know how to perform the following tasks in ER Mapper:

- Choose common ground control points (GCPs) between two images
- Use options to modify the GCP display and edit GCPs
- Rectify a “raw” image to the chosen datum and map projection
- Evaluate registration accuracy using a simple image overlay method

15

Processing Satellite images

This chapter shows several common image processing techniques for enhancing and transforming Landsat or other satellite data to create images that are useful in mineral exploration applications. You will learn to apply filters to highlight structural features, ratio different Landsat bands to highlight iron oxide and hydroxyl minerals (alteration zones) , and other techniques.

Note: It is assumed you have basic familiarity with how to load filters and specify formulas in ER Mapper.

Hands-on exercises

These exercises show you how to create common enhancements of Landsat TM satellite images to highlight geological structures and areas of hydrothermal alteration.

What you will learn...

After completing these exercises, you can perform the following tasks in ER Mapper:

- Apply filters to satellite images to enhance structural features

- Create Landsat band ratio images commonly used for mineral exploration
- Create RGB composite to highlight alteration zones and iron rich soil using Crosta algorithm which applies Principal Component Analysis.

Before you begin... Before beginning these exercises, make sure all ER Mapper image windows are closed. Only the ER Mapper main menu should be open on the screen.

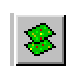
1: Filtering images to enhance structure

Objectives Learn to apply several types of convolution filters commonly used to enhance and highlight structural geology features in satellite images.

Faults may be recognized on satellite or DTM images by linear features. Fault lineaments can be recognized from i- abrupt topographic discontinuities of landforms, ii- depressions along fault zones caused by erosion along weak zones, iii-scarps or cliffs, iv- sudden shift of drainage courses, v- offset of lithologic units so that lithologies of different age or type become adjacent to each other.

Folds features on satellite images depend on their type and nature. If for example there is a vertical anticline fold and the image was taken vertically then you will see a circular feature with a dome shape. If it is in sedimenatry terrains and the top part of the fold was eroded you will be able to see the nature of the folds by tracing a marker bed. Often folds are associated with tectonic events and there maybe faults that cut through folds. If the limbs of the folds are exposed you will be able to judge the plunge direction of the folds if they are plunged folds.

Create a greyscale algorithm to display a Landsat image

1 In the main menu window, click the **Edit Algorithm**  button.

A new image window and the **Algorithm window** appear.

2 In the **Algorithm window**, click the Load Dataset  button.

3 From the **Directories** menu (in the **Raster Dataset** dialog), select the path ending with **\examples**.

4 Open the ‘Shared_Data’directory, then double-click on the dataset named ‘LandsatTM.ers’ to load it.

5 Click **OK** in the **Select a Dataset** dialog.

ER Mapper loads the Landsat TM dataset and displays band 1 as a contrast enhanced greyscale image.

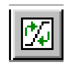
6 Make the image window about 50% larger by dragging a corner.

Display Landsat band 5 and adjust the contrast

1 From the **View** menu, select **Algorithm**.

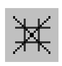
The **Algorithm** dialog opens.

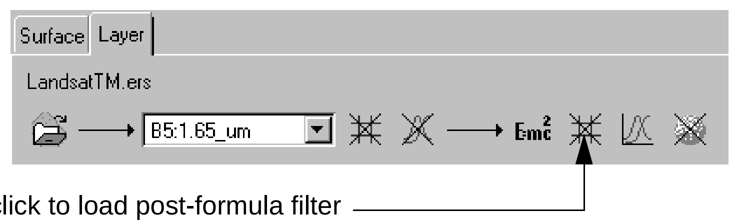
2 From the **Band Selection** drop-down list, select **B5:1.65_um**.

3 Click the **99% Contrast Enhancement**  button in the **Algorithm** dialog or main menu.

ER Mapper renders band 5 of the Landsat image with basic contrast enhancement. Band 5 (shortwave infrared - SWIR) is commonly used for analysis of structural geology features. (Lineaments resulting contrast between different types of soil or vegetation are often most clearly defined in near infrared (NIR) band such as TM4 and SWIR bands such as TM5 and TM7.)

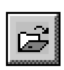
Apply high pass (sharpening) filters to the image

1 In the algorithm process diagram, click the post-formula **Edit Filter (Kernel)**  button.



click to load post-formula filter

The **Filter** dialog box appears.

2 Click the  button next to 'Filter filename.'

3 From the **Directories** menu, select the path ending with **\kernel**.

4 Open the 'filters_high_pass' directory, then double-click on the filter 'Sharpen2.ker' to load it.

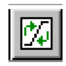
5 Click the **99% Contrast Enhancement**  button.

The 'Sharpen2' filter enhances high frequency detail to increase the local contrast around edge features in the image, such as lineaments and faults. High pass filters add crispness to an image, so they are sometimes called sharpening filters.

6 Click the  button next to 'Filter filename.'

7 Double-click on the filter 'Ford_5x5.ker' to load it.

These new values replace the previous values of the Sharpen2 filter. Notice that the Ford filter is a 5 by 5 array of values.

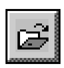
8 Click the **99% Contrast Enhancement**  button.

The ‘Ford_5x5’ filter also enhances high frequency detail, but has a stronger effect than the 3 by 3 ‘Sharpen2’ filter due to the larger array and different filter weighting values.

Apply directional gradient edge detection filters

Directional gradient filters (or sun angle filters) are designed to isolate and “raise” high frequency edge features in an image that trend in the direction normal to the angle of the filter. (You used these filters previously on magnetic data.) This type of filter is used in geological structure mapping with satellite images because features such as lineaments and fracture systems tend to be linear edge features and thus stand out from low frequency areas with less structural significance.

This class of filter acts like a sun shining on the image from a particular compass direction (similar in some ways to ER Mapper’s real time shading feature used on geophysical datasets). For example, a northwest filter isolates edge features trending in a northeast to southwest direction (normal to the northwest sun angle).

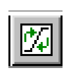
1 Click the  button next to ‘Filter filename.’

2 From the **Directories** menu, select the path ending with the text **\kernel**.

3 Open the ‘filters_sunangle’ directory

4 Click ***once*** on the filter ’North_West.ker’ to select it, then click **Apply**.

The filter is loaded and the **Load filter** dialog remains open.

5 Click the **99% Contrast Enhancement**  button.

The effect of the ‘North_West’ filter is to isolate and “raise” edge features trending in a northeast to southwest direction (features normal to the northwest sun angle). The northwest side of edge features are “illuminated” as white, the southwest side of the same feature is “in the shadow” and shows as black, and lower frequency “flat” areas show as a mid-grey color.

6 In the **Load filter** dialog, click once on ’North_East.ker,’ then click **Apply**.

The effect of the ‘North_East’ filter is similar to ‘North_West,’ but it isolates edge features trending in a northwest to southeast direction.

Tip: All the filters in the ‘filters_sunangle’ directory produce the same data range, so there is no need to use the **99% Contrast Enhancement** button in this case.

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7 In the **Load filter** dialog, click once on ’East_West.ker,’ then click **Apply**.

The ‘East_West’ filter enhances edge features trending in a north-south direction.

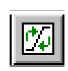
8 In the **Load filter** dialog, double-click on ’North_South.ker’ to load it and close the dialog.

The North_South filter enhances edge features trending in a east- west direction.

Tip: Gradient directional edge enhancement filters are sometimes used in conjunction with simple RGB displays. For example, display an image in RGB, then add an Intensity layer displaying band 5 with a directional edge filter applied. This produces an image that highlights edge features but also has the images colors draped on top to show associated lithology or surface cover.

Delete the filter and display Landsat band 5 again

1 From the **Edit** menu (in the **Filter** dialog), select **Delete this filter**.

2 Click the **99% Contrast Enhancement**  button.

Band 5 of the Landsat image displays with no filters applied.

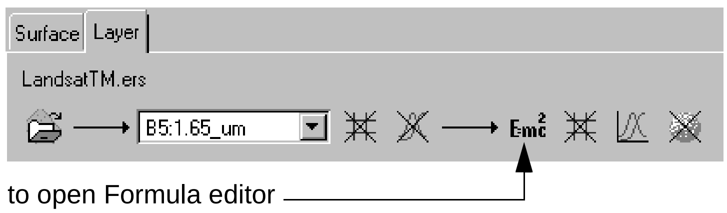
3 Click **Close** in the **Filter** dialog to close it.

2: Using Landsat band ratios

Objectives Learn how to enter a band ratio formula, and create three ratio images commonly used for Landsat TM data in mineral exploration. Ratios between two bands are commonly used to highlight features that reflect strongly in one band and poorly in the other band. Also learn to display the three ratios as an RGB color composite image.

Create a vegetation index image

1 In the **Algorithm** dialog, click the **Edit Formula** button in the process diagram.



click to open Formula editor

The **Formula Editor** dialog box opens and shows the default formula “INPUT1.”

2 In the Generic formula window, edit the formula text to read:

(INPUT1-RMIN(,R1,I1))/ (INPUT2-RMIN(,R1,I2))

3 Click the **Apply changes** button in the **Formula Editor** dialog.

This formula tells ER Mapper to divide the dataset band assigned to input1 by the band assigned to input 2 (a ratio between the two inputs).

4 In the Relations window, select **B4:0.83_um** from the drop-down list next to “INPUT1,” and select **B3:0.66_um** from the “INPUT2” drop-down.

Note: INPUT1 = TM band 4 (**B4:0.83_um**) and INPUT 2 = TM band 3 (**B3:0.66_um**). RMIN(,R1,I1) = the minimum value for a particular band within a region. Syntax:RMIN(dataset, region, band).

Note: The formula subtracts the darkest pixel value from each pixel of the band (Dark Pixel Correction) and ratio the two Dark Pixel Corrected bands TM4 and TM3. When used with Landsat TM datasets, the TM4/3 band ratio is a simple vegetation index formula.

Display the vegetation index image

1 Click the **99% Contrast Enhancement** button.

The vegetation index image shows vegetated areas (higher ratio values) in light tones, and areas with little or no vegetation in darker shades. The drainage patterns of stream beds are apparent due to the strong presence of green vegetation.

This band combination takes advantage of high vegetation reflectance in TM band 4 (near infrared light) and absorption by vegetation in band 3 (visible red light). Since vegetation vigor is influenced by soils, changes in the vigor or distribution of vegetation can sometimes provide clues to the presence of mineralized soils and alteration zones.

Tip: Ratio formulas create different data ranges depending on the bands being used. Therefore, it is easiest to use the **99% Contrast Enhancement** button to process the algorithm so ER Mapper automatically adjusts the contrast suit to the data range produced by any particular ratio.

---

2 In the **Algorithm** dialog, change the Pseudo Layer’s label to **`vegetation ratio (4/3)`**.

Create a new layer for an iron oxide ratio image

1 In the **Algorithm** dialog, click the **Duplicate** button.

ER Mapper creates a copy of the ‘vegetation ratio’ layer. Since the duplicate layer already contains the appropriate dataset and formula, you can easily modify it to create a different ratio image (iron oxides in this case).

2 In the Relations window (in the **Formula** dialog), select **B3:0.66_um** for “INPUT1” and select **B1:0.485_um** for “INPUT2.”

Using the same Generic formula **`(INPUT1-RMIN(,R1,I1))/ (INPUT2-RMIN(,R1,I2))`**, you have now chosen the appropriate TM band ratio (3/1) to create a simple iron oxide image.

3 Change the label for the new (lower) layer to **`iron oxide ratio (3/1)`**.

4 Right-click on the ‘vegetation ratio (4/3)’ layer and select **Turn Off**.

5 Click the **99% Contrast Enhancement** button.

Your contrast enhanced iron oxide ratio image shows iron-rich rocks (higher ratio values) in light shades of grey, and iron-poor rocks in darker shades. This band combination takes advantage of high iron oxide reflectance in TM band 3 (reflected VIS red light) and absorption in band 1 (VIS blue light).

Create a new layer for a clay minerals ratio image

1 Select the ‘iron oxide ratio (3/1)’ layer, then click the **Duplicate**  button.

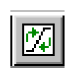
You will modify the copied layer with generic formula **`(INPUT1-RMIN(,R1,I1))/ (INPUT2-RMIN(,R1,I2))`** to create a clay minerals ratio image.

2 In the Relations window (in the **Formula** dialog), select **B5:1.65_um** for “INPUT1” and select **B7:2.215_um** for “INPUT2.”

You have now chosen the appropriate TM band ratio (5/7) to create a simple clay minerals image.

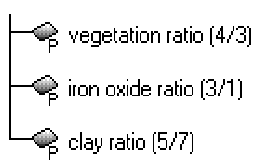
3 Change the label for the new (lowest) layer to **`clay ratio (5/7)`**.

4 Right-click on the ‘iron oxide ration (3/1)’ layer and select **Turn Off**.

5 Click the **99% Contrast Enhancement**  button.

Your contrast enhanced clay ratio image shows clay-rich rocks (higher ratio values) in light shades of grey, and clay-poor rocks in darker shades. This band combination takes advantage of high reflectance of clay minerals in TM band 5 and strong absorption by clay minerals in TM band 7. This ratio can be useful for detecting the presence of clays associated with alteration zones.

You now have three layers in your algorithm, each displaying a different ratio image. Your layers should look like this (but the upper two are turned off):



To view any ratio image, simply turn off the other two layers. (The transforms are already set correctly.)

6 Click the **Close** in the **Formula Editor** dialog box to close it.

Save the Landsat ratios algorithm to disk

1 In the **Algorithm** dialog, enter the text **`Landsat TM ratios`** in the ‘Description’ text field.

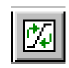
2 From the **File** menu (in the main menu), select **Save As...**.

3 From the **Directories** menu, select the path ending with the text **\examples\Miscellaneous**.

4 Double-click on the ‘Tutorial’ directory to open it.

5 In the **Save As:** text field, type a name for the algorithm file using your initials at the beginning, followed by the text ‘Landsat_ratios.’

6 Click **OK** to save the algorithm.

You now have a template algorithm that lets you compute these ratios for *any* Landsat TM image simply by loading the image, turning on all three layers, and clicking the **99% Contrast Enhancement**  button.

Display the three ratio images as an RGB color composite

Since you have already created a layer for each of the ratio images, it is easy to change the algorithm layers and Color Mode to display the three ratios as an RGB color composite image.

1 Turn on all three layers in the algorithm (right-click and select **Turn On**).

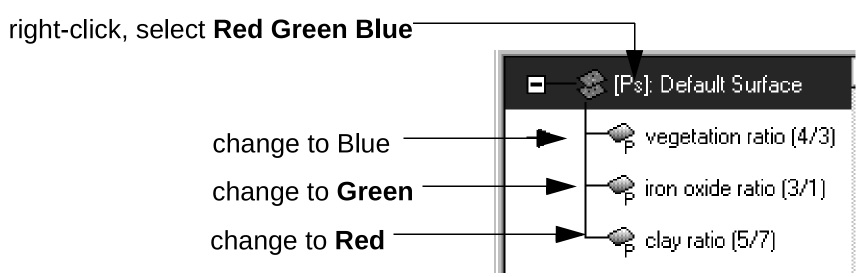
2 Right-click on the icon next to ‘[Ps]:Default Surface’ and select **Red Green Blue**.

Since the Pseudocolor layers in your algorithm are not valid with Red Green Blue Color Mode, they become invalid (crossed out). Next you will change them to Red, Green and Blue layers. (You can also select RGB color mode by clicking the **Surface** tab.)

3 Right-click on the ‘vegetation ratio (4/3)’ layer and select **Blue**.

4 Right-click on the ‘iron oxide ratio (3/1)’ layer and select **Green**.

5 Right-click on the ‘clay ratio (5/7)’ layer and select **Red**.



You now have an RGB image that allows you to see relationships between the three ratios by the composite color produced. This particular RGB ratio composite is sometimes called the “Abrams ratio” after one researcher.

To interpret this and other RGB ratio images, it is important to understand the RGB color system. For example, areas where one ratio is high and the other two low will appear in the high ratio’s layer color. Areas where two ratios have high values will appear in a combined color, for example high vegetation and clay ratios appear as magenta (since blue and red combine to create magenta in the RGB color system). Areas where all three ratios are roughly proportional will appear in white (if all three are high), black (if all are low) or grey (proportional mid-levels).

3: Applying Principal Component Analysis (Crosta Technique)

Principal Component Analysis (PCA) is a multivariate statistical analysis that transforms a set of correlated variables into a new set of uncorrelated variable. This transformation is a rotation of the original axes to new axes that are orthogonal to each other and therefore there is no correlation between variables. The first Principal Component (PC1) maps the maximum amount of variations that are common in all the bands into a new axis. PC2 maps the maximum amount of variation into a new axis unexplained by the PC1 and orthogonal to PC1, etc. Hence PCA is used to map common information between bands to the first few principal components thus reducing the number of image bands that have useful information.

Crosta technique selects 4 bands (TM1,4,5,7 or TM2,4,5,7 or TM3,4,5,7) to create principal components to highlight clay rich soils in PC3 or 4. The technique also selects 4 bands (TM1,3,4,5 or TM2,3,4,5 or TM1,3,4,7 or TM2,3,4,7) to create principal components to highlight iron rich soils in PC3 or 4. Loughlin (1991) (Loughlin,W., P., 1991, Principal Component Analysis for Alteration mapping, Photogrammetric Engineering & Remote Sensing, Vol. 57, No. 9, September 1991, pp. 1163-1169) used a TM subscene of Rocky Mountains, US, selected TM1,4,5,7 to highlight clay rich soils in PC4 created from those four bands and selected TM1,3,4,5 to highlight iron rich soils in PC4 created from those four bands based on their Eigenvectors loadings of TM bands into the principal components.

Note: Loughlin deliberately omitted TM 2 and 3 from TM1,4,5,7 combination to avoid mapping iron oxide and TM7 was deliberately omitted from TM1,3,4,5 to avoid hydroxyl mapping. In mapping hydroxyl clay soils two of the VIS bands TM1,2,3 are omitted and in mapping iron rich soils one of the SWIR bands TM5,7 and one of the VIS bands TM1,2,3 are omitted.

Note: Priori knowledge of the geology of the area of interest will be of great value. You can judge from the Eigenvectors loadings of the TM bands in the principal components and/or from the geology of the area which PC highlights clay rich and iron rich soils. Eigenvectors loadings are scene dependent and precaution should be taken in judging which PC highlights clay rich and iron rich soils. If necessary you may have to invert the dynamic range of the PCs to highlight clay rich and iron rich soils in the upper end of the histogram so that they will be displayed as bright pixels.

Creating Virtual Dataset of TM1,4,5,7

Before you begin...

Before beginning this exercise, make sure all ER Mapper image windows are closed. Only the ER Mapper main menu should be open on the screen.

Load a TM dataset

1 On the **Standard** toolbar, click on the **Edit Algorithm** button.

An image window and the **Algorithm** window appear.

2 Click on the Layer Tab to view the settings for the layer.

3 In the **Algorithm** window, click the **Load Dataset** button on the left side of the process stream diagram.

The **Raster Dataset** file chooser dialog box appears.

4 From the **Directories** menu, select the path ending with **\examples**.

5 Double-click on the directory 'Shared_Data' to open it.

6 Double-click on the dataset named 'LandsatTM.ers' to load the dataset.

Band one of the dataset is loaded into the Pseudocolor layer.

7 In the **Algorithm** window click on the Surface Tab. By default the **Color Mode** is Pseudocolor. If not, change it to Pseudocolor mode. From the **Color Table** drop down list choose greyscale color.

8 Click **99% Contrast Enhancement** button to display the band 1 of the dataset.

9 Click your left mouse button on the Pseudo Layer. A text field will appear. In the text field change the band description to **TM1**

10 In the **Algorithm** window click on the **Duplicate** button and duplicate band 1 of the dataset.

11 Turn off the first **Pseudo Layer**.

12 Click on the second **Pseudo Layer** and make it the active layer.

13 In the **Algorithm** window from the band selector, select band 4 of the 'LandsatTM.ers' dataset for the second pseudo layer.

14 Click **99% Contrast Enhancement** button to display the band 4 of the dataset.

15 Click your left mouse button on the **Pseudo Layer**. A text field will appear. In the text field change the band description to **TM4**

16 Repeat the process for bands 5 and 7: duplicate the last band, turn off the second-last Pseudo Layer, activate the last Pseudo Layer, change the last Pseudo Layer to band 5 or 7 of the dataset from the band selector in the **Algorithm** window, display it with 99% clip on limits and change the band description to **TM5** or **TM7**.

17 Turn on all the 4 Pseudo Layers of 'LandsatTM.ers' dataset.

18 Delete the transform of all the 4 layers

Note: Deleting the transform from each of the layers maintains the dynamic range of the data value of the 4 bands without scaling or clipping.

---

19 On the Standard toolbar, click the **Save As** button.

The **Save As** dialog box appears. This dialog lets you specify a path and name for your output disk file, and options for creating the new dataset.

20 In the **Save As** dialog, click the file chooser button next to **Output Dataset**.

21 From the **Directories** menu, select the path ending with the text '\examples\Miscellaneous'.

22 Double-click on the directory named 'Tutorial' to open it.

23 In the **Save As:** text field, type in a name for the disk file. Use your initials at the beginning, followed by the text 'LandsatTM1457_VDS' and separate each word with an underscore (_). For example, if your initials are 'DH' type in the name:

```
DH_LandsatTM1457_VDS
```

24 Click **OK** or **Save** to close the file chooser dialog.

Your name appears as the **Output Dataset** name with a '.ers' extension.

Note: You have saved the 'LandsatTM1457_VDS.ers' datasets as a Virtual Dataset.

Create a Virtual Dataset of TM1,3,4,5

1. Follow the steps mentioned above and create a VDS of TM1,3,4,5.
2. Save the Virtual Dataset as 'LandsatTM1345_VDS.ers' in the \examples\Miscellaneous\Tutorial directory.

Calculate statistics of the two TM1,4,5,7 and TM1,3,4,5 VDS datasets

---

Note: It is necessary to calculate the statistics of the dataset prior to applying Principal Component Analysis transformation.

---

1. In the ER Mapper main menu window click the **Calculate Statistics..** option from the dropdown list of the **Process** menu.
2. The Calculate Statistics dialog appears.
3. LOad the dataset 'LandsatTM1457_VDS.ers' from the \examples\Miscellaneous\Tutorial director.
4. Click OK button and calculate the statistics of the 'LandsatTM1457_VDS.ers' dataset.

Note: For large dataset you can choose **Subsampling Interval** a higher number. For example by choosing 4 for **Subsampling Interval** every 4th pixel will be calculated. For accurate statistics choose **Subsampling Interval** as 1. For second time or more statistics calculation choose **Force Recalculate stats:** option in the **Calculate Statistics** dialog.

---

5. Repeat the procedure and calculate the statistics for the TM1345 VDS dataset in the \examples\Miscellaneous\Tutorial directory.

Generating Principal Components

Before you begin...

Before beginning this exercise, make sure all ER Mapper image windows are closed. Only the ER Mapper main menu should be open on the screen.

Display the VDS dataset

1 On the **Standard** toolbar, click on the **Edit Algorithm**  button.

An image window and the **Algorithm** window appear.

2 Click on the Layer Tab to view the settings for the layer.

3 In the **Algorithm** window, click the **Load Dataset** button  on the left side of the process stream diagram.

The **Raster Dataset** file chooser dialog box appears.

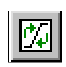
4 From the **Directories** menu, select the path ending with **\examples\Miscellaneous**.

5 Double-click on the directory ‘Tutorial’ to open it.

6 Double-click on the dataset named ‘LandsatTM1457_VDS.ers’ to load the dataset.

Band one of the dataset is loaded into the Pseudo layer.

7 In the **Algorithm** window click on the Surface Tab. By default the **Color Mode** is Pseudocolor. If not, change it to Pseudocolor mode.

8 Click **99% Contrast Enhancement**  button to display the band 1 of the dataset.

You will add a formula to this algorithm to perform Principal Components Analysis.

Load a formula to calculate Principal Component 1

1 In the Algorithms window, click the **Open Formula editor**  button.

2 From the **Principal Components** menu (in the **Formula Editor** dialog), select **Landsat TM PC1**. ER Mapper loads the following formula into the Generic formula window:

```
SIGMA(I1..I6 | I? * PC_COV(I1..I6 | ,R1 I?, 1))
```

This formula tells ER Mapper to generate Principal Component 1 (PC 1) from Landsat TM bands 1-5 and 7. It uses some of the special functions and constructs ER Mapper provides, including the “SIGMA” summation construct and the ““PC_COV” covariance principal component (Eigenvectors) value.

Principal Components Analysis is a statistical form of data compression often used to compress the information content of multiple image bands into just two or three “principal component” images. In this case, you are generating the first principal component of TM bands 1,4,5 and 7 (band 2 and 3 are not used for to avoid mapping iron rich soils).

3 In the Generic window change the formula to

```
SIGMA(I1..I4 | I? * PC_COV(I1..I4 | ,R1 I?, 1))
```

Note: Instead of I1..I6 it is changed to I1..I4 and tells ER Mapper to use bands 1 to 4 which are bands TM 1, 4, 5, & 7.

---

4 On the Standard toolbar, click the **99% Contrast Enhancement**  button to process and display the algorithm using the PC1 formula.

5 Click your left mouse button on the Pseudo Layer. A text field will appear. In the text field change the band description to **PC1**.

Edit the formula to calculate Principal Component 2

1 In the **Algorithm** window click on the **Duplicate** button  and duplicate the created **PC1**.

2 Turn off the first **PC1** layer.

3 Click on the second **PC1** and make it the active layer.

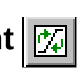
4 In the Generic formula window, edit the formula to change the last value from 1 to **2** as shown below:

```
SIGMA(I1..I4 | I? * PC_COV(I1..I4 | ,R1 ,I?, 1))
```

change to 2

This formula tells ER Mapper to generate Principal Component 2 (PC 2) from Landsat TM bands 1,3,4,5 and 7.

5 Click the **Apply changes** button to verify the formula syntax.

6 On the Standard toolbar, click the **99% Contrast Enhancement**  button.

7 Click **99% Contrast Enhancement** button to display the **PC2** of the dataset.

8 Click your left mouse button on the **PC1**. A text field will appear. In the text field change the band description to **PC2**.

9 Repeat the process for two more times and create PC3 and PC4. Change the last value in the generic formula to 3 to create PC3 and to 4 to create PC4. Change the band description to **PC3** and **PC**4.

Save the created Principal Components as a Virtual Dataset

1 Turn on all the 4 PC layers of ‘LandsatTM_VDS.ers’ .

2 Delete the transform from each of the 4 PC layers.

Note: Deleting the transform from each of the layers maintains the dynamic range of the atmospheric adjusted data value of the 4 bands without scaling or clipping.

---

3 On the Standard toolbar, click the **Save As** button.

The **Save As** dialog box appears. This dialog lets you specify a path and name for your output disk file, and options for creating the new dataset.

4 In the **Save As** dialog, click the file chooser button next to **Output Dataset**.

5 From the **Directories** menu, select the path ending with the text ‘\examples\Miscellaneous’.

6 Double-click on the directory named ‘Tutorial’ to open it.

7 In the **Save As:** text field, type in a name for the disk file. Use your initials at the beginning, followed by the text ‘LandsatTM1457_PC1234_VDS’ and separate each word with an underscore (_). For example, if your initials are ‘DH’ type in the name:

```
DH_LandsatTM1457_PC1234_VDS
```

8 Click **OK** or **Save** to close the file chooser dialog.

Your name appears as the **Output Dataset** name with a ‘.ers’ extension.

Note: You have saved the ‘LandsatTM1457_PC1234_VDS.ers’ datasets as a Virtual Dataset.

Create Principal Components of TM1,3,4,5 and save them as a VDS

1 Follow the steps mentioned above and create Principal Components of LandsatTM1345_VDS.ers dataset and save them as a VDS.

2 Save the Virtual Dataset as 'LandsatTM1345__PC1234_VDS.ers' in the \examples\Miscellaneous\Tutorial directory.

Judging which PC from LandsatTM1457_VDS.ers highlights hydroxyl-bearing minerals (clay rich soils)

1 Select **Show Statistics..** from the dropdown list of **View\Statistics** menu of the main menu.

2 Statistics Report dialog appears.

3 Load the LandsatTM1457_VDS.ers dataset from \examples\Miscellaneous\Tutorial directory and press OK button.

4 Display Dataset Statistics dialog appears with the statistics for LandsatTM1457_VDS dataset displayed.

5 Scroll down to view Cov. Eigenvectors of PC1- 4.

Note: In LandsatTM1457_VDS.ers dataset Band1 = TM1; Band2 = TM4; Band3 = TM5 and Band4 = TM7.

Cov. Eigenvectors	PC1	PC2	PC3	PC4
Band1	0.279	-0.038	-0.852	0.441
Band2	0.111	-0.988	0.028	-0.102
Band3	0.832	0.072	0.440	0.329
Band4	0.465	0.130	-0.283	-0.829

6 Covariance Eigenvectors loadings of TM 5 in PC3 and PC4 is positive whereas TM7 in PC3 and PC4 is negative.

Note: To highlight Eigenvectors loading from TM7 which has a high reflectance of hydroxyl-minerals invert the dynamic range of PC4 by inserting - sign (negative) in front of the INPUT1 in the generic formula in the Formula Editor window.

Note: Covariance Eigenvectors loadings from TM bands are scene dependent hence, you should check the Eigenvectors loadings of TM bands of your dataset. Cross-checking with existing geology map to see which PC highlights hydroxyl-minerals is important.

Judging which PC from LandsatTM1345_VDS.ers highlights iron-oxide minerals (iron rich soils)

1 Select **Show Statistics..** from the dropdown list of **View\Statistics** menu of the main menu.

2 Statistics Report dialog appears.

3 Load the LandsatTM1345_VDS.ers dataset from \examples\Miscellaneous\Tutorial directory and press OK button.

4 Display Dataset Statistics dialog appears with the statistics for LandsatTM1345_VDS dataset displayed.

5 Scroll down to view Cov. Eigenvectors of PC1- 4.

Note: In LandsatTM1345_VDS.ers dataset Band1 = TM1; Band2 = TM3; Band3 = TM4 and Band4 = TM5.

Cov. Eigenvectors	PC1	PC2	PC3	PC4
Band1	0.301	-0.021	-0.601	-0.740
Band2	0.357	0.015	-0.648	0.672
Band3	0.128	-0.989	0.072	0.022
Band4	0.875	0.147	0.462	-0.023

6 Covariance Eigenvectors loadings of TM1 in PC3 and PC4 is negative whereas TM2 in PC3 is negative and in PC4 is positive.

Note: To highlight Eigenvectors loading from TM1 which has a high reflectance of iron-oxide mineral invert the dynamic range of PC4 by inserting - sign (negative) in front of the INPUT1 in the generic formula in the Formula Editor window.

Note: Covariance Eigenvectors loadings from TM bands are scene dependent hence, you should check the Eigenvectors loadings of TM bands of your dataset. Cross-checking with existing geology map to see which PC highlights iron-oxide minerals is important.

Save the created PC4 of LandsatTM1457_VDS and PC4 of LandsatTM1345_VDS as Virtual Dataset

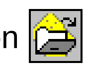
Before you begin...

Before beginning this exercise, make sure all ER Mapper image windows are closed. Only the ER Mapper main menu should be open on the screen.

1 On the **Standard** toolbar, click on the **Edit Algorithm**  button.

An image window and the **Algorithm** window appear.

2 Click on the Layer Tab to view the settings for the layer.

3 In the **Algorithm** window, click the **Load Dataset** button  on the left side of the process stream diagram.

The **Raster Dataset** file chooser dialog box appears.

4 From the **Directories** menu, select the path ending with **\examples\Miscellaneous**.

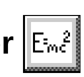
5 Double-click on the directory ‘Tutorial’ to open it.

6 Double-click on the dataset named ‘LandsatTM1457_PC1234_VDS.ers’ to load the dataset.

Band one (PC1) of the dataset is loaded into the Pseudocolor layer.

7 In the Algorithm window click the Band Selection button and from the dropdown list select PC4.

8 In the **Algorithm** window click on the Surface Tab. By default the **Color Mode** is Pseudocolor. If not, change it to Pseudocolor mode.

9 In the Algorithms window, click the **Open Formula editor**  button.

10 The **Formula Editor** dialog appears.

11 In the **Formula Editor** dialog, type in - (negative sign) in front of INPUT1 in the Generic formula window:

Note: Inserting negative sign in front of INPUT1 is telling ER Mapper to invert the dynamic range of PC4 in the algorithm inorder to highlight negative Eigenvectors loading of TM7 (high reflectance of clay mineral) and display them as bright pixels.

---

12 Click **99% Contrast Enhancement** button to display the band4 (PC4) of the dataset.

13 Click your left mouse button on the **Pseudo Layer**. A text field will appear. In the text field change the band description to **PC4_Clay**.

14 In the **Algorithm** window click on the **Duplicate** button and duplicate the created **PC4_Clay** layer.

15 Turn off the first **PC4_Clay** layer.

16 Click on the second **PC4_Clay** layer and make it the active layer.

17 In the **Algorithm** window, click the **Load Dataset** button on the left side of the process stream diagram.

The **Raster Dataset** file chooser dialog box appears.

18 From the **Directories** menu, select the path ending with **\examples\Miscellaneous**.

19 Double-click on the directory 'Tutorial' to open it.

20 Select the dataset named 'LandsatTM1345_PC1234_VDS.ers' and click **OK this layer only** to load the dataset into the second layer of **PC4_Clay** layer.

Band one (PC1) of the dataset is loaded into the PC4_Clay layer.

21 In the Algorithm window click the Band Selection button and from the dropdown list select PC4.

22 In the Algorithms window, click the **Open Formula editor** button.

23 The **Formula Editor** dialog appears.

24 In the **Formula Editor** dialog, type in - (negative sign) in front of INPUT1 in the Generic formula window:

Note: Inserting negative sign in front of INPUT1 is telling ER Mapper to invert the dynamic range of PC4 in the algorithm inorder to highlight negative Eigenvectors loading of TM7 (high reflectance of clay mineral) and display them as bright pixels.

---

25 Click **99% Contrast Enhancement** button to display the band4 (PC4) of the dataset.

26 Click your left mouse button on the second **PC4_Clay**. A text field will appear. In the text field change the band description to **PC4_Iron**.

27 Turn on both the PC4 layers of ‘LandsatTM1457_PC1234_VDS.ers’ and ‘LandsatTM1345_PC1234_VDS.ers’ datasets.

28 Delete the transform from each of the PC4 layers.

Note: Deleting the transform from each of the layers maintains the dynamic range of the two PC4 without scaling or clipping.

---

29 On the Standard toolbar, click the **Save As** button.

The **Save As** dialog box appears. This dialog lets you specify a path and name for your output disk file, and options for creating the new dataset.

30 In the **Save As** dialog, click the file chooser button next to **Output Dataset**.

31 From the **Directories** menu, select the path ending with the text ‘\examples\Miscellaneous’.

32 Double-click on the directory named ‘tutorial’ to open it.

33 In the **Save As:** text field, type in a name for the disk file. Use your initials at the beginning, followed by the text ‘PC4_Clay_Iron_VDS’ and separate each word with an underscore (_). For example, if your initials are ‘DH’ type in the name:

```
DH_PC4_Clay_Iron_VDS
```

34 Click **OK** or **Save** to close the file chooser dialog.

Your name appears as the **Output Dataset** name with a ‘.ers’ extension.

Note: You have saved the ‘PC4_Clay_Iron_VDS.ers’ datasets as a Virtual Dataset with both PC4 of Clay and Iron dynamic ranges inverted.

Display RGB composite to highlight clay and iron rich areas

Before you begin...

Before beginning this exercise, make sure all ER Mapper image windows are closed. Only the ER Mapper main menu should be open on the screen.

Load the PC4_Clay_Iron_VDS dataset

1. On the **Standard** toolbar, click on the **Edit Algorithm** button.

   An image window and the **Algorithm** window appear.

2. Click on the Layer Tab to view the settings for the layer.
3. In the **Algorithm** window, click the **Load Dataset** button on the left side of the process stream diagram.

   The **Raster Dataset** file chooser dialog box appears.

4. From the **Directories** menu, select the path ending with **\examples\Miscellaneous**.
5. Double-click on the directory ‘Tutorial’ to open it.
6. Double-click on the dataset named ‘PC4_Clay_Iron_VDS.ers’ to load the dataset.

   Band one (PC4_Clay) of the dataset is loaded into the Pseudocolor layer.

7. Click the **Create RGB Algorithm** button from the Forestry Toolbar on the main menu.

   ER Mapper displays three bands of the ‘PC4_Clay_Iron_VDS.ers’ dataset as an RGB image.

Select appropriate bands and enter labels for the RGB layers

‘PC4_Clay_Iron_VDS.ers data has only two bands hence it is necessary to select appropriate bands and load them into the RGB layers.

1. Highlight the inactive Pseudo Layer Pseudo Layer and remove it from the Data-Structure using the cut button in the Algorithm window.
2. Select the Blue layer in **Algorithm** dialog, then choose **B1:PC4_Clay** from the **Band Selection** drop-down list, and change the layer label to **`Clay`**.
3. Highlight the Green layer.

4 In the Algorithms window, click the **Open Formula editor** button.

5 The **Formula Editor** dialog appears.

6 In the **Formula Editor** dialog, type in “INPUT1 + INPUT2” in the Generic formula window and press **Apply changes**:

Note: The formula INPUT1 + INPUT2 tells ER Mapper to combine two bands. Since there is only two bands in the “PC4_Clay_Iron_VDS.ers” dataset the two bands PC4_Clay and PC4_Iron are taken as default

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7 Highlight the Green layer and enter the layer label **Clay + Iron.**

8 Select the Red layer, choose the band **B2:PC4_Iron**, and enter the layer label **`Iron`**.

9 Click **99% Contrast Enhancement** button to display the RGB color composite of PC4_Iron (Red), (PC4_Clay + PC4_Iron) (Green) and PC4_Clay (Blue).

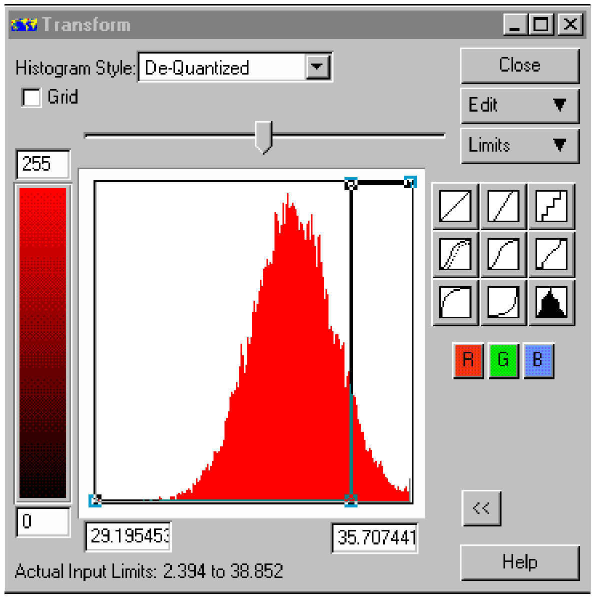
Apply thresholds to the transforms for the RGB layers to highlight Clay, Iron rich areas and common areas

1 With the ‘PC4_Iron’ (red) layer selected, click on the post-formula **Edit Transform Limits** button in the process diagram.

The **Transform** dialog box opens showing the histogram for the PC4_Iron data.

2 In the Transform window manually adjust the X-axis to about 34.5(vertical).

Note: You have selected 34.5 as the threshold to map high iron-rich soils anomalies above 34.5 DN as red. The dynamic range of PC4_Iron falls within 2.4 to 35.7.



3 Highlight the Green Layer by clicking the Green button in the Transform dialog.

4 In the Transform window manually adjust the X-axis to about 7.0(vertical).

Note: You have selected 7.0 as the threshold to map high anomalies of combined PC4_Clay and PC4_Iron above 7.0 DN as green. The Actual Input Limits of the combined PC4_Clay + PC4_Iron data fall within -60.3 to 10.5.

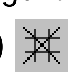
---

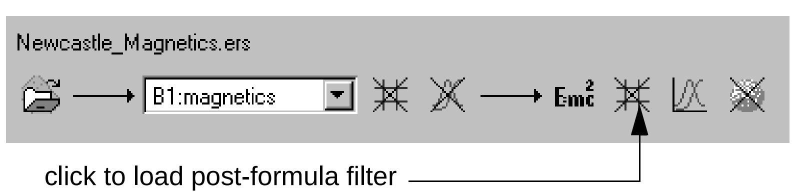
5 Highlight the Blue Layer by clicking the Blue button in the Transform dialog.

6 In the Transform window manually adjust the X-axis to about -26.4 (vertical).

Note: You have selected-26.4 as the threshold to map high Clay anomalies above -26.4 DN as blue. The Actual Input Limits of PC4_Clay image is -63.7 to -15.5.

---

7 In the Algorithm process diagram, click on the post-formula **Edit Filter (Kernel)**  button.



The **Filter** dialog box appears. This dialog allows you to load standard filters supplied with ER Mapper, and create and save your own filters.

8 From the **File** menu (in the **Filter** dialog), select **Load...**.

The **Load filter** file chooser dialog box appears.

9 From the **Directories** menu, select the path ending with the text **\kernel**.

10 Double-click on the ‘filters_ranking’ directory to open it.

11 Double-click on the filter ’median_3x3.ker’ to load it.

This filter is a larger (a 3 by 3 array) filter that is coded in C (that is why a matrix of weighting values does not appear).

12 Highlight the Green Layer by clicking the Green button in the Transform dialog.

13 Load the ‘median_3x3.ker’.

14 Highlight the Blue Layer by clicking the Green button in the Transform dialog.

15 Load the ‘median_3x3.ker’.

ER Mapper renders the image again.

Note: Red covers high anomalies areas of Iron-rich soils, blue covers high anomalies areas of Clay-rich soils and green covers high anomalies areas of combined Clay and Iron rich soils.

Note: Common areas between red and green will display yellow, common areas between red and blue will display magenta and common areas between red, green and blue will display white color.

Close the image window and Algorithm dialog

1 Select **Close** from the **File** menu to close the image window.

2 Click **Close** in the **Algorithm** dialog to close it.

Only the ER Mapper main menu is now open.

What you learned...

After completing these exercises, you know how to perform the following tasks in ER Mapper:

- Apply filters to satellite images to enhance structural features

- Create Landsat band ratio images commonly used for mineral exploration
- Create RGB composite to highlight alteration zones and iron rich soil using Crosta technique which applies Principal Component Analysis.

16

Vector and Satellite data Integration

This chapter explains how to use ER Mapper's vector annotation tools to draw annotation and interpretations on your images using polylines. It also explains how to generate vector polygon classes for raster classes mapped from satellite images.

About vector annotation

Once you have created processing algorithms to aid analysis of your data, it is usually helpful to draw interpretations on the image to communicate your results or recommendations. ER Mapper provides a complete set of vector annotation tools to let you draw text strings, polygons, lines, points and other objects. You can also set attributes such as color, line style, fill pattern and text rotation, and group objects and change their display order (move back and front). Your annotations are saved in a separate ER Mapper format vector file (.erv), and can be loaded and displayed over any other image as desired, or exported to other vector formats for use in other software products.

Hands-on exercises

What you will learn...

After completing these exercises, you will know how to perform the following tasks in ER Mapper:

- Geological structure interpretation and generate vector file with lineaments
- Generate binary raster images
- Generate vector polygon classes
- Display vector classes over TM images

Before you begin...

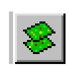
Before beginning these exercises, make sure all ER Mapper image windows are closed. Only the ER Mapper main menu should be open on the screen.

1: Highlighting structural features in Satellite images

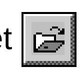
Objectives

Learn to apply convolution filters commonly used to enhance and highlight structural features in satellite images. Use ER Mapper's Annotation Tools to draw polylines of structural features highlighted in enhanced satellite images.

Create a greyscale algorithm to display a Landsat image

1. In the main menu window, click the **Edit Algorithm**  button.

   A new image window and the **Algorithm window** appear.

2. In the **Algorithm window**, click the Load Dataset  button.
3. From the **Directories** menu (in the **Raster Dataset** dialog), select the path ending with **\examples**.
4. Open the 'Shared_Data'directory, then double-click on the dataset named 'LandsatTM.ers' to load it.
5. Click **OK** in the **Raster Dataset** dialog.

   ER Mapper loads the Landsat TM dataset and displays band 1 as a contrast enhanced greyscale image.

6. Make the image window about 50% larger by dragging a corner.

Display Landsat band 5 and adjust the contrast

1 From the **View** menu, select **Algorithm**.

The **Algorithm** dialog opens.

2 From the **Band Selection** drop-down list, select **B5:1.65_um**.

3 Click the **99% Contrast Enhancement** button in the **Algorithm** dialog or main menu.

ER Mapper renders band 5 of the Landsat image with basic contrast enhancement. Band 5 (shortwave infrared - SWIR) is commonly used for analysis of structural geology features. (Lineaments resulting contrast between different types of soil or vegetation are often clearly defined in TM5.)

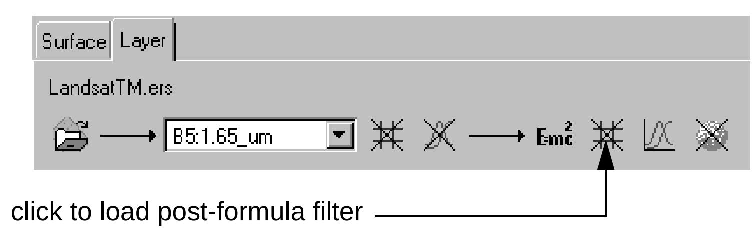
Note: Alternately you can create the first Principal Component (PC1) of TM bands 1-5 & 7 and use it to interpret geological structure from TM imagery. PC1 is an albedo image and will reflect the topography of the image.

Apply directional gradient edge detection filters

Directional gradient filters (or sun angle filters) are designed to isolate and “raise” high frequency edge features in an image that trend in the direction normal to the angle of the filter. (You used these filters previously on magnetic data.) This type of filter is used in geological structure mapping with satellite images because features such as lineaments and fracture systems tend to be linear edge features and thus stand out from low frequency areas with less structural significance.

This class of filter acts like a sun shining on the image from a particular compass direction (similar in some ways to ER Mapper’s real time shading feature used on geophysical datasets). For example, a northwest filter isolates edge features trending in a northeast to southwest direction (normal to the northwest sun angle).

1 In the algorithm process diagram, click the post-formula **Edit Filter (Kernel)** button.



The **Filter** dialog box appears.

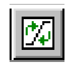
2 In the **Filter** dialog box, click the button next to ‘Filter filename.’

3 From the **Directories** menu, select the path ending with the text **\kernel**.

4 Open the 'filters_sunangle' directory

5 Click ***once*** on the filter 'North_West.ker' to select it, then click **Apply**.

The filter is loaded and the **Load filter** dialog remains open.

6 Click the **99% Contrast Enhancement**  button.

The effect of the 'North_West' filter is to isolate and "raise" edge features trending in a northeast to southwest direction (features normal to the northwest sun angle).

Note: You can apply 'North_East.ker,'; 'East_West.ker,'; 'North_South.ker' and other directional filters in the 'filters_sunangle' directory. The directional filters will highlight lineaments orthogonal to the direction of illumination.

Note: You can also apply multiple filters such as applying high pass filter (e.g. 'Sharpen2.ker' or 'Ford_5x5.ker') prior to applying one of the directional filters.

Tip: Gradient directional edge enhancement filters are sometimes used in conjunction with simple RGB displays. For example, display an image in RGB, then add an Intensity layer displaying band 5 with a directional edge filter applied. This produces an image that highlights structural features but also has the RGB composite image draped on top to show associated lithology or surface cover.

2: Creating vector annotation

Objectives

Learn to use ER Mapper's Annotation tools to draw interpretations and annotation objects such as geological structural features.

1 Drag the lower-right corner of the image window to make 50% larger.

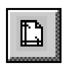
Tip: It is recommended to display side by side the unfiltered and directionally filtered images. For example: If your directional filtered image is generated from TM band 5 then display the TM5 in grey scale side by side with the directional filtered TM5 from which you are going to interpret the geological structure. You will be able to judge which linear features are of geological structure and which are cultural.

Display the Annotation toolbar

1. In the main menu window, select **Annotation** from the **Toolbars** menu.

   ER Mapper adds a third toolbar with buttons for quick access to common functions used for annotation and map composition.

Open the Page Setup dialog box

1. From the **File** menu, select **Page Setup** (or click the **Setup Algorithm Page Size**  button on the Annotation toolbar).

   The **Page Setup** dialog box opens. This dialog provides controls for you to choose a hardcopy device and set up a page size and scale for map output. (You will learn more about Page Setup later.)

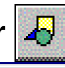
2. From the **Constraints** drop-down list, select **Auto Vary:Page**.

   In order to create accurate annotation, you must set the **Constraints** to something other than the default setting of **Fixed Page: Extents from Zoom**. This allows your annotations and text to be sized and scaled accurately during printing.

3. Click **OK** in the **Page Setup** dialog to close it.

   (If you were working with your own algorithm, you would want to resave the algorithm with the new Page Setup parameters at this point. It is not necessary for this simple exercise.)

Add a vector layer for map annotation

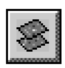
1 On the **Main Menu** toolbar, click the **Annotate Vector Layer**  button.

Annotate Vector Layer button

The **New Map Composition** dialog box opens to ask what type of annotation you want to create. You can create a vector file, raster regions or an ARC/INFO GIS coverage file. (You can also access this by selecting **Annotate Vector Layer** from the **Edit** menu.)

2 Make sure the **Vector File** option is selected, then click **OK** in the **New Map Composition** dialog.

ER Mapper opens the **Tools** dialog containing your drawing tools. Move the **Tools** dialog next to the right side of your image.

3 Click the **Edit Algorithm**  button.

Notice that a vector layer titled 'Annotation Layer' has been added to the layer list in the **Algorithm** dialog. This is the layer you will use to add your own annotation and items to the image.

4 Click **Close** in the **Algorithm** dialog.

Draw polylines to trace linear features on the image

Tip: In interpreting geological structure from raster images draw lineaments only those that you can see them. Avoid lineaments of cultural features such as roads.

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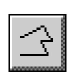
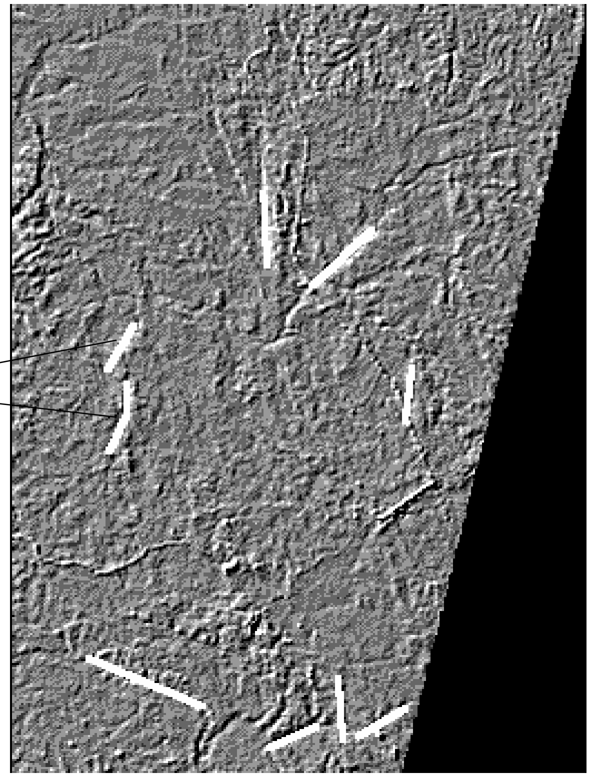
1 In the **Tools** dialog, click once on the **Poly Line**  button.

2 In the image, draw a line to trace a linear feature by clicking once at each point, then double-clicking to end the line.

A line appears on your image to highlight the linear feature. Note that markers appear on the line at each node to indicate that the line is "selected."



View and modify the attributes of the polyline

1 In the **Tools** dialog, *double-click* on the **Poly Line**  button.

The **Line Style** dialog box opens to let you choose attributes for your polylines.

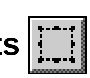
2 Click the **Set Color** button, choose any contrasting color, then click **OK** to close the **Color** chooser dialog.

The line color on the image changes to your selected color.

3 Click the **Width** drop-down list and choose **2.0** to increase the line width.

4 In the **Line Style** dialog, click the **Curved** option button next to 'Current Line.'

ER Mapper applies a spline function to the line to create smooth, rounded curves. This creates a more visually pleasing line and is especially helpful when tracing faults and other smoothly varying linear features.

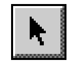
5 In the **Tools** dialog, click on the **Edit Object Extents**  button.

The **Map Composition Extents** dialog opens to show information about the polyline object. It shows the line length in map units, and other attributes such as the number of vertices, geographic extents, and so on.

6 Click **Close** in the **Object Extents** dialog.

7 Click **Close** in the **Line Style** dialog.

Modify the polyline nodes

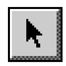
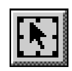
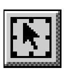
1 In the **Tools** dialog, click the **Select/Edit Points Mode**  button, then click on the polyline you drew to select it.

2 Point to any node an drag to a new location.

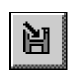
The line shape adjusts as you move the node. By dragging a node, you can reshape or fine tune a polyline (or polygon) as needed.

Tips for selecting objects

ER Mapper's annotation tool set provides two "select" tools for different tasks:

- Use the **Select/Edit Points Mode**  button to select a polyline or polygon object when you want to move the individual line nodes, or select nodes.
- Use the **Select and Move/Resize Mode**  button to select any annotation object when you want to move the entire object (drag from the center) or resize the entire object (drag one of the yellow handles).
- To select multiple objects at once, choose the **Select and Move/Resize Mode**  button. Then either drag a marquee box around all the objects, or select them one at a time by holding down the Shift key and clicking on them.

Save the annotation to a file on disk

1 In the **Tools** dialog, click the blue **Save As**  button.

The **Map Composition Save As** dialog opens.

2 Make sure the 'Vector File' option is selected, then click the  button next to 'Save to File.'

3 From the **Directories** menu (in the File chooser dialog) , select the **\examples\Miscellaneous** path.

4 Double-click on the directory 'Tutorial' to open it.

5 In the **Save As:** text field, type a name using your initials followed by the text **`Lineaments_interpretations`**. Separate each word with an underscore (_).

6 Click **OK** to validate the filename.

7 Click **OK** in the **Map Composition Save As** dialog.

Your vector annotation objects are saved to an ER Mapper format vector file (.erv) on disk.

8 Click **Close** in the **Tools** dialog.

Note: Apply different directional filters (e.g. North_East; East_West; North_South) on TM 5 , interpret geological structures and display them on the TM5 greyscale image. Save them as separate vector files.

3: Creating vector polygon classes

Objectives Learn to use ER Mapper's Raster to Vector conversion to create vector polygons of surface classes.

Loading the PC4_Clay_Iron_VDS dataset

1 On the **Standard** toolbar, click on the **Edit Algorithm**  button.

An image window and the **Algorithm** window appear.

2 Click on the Layer Tab to view the settings for the layer.

3 In the **Algorithm** window, click the **Load Dataset** button  on the left side of the process stream diagram.

The **Raster Dataset** file chooser dialog box appears.

4 From the **Directories** menu, select the path ending with **\examples\Miscellaneous**.

5 Double-click on the directory 'Tutorial' to open it.

6 Double-click on the dataset named 'PC4_Clay_Iron_VDS.ers' to load the dataset.

Band one (PC4_Clay) of the dataset is loaded into the Pseudocolor layer.

Note: 'PC4_Clay_Iron_VDS.ers' datasets is the Virtual Dataset you created earlier with both PC4 of Clay and Iron dynamic ranges inverted.

---

7 Click the **Create RGB Algorithm** button from the Forestry Toolbar, in the main menu.

ER Mapper displays three bands of the 'PC4_Clay_Iron_VDS.ers' dataset as an RGB image.

Select appropriate bands and enter labels for the RGB layers

'PC4_Clay_Iron_VDS.ers data has only two bands hence it is necessary to select appropriate bands and load them into the RGB layers.

1 Highlight the inactive Pseudo Layer Pseudo Layer and remove it from the Data-Structure using the cut button in the Algorithm window.

2 Select the Blue layer in **Algorithm** dialog, then choose **B1:PC4_Clay** from the **Band Selection** drop-down list, and change the layer label to **`Clay`**.

3 Highlight the Green layer.

4 In the Algorithms window, click the **Open Formula editor** button.

5 The **Formula Editor** dialog appears.

6 In the **Formula Editor** dialog, type in "INPUT1 + INPUT2" in the Generic formula window and press **Apply changes**:

Note: The formula INPUT1 + INPUT2 tells ER Mapper to combine two bands. Since there is only two bands in the "PC4_Clay_Iron_VDS.ers" dataset the two bands PC4_Clay and PC4_Iron are taken as default

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7 Highlight the Green layer and enter the layer label **Clay + Iron.**

8 Select the Red layer, choose the band **B2:PC4_Iron**, and enter the layer label **`Iron`**.

9 Click **99% Contrast Enhancement** button to display the RGB color composite of PC4_Iron (Red), (PC4_Clay + PC4_Iron) (Green) and PC4_Clay (Blue).

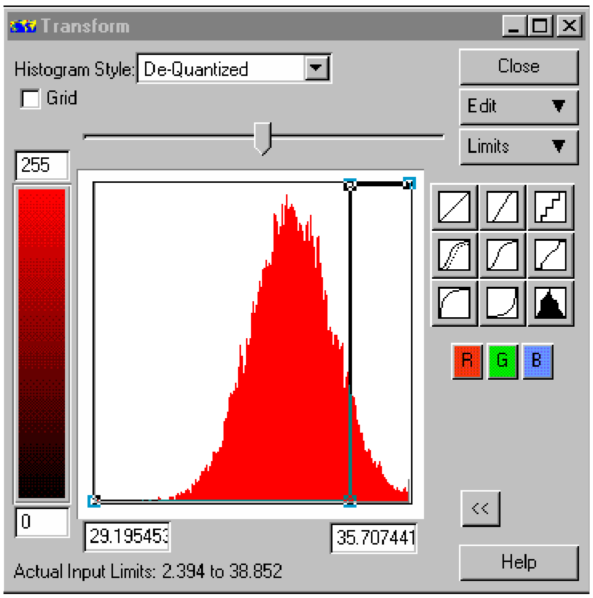
Apply thresholds to the transforms for the RGB layers to highlight Clay, Iron rich areas and common areas

1 With the 'PC4_Iron' (red) layer selected, click on the post-formula **Edit Transform Limits** button in the process diagram.

The **Transform** dialog box opens showing the histogram for the PC4_Iron data.

2 In the Transform window manually adjust the X-axis to about 34.5(vertical).

Note: You have selected 34.5 as the threshold to map high iron-rich soils anomalies above 34.5 DN as red. The dynamic range of PC4_Iron falls within 2.4 to 35.7.



3 Highlight the Green Layer by clicking the Green button in the Transform dialog.

4 In the Transform window manually adjust the X-axis to about 7.0(vertical).

Note: You have selected 7.0 as the threshold to map high anomalies of combined PC4_Clay and PC4_Iron above 7.0 DN as green. The Actual Input Limits of the combined PC4_Clay + PC4_Iron data fall within -60.3 to 10.5.

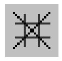
---

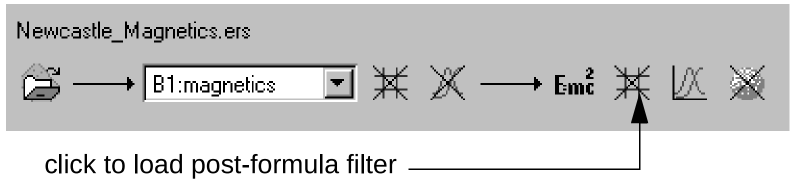
5 Highlight the Blue Layer by clicking the Blue button in the Transform dialog.

6 In the Transform window manually adjust the X-axis to about -26.4 (vertical).

Note: You have selected-26.4 as the threshold to map high Clay anomalies above -26.4 DN as blue. The Actual Input Limits of PC4_Clay image is -63.7 to -15.5.

---

7 In the Algorithm process diagram, click on the post-formula **Edit Filter (Kernel)**  button.



The **Filter** dialog box appears. This dialog allows you to load standard filters supplied with ER Mapper, and create and save your own filters.

8 From the **File** menu (in the **Filter** dialog), select **Load...**.

The **Load filter** file chooser dialog box appears.

9 From the **Directories** menu, select the path ending with the text **\kernel**.

10 Double-click on the ‘filters_ranking’ directory to open it.

11 Double-click on the filter ’median_3x3.ker’ to load it.

This filter is a larger (a 3 by 3 array) filter that is coded in C (that is why a matrix of weighting values does not appear).

12 Highlight the Green Layer by clicking the Green button in the Transform dialog.

13 Load the ‘median_3x3.ker’.

14 Highlight the Blue Layer by clicking the Green button in the Transform dialog.

15 Load the ‘median_3x3.ker’.

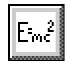
ER Mapper renders the image again.

Note: Red covers high anomalies areas of Iron-rich soils, blue covers high anomalies areas of Clay-rich soils and green covers high anomalies areas of combined Clay and Iron rich soils.

Note: Common areas between red and green will display yellow, common areas between red and blue will display magenta and common areas between red, green and blue will display white color.

Enter formulas to create binary images

1 Highlight the Red layer which is the inverted PC4 iron rich image

2 Click the **Open Formula editor**  button in the process stream to open the **Formula** dialog box.

3 In the **Generic** formula window, edit the formula text to read:

```
if i1 > 34.5 then 1 else 2
```

This formula tells ER Mapper “if the inverted PC4 of iron rich data values are more than the threshold 34.5 then set the value to 1, else set it to 2.”

4 Highlight the Green layer which is the combined inverted PC4 iron rich and inverted PC4 clay rich image

5 In the **Generic** formula window of the **Formula** dialog box, edit the formula text to read:

```
if (i1+i2) > 7.0 then 1 else 2
```

6 This formula tells ER Mapper “if the combined inverted PC4 of iron rich and inverted PC4 clay rich data values are more than the threshold 7.0 then set the value to 1, else set it to 2.”Click **Close** in the **Formula Editor** dialog to close it.

7 Highlight the Blue layer which is the inverted PC4 clay rich image

8 In the **Generic** formula window of the **Formula** dialog box, edit the formula text to read:

```
if i1 > -26.4 then 1 else 2
```

This formula tells ER Mapper “if the inverted PC4 of clay rich data values are more than the threshold -26.4 then set the value to 1, else set it to 2.”

Note: ER Mapper renders the image again but the image does not show the high anomaly classes of iron and clay. Using formulas you have changed the dynamic range of all the three bands to 1 and 2. You need to set the dynamic range to limits to actual.

---

9 Highlight the Red layer.

10 Click on the post-formula **Edit Transform Limits**  button in the process diagram.

The **Transform** dialog box opens.

11 In the Transform window click the **Create default linear transform** button and then from the drop down list of Limits menu select **Limits to Actual**.

12 In the Transform window click the **Move to next Green layer in surface** button.

13 The Green layer is highlighted.

14 In the Transform window click the **Create default linear transform** button and then from the drop down list of Limits menu select **Limits to Actual**.

15 In the Transform window click the **Move to next Blue layer in surface** button.

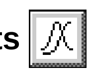
16 The Blue layer is highlighted.

17 In the Transform window click the **Create default linear transform** button and then from the drop down list of Limits menu select **Limits to Actual**.

Note: ER Mapper renders the image again showing the high anomaly classes of iron, clay and combined (iron & clay) areas. The background is white because the dynamic range of areas less then the thresholds of the three bands are set to 2 and the combination of red, green and blue in those areas will produce white.

Saving the binary images as Virtual Dataset

1 Highlight the Red layer.

2 Click on the post-formula **Edit Transform Limits**  button.

3 From the **Edit** menu in the Transform dialog, select **Delete this transform**.

ER Mapper deletes the post-formula transform from the layer. (You should delete the transform to prevent the dynamic range of the data that you have set through the formula from being rescaled.)

4 In the Transform window click the **Move to next Green layer in surface** button.

5 The Green layer is highlighted.

6 From the **Edit** menu in the Transform dialog, select **Delete this transform**.

7 In the Transform window click the **Move to next Blue layer in surface** button.

8 The Blue layer is highlighted.

9 From the **Edit** menu in the Transform dialog, select **Delete this transform**.

10 Click **Close** in the **Transform** dialog to close it.

Select bands and enter labels for the lowest three layers

1 Click on the Red layer to select it.

2 Enter the layer description **`Binary_Iron`** for the first layer. (It should already have band 1 chosen by default.)

3 Select the Green layer, and enter the layer description **`Binary_Iron&Clay`**.

4 Select the Blue layer, and enter the layer description **`Binary_Clay`**.

Save the algorithm as a Virtual Dataset

1 Click the **Save As**  toolbar button.

The **Save As** dialog box appears.

2 In the **Files of Type:** field, select “ER Mapper Virtual Dataset (.ers)”

3 From the **Directories** menu, select the path ending with the text **\examples\Miscellaneous**.

4 Double-click on the directory named ‘Tutorial’ to open it.

5 In the **Save As:** text field, enter your initials followed by the text ‘Binary_Iron_Combined_Clay,’ and separate each word with an underscore (_). For example, if your initials are “JM,” type in the name:

`JM_Binary_Iron_Combined_Clay_VDS`

6 Click **OK** to save the Virtual Dataset.

The binary images of Iron, combined (Iron & Clay) and Clay are saved in a single Virtual Dataset, so they can now be referenced as if they are a single dataset on disk.

Convert the raster cells to vector polygons

1 From the **Process** menu, select **Raster Cells to Vector Polygons...**.

The **Raster to Vector Conversion** dialog box opens. This dialog contains options to vectorize specific bands or cells values in a dataset, to create polygons, polylines, or filled polygons, and to smooth (interpolate) vectors.

2 Click the **Input Raster Dataset**  chooser button.

3 From the **Directories** menu, select the path ending with the text **\examples\Miscellaneous**. Then open the ‘Tutorial’ directory and load the ‘Binary_Iron_Combined_Clay_VDS.ers’ dataset you just created.

4 Turn on the **Fill Polygons** option (to create polygons instead of polylines)

Tip: To smooth rugged edges of the polygons turn on **Smooth** option.

---

5 Click the **Output Vector Dataset** chooser button.

6 From the **Directories** menu, select the path ending with the text **\examples\Miscellaneous**. Then open the ‘Tutorial’ directory and type a name in the **Save As:** text field as follows, then click **OK** to close the chooser. For example, if your initials are "JT," type in the name:

`JT_Iron_polygons`

7 Click the **Band** chooser button and select Binary_Iron band.

8 Edit the value in the **Cell Value** field to read **`1`** then press Enter or Return.

This tells ER Mapper to vectorize all pixels (cells) with the value 1 of Binary_Iron band in the Virtual Dataset. By default, ER Mapper will create vector polygons.

9 Click **OK** to start the raster to vector conversion.

ER Mapper displays a status dialog indicating the progress, then displays a confirmation dialog when the conversion is complete.

Note: Following the same procedures create vector (polygons) files for the combined (Iron & Clay) and Clay bands.

---

10 In the **Raster to Vector Conversion** dialog box click the **Output Vector Dataset** chooser button.

11 From the **Directories** menu, select the path ending with the text **\examples\Miscellaneous**. Then open the ‘Tutorial’ directory and type a name in the **Save As:** text field as follows, then click **OK** to close the chooser. For example, if your initials are "JT," type in the name:

`JT_Combined_polygons`

12 Click the **Band** chooser button and select Binary_Iron&Clay band.

13 Edit the value in the **Cell Value** field to read **`1`** then press Enter or Return.

This tells ER Mapper to vectorize all pixels (cells) with the value 1 of Binary_Iron&Clay band in the Virtual Dataset. By default, ER Mapper will create vector polygons.

14 Click **OK** to start the raster to vector conversion.

15 ER Mapper displays a status dialog indicating the progress, then displays a confirmation dialog when the conversion is complete.

16 In the **Raster to Vector Conversion** dialog box click the **Output Vector Dataset** chooser button.

17 From the **Directories** menu, select the path ending with the text **\examples\Miscellaneous**. Then open the 'Tutorial' directory and type a name in the **Save As:** text field as follows, then click **OK** to close the chooser. For example, if your initials are "JT," type in the name:

```
JT_Clay_polygons
```

18 Click the **Band** chooser button and select Binary_Clay band.

19 Edit the value in the **Cell Value** field to read **1** then press Enter or Return.

This tells ER Mapper to vectorize all pixels (cells) with the value 1 of Binary_Clay band in the Virtual Dataset. By default, ER Mapper will create vector polygons.

20 Click **OK** to start the raster to vector conversion.

21 ER Mapper displays a status dialog indicating the progress, then displays a confirmation dialog when the conversion is complete.

22 Click **OK** to close the confirmation dialog, then click **Close** and **Cancel** to close the other two raster to vector dialogs.

You have now created three vector files containing polygons representing the areas of Iron_rich, Combined (Iron & Clay) and Clay_rich soils.

Display the vector classes on top of TM5 raster image

Note: Close all windows except the ER Mapper main menu window.

1 On the **Standard** toolbar, click on the **Edit Algorithm** button.

An image window and the **Algorithm** window appear.

2 Click on the Layer Tab to view the settings for the layer.

3 In the **Algorithm** window, click the **Load Dataset** button on the left side of the process stream diagram.

The **Raster Dataset** file chooser dialog box appears.

4 From the **Directories** menu, select the path ending with **\examples**

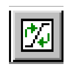
5 Open the ‘Shared_Data’directory, then double-click on the dataset named ‘LandsatTM.ers’ to load it.

Display Landsat band 5 and adjust the contrast

1 In the **Algorithm** dialog, click the **Surface** tab, then select **greyscale** from the ‘Color Table’ list.

2 Click the **Layer** tab again to display the process diagram.

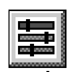
3 From the **Band Selection** drop-down list, select **B5:1.65_um**.

4 Click the **99% Contrast Enhancement**  button in the **Algorithm** dialog or main menu.

Load and display vector classes over TM5 image

1 In the Algorithm window, select **Annotation/Map Composition** from the **Edit/Add Vector Layer** menu.

A new annotation layer is added to the algorithm.

2 Click the **Edit Layer Color**  button in the process stream diagram to choose a color for displaying the vectors.

3 Select a red color, and click **OK** to close the **Color Chooser**.

4 Click the **Load Dataset**  button in the process steam diagram.

5 From the **Directories** menu, select the path ending with the text **\examples\Miscellaneous**.

6 In the directory ‘Tutorial,’ double-click on the ‘Iron_polygons.erv’ dataset you created to load it.

ER Mapper first processes the raster data, then draws the vector polygons in red.

Display the vector polygons alone

1 Turn off the Pseudo layer containing the TM band 5 of the LandsatTM.ers dataset.

ER Mapper draws the vector polygons in red over an empty (black) backdrop image so your can see them more clearly. As you can see, vectorizing raster data in this way can save hours or days of digitizing feature outlines by hand, so it is especially valuable for updating vector information for use in GIS products.

Note: Choose Combined_Polygons and Clay_polygons vector classes and display them individually over the TM5 image. You can also display all three vector classes over the TM5 image. If you display all three vector classes over TM5 you will see some common areas of the three classes.

Close the image window and Algorithm dialog

1 Select **Close** from the **File** menu to close the image window.

2 Click **Close** in the **Algorithm** dialog.

Only the ER Mapper main menu is now open.

What you learned...

After completing these exercises, you know how to perform the following tasks in ER Mapper:

- Geological structure interpretation and generate vector file with lineaments
- Generate binary raster images
- Generate vector polygon classes
- Display vector classes over TM images

17

Spatial filtering

This chapter shows you how to use ER Mapper's filter features to apply spatial filtering techniques commonly used to enhance geophysical data in mineral exploration applications. You will learn the common filtering techniques for geophysical data.

About spatial filtering

Spatial filtering is a common operation applied to raster image data to enhance or suppress spatial detail to improve visual interpretation. Common examples include applying filters to enhance edge detail in images, or to remove or decrease noise patterns or gridding artifacts in an image. Spatial filtering is called a "local operation" in image processing because it modifies the value of each pixel in the dataset according to the values of the pixels surrounding it. Filters work by removing certain spatial frequencies to enhance features in the remaining image. For geophysical data such as magnetics, sets of filter coefficients whose frequency response (i.e.) are the same as the desired amplitude and phase changes are commonly used to enhance or suppress high or low frequency information, for example to aid identification of deeper or shallower features.

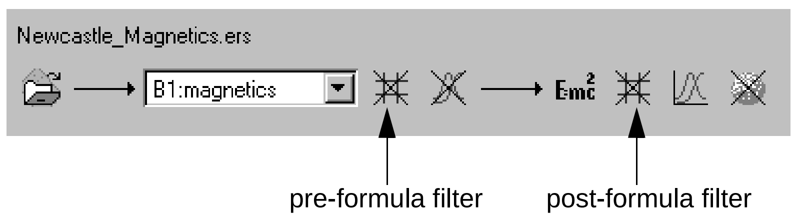
ER Mapper supplies a wide range of special filters for enhancing geophysical datasets such as magnetics. Many of these are located in the 'filters_geophysics' directory in the ER Mapper filters area.

How convolution kernels work

Spatial filtering is accomplished by passing a two-dimensional rectangular array (or window) containing weighting values over the image data at each pixel location. The pixel in the center of the window is evaluated according to the surrounding pixels and weighting values defined for each cell in the array, then a new output pixel value is calculated. The window then shifts over to the next pixel and performs the same operation. This process of evaluating the weighted neighboring pixel values is called two-dimensional convolution, and the filter array is often called a *convolution kernel*.

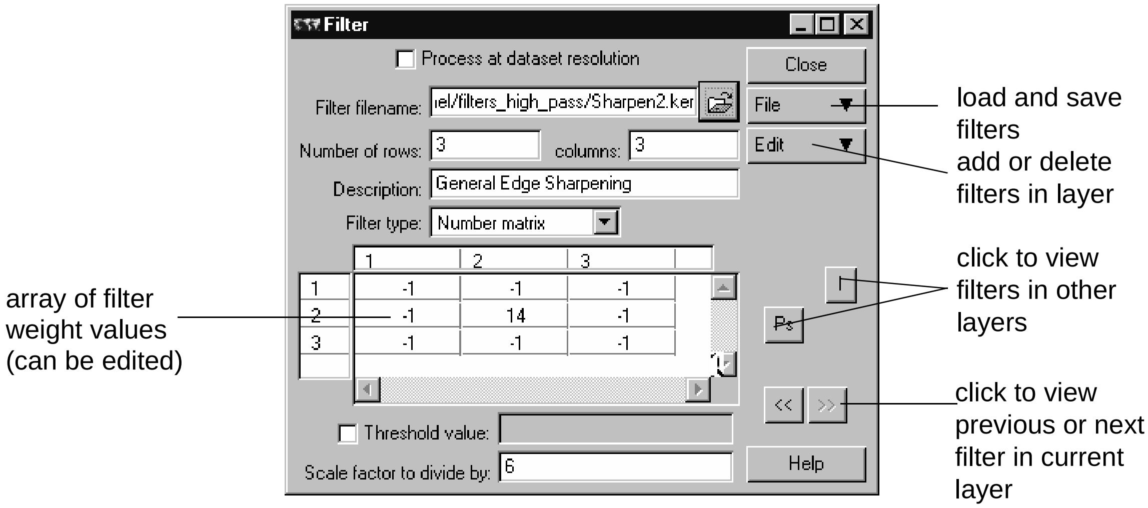
The Edit Filter buttons

By default, each raster layer in ER Mapper has two **Edit Filter (Kernel)** buttons in the algorithm process diagram. One lets you apply a filter *before* a formula (pre-formula), and the other *after* a formula (post-formula). You can also insert additional filters in either location to create sequential filtering operations.



The Filter editor dialog box

To add a filter into the process stream, or create a new filter, click on the desired **Edit Filter (Kernel)** button to open the **Filter** dialog box. ER Mapper provides a wide variety of standard spatial filters, including low and high pass filters, directional edge enhancement filters, and special filters for classification smoothing and for geophysical and seismic data.



ER Mapper also lets you use filters that are written in C or Fortran code, and provides several C and Fortran filters as examples. Using C or Fortran allows you implement more complex or specialized filtering techniques that are not possible with simple convolution kernels. There is no limit to the dimensions (size) of filters that can be defined and used in ER Mapper.

Hands-on exercises

These exercises show you how to use spatial filters in algorithms, and several common filtering techniques used for geophysical datasets.

What you will learn...

After completing these exercises, you will know how to perform the following tasks in ER Mapper:

- Apply upward and downward continuation filters commonly used for geophysical datasets
- Use formulas and filters to generate Vertical Derivatives of magnetic data

Before you begin...

Before beginning these exercises, make sure all ER Mapper image windows are closed. Only the ER Mapper main menu should be open on the screen.

1: Upward continuation spatial filtering

Objectives Learn to apply several types of upward continuation filters commonly used to enhance features in geophysical datasets.

Open an example magnetics algorithm

1 magnetic main menu window, lick the **Open** button.

An image window and the **Open** file chooser appear.

In the **Files of Type:** field, select “ER Mapper Algorithm (.alg)”

2 From the **Directories** menu, select the path ending with the text **\examples\Data_Types**

3 Open the **Magnetics_And_Radiometrics**’ directory. Double-click on the algorithm ’Magnetics_Pseudocolor.alg’ to open it.

ER Mapper displays the sample magnetic dataset of the Newcastle area in southeastern Australia.

4 Click on the **Edit Algorithm** button to open the **Algorithm** dialog.

5 Click the **Surface** tab in the **Algorithm** dialog.

6 From the ‘Color Table’ drop-down list, select **greyscale**.

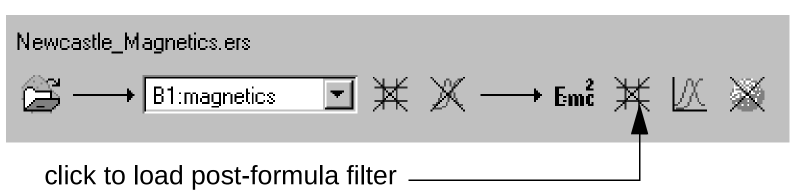
The image displays in greyscale, so high magnetic values display as light greys and low values as dark greys.

7 Click the **Layer** tab in the **Algorithm** dialog.

8 Drag the image window corner to make it about 50% larger.

Apply an upward continuation filter to the image

1 In the algorithm process diagram, click on the post-formula **Edit Filter (Kernel)** button.



The **Filter** dialog box appears. This dialog allows you to load standard filters supplied with ER Mapper, and create and save your own filters.

2 From the **File** menu (in the **Filter** dialog), select **Load...**.

The **Load filter** file chooser dialog box appears.

3 From the **Directories** menu, select the path ending with the text **\kernel**.

4 Double-click on the ‘filters_geophysics’ directory to open it.

5 Double-click on the filter ’up_cont_1.ker’ to load it.

This filter is much larger (a 9 by 9 array), and is designed specifically to suppress high frequency features in geophysical datasets such as magnetics and gravity.

6 The image with your 9x9 upward continuation 1 filter is displayed.

Upward continuation filters transform the data by shifting the point of observation up vertically (as if the field had been measured at a higher aircraft flying height). In the filter name ‘up_cont_1,’ the value 1 refers to the vertical continuation distance in number of grid cells (80m upward in this case because the dataset cell size is 80m). Upward continuation filters are used to suppress high frequency (near surface) features in magnetic data to aid identification of deeper causative bodies.

Apply an upward continuation 2 filter

1 In the **Filter** dialog click the button next to ‘Filter filename.’

2 Double-click on the filter ’up_cont_2.ker’ to load it.

This filter shifts the point of observation up vertically 2 grid cells (160m for this dataset), and creates a stronger effect to suppress high frequency (near surface) features.

Delete the filter from the algorithm

1 From the **Edit** menu (in the **Filter** dialog), select **Delete this filter**.

The array of filter values disappears from the **Filter** dialog, and the post-formula Filter button on the process diagram changes from to to indicate that no filter is currently used in that part of the algorithm.

The image appears as it did originally without any filters applied. As you can see, it is easy to add, change, and delete filters and interactively see the results.

2: Downward continuation spatial filtering

Objectives Learn to apply several types of downward continuation filters commonly used for geophysical datasets.

Apply a downward continuation 1 filter

1 In the **Filter** dialog click the button next to ‘Filter filename.’

2 From the **Directories** menu (in the **Load filter** dialog), select the path ending with **\kernel**.

3 Double-click on the ‘filters_geophysics’ directory to open it.

4 Double-click on the filter ’down_cont_1.ker’ to load it.

This 11 by 11 array filter is designed specifically to enhance high frequency features in geophysical datasets such as magnetics and gravity.

5 Click the **99% Contrast Enhancement** button to process the algorithm (you will need to wait a few seconds for the image to appear).

Downward continuation filters are similar in concept to upward continuation filters, but they transform the data by shifting the point of observation *down* vertically (as if the field had been measured at a lower flying height). The down_cont_1’ continues the field 80m downward (because the dataset cell size is 80m). Downward continuation filters are used to suppress deeper/broader (regional) features to aid identification of shallower/narrower features.

Delete the downward continuation filter and adjust the contrast

1 From the **Edit** menu (in the **Filter** dialog), select **Delete this filter**.

The filter is cleared from the algorithm.

2 Click the **99% Contrast Enhancement** button.

ER Mapper automatically adjusts the transform and displays the image without any filters applied.

3: Creating vertical derivatives

Summary

ER Mapper can easily create vertical derivative (VD) images of magnetic data using filters and formulas. In this exercise you will create one-quarter grid space (1Q), first and second vertical derivatives of a magnetic dataset.

Vertical derivative (or vertical gradient) images of magnetics show the rate of change in the magnetics field with height. Vertical derivatives enhance high frequency gradients (narrower features) that are usually associated with shallower magnetic bodies. Typically these are displayed as greyscale images to help interpret the structure and depth of ore bodies.

Open a new image window

1 In the main menu window, click the **New** button.

A new image window opens. The **Algorithm** dialog shows a single Pseudo layer with no dataset loaded yet.

Load the sample Newcastle magnetic dataset

1 In the **Algorithm** dialog, click the **Load Dataset** button in the process diagram.

The **Raster Dataset** dialog opens.

2 From the **Directories** menu, select the path ending with **\examples**.

3 Open the ‘Shared_Data’ directory, then double-click on the ‘Newcastle_Magnetics.ers’ dataset to load it.

Use a formula to subtract input2 from input1

Creating a one-quarter Vertical Derivative image requires applying an upward continuation one-half grid spacing filter to the magnetic data, then subtracting the original unfiltered data from the filtered data. In order to do this, you must first enter the “input1-input2” formula to create two input streams in the algorithm, then insert the filter in the Input1 stream.

1 In the **Algorithm** dialog, click the **Edit Formula** button in the process diagram.

The **Formula Editor** dialog box appears.

2 .In the **Formula Editor** dialog, edit the existing “INPUT1” formula to read:

```
INPUT1-INPUT2
```

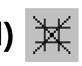
This formula tells ER Mapper to subtract the values of INPUT2 from INPUT1

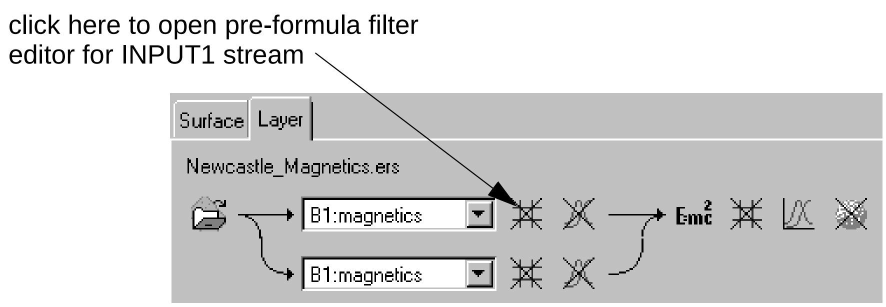
3 Click the **Apply changes** button to validate the formula.

4 Click **Close** in the **Formula Editor** dialog.

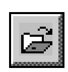
Add an upward continuation half filter to the INPUT1 stream

Notice that the process diagram in the **Algorithm** dialog now shows two separate streams leading into the formula. The top stream represents “INPUT1” in the formula and bottom stream “INPUT2.”

1 In the process diagram, click the pre-formula **Edit Filter (Kernel)**  button for the INPUT1 stream before the formula:



The **Filter** dialog box appears to let you to load a filter.

2 In the **Filter** dialog, click the  button next to ‘Filter filename.’

3 From the **Directories** menu (in the **Load filter** dialog), select the path ending with **\kernel**.

4 Open the ‘filters_geophysics’ directory, then double-click on the filter ’up_cont_half.ker’ to load it.

This 9 by 9 filter transforms the magnetic data by shifting the point of observation up vertically (upward continuation). It calculates what the field measured at one height would be if it had been measured at a higher flying altitude.

5 Click **Close** in the **Filter** dialog to close it.

Display the image and adjust the color mapping (transform)

1 In the **Algorithm** dialog, click the **Surface** tab.

2 From the **Color Table** drop-down menu, choose **greyscale**.

The image appears black because the transform limits need to be adjusted to the range of data values created by the filters and formula.

3 In the **Algorithm** dialog, click the **Layer** tab.

4 Click the right-hand **Edit Transform Limits**  button in the process diagram.

5 From the **Limits** menu (in the **Transform** dialog), select **Limits to Actual**.

The X axis data range changes to match the Actual Input Limits created by the filter and formula.

ER Mapper renders the image again with improved contrast but you may need to increase it further.

6 In the **Transform** dialog, click the **Histogram equalize**  button.

The image should now have good contrast and highlight high frequency trends in the magnetic data. (Try other types of transforms if desired to see if they provide better contrast enhancement.)

7 Click **Close** in the **Transform** dialog to close it.

8 In the layer list, change the Pseudo Layer's label to **`1Q vert deriv`**.

You have now created a layer that generates a one-quarter grid space vertical derivative of the magnetic data.

Create a 1st Vertical Derivative image

Next you will add a second layer to the algorithm that creates a 1st Vertical Derivative image at the plane of observation. A 1st VD creates a stronger effect than the 1Q VD to further emphasize shallower/narrower features in the magnetic data.

The technique to create a 1st VD image is similar to the one used to create a 1Q VD, except you also need to apply a pre-formula filter to the INPUT2 stream. Therefore, it is easiest to create the second layer by duplicating the 1Q VD layer and adding a filter to the Input2 stream.

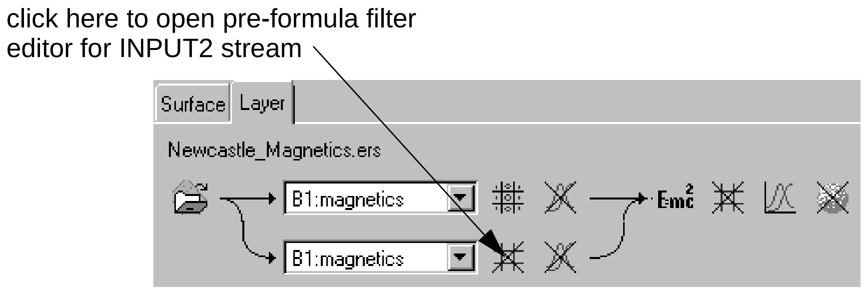
1 In the **Algorithm** dialog, click the **Duplicate**  button.

The '1Q vert deriv' layer is duplicated.

2 Change the label of the new (lower) layer to read **`1st vert deriv`**.

Since this layer was duplicated from the 1Q VD layer, it already has the magnetic dataset loaded, the "INPUT1-INPUT2" formula, and a pre-formula filter for INPUT1.

3 In the process diagram, click on the **Edit Filter (Kernel)** button for the INPUT2 stream before the formula.:



4 In the **Filter** dialog, click the button next to ‘Filter filename.’

5 Double-click on the filter ’down_cont_half.ker’ to load it.

This is a 9x9 downward continuation half grid spacing filter.

6 Click **Close** in the **Filter** dialog.

As you can see, the 1st VD image is the difference between the downward continuation half and the upward continuation half filtered data.

Display the image and adjust the transform

1 Turn off the layer labelled ‘1Q vert deriv’ by right-clicking on the layer and selecting **Turn Off**.

The 1st VD processing creates a slightly different data range than the 1Q VD, so you need to adjust the transform to optimize the contrast.

2 Click on the layer labelled ‘1st vert deriv’ to select it (if needed).

3 Click the right-hand **Edit Transform Limits** button in the process diagram.

4 From the **Limits** menu (in the **Transform** dialog), select **Limits to Actual**.

The X axis data range changes to match the Actual Input Limits.

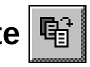
5 In the **Transform** dialog, click the **Gaussian Equalize** button.

The image should now have good contrast. (With the sample dataset used here, the 1st VD image looks similar to the 1Q VD image.)

6 Click **Close** in the **Transform** dialog to close it.

Create a 2nd Vertical Derivative image

Next you will create a third layer in your algorithm that generates a 2nd Vertical Derivative image at the plane of observation. A 2nd VD creates a stronger “sharpening” effect to further emphasize shallower/narrower features, but can also add noise to the image.

1 In the **Algorithm** dialog, click the **Duplicate**  button.

The ‘1st vert deriv’ layer is duplicated.

2 Change the label of the new (lower) layer to read **`2nd vert deriv`**.

Enter a formula to compute the 2nd VD

1 With the ‘2nd vert deriv’ layer selected, click the **Edit Formula**  button in the process stream diagram.

2 In the **Formula Editor** dialog, edit the existing formula to read:

```
INPUT1 - (2*INPUT2) + INPUT3
```

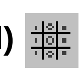
As indicated, this formula uses three inputs.

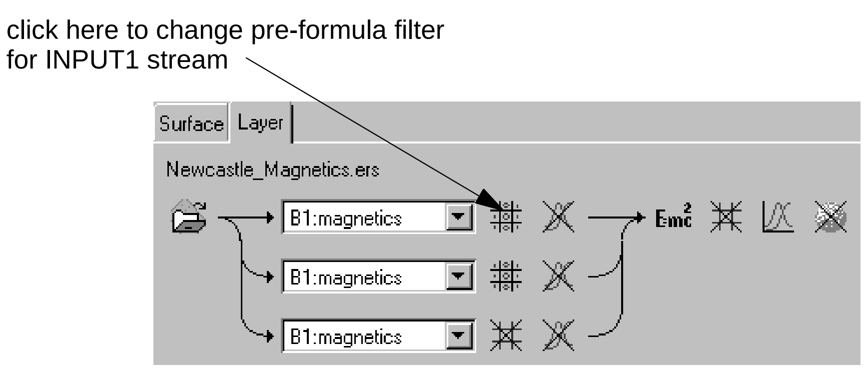
3 In the **Formula Editor** dialog, click the **Apply changes** button.

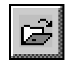
4 Click the **Close** button to close the **Formula Editor** dialog.

Change the INPUT1 filter to a downward continuation half

Notice now that the process diagram shows three input streams leading to the formula, for INPUT1, INPUT2 and INPUT3 in your formula.

1 In the process diagram, click the pre-formula **Edit Filter (Kernel)**  button for the INPUT1 stream before the formula.



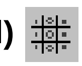
2 In the **Filter** dialog, click the  button next to ‘Filter filename.’

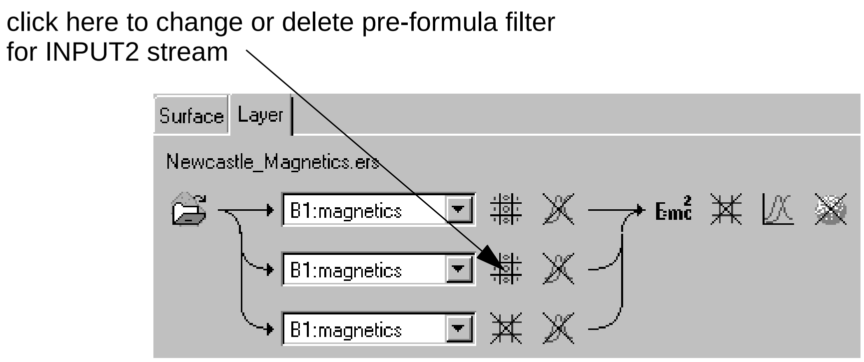
3 Double-click on the filter ’down_cont_half.ker’ to load it.

This is an 11x11 filter used to compute downward continuation at one-half grid spacing.

Delete the filter from the INPUT2 stream

To create a 2nd VD image, the second input must be the original unfiltered data, so you must delete the existing filter copied from the 1st VD layer.

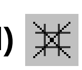
1 In the process diagram, click the pre-formula **Edit Filter (Kernel)**  button for the INPUT2 stream before the formula.

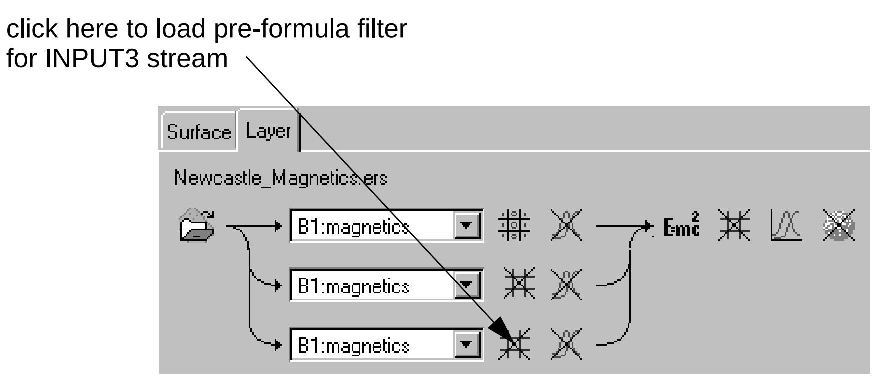


2 In the **Filter** dialog, select **Delete this filter** from the **Edit** menu.

The filter array clears to indicate that no filter is used.

Add an upward continuation half filter to the INPUT3 stream

1 In the process diagram, click the pre-formula **Edit Filter (Kernel)**  button for the INPUT3 stream before the formula.



The contents of the **Filter** dialog box change to show that INPUT3 currently has no filter loaded.

2 In the **Filter** dialog, click the button next to 'Filter filename.'

3 Double-click on the filter 'up_cont_half.ker' to load it.

This is the same 9x9 upward continuation filter used to create the 1Q VD image.

4 Click the **Close** button to close the **Filter Editor** dialog.

Display the image and adjust the color mapping (transform)

1 Right-click and turn off the layer labelled '1st vert deriv' (only the '2nd vert deriv' layer should be on).

2 Click on the layer labelled '2nd vert deriv' to select it.

This computes the new data range, now you need to adjust the transform.

3 Click the right-hand **Edit Transform Limits** button in the process diagram.

4 From the **Limits** menu (in the **Transform** dialog), select **Limits to Actual**.

The X axis data range changes to match the Actual Input Limits.

5 Click the **Create default linear transform** button.

ER Mapper renders the image again with the correct transform range.

6 In the **Transform** dialog, click the **Gaussian Equalize** button.

The image should now have good contrast. (Autoclip or Histogram Equalization transforms may also provide good effects.)

7 Click **Close** in the **Transform** dialog to close it.

You now have an algorithm that computes one-quarter, 1st and 2nd Vertical Derivatives.

8 Save the Vertical Derivatives algorithm to disk

9 In the **Algorithm** dialog, enter the text **`Magnetics Vertical Derivatives`** in the 'Algorithm Description' text field.

10 From the **File** menu (in the main menu), select **Save As...**.

The **Save As** dialog appears.

11 From the **Directories** menu, select the path ending with the text **\examples\Miscellaneous**.

12 Double-click on the directory named ‘Tutorial’ to open it.

13 In the **Save As:** text field, enter your initials followed by the text **`Magenetics_Vertical_Derivatives`**.

14 Click the **OK** button to save the algorithm.

Tip: Although it took a few minutes to create this algorithm, you now have template that you can use to create the VD images on any other magnetic dataset. Simply load the new dataset and adjust the transform limits and contrast for each layer as needed.

Close image windows and the Algorithm window

1 Close all image windows using the window system controls:

- For Windows, click the  **Close** button in the upper-right window corner.
- For Unix systems, select **Close** or **Quit** from the window control menu in the upper-left corner (for systems with both options, select **Quit**).

2 Click **Close** in the **Algorithm** dialog to close it.

Only the ER Mapper main menu is now open.

What you learned...

After completing these exercises, you know how to perform the following tasks in ER Mapper:

- Apply upward and downward continuation filters commonly used for geophysical datasets
- Use formulas and filters to generate Vertical Derivatives of magnetic data

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Fourier transforms

This chapter explains how to use ER Mapper's Fourier Transforms feature to convert raster datasets to and from frequency space, and to apply various processing techniques commonly used for geophysical datasets. Use of Fast Fourier Transforms (FFTs) is especially valuable in the processing and enhancement of potential fields data such as aeromagnetics.

ER Mapper also provides an image wizard that automatically carries out first vertical derivative and reduce to pole FFT operations for magnetic datasets. You will use this wizard at the end of this chapter.

Note: A thorough discussion of the concepts and theory behind FFTs is beyond the scope of this workbook, however a simple introduction and some explanations are provided. Please refer to Chapter 11 of the *ER Mapper Applications* manual and other references for more detailed information..

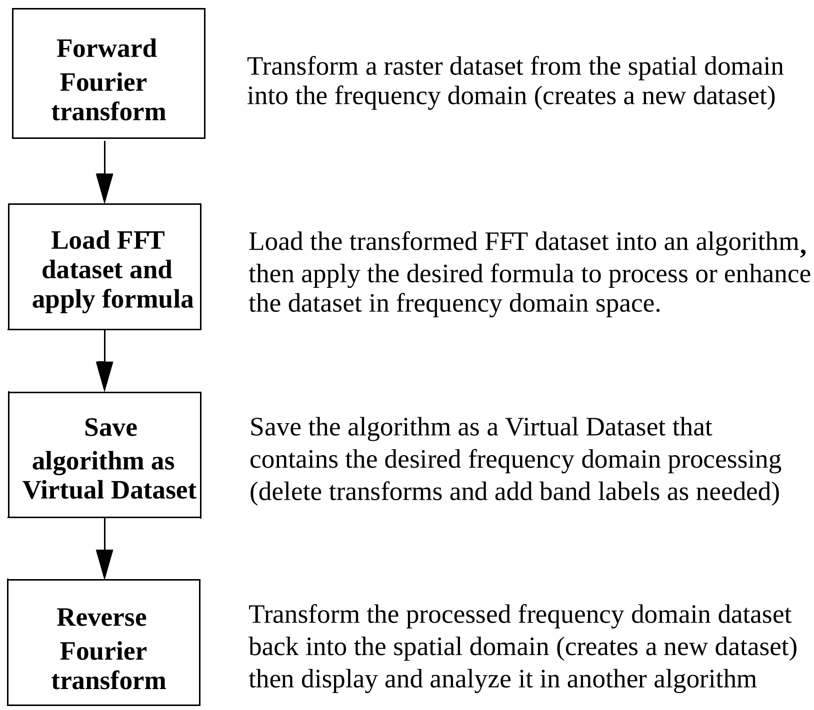
About Fourier transforms

Up until this point, all the operations you have performed in ER Mapper have been carried out in the *spatial domain*–the (x,y) coordinate space of images. The *frequency domain* is an alternative coordinate space that can be used for image processing and analysis. In this approach, the image is separated into its various spatial frequency components through the application of a mathematical operation known as the *Fourier transform*. This involves fitting a continuous function through the pixel values as if they were plotted along each row and column of an image. The "peaks" and "valleys" along any given row or column can be described mathematically by a combination of sine and cosine waves with various amplitudes, frequencies and phases. The Fast Fourier Transform (FFT) is a fast, mathematically efficient means of converting raster datasets to and from the frequency domain.

FFTs are a powerful image processing and enhancement technique that can be used to create vertical continuations, first and second derivatives, reduction to pole, and other common transforms and enhancements of potential fields data.

FFT processing in ER Mapper

The basic procedure to use ER Mapper's FFT feature is to transform a dataset in frequency space, use the appropriate formula in an algorithm to process the data, then transform the result back to the spatial domain for viewing and analysis. The following flowchart shows the basic sequence of steps:



ER Mapper provides many template algorithms that make it easier to apply many types of common FFT processing techniques. These algorithms already contain the required ER Mapper formulas. You will use them and the FFT image wizard for magnetic data in the following exercises.

Hands-on exercises

These exercises show you how to transform data into frequency domain space, apply several types processing techniques for geophysical datasets, and convert the processed data back to the spatial domain for display.

What you will learn...

After completing these exercises, you can perform the following tasks in ER Mapper:

- Use FFTs to transform a dataset into the frequency domain (forward FFT)
- Apply formulas to process/enhance the data in the frequency domain, including upward and downward continuation and reduce to pole (RTP) processing
- Transform the processed FFT dataset back into the spatial domain for display (reverse FFT)
- Use the Magnetics Fourier Wizard to automate common FFT enhancements for magnetic data

Before you begin...

Before beginning these exercises, make sure all ER Mapper image windows are closed. Only the ER Mapper main menu should be open on the screen.

1: FFT transformations

Objectives

Learn how to transform a raster dataset (a magnetics grid) to frequency domain space, and view the Fourier power spectrum of the dataset.

Display the dataset to be transformed

1 In the main menu window, click the **Open**  button.

A new image window and the **Open** dialog appear.

2 From the **Directories** menu, select the path ending with **\examples\Data_Types**.

3 Open the directory named 'Magnetics_And_Radiometrics,' then double-click on the algorithm named 'Magnetics_Colordrape.alg' to open it.

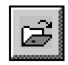
The algorithm displays a colordrape image of Total Magnetic Intensity (TMI) data acquired by aircraft over the Cape York Peninsula area of Queensland in northeastern Australia. Red and yellow colors represent higher TMI values. This is the dataset you will transform and process using FFTs in these example exercises.

4 Select **Close** from the **File** menu to close the image window.

Transform the dataset into the frequency domain

1 From the **Process** menu in the main menu window, select **Fourier Transformations...**

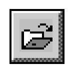
The **Forward & Reverse Fourier Transformation** dialog box appears.

2 Next to the ‘Input Dataset’ field, click the  button.

3 From the **Directories** menu, select the path ending with the text **\examples**.

4 Open the directory ‘Shared_Data’ then double-click on the dataset named ‘Magnetics_Grid.ers’ to load it.

Notice that the dialog box title changes to ‘FFT- Forward Fourier Transformation.’ ER Mapper determined that the input magnetic dataset was not in frequency domain space, so it automatically assumes a forward FFT transformation.

5 Next to the ‘Output Dataset’ field, click the  button.

6 From the **Directories** menu, select the path ending with the text **\examples\Miscellaneous**.

7 Open the directory ‘Tutorial,’ then enter a name for the FFT dataset in the **Save As:** text field. Use your initials at the beginning, followed by the text ‘Magnetics_FFT.’ Separate each word with an underscore (_). For example, if your initials are “MD,” type:

```
MD_Magnetics_FFT
```

8 Click **OK** in the **Output Dataset** dialog.

9 Turn on the ‘Full Spectrum’ option to create a full spectrum FFT dataset.

ER Mapper indicates the input and output file sizes, and the disk space required for the work area needed for the forward FFT transform. Output files sizes are significantly larger than the original input file size because two bands are created for each input dataset band, and (by default) the output dataset values are stored as double-precision real numbers.

10 Click **OK** to start the transformation.

ER Mapper converts the dataset to frequency domain space, then displays a notification dialog when the process is complete.

11 Click **OK** in the small completion dialog, then click **Cancel** in the **FFT-Forward Fourier Transformation** dialog to close it.

You have now created a new dataset in frequency domain space. The FFT dataset contains two bands for each input dataset band (a “real” band an an “imaginary” band). Next you will load the FFT dataset into an algorithm to view its Fourier power spectrum.

Load the FFT dataset into an algorithm

1 From the **View** menu, select **Algorithm...**.

A new empty image window and the **Algorithm** dialog open.

2 In the **Algorithm** dialog, click the **Load Dataset** button.

3 From the **Directories** menu, select the path ending with **\examples\Miscellaneous**.

4 Open the ‘Tutorial’ directory, then double-click on your dataset ‘Magnetics_FFT.ers’ with your initials to load it.

The file chooser dialog box closes, and the FFT dataset is loaded into the Pseudocolor layer.

Load a formula to compute the Fourier power spectrum

1 Click the **Edit Formula** button in the process diagram.

The **Formula Editor** dialog box opens.

2 From the **File** menu (in the **Formula** dialog), select **Open...**.

3 From the **Directories** menu, select the path ending with the text **\formula**.

4 Open the ‘fourier’ directory, then double-click on the formula ’fft_log_power_spectrum.frm’ to load it. The formula looks like this:

```
log(sqrt(I1*I1 + I2*I2))
```

This formula computes the log power spectrum of the FFT magnetic dataset. It automatically references band 1 of the FFT dataset (the real band) as INPUT1, and band 2 (the imaginary band) as INPUT2.

5 Click **Close** in the **Formula** dialog.

Display the Fourier power spectrum of the FFT dataset

1 Click the **Surface** tab, select **pseudocolor** from the ‘Color Table’ list, then click the **Layer** tab again.

2 Click the **99% Contrast Enhancement** button..

ER Mapper displays an image representing the Fourier log power spectrum of the FFT magnetic dataset. The power spectrum is a two-dimensional scatterplot of the spatial frequencies in the FFT dataset. Low frequency components are displayed in the center, with progressively higher frequency components toward the outer edge (such as strong gradients in the mag data).

Most images are dominated by low frequency information, as shown by the dominance of red colors (more frequently occurring data values) in the center of the power spectrum plot. Displaying the power spectrum of an image can help isolate striping or noise patterns in datasets, and allow you to suppress them using “notch filtering” and other techniques. (For example, the left-to-right banding pattern in the center may represent some gridding noise.)

2: FFTs for Vertical Continuation

Objectives

Learn how to use template FFT algorithm and a formula to create an upward or downward vertical continuation image, and transform the processed FFT data back into the spatial domain for display and analysis.

Vertical continuations are commonly applied to magnetic datasets. Downward continuation helps counteract attenuation imposed by the need to fly aerial surveys at a safe flying height. Upward continuation is commonly used to help isolate the contribution from magnetic sources deep below the surface.

Open the FFT Vertical Continuation template algorithm

1. In the main menu window, click the **Open**  button.
2. From the **Directories** menu, select the path ending with **\examples\Miscellaneous\Template**.
3. Open the ‘FFT’ directory.
4. Double-click on the algorithm named ‘Vertical_Continuation.alg’ to open it.

Load the forward FFT dataset

1. In the **Algorithm** dialog, click the **Load Dataset**  button in the process diagram.
2. From the **Directories** menu, select the path ending with **\examples\Miscellaneous**.

3 Open the directory ‘tutorial,’ then double-click on the dataset named ‘Magnetics_FFT.ers’ *with your initials* to load it.

View the formula used to compute the vertical continuation

1 Click the **Edit Formula** button in the process diagram to view the Vertical Continuation formula:

```
fft_vertical_continuation(INPUT1,cellx(),celly(),rcols(),nrrows(),up)
```

C usercode FFT function — ER Mapper special formula constructs — variable name to control direction and amount of vertical continuation

This formula uses a C user code function, ER Mapper special constructs, and a variable that controls to direction (upward or downward) and amount of vertical continuation.

Set the desired direction and amount of vertical continuation

The vertical continuation user code requires only one parameter: *the amount of vertical continuation*. Negative values continue the field down, and positive values continue the field up. The value entered is expressed in terms of the gridded cell (pixel) size. To calculate the correct value, you need to know the height the survey data was acquired from (80 meters in this case) and the gridded cell size (100 meters) then use the following formula:

- (sample height - required height) / gridded cell size

or

(required height - sample height) / gridded cell size

So, to continue the field downward 40 meters, the value would be:

`-(80 - 40) / 100 =` **`-0.4`**

`or`

`(40 - 80) / 100 =` **`-0.4`**

1 In the Relations area of the **Formula** dialog, click the **Variables** button.

The default value of the ‘up’ variable is displayed (10.00000). (The text “up” is simply a name used for the variable; you could change this to “down” or another word if desired and then click **Apply changes** to validate it.)

2 Change the value of the ‘up’ variable to **`-0.4`**, then press Enter or Return to validate.

3 Click **Move to next Pseudo layer in surface** [Ps] button in the **Formula** dialog to view the formula for the other Pseudo layer in the algorithm.

4 Change the value of the 'up' variable to **`-0.4`**, then press Enter or Return to validate.

The 'up' variable should now be set to -0.4 for both layers.

5 Click **Close** in the **Formula Editor** dialog to close it.

Set the appropriate bands and labels for the two layers

1 Click on the upper of the two Pseudo layers to select it, then select **B1: (Re) FFT - magnetics** from the **Band Selection** list in the process diagram.

(Band 1 is the "Real" band in the FFT dataset.)

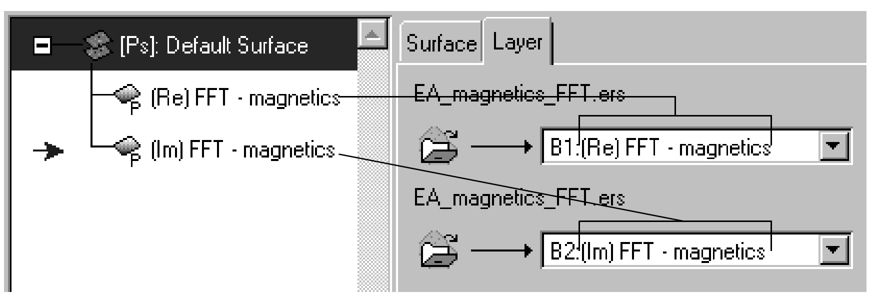
2 Click on the lower Pseudo layer to select it, then select **B2: (Im) FFT - magnetics** from the **Band Selection** list.

(Band 2 is the "Imaginary" band, or Im, in the FFT dataset.)

3 Click on the top layer to select it, then type the label text **`(Re) FFT - magnetics`** (to match the band label in the dataset).

4 Click on the lower layer to select it, then type the label text **`(Im) FFT - magnetics`**.

5 Click on the surface icon next to '[Ps]:Default Surface' to show process diagrams for both layers; they should look like the following:



Caution: As noted above, it is **very important** that the layer labels exactly match the input dataset labels for the reverse FFT transformation. Otherwise you will get a band mismatch error in the reverse FFT transform. (The part of the band 2 label in parentheses is a capital "I" and small "m" for "Imaginary.")

Save the algorithm as a Virtual Dataset

A Virtual Dataset (or “VDS”) is a special feature of ER Mapper that creates a file that can used like a real dataset stored on disk, however it uses almost no additional disk space. Virtual Datasets are handy, for example, to store the results of an intermediate processing step without needing to create a real dataset. You will save the transformed result of the vertical continuation formula as VDS in this case to save disk space. (Virtual Datasets will be discussed again later.)

1 From the **File** menu (in the main menu window), select **Save as ...**.

The **Save As** dialog box appears.

In the **Files of Type:** field, select “ER Mapper Virtual Dataset (.ers)”

2 From the **Directories** menu, select the path ending with the text **\examples\Miscellaneous**.

3 Double-click on the directory named ‘Tutorial’ to open it.

4 In the **Save As:** text field, type a name with your initials at the beginning, followed by the text ‘Mag_FFT_down_cont_40m_vds,’ and separate each word with an underscore (_). For example, if your initials are "JR," type in the name:

```
JR_Mag_FFT_down_cont_40m_vds
```

5 Click **OK** to save the Virtual Dataset and close the file chooser dialog.

You now have a Virtual Dataset that applies a 40m downward continuation to the FFT magnetic dataset. This Virtual Dataset will be used as input for the reverse FFT transformation.

Note: Notice that the transform for both layers is **Histogram Only** , so the data will not be rescaled into a 0-255 range. This is important when creating Virtual Datasets for FFT applications. (You can also use **Compose/Delete this transform** in the **Transform** dialog to prevent rescaling.)

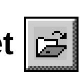
---

6 In the main menu window, select **Close** from the **File** menu to close the image window.

Transform the processed dataset back into the spatial domain

1 From the **Process** menu, select **Fourier Transformations...**

The **Forward & Reverse Fourier Transformation** dialog box appears.

2 Next to the ‘Input Dataset’ field, click the **Load Dataset**  button.

3 From the **Directories** menu, select the path ending with **\examples\Miscellaneous**.

4 Open the directory ‘Tutorial,’ then double-click on your Virtual Dataset named ‘Mag_FFT_down_cont_40m_vds.ers’ with your initials to load it.

Notice that the dialog box title changes to ‘FFT- Reverse Fourier Transformation.’ ER Mapper automatically recognizes that the input magnetic dataset is already in frequency domain space, so it assumes a reverse FFT transformation.

5 Next to the ‘Output Dataset’ field, click the **Load Dataset** button.

6 From the **Directories** menu, select the path ending with the text **\examples\Miscellaneous**.

7 Open the directory ‘Tutorial,’ then enter a name for the 1st VD dataset in the **Save As:** text field. Use your initials at the beginning, followed by the text `Mag_FFT_down_cont_40m`. Separate each word with an underscore (_).

8 Click **OK** in the **Output Dataset** dialog.

9 Click **OK** to start the transformation.

ER Mapper converts the frequency domain dataset back to the spatial domain, then displays a notification dialog when the process is complete.

10 Click **OK** in the small completion dialog, then click **Cancel** in the **FFT-Reverse Fourier Transformation** dialog to close it.

You have now created a new dataset in the spatial domain that has a 40m downward continuation applied. Next you will display the downward continued dataset in an algorithm.

Display the downward continued dataset using a wizard

Up until now, you have created algorithms manually by loading datasets, adjusting transforms, and so on. However, ER Mapper also provides “image wizards” that automate many of the common tasks. You will use a wizard next to quickly display the downward continued dataset.

1 In the main menu window, click the **Edit Algorithm** button.

An image window and the **Algorithm window** appear. The **Algorithm window** informs you no dataset is yet associated with this algorithm.

2 In the **Algorithm window**, click the Load Dataset button.

3 Raster Dataset dialog appears.

4 From the **Directories** menu (in the **Raster Dataset** dialog), select the path ending with **\examples\Miscellaneous**.

5 Open the 'Tutorial' directory, then double-click on your dataset 'Mag_FFT_down_cont_40m.ers' with your initials to load it.

6 Click the **OK** button in the **Select a Dataset** dialog.

ER Mapper automatically creates a greyscale Pseudocolor algorithm and displays the downward continued magnetic dataset you created using the Fourier Transforms. The wizard automatically adjusted the image contrast.

3: FFTs for Reduction to Pole

Objectives

Learn how to use FFT processing to perform reduction to the pole for magnetic datasets. This is an example of a more complex transformation that requires information about the acquisition parameters of the dataset.

About the Reduction to Pole process

The Reduction to Pole (RTP) process is used to transform magnetic anomalies to the North Pole where the field is vertical. This effectively remove asymmetries caused by the non-vertical magnetization and the regional field, and enables easier interpretation and more precise positioning of ore bodies.

The Reduce to Pole process requires the following information about the input magnetic dataset (values for sample Cape York peninsula dataset are shown):

Lat/Long extents: (142:57:19.3, -13:59:20.2), (143:32:43.35, -14:32:23.98)

Magnetic declination: 6.4 degrees

Magnetic inclination: - 42.1 degrees

Data acquired at 80m flying height with 200m line spacing

Data gridded at a 100m cell size

Open the FFT Reduce to Pole template algorithm

1 Click the **Open**  toolbar button.

2 From the **Directories** menu, select the path ending with the text **\examples\Miscellaneous**.

3 Open the 'Templates' directory, then open the 'FFT' directory.

4 Double-click on the algorithm named 'Reduce_to_Pole.alg' to open it.

This template algorithm is designed to simplify the application of FFTs for Reduce to Pole processing.

Load the forward FFT magnetic dataset

1 In the **Algorithm** dialog, click the **Load Dataset** button in the process diagram.

2 From the **Directories** menu, select the path ending with the text **\examples\Miscellaneous**.

3 Open the 'Tutorial' directory, then double-click on the dataset named 'Magnetics_FFT.ers' *with your initials* to load it. (This is the same FFT dataset you created earlier and used in the vertical continuation exercise.)

View the formula used to compute the reduction to pole

1 Click on the top layer '(Re)FFT - Pseudo' to select it.

2 Click the **Edit Formula** button in the process stream diagram to view the Real component's reduce to pole formula:

```
fft_reduce_to_pole_r(INPUT1,INPUT2,cellx(),celly(),rcols(),nrrows(),
field_p,field_q,field_r,POL_p,POL_q,POL_r)
```

variables for components of unit vector in direction of terrestrial field

variables for components of unit vector in direction of total polarization of rock mass

This formula uses a C user code function and several variables that control the unit vector in the direction of the terrestrial field and polarization of the rock mass.

Set the formula variables for the Real component

The field values can be determined from the dataset's magnetic inclination and declination values as follows:

```
field_p = cos(inclin.) * sin(declin.) - East
field_q = cos(inclin.) * cos(declin.) - North
field_r = sin(declin.) - Vertical
```

Applying in the dataset parameters gives the following values:

field_p = **0.008271**

field_q = **0.737352**

```
field_r = -0.670427
```

(The rock polarization vector is usually unknown, and so is set to the same values as the field components.)

1 In the Relations area of the **Formula** dialog, click the **Variables** button.

The default values of the six variables are displayed.

Tip: To make it easier to see and edit the variable values, increase the vertical size of the **Formula** dialog box or resize the Generic and Specific windows until all six variable names are visible in the central Relations part of the dialog.

---

2 Change the value of each variable as follows (press Enter or Return to validate each one):

```
field_p = 0.008271
field_q = 0.737352
field_r = -0.670427
pol_P = 0.008271
pol_Q = 0.737352
pol_R = -0.670427
```

Set the formula variables for the Imaginary component

1 Click **Move to next Pseudo layer in algorithm** button in the **Formula** dialog to view the formula for the other layer in the algorithm.

This formula creates the Imaginary component for the Reduce to Pole process. It is similar to the Real component formula, but uses a different C usercode function (‘fft_reduce_to_pole_i’ instead of ‘fft_reduce_to_pole_r’).

2 Change the value of each variable as follows, then press Enter or Return to validate each one (the same values as for the Real component):

```
field_p = 0.008271
field_q = 0.737352
field_r = -0.670427
pol_P = 0.008271
pol_Q = 0.737352
pol_R = -0.670427
```

3 When finished, click **Close** in the **Formula Editor** dialog to close it.

Set the appropriate labels for the two layers

The layer description labels must match the input dataset band labels.

1 Click on the top layer to select it, then type the label text **`(Re) FFT - magnetics`**.

2 Click on the lower layer to select it, then type the label text **`(Im) FFT - magnetics`**.

(Even though both layers use both bands as input to the formula, each will output only the transformed real or imaginary band.)

Save the algorithm as a Virtual Dataset

1 From the **File** menu, select **Save as...**.

The **Save As** dialog box appears.

In the **Files of Type:** field, select "ER Mapper Virtual Dataset (.ers)"

2 From the **Directories** menu, select the path ending with the text **\examples\Miscellaneous**.

3 Double-click on the directory named 'TTutorial' to open it.

4 In the **Save As:** text field, type a name with your initials at the beginning, followed by the text 'Mag_FFT_RTP_vds,' and separate each word with an underscore (_). For example, if your initials are "CJ," type in the name:

`CJ_Mag_FFT_RTP_vds`

5 Click **OK** to save the Virtual Dataset and close the file chooser dialog.

You now have a Virtual Dataset that applies a Reduce to Pole process to the FFT magnetic dataset. This Virtual Dataset will be used as input for the reverse FFT transformation.

6 In the main menu window, select **Close** from the **File** menu to close the image window.

Transform the processed dataset back into the spatial domain

1 From the **Process** menu, select **Fourier Transformations...**

The **Forward & Reverse Fourier Transformation** dialog box appears.

2 Next to the 'Input Dataset' field, click the  button.

3 From the **Directories** menu, select the path ending with the text **\examples\Miscellaneous**.

4 Open the directory 'Tutorial,' then double-click on your Virtual Dataset named 'Mag_FFT_RTP_vds.ers' with your initials to load it.

The dialog box title changes to 'FFT- Reverse Fourier Transformation' to indicate that the input magnetic dataset is already in frequency domain space, and a reverse FFT transformation will be performed.

5 Next to the 'Output Dataset' field, click the button.

6 From the **Directories** menu, select the path ending with the text **\examples\Miscellaneous**.

7 Open the directory 'Tutorial,' then enter a name for the RTP dataset in the **Save As:** text field. Use your initials at the beginning, followed by the text 'Mag_FFT_RTP.' Separate each word with an underscore (_). For example, if your initials are "KA," type:

```
KA_Mag_FFT_RTP
```

8 Click **OK** in the **Output Dataset** dialog.

9 Click **OK** to start the transformation.

ER Mapper converts the frequency domain dataset back to the spatial domain, then displays a notification dialog when the process is complete.

10 Click **OK** in the small completion dialog, then click **Cancel** in the **FFT- Reverse Fourier Transformation** dialog to close it.

You have now created a new dataset in the spatial domain that has a Reduction to Pole transformation applied. Next you will display the RTP dataset in an algorithm.

Display the Reduced to Pole magnetic dataset

1 In the main menu window, click the **Edit Algorithm** button.

An image window and the **Algorithm window** appear.

2 In the **Algorithm window** dialog, click the button.

3 Raster Dataset dialog appears

4 From the **Directories** menu (in the **Raster Dataset** dialog), select the path ending with **\examples\Miscellaneous**.

5 Open the 'Tutorial' directory, then double-click on your dataset 'Mag_FFT_RTP.ers' with your initials to load it.

6 Click the **OK** button in the **Select a Dataset** dialog.

ER Mapper automatically creates a greyscale Pseudocolor algorithm and displays the RTP magnetic dataset you created using the Fourier Transforms. (If desired, you can open the Transform dialog and further enhance the contrast.)

Reduction to pole attempts improved spatial correlation, between magnetic anomalies and their sources, by giving the induced magnetization a vertical direction. This technique helps to obtain more precise geographic positioning of magnetic bodies.

7 In the main menu window, select **Close** from the **File** menu to close the image window.

4: Using the magnetics FFT image wizard

Objectives Learn how to use an image wizard to automate FFT processing for vertical continuation and reduction to the pole for magnetic datasets.

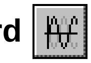
Note: Image wizards are created using ER Mapper's batch scripting language. You can also create your own wizards similar to this one to automate commonly used processing techniques. See the ER Mapper *Reference* and *About Release 5.5* manuals for complete information.

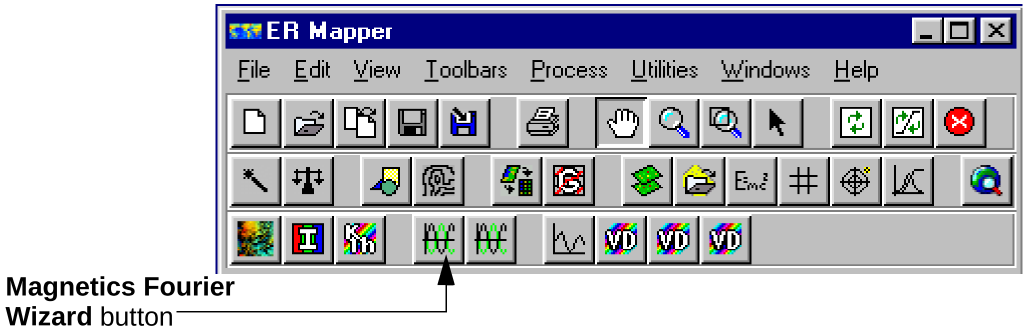
Display the Geophysics toolbar

1 In the main menu window, select **Geophysics** from the **Toolbars** menu.

A third row of toolbar buttons is added to the main menu. Most of these are wizards to automate creation of algorithms commonly used in processing of magnetic and gravity data.

Start the magnetics FFT image wizard

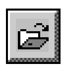
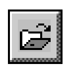
1 On the **Geophysics** toolbar, click the **Magnetics Fourier Wizard**  button.



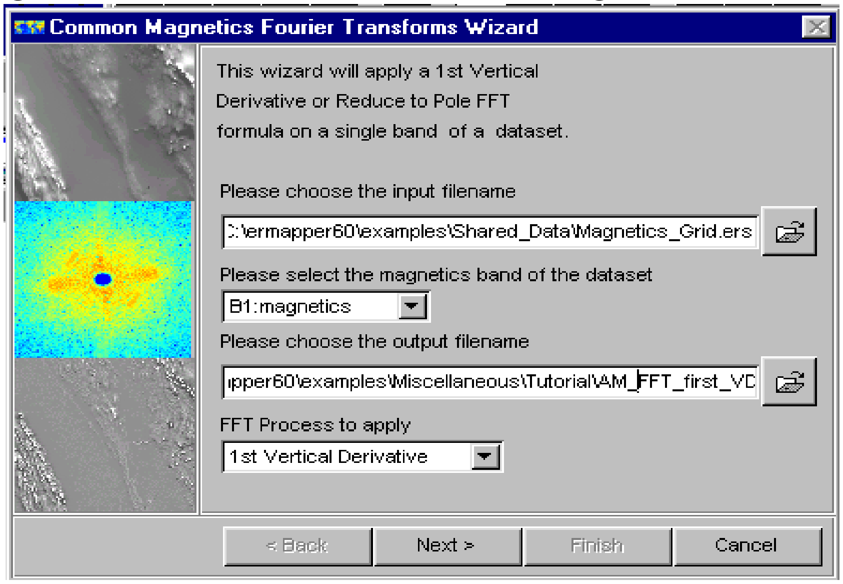
The **Common Magnetics Fourier Transforms Wizard** dialog opens. This dialog provides choices to guide you through the creation of common magnetics FFT processed images.

Choose dataset names and types of processing

1 Enter the following information in the dialog:

- **Input filename** - use the  button to select Magnetics_Grid.ers (in \examples\Miscellaneous\Shared_Data)
- **Band** - choose **B1:Magnetics**
- **Output filename** - use the  button, navigate to the directory \examples\Miscellaneous\Tutorial, then enter the filename **`FFT_first_VD`** preceded by your initials.
- **FFT process** - choose **1st Vertical Derivative**

The dialog contents should look similar to the following:

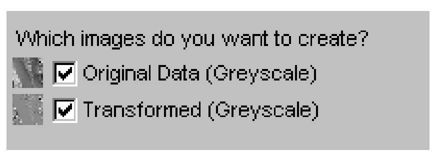


Choose the images and create the algorithms

1 Click the **Next>** button at the bottom of the dialog.

The next panel of the **Common Magnetics Fourier Transforms Wizard** dialog displays to let you choose the images that will be created.

2 Turn on both the ‘Original Data’ and ‘Transformed’ options.



This tells ER Mapper to display the original data in one image window, and the transformed 1st vertical derivative image in a second window so you can easily compare the two.

3 Click the **Finish** button at the bottom of the dialog.

ER Mapper begins the batch processing (this may take a few minutes), and then displays both images for comparison. The forward and reverse FFT operations you previously performed yourself were handled automatically by the image wizard. As you can see, using wizards can greatly speed and simplify processing, especially for fairly complex techniques such as FFTs.

4 Click **Close** in the **ER Mapper Batch** dialog.

5 In the main menu window, select **Geophysics** from the **Toolbars** menu.

The **Geophysics** toolbar buttons are hidden again.

Close all image windows and the Algorithm dialog

1 Close all image windows using the window system controls:

- For Windows, click the **Close** button in the upper-right window corner.
- For Unix systems, select **Close** or **Quit** from the window control menu in the upper-left corner (for systems with both options, select **Quit**).

2 Click **Close** in the **Algorithm** dialog to close it.

Only the ER Mapper main menu is now open.

What you learned...

After completing these exercises, you know how to perform the following tasks in ER Mapper:

- Use FFTs to transform a dataset into the frequency domain (forward FFT)
- Apply formulas to process/enhance the data in the frequency domain, including upward and downward continuation and reduce to pole (RTP) processing
- Transform the processed FFT dataset back into the spatial domain for display (reverse FFT)
- Use the Magnetics Fourier Wizard to automate common FFT enhancements for magnetic data

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Composing maps

This chapter explains how to use ER Mapper’s Page Setup and Map Composition tools to create top quality cartographic image maps that combine raster and vector data. You will learn about setting up a page size and extents for your map, how add map objects such as coordinate grids and scale bars, and considerations for printing to hardcopy devices.

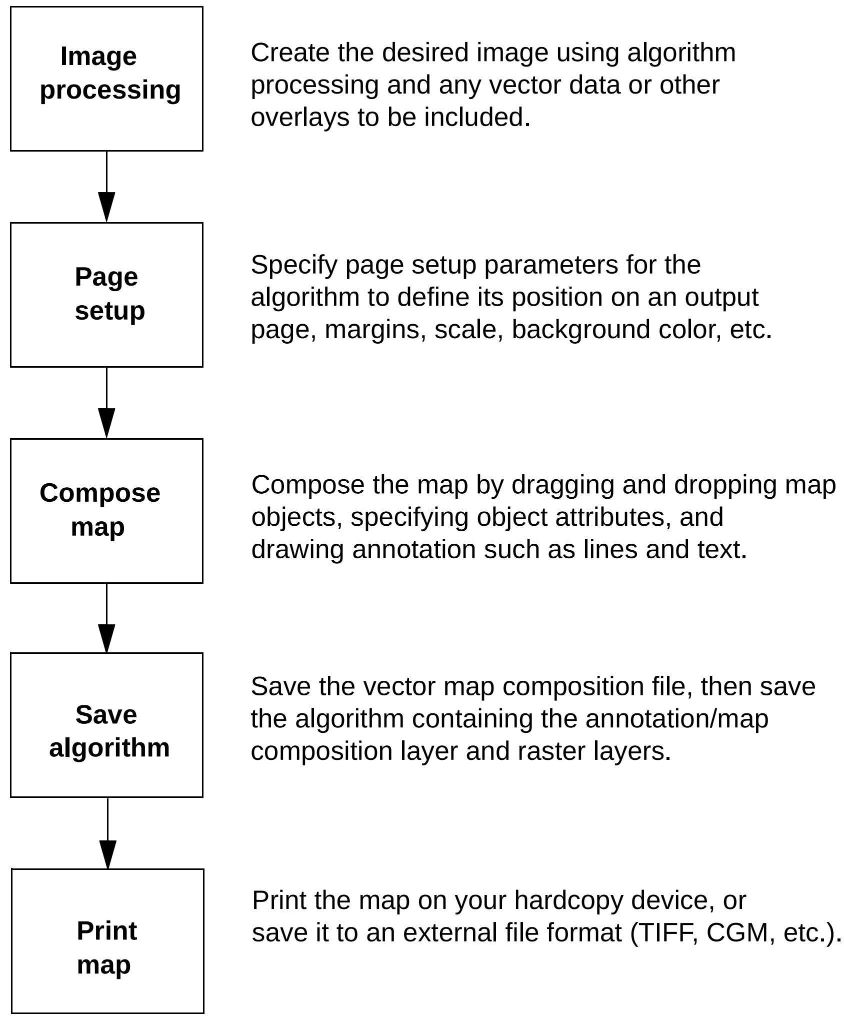
Note: The following exercise is a simplified example of creating a map. More details on some aspects are provided at the end of the chapter, and you are referred to the *ER Mapper User Guide* for more complete information.

About map composition

ER Mapper provides a complete set of map composition tools that let you easily transform images into top quality image maps. Your maps can include common map objects such as coordinate grids, scale bars, legends, north arrows, and more. You can use the annotation tools to draw lines, text, shaded polygons, and other vector objects for interpretations or illustrations. Your maps can also include other layers to add vector data from GIS systems, tabular data, or other external data.

ER Mapper’s map composition also has an open design and is user-extendable and customizable. You can add your own Postscript map objects to ER Mapper's map object library, such as company logos or north arrows, include external files and text, and many other types of data. You can also modify the default attributes of map objects and save them under your own unique names for later use.

The following diagram shows the general procedure for creating and printing a map in ER Mapper:



Hands-on exercises

These exercises give you practice setting up an algorithm to create a map, defining Page Setup parameters, and composing the map by adding map objects and other annotation.

What you will learn...

After completing these exercises, you will know how to perform these tasks in ER Mapper:

- Define Page Setup parameters for an algorithm
- Add an Annotation/Map Composition layer to an algorithm
- Place map objects (grids, scale bars, etc.) on your map

- Specify color and other attributes for map objects
- (optional) - Place an inset image onto a map

Before you begin... Before beginning these exercises, make sure all ER Mapper image windows are closed. Only the ER Mapper main menu should be open on the screen.

1: Setting up the page

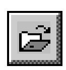
Objectives Learn to use ER Mapper's Page Setup options to define the position of an image on an output page, and specify other options such as map scaling parameters and background color. In this case, you will create a 1:100,000 scale regional magnetics map to be printed on a hardcopy device that uses an A0 size page.

Typically you are interested in two primary things when setting up a map:

- the size of the map
- the scale at which the map will be printed

The Page Setup options let you precisely control these aspects, and also set up other aspects such as the background color and size of margins.

Open the sample Magnetics colordrape algorithm

1 Click on the **Open**  toolbar button.

An image window and the **Open** dialog appear.

2 From the **Directories** menu, select the **\examples** path.

3 Open the 'Data_Types\Magnetics_And_Radiometrics' directory, then double-click on the algorithm 'Magnetics_Colordrape.alg' to display it.

This algorithm displays the Cape York magnetics TMI data draped over shaded magnetics to enhance structural features. This is the base image you will use to create your regional magnetics map.

Display the Annotation toolbar

1 From the **Toolbars** menu (on the main menu), select **Annotation**.

ER Mapper adds a third row of toolbar buttons to the main menu. These buttons are shortcuts to functions commonly used during annotation and map composition.

Specify Metric or Imperial units for page setup

1 On the main menu, select **Preferences** from the **Edit** menu.

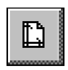
The **Preferences** dialog opens providing **General**, **3D Options**, and **Advanced** tab pages.

2 Select the **General** tab page (if needed), then select either **Metric** or **Imperial** from the 'Display Units' drop-down list (whichever you prefer).

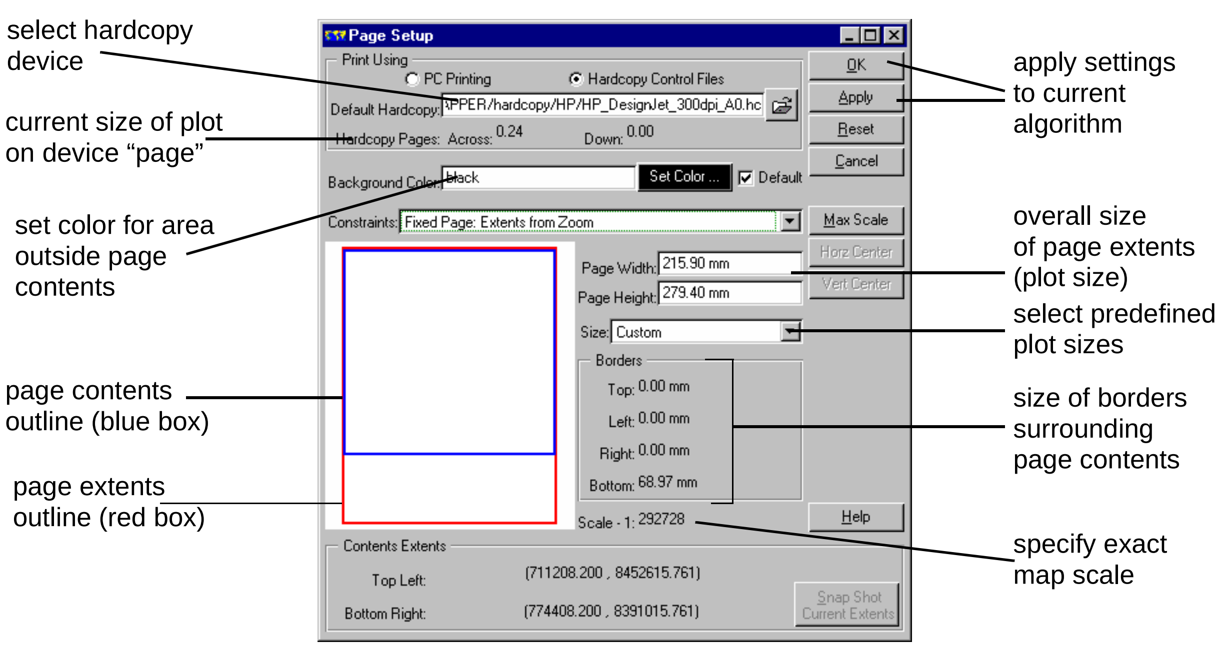
3 Click **Close** on the **Preferences** dialog to close it.

All values regarding the plot size, margin sizes and other page setup and printing parameters will be displayed in the measurement units you selected.

Open the Page Setup dialog box

1 From the **File** menu, select **Page Setup...** (or click the **Setup Algorithm Page Size**  button on the Annotation toolbar).

The **Page Setup** dialog box opens. This dialog provides controls for you to choose a default hardcopy device, position and scale your image on the output plot area, specify a background color and more.



The white area shows the size of the output print area in red (the "page extents"), and the size and position of the algorithm image within the print area in blue (the "contents extents").

Select the destination hardcopy device

It is helpful to select the hardcopy device you plan to print on before you create your map to get an idea of how large the plot will be when printed. (You can change this later is desired.)

1 If you are running ER Mapper on a PC, click the ‘Hardcopy Control Files’ option at the top of the **Page Setup** dialog.

2 On the **Page Setup** dialog, click the **Default Hardcopy**  file chooser button.

The **Default Hardcopy** dialog opens to let you select a printer.

3 From the **Directories** menu (on the **Default Hardcopy** dialog), select the path ending with the text **\hardcopy**.

A list of directories for categories of hardcopy devices and file formats appears.

4 Open the ‘HP’ directory, then double-click on the entry ‘HP_DesignJet_300dpi_A0.hc’ to select it.

This device is now selected as your default hardcopy device.

(The HP DesignJet is a large format color inkjet plotter. The entry you selected is designed to tell the printer to print at 300 dots per inch on an A0 size area of the device’s plotting surface, which is approximately 33 by 46 inches or 84 by 118 cm.)

Specify how the page or map contents can be scaled

The **Constraints** drop-down list lets you specify how map objects are scaled relative to the output page. Typically you need to decide which parameters are most important for your map: a fixed page size, fixed borders, or a fixed map scale.

1 From the **Constraints** drop-down list, select **Auto Vary:Page**.

The outlines representing the page extents (red) and page contents (in blue) become the same size, and the **Border** and **Scale** fields are now editable.

Auto Vary:Page mode tells ER Mapper that it can automatically change the size of the graphic’s extents (size) to accommodate any changes you make to the map scale or the size of borders surrounding the graphic. (Other **Constraints** options will automatically change plot borders or map scale if other parameters are changed.)

Specify the output map scale

1 In the **Scale - 1:** text field, enter the value **`100000`** then press Enter or Return to validate.

ER Mapper sets the size of the page contents (the physical size of the magnetics image on the page) to print at 1:100,000 map scale. Since you selected **Auto Vary:Page** mode, the Page Height and Width values are automatically adjusted to show the actual size of the plot at 1:100,000 scale.

Specify borders surrounding the page contents

Right now the page extents and page contents are the same size. Next you will add borders around the contents (the magnetics image) so you have space to add a title, scale bar, coordinate grid, and other items.

1 In the text fields under 'Border,' enter the following values for each field (press Enter or Return after each to validate):

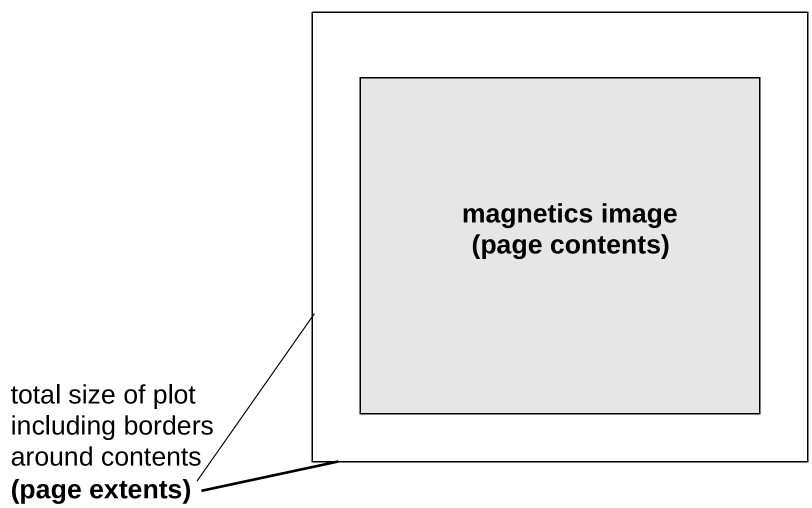
Top: **`80`** (mm) or **`3.15`** (inches)

Left: **`60`** (mm) or **`2.35`** (inches)

Right: **`60`** (mm) or **`2.35`** (inches)

Bottom: **`60`** (mm) or **`2.35`** (inches)

By adding borders, you increased the total plot size. The blue outline shows the relative size and position of the page contents in the new, larger page. (The physical size of the page contents has *not* changed, it will still print at 1:100,000 scale).



Tip: After setting the desired map scale and border values, notice that the Hardcopy Pages Across and Down fields show the percentage of device's the A0 size print area that the plot will occupy (72% of the width of an A0 page in this case). If your total plot size (page extents) is larger than the selected print area of your device, these values will be greater than one, indicating that ER Mapper would need to divide the plot and print each portion on a separate page in order to maintain your requested map size/scale. (The Down value is zero in this case because this is a roll paper plotter so it has no meaning.)

Set the background color to white

1 Select the text in the **Background Color** field, type **`white`**, and press Enter or Return to validate.

ER Mapper sets the page background color to white (the areas of the page surrounding the page contents). If you will be printing on a device that has a white background, it is often helpful to set the background color to white while you are composing the map to get a better idea of the final output. (You can use the **Set Color** button as well to choose any arbitrary background color. Black is often used for film output.)

Save the algorithm with the Page Setup parameters

1 Click **OK** on the **Page Setup** dialog to apply your settings and close it.

ER Mapper redisplays the image with your borders and white background added around the outside.

2 From the **File** menu, select **Save As...** to save the algorithm under a new name.

3 In the **Files of Type** field, select 'ER Mapper Algorithm (.alg).

4 From the **Directories** menu, select the path ending with the text **\examples**.

5 Double-click on the 'miscellaneous\tutorial' directory to open it.

6 In the **Save As:** text field, type your initials followed by the text **`magnetics_map`**. Separate each word with an underscore (_).

7 Click **OK** to save the algorithm, which now includes your page setup parameters.

2: Defining map objects

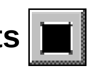
Objectives

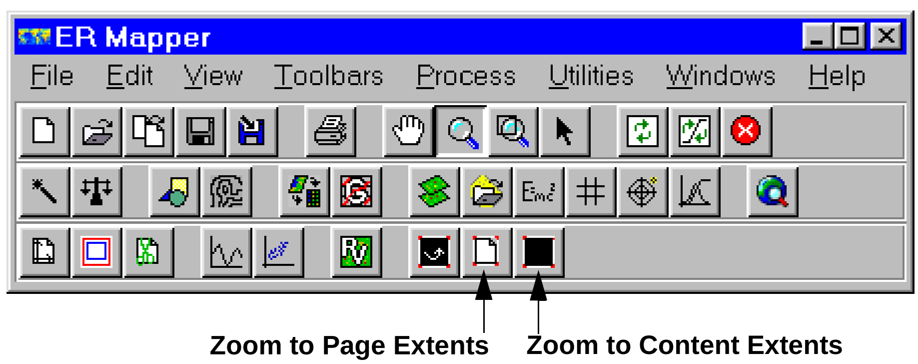
Learn to use ER Mapper’s Map Composition tools to place and modify map objects such as scale bars, coordinate grids, north arrows, and others.

Previously you learned to use ER Mapper’s vector annotation tools to draw line, polygon, and text objects (so you not repeat that now). Next you will use the Map Composition tools to automatically create complex color map objects that you can position and size on the page.

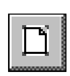
Zoom to the Contents and Page Extents

The Annotation toolbar provides two helpful buttons that let you quickly zoom to the contents extents (so you see only the image) or to the page extents (so you see the image plus any borders surrounding it).

1 On the Annotation toolbar, click the **Zoom to Contents Extents**  button.

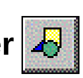


The image zooms in so that only the image (page contents) are displayed. This view is best for drawing interpretations on the image itself.

2 Click the **Zoom to Page Extents**  button

The image zooms out to the extents of the page defined for the algorithm. This view is best for adding map composition objects to your page as you will do next.

Add a vector layer for map annotation

1 On the **Common Functions** toolbar, click the **Annotate Vector Layer**  button.

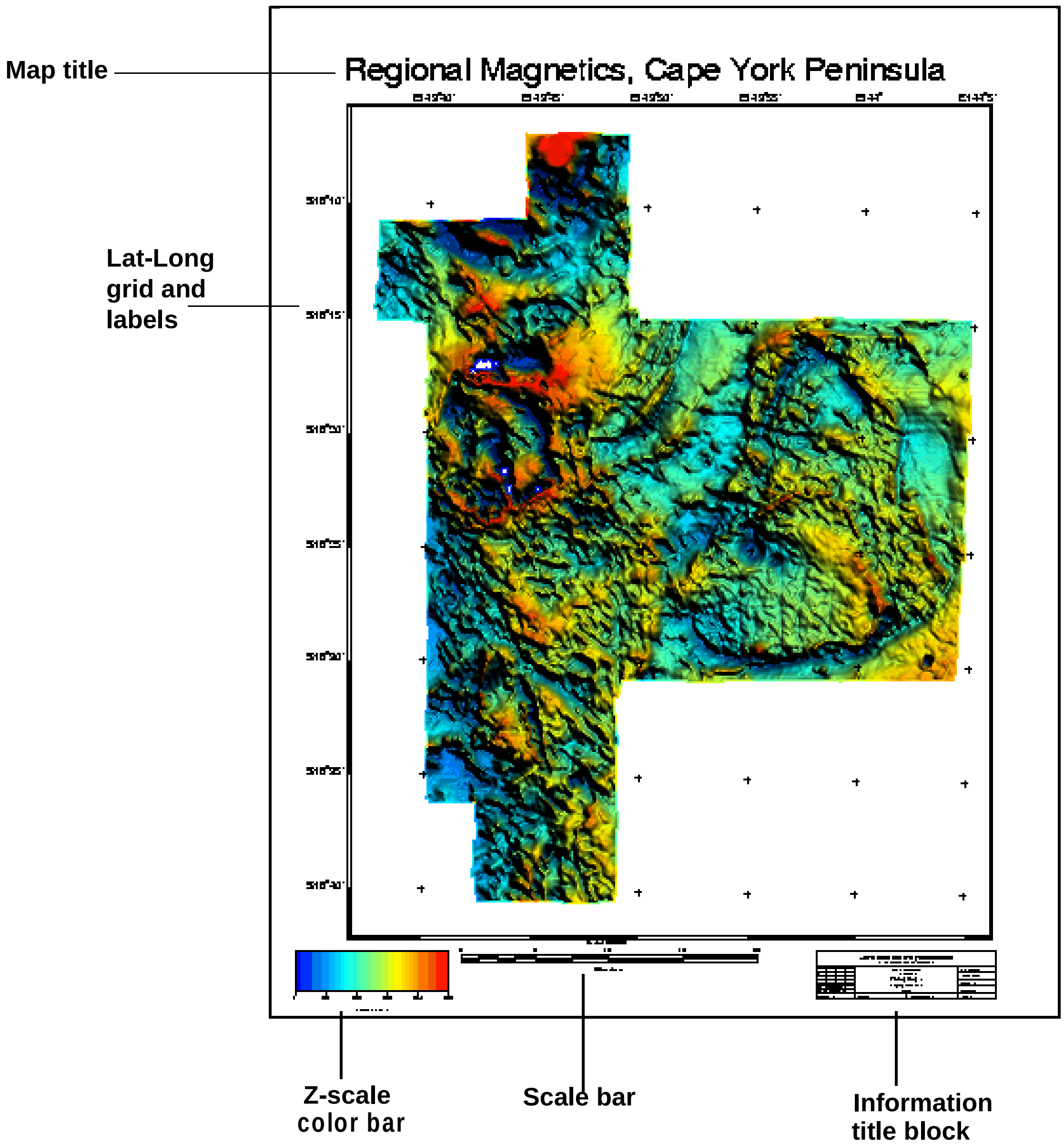
The **New Map Composition** dialog box opens to ask what type of annotation you want to create. You can create a vector file, raster regions (as you did in an earlier exercise), or an ARC/INFO GIS coverage file.

2 Make sure the **Vector File** option is selected, then click **OK** on the **New Map Composition** dialog.

ER Mapper opens the **Tools** dialog containing your drawing tools. Move the **Tools** dialog next to the right side of your image.

Layout the types and positions of map objects

Before creating your map, it is a good idea to determine which types of map objects you want to use, and their relative sizes and positions on the page. In this exercise, you will create a simple map with map objects similar to this one:



You will define these objects on your image window “page” in two ways:

- draw a bounding box and drag-and-drop the object into it; or
- drag-and-drop the object onto the page and resize the bounding box afterward

Refer back to the diagram above as a guide for the size and position of map objects you are asked to create in the next sections.

Add a scale bar centered below the image

1 On the **Tools** dialog, click on the **Map Rectangle**  button.

The **Map Object Select** and **Map Object Attributes** dialog boxes open (move them to the right side of the screen if needed). These dialogs let you drag and drop map objects onto your map page and specify attributes for the objects.

2 In the **Map Object Select** dialog, select **Scale_Bar** from the **Category** drop-down list.

A list of icons representing various types of scale bar map objects appears. The name of the object is shown in the status line at the bottom of the dialog when you point to it.

3 Point to the icon titled **Scale_Bar/Box**, then drag and drop it into a position centered below the color image.

The scale bar object is “dropped” onto the page and it draws a few seconds later. Notice that the scale bar is contained inside a box defined by selection handles at the corners. This is called the object *bounding box*, and it lets you control the size and position of the map object on the page.

The default attributes for the scale bar appear in the **Map Object Attributes** dialog box.

4 On the **Map Object Attributes** dialog, change the following attributes for your scale bar:

Start Scale at Zero: Yes

Number of Divisions: 4

Labels Font: Helvetica-Bold

Units Font: Helvetica-Bold

Notice that the scale bar object automatically updates as you change the attributes.

5 On the **Tools** dialog, click the **Select and Move/Resize Mode**  button.

The scale bar object displays with nine selection handles so you can move or resize it as desired.

6 Reposition the scale bar by dragging the object from the center, or resize the scale bar by dragging selection handles. (Try to center the scale bar below the image, see the sample map for an idea.)

Add an information title block in the lower-right

1. In the **Map Object Select** dialog, select **Title_Block** from the **Category** drop-down list.

   A list of icons representing various types of title blocks appears.

2. Point to the icon titled **Title_Block/Common**, then drag and drop it into the center of the image window.

   The object draws at a default size, and is already selected in Move/Resize mode. Now you need to resize and position it.

3. Drag the selection handles to resize the title block object until it is small enough to fit into the area in the lower right below the image, then drag the object by its center to that location.

4. On the main menu, click the **Zoom Box Tool** button, then drag a zoom box around the title block object.

   ER Mapper zooms in to show details of the title block object.

5. On the **Map Object Attributes** dialog, enter any desired information about your map (company name, project descriptions, etc.)

   The title block object automatically updates as you change the attributes.

6. When finished, click the **Zoom to Page Extents** button on the Annotation toolbar.

   ER Mapper zooms back out to the full map page extents.

Add a z-scale color bar in the lower-left

1. On the **Tools** dialog, click on the **Map Rectangle** button.

2. Drag a short, wide box below the image and left of the scale bar.

   A dotted bounding box appears.

3. On the **Tools** dialog, click the **Select and Move/Resize Mode** button–the box becomes selected (if it was not previously).

4. In the **Map Object Select** dialog, select **ZScale** from the **Category** drop-down list.

   A list of various types of z-scale color bar objects appears.

5. Point to the icon titled **ZScale/Algorithm_LUT** (in the top row), then drag and drop it *into* the selected bounding box you drew.

A z-scale color bar draws to fill the box. (Note that the box must be selected first before you can drop an object into it.)

Tip: As shown here, you can place map objects either by dragging them onto the page and then moving/resizing, or first draw a bounding box at the desired location and size and then dragging the object in to fill it.

6 On the main menu, click the **Zoom Box Tool** button, then drag a zoom box around the zscale object to zoom in on it.

7 On the **Map Object Attributes** dialog, change the following attributes for your z-scale color bar:

Color: black

Units: type the text **`TMI (nT)`** then press Enter or Return

Units point size: type the text **`20`** then press Enter or Return

You now have a z-scale color bar with labels to indicate how total magnetic (TMI) values are mapped to the lookup table colors used to display the image.

8 When finished, click the **Zoom to Page Extents** button on the Annotation toolbar.

ER Mapper zooms back out to the full map page extents.

You z-scale color bar, scale bar, and title block objects should now look similar in size and location to those on the example map shown previously. (Move or resize it if needed.)

Note: The "Algorithm_LUT" zscale always uses a linear scale for the labels and "warps" the distribution of colors to match the linear scale. Therefore, the zscale shows the true mapping of values to colors. Unless you are using a default linear transform in the color layer of you algorithm, the color spacing will not be evenly spaced the way it appears in the **Transform** dialog. (This algorithm has 99% clip transform, so the lowest and highest values are saturated to blue and red in the zscale.) Zscale color bars are "smart," so the colors change automatically if you were to change the lookup table or transform used in your algorithm.

Add a Latitude/Longitude grid to surround the image

1 In the **Map Object Select** dialog, select **Grid** from the **Category** drop-down list.

2 Point to the **Grid/LatLong** icon, drag it into the center of the image.

The grid map object draws in a default area of the page.

3 On the **Map Object Attributes** dialog, click the **Fit Grid** button.

ER Mapper automatically resizes and positions the bounding box for the grid to fit exactly to the extents of the page contents (image).

4 On the **Map Object Attributes** dialog, turn on the **Fast Preview** option.

The grid object is replaced by a dotted bounding box. **Fast Preview** tells ER Mapper *not* to update the object interactively as you change the attributes. (Since the grid is a complex object, you will change all the desired attributes first, then refresh the object all at once to save time.)

5 On the **Map Object Attributes** dialog, change the following attributes for your grid (use defaults for all others):

Grid Spacing X: 5minutes

Grid Spacing Y: 5minutes

Border Type: Check Ticks

Top Labels Orientation: Horizontal Right

6 On the **Map Object Attributes** dialog, turn off the **Fast Preview** option.

The grid map object is rendered using the attributes you defined. The "checks" option draws black and white map collar for the grid borders at the 5 minute spacing you specified.

Add a main title above the image

1 On the **Tools** dialog, click on the **Map Rectangle**  button.

2 Drag a short, wide box above the image for the title.

A dotted bounding box appears.

3 On the **Tools** dialog, click the **Select and Edit Points Mode**  button–the box become selected (if it was not previously).

4 In the **Map Object Select** dialog, select **Title** from the **Category** drop-down list.

5 Point to the icon titled **Title/Scaling**, drag it into the bounding box you defined above the image.

(The default title color is white, so no text is visible yet.)

6 On the **Map Object Attributes** dialog, change the following text and attributes for your title:

Color: black

Title: Regional Magnetics, Cape York Peninsula (press Enter or Return afterward)

The title object automatically updates as you change the attributes.

Adjust the size or position of any object

If desired, you can easily resize or position any map object by moving or resizing the bounding box that contains it.

1 In the **Tools** dialog, click the **Select and Move/Resize Mode**  button.

2 Click on any map object to select it (nine handles will appear), and drag the bounding box to reposition it or change the size by dragging a handle.

Save the annotation/map composition file to disk

1 On the **Tools** palette dialog, click the **Save File**  button.

The **Save Annotation File** dialog box opens.

2 From the **Directories** menu, select the path ending with the text **\examples**.

3 Open the 'miscellaneous\tutorial' directory.

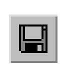
4 In the **Save As:** text field, enter your initials followed by the text **`map_composition`**. Separate each word with an underscore (_).

5 Click **OK** to save the annotation file to disk.

The annotation file contains all the objects you defined, and their attributes, position and size on the page.

6 Click **Close** on the **Tools** dialog to close all three annotation dialogs.

Save the algorithm to update the changes

1 On the main menu, click the **Save**  button.

2 When asked to confirm the overwrite, click **OK**.

Your algorithm can now be printed using the **Print**  toolbar button or by selecting **Print** from the **File** menu.

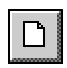
Note: It is important to remember to save your algorithm after defining map objects. Otherwise the annotation file will not be part of the algorithm when you go to print it later.

(Optional) 3: Adding an inset image

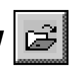
Objectives This exercise is optional. Learn to add an inset image to the map.

An inset image is a secondary image that shows an overview of the area shown by the main map, or a detailed area of a part of the main map. In this case, you will add an inset of a Landsat TM satellite image to show geological detail of the actively mined area of the regional magnetics map. You will also draw an inset box to indicate the Landsat image location on the regional map.

Open the sample Newcastle TM RGB=741 algorithm

1 On the main menu, click the **New**  button.

A new image window opens.

2 Click the **Open Algorithm into Image Window**  button.

3 From the **Directories** menu, select the **\examples** path.

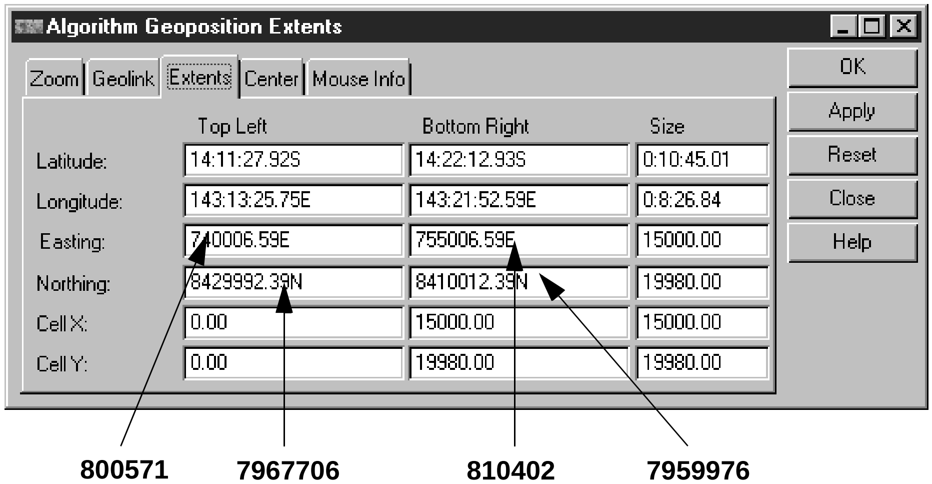
4 Open the ‘Applications\Mineral_Exploration’ directory, then double-click on the algorithm ‘Newcastle_TM_RGB_741.alg’ to display it.

This algorithm displays bands 7, 4 and 1 of a Newcastle TM image.

Zoom to the area of interest and save the algorithm

1 From the **View** menu, select **Geoposition...**.

2 On the **Algorithm Geoposition Extents** dialog, click the **Extents** option, then enter the following values in the Easting and Northing fields:



3 Click the **Apply** button to apply the new values.

ER Mapper zooms into the area (approximately centered on the mines).

Save the Newcastle TM inset image algorithm to disk

1 From the **File** menu (on the main menu), select **Save As...**.

2 From the **Directories** menu, select the **\examples** path.

3 Open the ‘miscellaneous\tutorial’ directory.

4 In the **Save As:** text field, type your initials followed by **`map_inset_image`**. Separate each word with an underscore (_).

5 Click **OK** to save the algorithm.

You will now add this algorithm as an inset image on your magnetics map. Leave the algorithm open on the screen for now.

Add a new annotation layer for the inset image

When creating more complex maps, it is helpful to group related items into separate annotation layers to make it easier to manipulate them and speed drawing.

1 On the main menu, select **Algorithm** from the **View** menu.

2 Activate the image window containing the magnetics map image.

3 In the **Algorithm** dialog, change the ‘Annotation Layer’ label to **`map composition`**, then right-click on the layer and select **Turn Off**.

4 On the **Common Functions** toolbar, click the **Annotate Vector Layer** button.

The **New Map Composition** dialog box opens.

5 Make sure the **Vector File** option is selected, then click **OK** on the **New Map Composition** dialog.

A second annotation layer is added to the algorithm, and the **Tools** dialog opens.

Geolink the map sheet window to the Landsat window

Next you will draw a box on the magnetics map to indicate the geographic extents of the Landsat inset image that will be added later. One easy way to do this is to geolink the magnetics map window to the Landsat window, so the magnetics image zooms to the same area as covered by the Landsat image.

1 On the **Algorithm Geoposition Extents** dialog, select the **Geolink** tab.

2 Activate the TM image window (click inside it).

3 On the **Algorithm Geoposition Extents** dialog, select the 'Window' option, then click **Apply**.

4 Activate the magnetics map image window (click inside it).

5 On the **Algorithm Geoposition Extents** dialog, select the 'Window' option, then click **Apply**.

The magnetics map image zooms to the same geographic extents as the Landsat image.

Close the Geoposition dialog and Landsat image window

1 Click **Close** on the **Algorithm Geoposition Extents** dialog.

2 Close the TM inset image window using the window system controls:

- For Windows, click the **Close** button in the upper-right window corner.

Draw a box around the current extents of the magnetics map

1 On the **Tools** dialog, click the **Rectangle** button.

2 Inside the magnetics map image, drag a box from the upper-left corner down to the lower-right corner.

The box should outline the entire displayed image.

3 If you need to adjust it, click the **Select and Move/Resize Mode** button and drag the corners to cover the entire image extents as needed.

4 Double-click the **Rectangle** button to open the **Line Style** dialog.

5 From the 'Width' drop-down menu, select **5.0**.

The line width for the box increase to 5 points to make it thicker.

6 Click **Close** on the **Line Style** dialog.

You now have an outline box indicating the exact position of the Landsat inset image you will add.

Tip: To get precise geographic positioning of the outline box, you can also click the **Edit Object Extents** button (on the **Tools** dialog), and enter the exact extents values. (These would be the same Eastings/Northings values you entered on the **Geoposition** dialog when zooming on the Landsat image.)

Zoom to the Page Extents to view the entire map page

1 On the Annotation toolbar (on the main menu), click the **Zoom to Page Extents** button.

The algorithm zooms out to the full map extents. (Your other map items do not appear because that annotation layer is turned off.)

Load the Landsat algorithm as a map object

1 On the **Tools** dialog, click on the **Map Rectangle** button.

The **Map Object Select** and **Map Object Attributes** dialog boxes open.

2 In the **Map Object Select** dialog, select **Algorithm** from the **Category** drop-down list.

3 Drag the single icon (the color Australia image) into the square area in the upper-right corner of the **Map Object Attributes** dialog.

The icon drops in and the default attributes of the algorithm map object appear in the **Map Object Attributes** dialog.

4 On the **Map Object Attributes** dialog, click the button next the 'Algorithm Name' field.

5 Open the ‘miscellaneous\tutorial’ directory, then double-click on the ‘map_inset_image.alg’ algorithm with your initials to load it.

(The icon in the **Map Object Attributes** dialog will not change.)

6 For ‘Border Color,’ choose **black**.

Place the Landsat algorithm on the map page

1 Drag the small color Australia image icon from the **Map Object Attributes** dialog to the upper-right area of the magnetics map image window.

The map object bounding box draws at the default size. It does not yet appear because **Fast Preview** is the default setting for algorithm map objects.

2 On the **Map Object Attributes** dialog, turn off **Fast Preview**.

After some internal processing, ER Mapper draws the Landsat algorithm inside the bounding box on the map image.

Note: Algorithms are fairly complex map objects that require some internal processing time before they are drawn on the screen. Therefore, **Fast Preview** is selected by default.

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3 Shape the bounding box as needed to best fit the image shape (you will need to make it slightly narrower).

4 On the **Map Object Attributes** dialog, turn on **Fast Preview** again.

The inset image changes back to a bounding box. (It is faster to preview the location of the image while drawing lines and text, then turn it on again when you want to view the final result.)

Draw lines to connect the two boxes

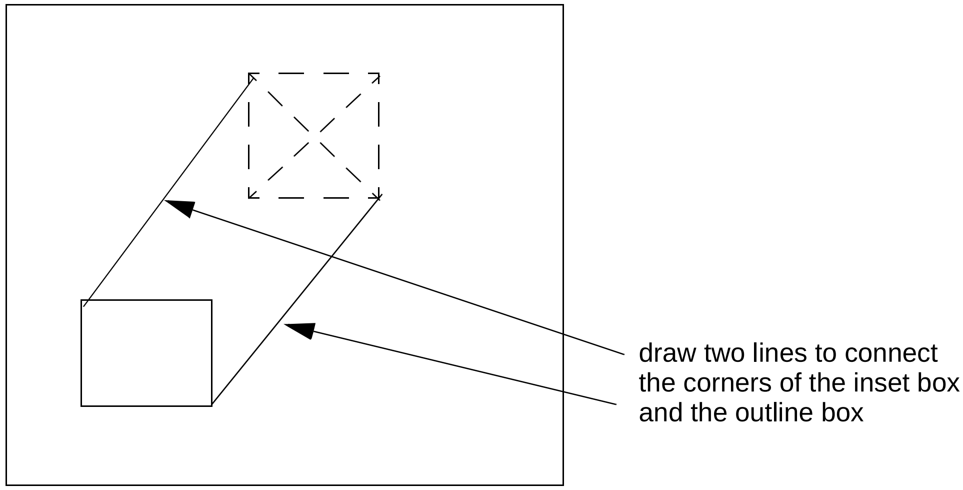
1 On the **Tools** dialog, *double-click* the **Polyline**  button.

The **Line Style** dialog box opens to let you choose attributes for your polylines.

2 Choose **3.0** from the **Width** drop-down list to increase the line width.

3 Click **Close** on the **Line Style** dialog to close it.

4 In the image, draw two lines to connect the lower-left corner of the inset and outline boxes, and the upper-right corners of the two boxes..



Your two lines should look similar to the diagram above.

Tip: To precisely position the line endings with the corners of the boxes, zoom into each area, select the line with the **Select and Edit Points Mode** button, then move the line end to align it exactly with the box corner.

Create a text title over the TM inset image

1 On the main menu, click the **Zoom Box Tool** button, then drag a box around the top of the inset box and the area above it.

2 On the **Tools** dialog, click the **Text Object** button.

3 In the map image window, drag a short, wide box over the inset image bounding box.

4 In the **Text Style** dialog, click in the **Text** field at the bottom, then type **`Newcastle TM RGB=741`**. Press Return or Enter to validate.

The text appears on the image as you type.

5 In the **Text Style** dialog box, select the following text attributes:

Size: 24.0

Font: Helvetica-Bold

6 If needed, click **Select and Move/Resize Mode** and adjust the position of the text string (do not resize it).

7 When finished, click **Close** on the **Text Style** dialog box.

8 Click the **Zoom to Page Extents** button on the Annotation toolbar.

ER Mapper zooms back out to the full map page extents.

Display the TM inset image again

1 In the Tool dialog, click **Select and Move/Resize Mode**, then click on the inset image bounding box to select it.

2 On the **Map Object Attributes** dialog, turn off **Fast Preview**.

After internal processing, ER Mapper displays the Landsat algorithm inside the bounding box on the map image.

Save the annotation/map composition file to disk

1 On the **Tools** palette dialog, click the **Save File** button.

2 Open the 'tutorial' directory.

3 In the **Save As:** field, type your initials followed by **`inset_image_overlay`**. Separate each word with an underscore (_).

4 Click the **OK** button to save the algorithm.

The annotation file contains algorithm map object, and the outline box, lines and text you drew.

5 Click **Close** on the **Tools** dialog to close all three annotation dialogs.

Display the entire algorithm

1 In the **Algorithm** dialog, turn on the 'map composition' layer.

Your algorithm displays with the map objects in both map layers.

Note: When you have more than one annotation layer, objects in the uppermost layer in the algorithm list will cover objects in lower annotation layers where there is overlap. You can simply change the order of the layers to put the objects in any layer on top.

Save the algorithm to update the changes

1 On the main menu, click the **Save** toolbar button.

2 When asked to confirm the overwrite, click **OK**.

Close the image window and Algorithm dialog

1 Close image window using the window system controls:

- For Windows, click the **Close** button in the upper-right window corner.

2 Click **Close** on the **Algorithm** dialog.

Only the ER Mapper main menu is now open.

Additional features of Map Composition

The preceding simple example covered only the basics of using ER Mapper's Map Composition, and following are some additional features. Refer to the chapter on creating maps in the *ER Mapper User Guide* for complete information.

- If you drag an object into a bounding box that already contains an object, the old object is replaced by the new one. This is an easy way to try several north arrows, for example.
- Objects that are dragged and dropped to replace a current object automatically inherit any common attributes from the previous object. For example, if you have a red north arrow in a bounding box and then drag in a scale bar object, the scale bar automatically inherits the red color (since both objects have the "Color" attribute in common).
- You can modify the default attributes of map objects and save them under your own names (using **Save As** on the **Map Object Attributes** dialog).
- You can draw other image processing algorithms you've created as map objects on the page (using the **Category: Algorithm** on the **Map Object Select** dialog). This is useful for drawing inset images that show an overview map, inset image, or other types of processing techniques or data of the same area.
- You can plot objects from external files like TIFF, EPS, or Targa (using the **Category: Image** on the **Map Object Select** dialog)
- You can import text directly from ASCII text files and plot it on your map page (using the **Category: Text** on the **Map Object Select** dialog)

Page Relative and Map Unit Relative map objects

The vector map objects you defined in this exercise have their position and size specified relative to the page, rather than to map units (such as Latitude Longitude). This allows you to create standard map sheets with objects that remain in a fixed size and position on the page, regardless of how the page is scaled or the extents of the datasets used in the page contents are changed.

You can also specify the position of map objects in geographic coordinate units. The position of each object is tied to a particular geographic location and map sheet size.

To specify a map object as map unit relative, turn off the **Page Relative** option on the **Map Object Attribute** dialog box. The page relative attribute can be assigned either before or after the object is dragged-and-dropped onto the page. See the *ER Mapper User Guide* for more information.

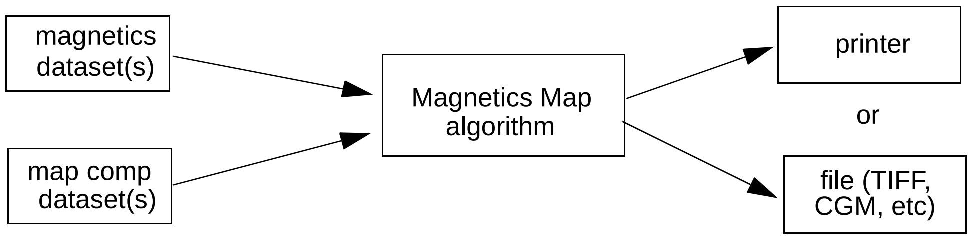
Page Setup Constraints options

In the previous simple example, you chose the ‘Auto Vary:Page’ option, although you could have chosen others as well. The Constraints options you can use are summarized briefly below:

- **Fixed Page:Extents from Zoom**–This is the default setting for all new algorithms, where the contents scale and borders are taken from the current zoom extents of the algorithm. For map making purposes, Extents from Zoom is not recommended because it can effect line thickness and text sizing.
- **Auto Vary:Page**–This mode allows ER Mapper to automatically vary the page size to account for any changes made to the map scale or page borders. This mode is easiest, for example, to print a map at an exact scale without regards to constraining it to a specific page size. If you want to place map objects outside the image (page contents) area, enter the desired border sizes to create space for them. (This is a good initial choice when you are prompted to change the mode when using the annotation tools.)
- **Auto Vary:Borders**–This mode allows ER Mapper to automatically vary the page borders to account for any changes made to the map scale or page size. This mode is most useful for printing at both an exact map scale and exact plot size.
- **Auto Vary:Scale**–This mode allows ER Mapper to automatically vary the map scale to account for any changes made to the page size or page borders. This mode is useful, for example, for printing an image at various sizes when exact map scale is not important.

Printing your map

When you want to print your final map algorithm (using **File/Print** or the **Print**  button), ER Mapper asks for the name of the algorithm. When the print operation begins, ER Mapper automatically locates, processes and renders all the datasets used in the algorithm into one final print image. In this case, your map algorithm uses two datasets–a magnetics grid raster dataset, and a vector map annotation dataset (which you created, and possibly another for the inset image).



Since the map algorithm is made of several layers (and datasets), you can easily change it. For example, to print the image without the map annotation, simply turn off that layer in the algorithm, resave it, and print it.

Tip: If you select **Print** while your algorithm is open on the screen, ER Mapper makes a temporary copy of the algorithm in memory and automatically loads it into the **Print** dialog. This lets you print the current algorithm, even if you have not re-saved it after you made changes or added vector layers.

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Hardcopy Printing

This chapter discusses ER Mapper hardcopy printing.

About Hardcopy Printing

ER Mapper requires algorithms to print out images as hardcopies. You can print an algorithm to a black and white, to a color printer/plotter, to a film writer or to graphic formats such as tiff files or to ER Mapper raster file (*.ers). The algorithm to print out as a hardcopy is normally a processed image, possibly with vector layers. Before printing it is important to correctly specify the page setup.

Note: Printing an algorithm that contains a large file or files with many vector layers or to a large paper size (e.g. A0 size) will require large printer memory. Normally printers have a memory of 1-2 MB. If the printer memory is insufficient use hard disk space as Virtual memory.

Note: Example: Setting hard disk space as Virtual memory. Click on the HP DesignJet 650C or 750C icon (or your printer icon) and the plotter dialog box appears. On the plotter dialog box click on the Printer menu and select Properties option from the dropdown list. On the Properties dialog box click on the Advanced tab and select **..In computer** option rather than **..In printer** option for Process document. It will set the hard disk space as Virtual memory.

Note: If the number of pages across and down are greater than 1 than that means that the page size setup for the algorithm is larger than the page size of the hard copy. In that case the algorithm will be printed in strips on more than one page. If you want to void printing the algorithm in strips choose **Fit page to output device** option. However the scale may have changed.

Strip printing

When you print there are two sizes to consider: the **algorithm** size is the size you want your entire map and border to be, while the **hardcopy** size is the size of the paper (or film etc.) of your hardcopy device. The two sizes do not need to be the same. If your algorithm size is larger than your hardcopy page size, ER Mapper automatically prints strips of output which can be pasted together.

The algorithm size is set using the **Page Setup** option from the drop down list of the **File** menu in the ER Mapper main menu window. It is important to set up the page before adding vectors to your image or printing, as it effects the image scale, text height, and vector thickness and dimensions. If the Page Setup has not been set, the default is to print just the image area, without borders.

Printing to graphics files

If you are not outputting to a hardcopy device but to a graphics file, you usually do not want to print strips. Select **Force Single Page** to create only one output file. If you want to strip print to file on disk, make sure to change the output device to send each strip to a different file so your strips do not overwrite each other.

Tip: When saving files during strip printing use "he-writetouniqfile D:\ERMAPPER60\examples\Miscellaneous\Tutorial\my_strip_printfile.tif". The different strips will then be saved under different file names as different serial numbers appended to the file name you have given.

Printing with 'Hardcopy Control Files' mode

Images are sent to hardcopy devices by a program called 'ermhe' ('hardcopy engine').

Output to a hardcopy device normally involves 3 programs: ermhe, a filter program, and an output program. The filter and output programs are specified in the hardcopy control files which are stored in the directory $ERMAPPER/ hardcopy. (See switches used in *.hc files. For example: -d 300 stands for 300DPI)

These three stages are shown below.

Hardcopy Engine ("ermhe" hardcopy definition file (*.hc)) --> Filter Program --> Output Program

The hardcopy engine

The hardcopy engine gets information about a hardcopy device by looking in a 'hardcopy control' file. The information in this file includes the page size, print density, and the filter and output programs to use when sending an image to the device.

The output from ermhe is piped into the filter program.

Filter Program

The filter program receives the data in hardcopy engine and converts it into the format required by the hardcopy device. The output from the filter program is then piped into the output program.

Tip: If you want to have your processed image saved as a tiff file in the "Filter program" type in Filter program = " hetotiff -d24 D:/ERMapper60\examples\Miscellaneous/tutorial/TEST_TIFF1.tif". Your tiff file TEST_TIFF1.tif will be saved in the D:\ERMapper60\examples\Miscellaneous\tutorial\ directory.

Output Program

The output program takes the hardcopy device specific format and simply sends it to the hardcopy device. Usually the output program is an operating system command: such as "lpr" command on UNIX.

lpr creates a printer job in a spooling area for subsequent printing as facilities become available. For example the hardcopy definition file Output Program command may be as follows:

Output Program = "lpr -Ppaintjet" OR Output Program = "lpr -Pdj650C" ("lpr" for UNIX only)

The -P option sends the output to the printer called PaintJet or DesignJet. For more information on the lpr options see "man lpr".

If your default printer is named something different, then change the output program line -P printer switch.

You can change the Output Program to save the plot to a file using "he_writetofile". An example of this might be:

Output Program = "he_writetofile D:\ERMapper60\examples\Miscellaneous\tutorial\DesignJet.erm"

OR Output Program = "he_writetofile \\server\dj650C" it will print it on DeskJet650C plotter (Works for both PC & UNIX)

Tip: "he_writetofile" can be used for both PC and UNIX. "lpr" for UNIX only

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The **he_writetouniqfile** script outputs each strip of the image to a different file on disk. This may be useful if you wish to print the images in a batch mode. The files are named time.ermhe, time being in the format "HH:MM:SS".

If the hardcopy output consists of only one strip then the following Output Program statement:

"he_writetofile /tmp/he.raw"

may be used. The he_writetofile script in this example outputs the strip of the image to the file "/tmp/he.raw" on disk. If there is more than one strip, then the last strip will overwrite all the previous strips.

Sometimes no output program is required, when the filter program sends its output directly to a file or device. If an output program is not required then specify "cat".

Output Program = "cat"

Hands-on exercises

These exercises show you how to print hardcopies using ‘PC Printing’ and ‘Hardcopy Control Files’ modes.

What you will learn...

After completing these exercises, you can perform the following tasks in ER Mapper:

- Set parameters for hardcopy printing with ‘PC Printing’ mode
- Set parameters for hardcopy printing with ‘Hardcopy Control Files’ mode
- Adjust color variation using Gamma Correction

Before you begin...

Before beginning these exercises, make sure all ER Mapper image windows are closed. Only the ER Mapper main menu should be open on the screen.

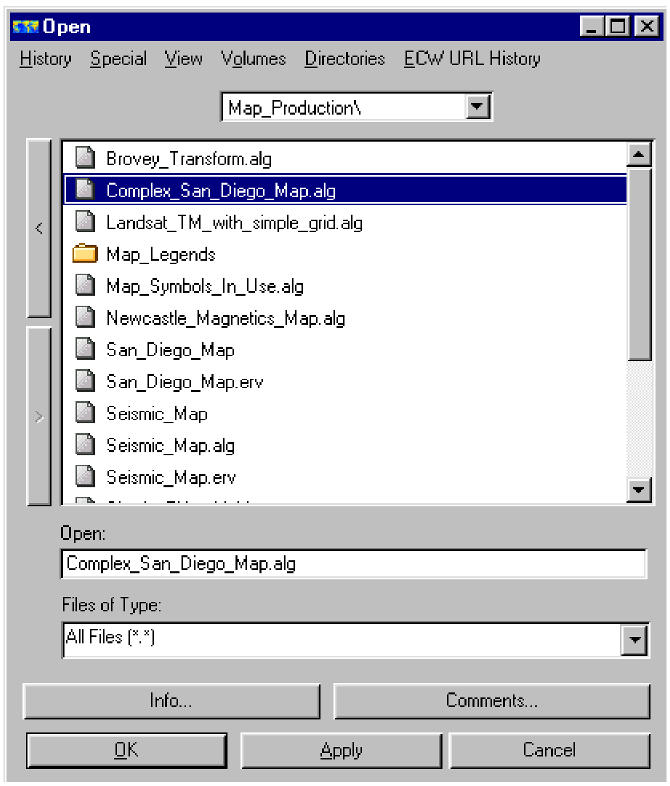
1: Printing with ‘PC Printing’ mode

Objectives Learn to print an algorithm using PC Printing option.

Load and display the Complex_San_Diego_Map algorithm

1 On the Standard toolbar, click on the **Open**  button.

The **Open** dialog box file chooser appears.



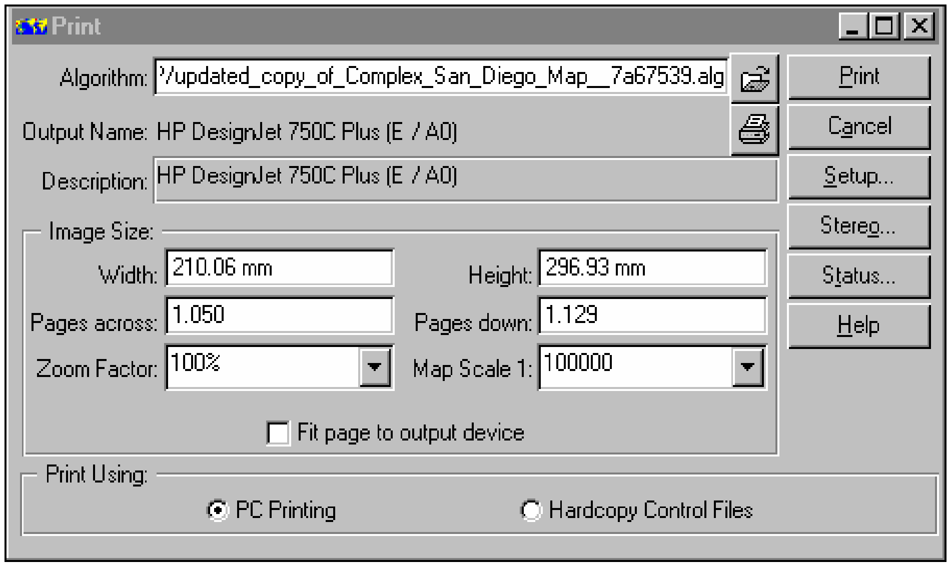
2 On the file chooser **Open** dialog box double click on **Complex_San_Diego_Map.alg** in the **\examples\Functions_And_Features\Map_Production** directory.

The image is the San Diego image processed using BROVEY transformation and vector layers added. The algorithm is a map composition example with page setup, index, title, histograms, grids, north arrow, color bar etc.

3 The composed map of San Diego image is displayed in the image window.

Printing the Complex_San_Diego_Map algorithm

1 On the **main menu** window click on the **Print**  button. The **Print** dialog box appears.



Note: The displayed algorithm is loaded as a temporary algorithm in the Algorithm text field on the **Print** dialog box.

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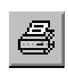
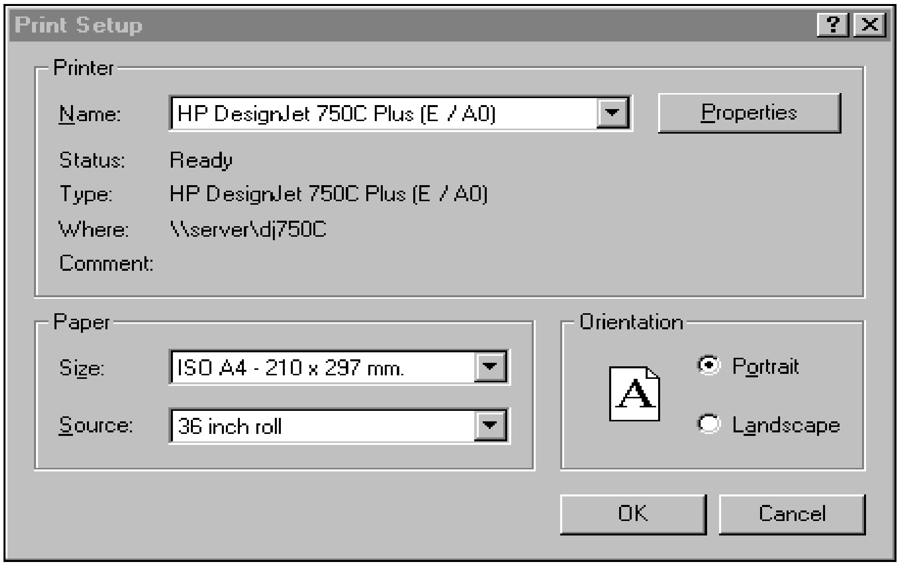
2 In the **Print** dialog box choose the **PC Printing** option**.**

3 Click the **Output Name** button  to select printer.

4 The **Print Setup** dialog box appears.

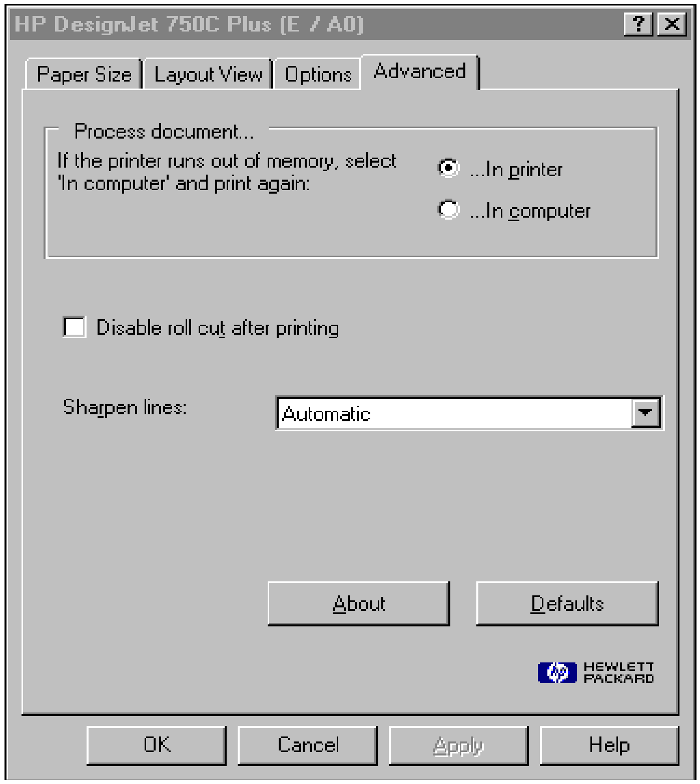


5 Select the printer from the dropdown list at **Name:** text field.

Note: HP DesignJet 750C Plus (E / A0) is selected in this case.

6 Click the Properties button on the Print Setup dialog.

7 The dialog box for the printer that you have chosen appears.



8 From the Paper Size tab page choose paper size (A4 in this case), Portrait or Landscape.

9 From the Advanced tab page select either **In Printer** memory or **In Computer** memory. To print an algorithm processed from a large dataset or to print a hardcopy onto a large paper size you will need a large memory. In such a case set the memory to **In Computer** memory so that hard disk space will be used as Virtual memory.

Note: You can also select Paper Size and Orientation on the Print Setup dialog.

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10 Click OK button on the DJ750C properties dialog box.

11 Click OK on the Print Setup dialog box.

Note: You can also setup the print parameters mentioned above from the **Setup** button on the **Print** dialog box.

Note: On the **Print** dialog box if you select the **Fit page to output device** option **Pages across:** and **Pages down:** are changed to 1.000 to fit the page. However, **Width:** and **Height:** are also changed to 186.04mm and 262.97mm respectively. The Zoom Factor reduces to 89%. The scale is also changed to 112910, instead of 100000, as setup previously in the algorithm.

Note: To maintain the scale that you setup in the algorithm choose a larger paper size (for example in this case choose A3). The size of the page setup for the image becomes smaller than the paper size of the hardcopy printout than Pages across: and Pages down will be 1:00 or smaller and the map will be printed out on one page. If the Pages across and Pages down are larger than 1:00 than the map will be printed out in strips.

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12 Click the **Print** button on the **Print** dialog box and start printing the Complex_San_Diego_Map algorithm.

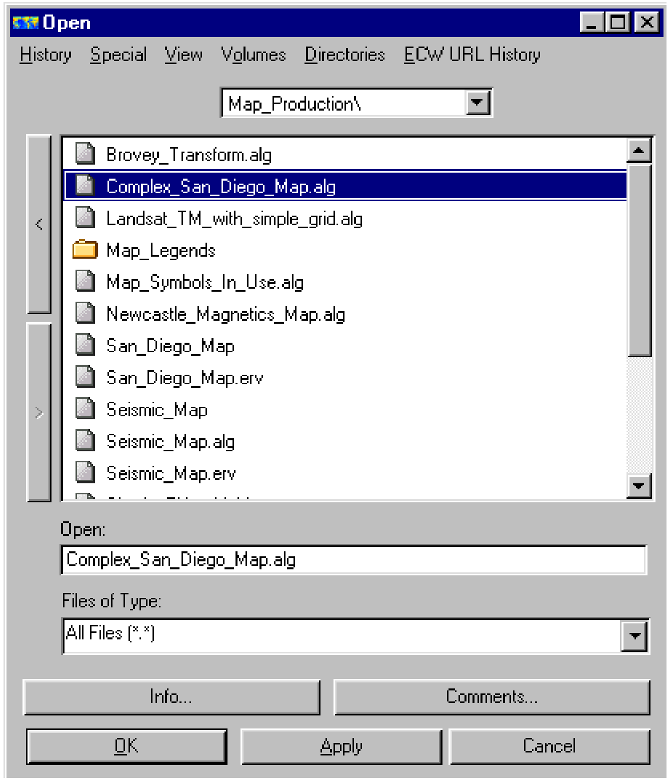
2: Printing with ‘Hardcopy Control Files’ mode

Objectives Load an already composed map (Complex_San_Diego_Map.alg) as a sample and learn how to print hardcopy using the Hardcopy Control Files option.

Load and display the Complex_San_Diego_Map algorithm

1 On the Standard toolbar, click on the **Open**  button.

The **Open** dialog box file chooser appears.



2 On the file chooser **Open** dialog box double click on **Complex_San_Diego_Map.alg** in the **\examples\Functions_And_Features\Map_Production** directory.

Note: The image is the San Diego image processed using BROVEY transformation and vector layers added. The algorithm is a map composition example with page setup, index, title, histograms, grids, north arrow, color bar etc.

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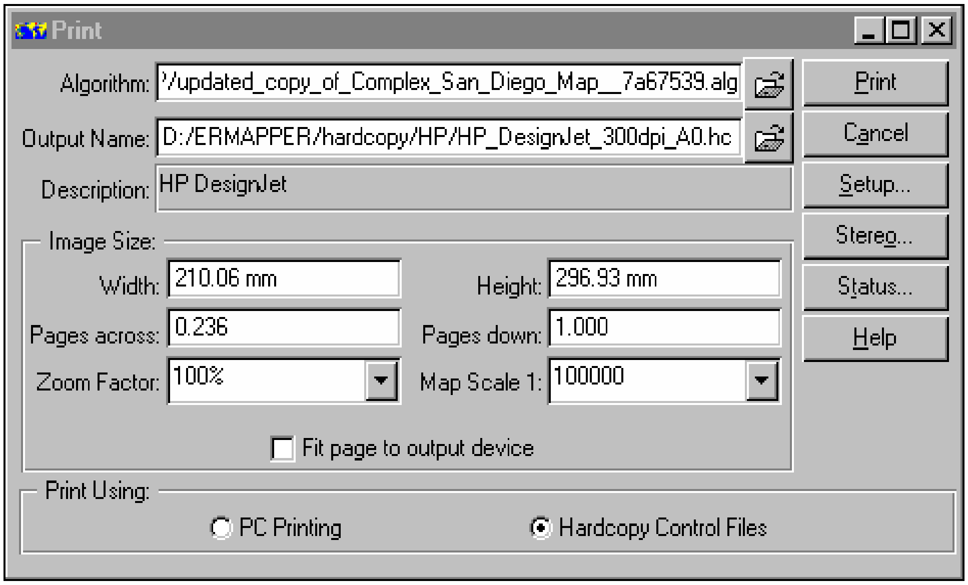
3 The composed map of San Diego image is displayed in the image window.

Printing the Complex_San_Diego_Map algorithm

1 On the **main menu** window click on the **Print**  button. The **Print** dialog box appears.



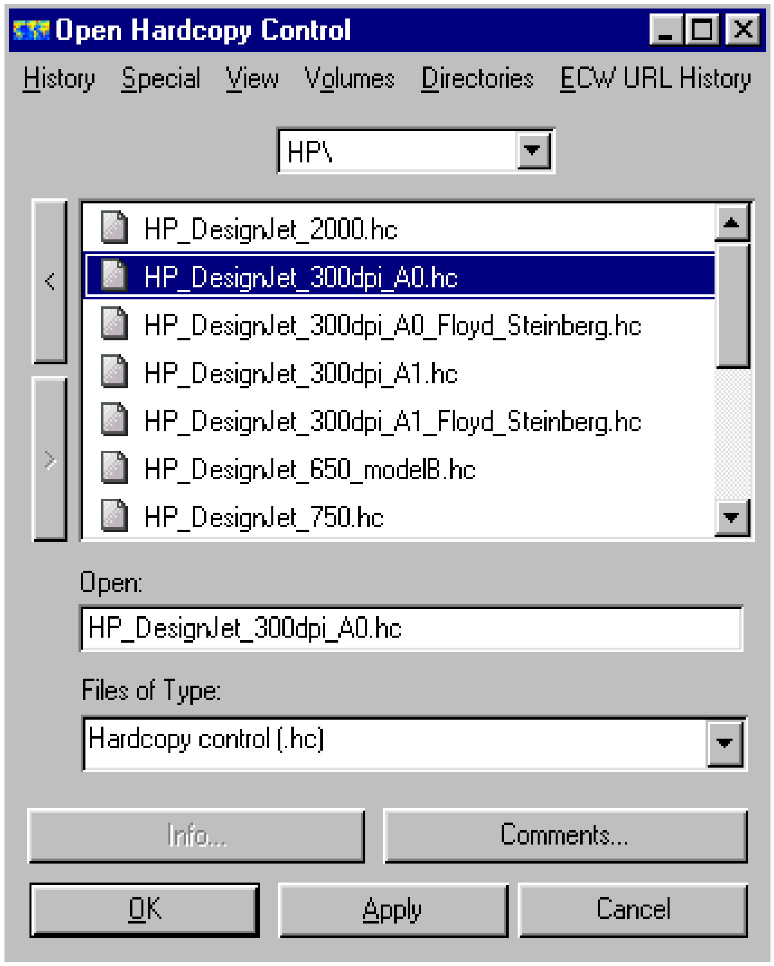
Note: The displayed algorithm is loaded as a temporary algorithm in the Algorithm text field on the **Print** dialog box.

---

2 In the **Print** dialog box choose the **Hardcopy Control File** option**.**

3 Click the load **Hardcopy Control File** button  for the Hardcopy Control file to be loaded in the **Output Name:** text field.

4 The **Open Hardcopy Control** dialog box appears.

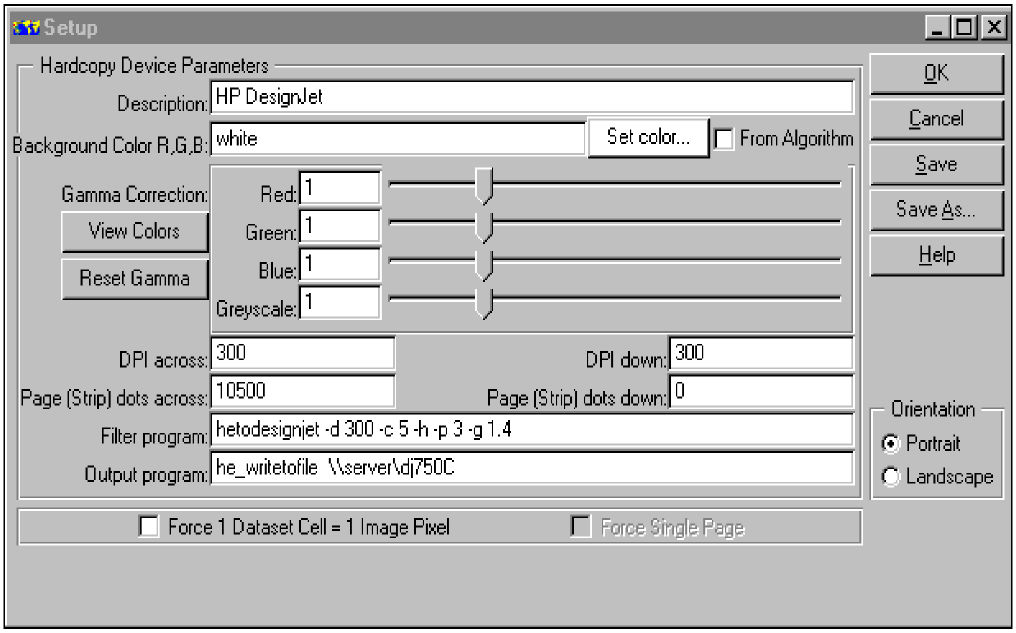


5 Choose the appropriate hardcopy control file from the **\hardcopy** directory. If your plotter is a Hewlett-Packard (HP) plotter then choose the appropriate hardcopy control file from the **\hardcopy\HP** directory. In this exercise the **HP_DesignJet_300dpi_A0.hc** hardcopy control file is chosen from the **\hardcopy\HP** directory and loaded in the **Output Name:** text field.

6 After choosing the appropriate hardcopy control file, click the **OK** button on the **Open Hardcopy Control** dialog box and load the file in the **Output Name:** text field.

7 Click the **Setup** button on the **Print** dialog box.

8 The **Setup** dialog box appears.



9 On the **Setup** dialog box, in the **Output Program** text field, delete **LPT1:** and type in your plotter directory path and name. For example in this exercise the **“he_writetofile LPT1:**” has been changed to “**he_writetofile \\server\dj750C**” where dj750C stands for DeskJet 750C. The Complex_San_Diego_Map algorithm will be printed out from the DeskJet 750C plotter.

Note: To check the functions of the switches used in the HC_DesignJet_300dpi_A0.hc hardcopy file read the $ERMAPPER\hardcopy\Hp\HC_DesignJet_300dpi_A0.hc file in a text editor.

---

10 On the **Setup** dialog box, set the page size for printing out the image by adjusting the **Page (Strip) dots across:.** For example, in this exercise the **Page (Strip) dots across** has been chosen to be 2000. After typing the desired **Page (Strip) dots across**, click **OK** button on the **Setup** dialog box.

11 On the **Print** dialog box select the **Fit page to output device** option.

Note: Notice that **Pages across:** and **Pages down:** are changed to 1.000 to fit the page. **Width:** and **Height:** are also changed to 169.33mm. You can adjust the page size by adjusting the **Page (Strip) dots across:** on the **Setup** dialog box.

---

12 Click the **Print** button on the **Print** dialog box and start printing the Complex_San_Diego_Map algorithm.

3: Testing print color (Gamma Correction)

Objectives Load an example color pattern to test the print color.

Some printers have a color bias. To compensate for this you can adjust the red, green and blue components of the printed image. These default to the values stored in the hardcopy control file, usually 1.

To test your print color, print the test algorithm color wheel in the ‘Example_Test_Patterns' directory and compare the printed output with the color wheel displayed on the screen.

Greyscale adjustments can also be made. This adjusts the brightness of the image by moving the RGB components together.

Load and display the rgbcmyk_bands algorithm

1 On the Standard toolbar, click on the **Open** button.

The **Open** dialog box file chooser appears.

2 On the file chooser **Open** dialog box double click on **rgbcmyk_bands.alg** in the **\examples\Miscellaneous\Test_Patterns** directory.

3 The color test pattern is displayed in the image window.

Printing the rgbcmyk_bands algorithm

1 On the **main menu** window click on the **Print** button. The **Print** dialog box appears.

2 In the **Print** dialog box choose the **Hardcopy Control File** option**.**

3 Click the load **Hardcopy Control File** button for the Hardcopy Control file to be loaded in the **Output Name:** text field.

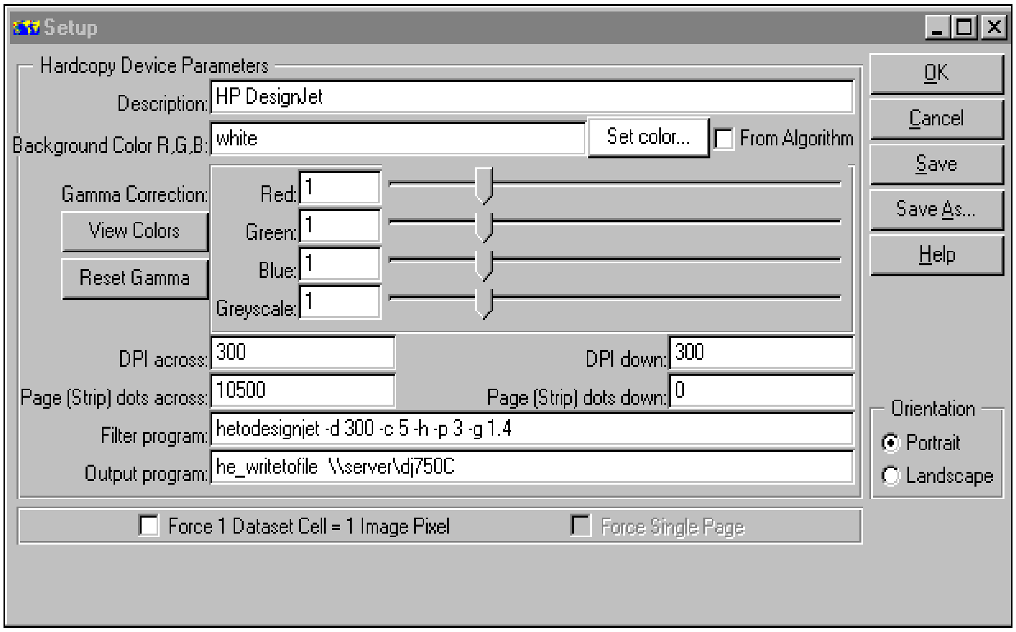
4 The **Open Hardcopy Control** dialog box appears.

5 Choose the appropriate hardcopy control file from the **\hardcopy** directory. If your plotter is a Hewlett-Packard (HP) plotter then choose the appropriate hardcopy control file from the **\hardcopy\HP** directory. In this exercise the **HP_DesignJet_300dpi_A0.hc** hardcopy control file is chosen from the **\hardcopy\HP** directory and loaded in the **Output Name:** text field.

6 After choosing the appropriate hardcopy control file, click the **OK** button on the **Open Hardcopy Control** dialog box and load the file in the **Output Name:** text field.

7 Click the **Setup** button on the **Print** dialog box.

8 The **Setup** dialog box appears.



9 On the **Setup** dialog box, in the **Output Program** text field, delete **LPT1:** and type in your plotter directory path and name. For example in this exercise the **"he_writetofile LPT1:**" has been changed to "**he_writetofile \\server\dj750C**" where dj750C stands for DeskJet 750C. The rgbcmyk_bands algorithm will be printed out from the DeskJet 750C plotter.

10 Take the Gamma Correction as default which is all Red, Green and Blue set to 1.

Note: This is a test print to check print color. So output page size is not important. On the **Print** dialog box do not select the **Fit page to output device** option. It has only 256 lines and 256 columns and the file size is less than 0.2MB, the Pages across is well below 1 and it will print out only in a portion of the A0 paper size.

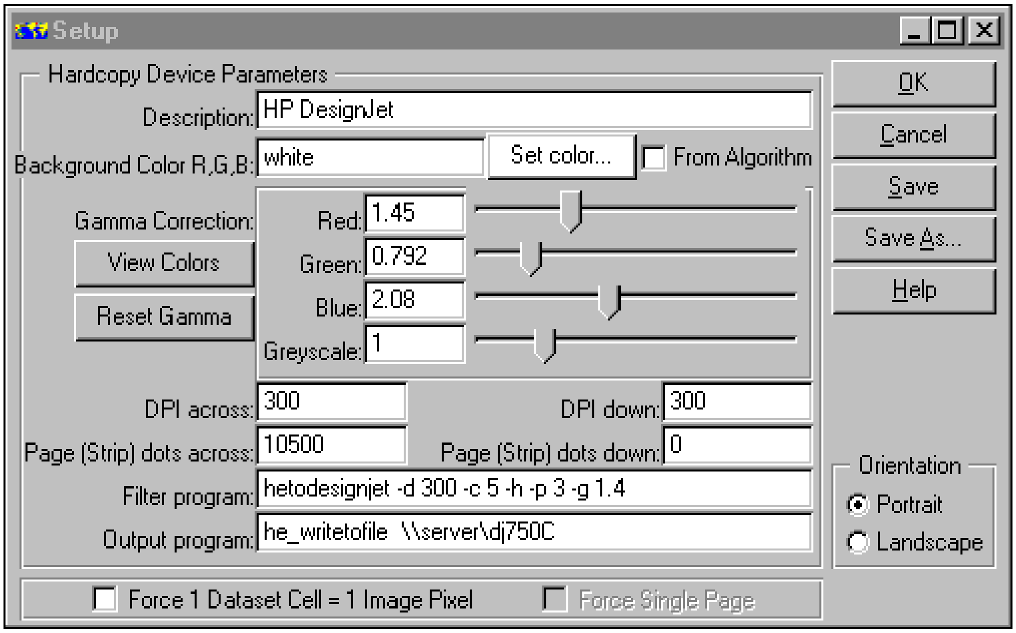
---

11 Click the **Print** button on the **Print** dialog box and start printing the rgbcmyk_bands algorithm.

12 Compare the color in the print out and the color on the screen.

Adjusting the color using Gamma Correction

1 If there is any color variation adjust the **Gamma Correction** in the **Setup** dialog box and print the rgbcmyk_bands.alg again.



2 In the **Setup** dialog box click on the **View Colors** button.

3 Colors dialog box appears.

4 In the Setup dialog box increase or decrease the Red, Green and Blue colors and see the color changes in the **Colors** dialog box.

Note: You can adjust th greyscale by increasing or decreasing Red, Green and Blue simultaneously.

---

5 Click the **Print** button on the **Print** dialog box and start printing the rgbcmyk_bands algorithm.

Compare the color in the print out and the color on the screen.

Close all image windows and dialog boxes

1 Close all image windows using the window system controls:

- For Windows, select **Close** from the window control-menu.
- For Unix systems, press right mouse button on the window title bar, and select **Close** or **Quit** (for systems with both options, select **Quit**).

2 Click **Close** on the **Algorithm** window to close it.

Only the ER Mapper main menu should be open on the screen.

What you learned

After completing these exercises, you know how to perform the following tasks in ER Mapper:

- Set parameters for hardcopy printing with ‘PC Printing’ mode
- Set parameters for hardcopy printing with ‘Hardcopy Control Files’ mode
- Adjust color variation using Gamma Correction

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Radiometric Classes Integration

This chapter shows you how to integrate Radiometric classes created from different techniques such as classification, ratioing and density slicing.

About Radiometric classes

In interpreting radiometric data it is important to have some knowledge on the **distribution of radioelements in rocks** and the **distribution of radioelements in soils** of the area of interest. Providing that the necessary corrections such as **Dead time correction, Energy drift correction, Aircraft and cosmic background correction, Radon background correction, Channel interaction correction, Height correction, Background radioelements concentration correction, Levelling and Error propagation correction** are made on radiometric data you can classify, perform band ratio and density slice the radiometric data to map radiometric classes. Since there is a wide range of radioelements values within any given rock types there is no global classification for rock types based on radioelements content. However, within a small region, different rock types can often be identified on the basis of the relative concentration of radioelements. Regolith mapping using radiometrics is essentially correlation between radioelements and the groundtruthed geology of the area of investigation and extension to unknown areas with similar signatures. You should be careful of whether the radiometric signatures are true representation of the underlying geology especially if the soil is not in situ but have been transported from distant sources.

Hands-on exercises

These exercises show you how to classify radiometric data, identify high anomaly classes of individual radioelement, ratioing and integrating the radiometric classes..

What you will learn...

After completing these exercises, you can perform the following tasks in ER Mapper:

- Classify radiometric data
- Highlighting individual K, Th, U radioelements through ratioing
- Integrating radiometric classes

Before you begin...

Before beginning these exercises, make sure all ER Mapper image windows are closed. Only the ER Mapper main menu should be open on the screen.

1: Defining radiometric classes

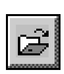
Objectives

Learn to classify radiometric data, ratio and density slice and classify K, Th and U components of a radiometric dataset.

Unsupervised classification of Radiometric dataset

1 From the **Process** menu, select **Classification**, then select **ISOCLASS Unsupervised Classification**.

The **Unsupervised Classification** dialog box appears.

2 Click the **Input Dataset**  chooser button.

3 From the **Directories** menu in the **Open Dataset** dialog, select the path ending with the text **\examples**.

4 Open the ‘Shared_Data’ directory, then double-click on the dataset named ‘Newcastle_Radiometrics.ers’ to load it.

Note: Select **All** for **Bands to use** and use all four bands; Total_Count_cps, Potassium_cps, Thorium_cps and Uranium_cps of the Newcastle_Magnetics.ers dataset.

---

5 Click the **Output Dataset**  chooser button.

6 From the **Directories** menu, select the path ending with the text **\examples\Miscellaneous**.

7 Double-click on the ‘Tutorial’ directory to open it.

8 In the **Save As** field, type a name using your initials at the beginning followed by the text ‘10_class_Radiometrics_ISOCLASS,’ and separate each word with an underscore (_). For example, if your initials are “DH,” type in the name:

```
DH_10_class_Radiometrics_ISOCLASS
```

9 Click **OK** or **Save** to validate the name and close the file chooser dialog.

10 In the **Maximum number of classes** field, enter the value **`10`** and press the Return or Enter key.

11 Click **OK** in the **Unsupervised Classification** dialog to start the clustering process.

12 When the dialog appears indicating successful completion, click **OK**.

13 Click **Close** in the **Processing Status** dialog, and click **Cancel** in the **Unsupervised Classification** dialog.

14 From the **Process** menu, select **Classification**, then select **Edit Class/ Region Color and Name...**.

15 The **Edit Class/Region Detail** dialog box appears.

16 In the **Name** field for class 1 in the **Edit Class/Region Details** dialog, select the text ‘1: unlabelled,’ and type in **`High Uranium`**.

17 Click the **Set color...** button for class 1 to open the color chooser.

18 Choose blue color, then click **OK** to close the dialog.

19 Click **Save** in the **Edit Class/Region Details** dialog to save the color change.

20 Similarly if you know the classes then type in appropriate names and assign colors for each of the class.

Create a K/Th ratio image

1 Click the **Edit Algorithm** button in the main menu window.

ER Mapper opens a new image window and the **Algorithm** dialog.

2 In the Algorithm dialog, click the **Load Dataset** button.

3 From the **Directories** menu, select the path ending with the text **\examples**.

4 Select **ER Mapper Raster Image (.ers)** from the “Files of Type” dropdown list in the **Raster Dataset** dialog.

5 Open the ‘Shared_Data’ directory, then double-click on the dataset named ‘Newcastle_Radiometrics.ers’ to load it.

Band 1 (B1:Total_Count_cps) of the dataset is loaded into the Pseudo Layer.

6 Click on the Edit Formula button in the Algorithm window.

7 Formula Editor dialog appears.

8 In the **Formula Editor** dialog type in “ (i1 - rmin(,r1,i1))/(i2)” in the generic formula window area.

9 Select INPUT1: (i1) to be Potassium_cps and INPUT2: (i2) to be Thorium_cps in the relation window area.

Note: i1 = is K band; rmin(,r1,i1) = the minimum value for a particular band within a region. Syntax:RMIN(dataset, region, band). The Dark Pixel Correction formula (i1 - rmin(, r1, i1) is applied to the K band to adjust the dynamic range starting from zero (0). The dynamic range of Th band is all positive hence the formula is not applied.

---

10 Click the **Apply changes** button in the **Formula Editor** dialog.

11 Click the **99% Contrast Enhancement** button in the main menu (or **Algorithm** dialog).

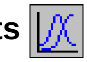
12 The ratio (K - K min) / (Th) image is displayed.

13 In the process diagram, click the pre-formula **Edit Filter (Kernel)** button. (Be sure to choose the button right of the **Formula** button.)

14 In the **Filter** dialog, click the **Filter filename** chooser button.

15 From the **Directories** menu, select the path ending with the text **\kernel**.

16 In the directory ‘filters_ranking,’ load the filter ‘median_5x5.ker.’

17 In the **Algorithm** window click the **Edit Transform Limits**  button.

18 The **Transform** window appears.

19 In the **Transform** window manually adjust the X-axis to find the appropriate threshold for high K/Th anomalous areas (about 5 (vertical)).

20 Click **Close** in the **Filter** dialog to close it.

21 Delete the transform of the ratio image.

Note: It is necessary to delete the transform so that ratioed image information, will be maintained and not scaled or clipped.

---

22 From the **File** menu, select **Save as ...**.

23 In the **Files of Type:** field, select “ER Mapper Virtual Dataset (.ers)”

24 From the **Directories** menu, select the path ending with the text **\examples\Miscellaneous**.

25 Double-click on the directory named ‘Tutorial’ to open it.

26 In the **Save As:** text field, type a name using your initials at the beginning, followed by the text ‘K_by_Th_VDS,’ and separate each word with an underscore (_). For example, if your initials are "CJ," type in the name:

```
CJ_K_by_Th_VDS
```

27 Click **OK** to save the Virtual Dataset.

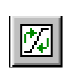
Create a Th/(Th+K+U) ratio image

1 Follow the procedure to create K/Th ratio image mentioned above and create a Th/(Th+K+U) ratio image.

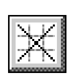
2 In the **Formula Editor** dialog type in “ (i1)/((i1)+(i2 - rmin(,r1,i2))+(i3 - rmin(,r1,i3)))” in the generic formula window area.

3 Select INPUT1: (i1) to be Thorium_cps INPUT2: (i2) to be Potassium_cps and INPUT3: (i3) to be Uranium_cps in the relation window area.

4 Click the **Apply changes** button in the **Formula Editor** dialog.

5 Click the **99% Contrast Enhancement**  button in the main menu (or **Algorithm** dialog).

6 The ratio (Th) / ((Th)+(K - Kmin)+(U - Umin)) image is displayed.

7 Through the **Edit Filter (Kernel)**  apply the ‘median_5x5.ker.’ filter and smooth the image.

8 From the Transform window manually adjust the X-axis to find the appropriate threshold for high Th anomalous areas (about 0.3 (vertical)).

9 Delete the transform of the ratio image.

10 From the **File** menu, select **Save as ...**.

11 In the **Files of Type:** field, select “ER Mapper Virtual Dataset (.ers)”

12 From the **Directories** menu, select the path ending with the text **\examples\Miscellaneous**.

13 Double-click on the directory named ‘Tutorial’ to open it.

14 In the **Save As:** text field, type a name using your initials at the beginning, followed by the text ‘Th_by_KThU_VDS,’ and separate each word with an underscore (_). For example, if your initials are "CJ," type in the name:

```
CJ_Th_by_KThU_VDS
```

15 Click **OK** to save the Virtual Dataset.

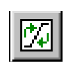
Create a U/(U+Th+K) ratio image

1 Follow the procedure to create Th/(Th+K+U) ratio image mentioned above and create a U/(U+Th+K) ratio image.

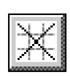
2 In the **Formula Editor** dialog type in “ (i1 - rmin(,r1,i1))/((i1 - rmin(,r1,i1))+(i2 - rmin(,r1,i2))+(i3))” in the generic formula window area.

3 Select INPUT1: (i1) to be Uranium_cps INPUT2: (i2) to be Potassium_cps and INPUT3: (i3) to be Thorium_cps in the relation window area.

4 Click the **Apply changes** button in the **Formula Editor** dialog.

5 Click the **99% Contrast Enhancement**  button in the main menu (or **Algorithm** dialog).

6 The ratio (U - Umin) / ((U - Umin)+(K - Kmin)+(Th - Thmin)) image is displayed.

7 Through the **Edit Filter (Kernel)**  apply the ‘median_5x5.ker.’ filter and smooth the image.

8 From the Transform window manually adjust the X-axis to find the appropriate threshold for high Th anomalous areas (about 0.13 (vertical)).

9 Delete the transform of the ratio image.

10 From the **File** menu, select **Save as ...**.

11 From the **Directories** menu, select the path ending with the text **\examples\Miscellaneous**.

12 Double-click on the directory named ‘Tutorial’ to open it.

13 In the **Save As:** text field, type a name using your initials at the beginning, followed by the text ‘U_by_KThU_VDS,’ and separate each word with an underscore (_). For example, if your initials are "CJ," type in the name:

`CJ_U_by_KThU_VDS`

14 Click **OK** to save the Virtual Dataset.

2: Integrating Radiometric classes

Objectives Learn to compare and integrate radiometric classes.

Display the classified image you created earlier

1 Click the **New** toolbar button.

An image window appears.

2 Click the **Edit Algorithm** toolbar button.

3 The Algorithm window appears.

4 Click your right mouse button on the Pseudo Layer

5 A short-cut menu appears.

6 In the **Short-Cut** menu click on Class Layer and change the Pseudo Layer to Class Layer.

Note: The Class Display layer is designed to display images created with ER Mapper’s classification functions.

---

7 In the process diagram, click the **Load Dataset** button.

8 From the **Directories** menu, select the path ending with the text **\examples\Miscellaneous**.

9 Double-click on the file named ‘Tutorial/ 10_class_Radiometrics_ISOCLASS.ers,’ with your initials to load it.

10 Through the **Edit Filter (Kernel)** apply the ‘median_5x5.ker.’ filter to smooth the image.

The image will be displayed in colors which you have assigned to the classes previously. If you have not assigned colors to the classes do so as mentioned below.

Assign appropriate colors to known classes

1 From the **Process** menu, select **Classification**, then select **Edit Class/ Region Color and Name...**.

2 The **Edit Class/Region Detail** dialog box appears.

3 In the **Name** field for class 1 in the **Edit Class/Region Details** dialog, select the text ‘1: unlabelled,’ and type in **`High Uranium`**.

4 Click the **Set color...** button for class 1 to open the color chooser.

5 Choose blue color, then click **OK** to close the dialog.

6 Similarly if you know the classes then type in appropriate names and assign colors for each of the class.

7 Click **Save** in the **Edit Class/Region Details** dialog to save the colors assigned to classes.

8 Reload the classified image to redisplay the classified image.

3: Draping high anomaly radiometric classes over a classified image

Objectives Learn how to use a Classification layer to drape classes from ratioed images over a classified image.

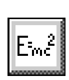
Add a Classification layer to display high K class over the radiometric classified image

1 In the Algorithm dialog, click the **Load Dataset**  button.

2 From the **Directories** menu, select the path ending with the text **\examples\Miscellaneous**.

3 Open the ‘Tutorial’ directory, select the K_by_Th_VDS.ers with your initial in front, and click on **OK this layer only** button to load it.

Median filtered K_by_Th_VDS dataset is loaded into the Classification Layer.

4 Click on the **Edit Formula**  button for the Classification layer

The **Formula** dialog box opens and shows the default formula “INPUT1.”

5 In the Generic formula window, edit the formula text to read:

```
if input1> 5 then 1 else null
```

This formula tells ER Mapper “if pixels have a value greater than 5 (high anomalies of K/Th ratio image) in the dataset, assign them a value of 1 for display, else assign them a value of null” (so the backdrop image shows through).

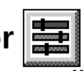
Tip: This formula can also be loaded from the **Standard** menu in the **Formula Editor** dialog box.

---

6 Click the **Apply changes** button to validate the formula.

7 Click **Close** to close the **Formula Editor** dialog.

Choose a color for the class overlay

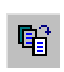
1 With the Classification layer selected, click the **Edit Layer Color**  button in the process stream diagram. (It is on the far right side, scroll the process stream if needed to view it.)

The **Color Chooser** dialog box appears.

2 Select a black color, and click **OK** to close the **Color Chooser**.

3 The image is displayed with the K/Th high anomaly class (as black) over the classified image.

Add a second Classification layer to display high Th class over the radiometric classified image

1 In the **Algorithm** window, with the Classification layer selected, click on the **Duplicate** button  and duplicate the Classification layer.

2 In the Algorithm dialog, highlight the second Classification layer and click the **Load Dataset**  button.

3 From the **Directories** menu, select the path ending with the text **\examples\Miscellaneous**.

4 Open the ‘Tutorial’ directory, select the Th_by_KThU_VDS.ers with your initial in front, and click on **OK this layer only** button to load it.

Median filtered K_by_KThU_VDS dataset is loaded into the second Classification Layer.

5 Click on the **Edit Formula** button for the second Classification layer

The **Formula** dialog box opens and shows the default formula “INPUT1.”

6 In the Generic formula window, edit the formula text to read:

```
if input1> 0.3 then 1 else null
```

This formula tells ER Mapper “if pixels have a value greater than 0.3 (high anomalies of Th/(Th+K+U) ratio image) in the dataset, assign them a value of 1 for display, else assign them a value of null” (so the backdrop image shows through).

Tip: This formula can also be loaded from the **Standard** menu in the **Formula Editor** dialog box.

---

7 Click the **Apply changes** button to validate the formula.

8 Click **Close** to close the **Formula Editor** dialog.

Choose a color for the class overlay

1 With the second Classification layer selected, click the **Edit Layer Color** button in the process stream diagram. (It is on the far right side, scroll the process stream if needed to view it.)

The **Color Chooser** dialog box appears.

2 Select a white color, and click **OK** to close the **Color Chooser**.

3 Click the Refresh to display with the Th/(Th+K+U) high anomaly class (as white) over the classified image.

Add a third Classification layer to display high U class over the radiometric classified image

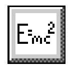
1 In the **Algorithm** window, with the second Classification layer selected, click on the **Duplicate** button and duplicate the second Classification layer.

2 In the Algorithm dialog, highlight the third Classification layer and click the **Load Dataset**  button.

3 From the **Directories** menu, select the path ending with the text **\examples\Miscellaneous**.

4 Open the ‘Tutorial’ directory, select the U_by_KThU_VDS.ers with your initial in front, and click on **OK this layer only** button to load it.

Median filtered U_by_KThU_VDS dataset is loaded into the third Classification Layer.

5 Click on the **Edit Formula**  button for the third Classification layer

The **Formula** dialog box opens and shows the default formula “INPUT1.”

6 In the Generic formula window, edit the formula text to read:

```
if input1> 0.13 then 1 else null
```

This formula tells ER Mapper “if pixels have a value greater than 0.13 (high anomalies of U/(U+Th+K) ratio image) in the dataset, assign them a value of 1 for display, else assign them a value of null” (so the backdrop image shows through).

Tip: This formula can also be loaded from the **Standard** menu in the **Formula Editor** dialog box.

---

7 Click the **Apply changes** button to validate the formula.

8 Click **Close** to close the **Formula Editor** dialog.

Choose a color for the class overlay

1 With the second Classification layer selected, click the **Edit Layer Color**  button in the process stream diagram. (It is on the far right side, scroll the process stream if needed to view it.)

The **Color Chooser** dialog box appears.

2 Select a dark brown color, and click **OK** to close the **Color Chooser**.

3 The image is displayed with the U/(U+Th+K) high anomaly class (as white) over the classified image.

Note: The high Potassium areas (black), high Thorium areas (white) and high Uranium areas (dark brown) display over the backdrop of the classified image. This is one way to overlay thematic data, and help analyze and assess the accuracy of a classification.

Note: You can adjust the thresholds of the three K, Th and U high anomaly classes and compare with the classified image.

Note: In the classified image for the other classes other than K, Th and U high anomaly classes they can be combined using the formula “ If i1 = 6 or i1 = 7 then 6 else i1 “. Class 6 and 7 are combined.

Close the image window and the Algorithm dialog

1 Close both image windows using the window system controls:

- For Windows 95, click the [X] **Close** button in the upper-right corner.
- For Windows NT, select **Close** from the window control-menu.
- For Unix systems, select **Close** or **Quit** from the window control menu in the upper-left corner (for systems with both options, select **Quit**).

2 Click **Close** in the Algorithm window and **Edit Sun Angle** dialog box to close them.

Only the ER Mapper main menu is now open.

What you learned...

After completing these exercises, you know how to perform the following tasks in ER Mapper:

- Create a classified image of Radiometric dataset
- Create ratio images and define thresholds for high anomaly classes of K, Th and U
- Overlay high anomaly classes of K, Th and U over the classified image
- Compare the high anomaly classes of K, Th and U with classes in the classified image.

22

Radiometrics and Magnetics Integration

This chapter shows you how to integrate radiometric and magnetic datasets.

About integrating radiometric and magnetic datasets

Radiometrics provide you with information on radiometric elements (K, Th and U) distribution for the top 30 cm of soil whereas magnetics give you magnetic anomalies of rocks from surface down to a subsurface depth of 5-10 km. Magnetics will also give you subsurface magnetic rocks structure which can be correlated to the radiometrics when integrated together. Radiometrics can be displayed as RGB color composite drape over magnetics intensity layer. You can also drape radiometric classes over the magnetics.

Hands-on exercises

These exercises show you how to create RGBI algorithms with radiometrics RGB composite drape over magnetics intensity layer.

What you will learn...

After completing these exercises, you can perform the following tasks in ER Mapper:

- Creating RGBI colordrape algorithms with radiometrics as RGB composite and magnetics in the intensity layer
- Draping radiometric classes over magnetics intensity layer
- Correlate between radiometrics and magnetics and between different algorithms (RGBI vs radiometric classes colordrape).

Before you begin...

Before beginning these exercises, make sure all ER Mapper image windows are closed. Only the ER Mapper main menu should be open on the screen.

1: Integrating radiometrics with magnetics using RGBI algorithm

Objectives

Learn to drape three components of a radiometric dataset as an RGB color composite image over an Intensity layer displaying a shaded magnetic dataset to create a combined RGB-Intensity (RGBI) colordrape image.

Open an image window and Algorithm window

1 Click the **Edit Algorithm** button in the main menu window.

ER Mapper opens a new image window and the **Algorithm** dialog.

Load and display the radiometric dataset in RGB composite

1 In the **Algorithm** dialog, click the **Load Dataset** button.

2 From the **Directories** menu, select the path ending with the text **\examples**.

3 Select **ER Mapper Raster Image (.ers)** from the “Files of Type” dropdown list in the **Raster Dataset** dialog.

4 Open the ‘Core_Datasets’ directory, then double-click on the dataset named ‘Newcastle_Radiometrics.ers’ to load it.

Band 1 (Total_cnt) of the dataset is loaded into the Pseudo layer.

5 In the main menu window, from the Forestry Toolbar, click on the **Create RGB Algorithm** toolbar button to display the ‘Newcastle_Radiometrics.ers’ dataset as RGB composite.

Note: Delete the inactive Pseudo Layer in the data structure in the algorithm window by highlighting the Pseudo Layer and click the **Cut** button.

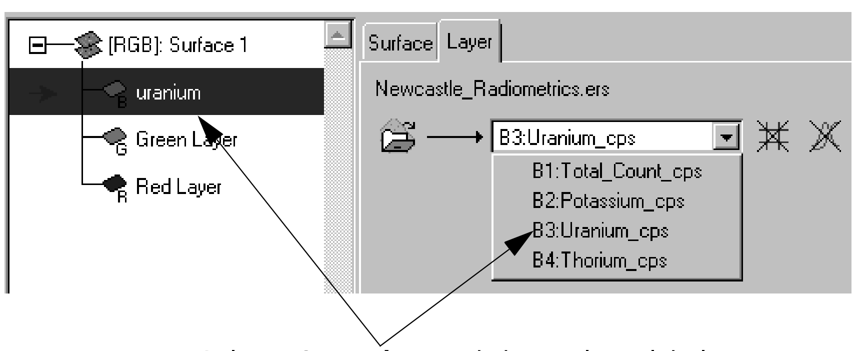
---

6 ER Mapper displays three bands of the radiometric dataset as an RGB image. You need to choose the desired bands to display and adjust the contrast (transform) of each layer next to create an enhanced color image.

Select appropriate bands and enter labels for the RGB layers

Radiometric data is often displayed in RGB by selecting the potassium data as the red component, thorium as the green component, and uranium as the blue component.

1 Select the Blue layer in **Algorithm** dialog, then choose **B3:Uranium_cps** from the **Band Selection** B3:Uranium_cps drop-down list, and change the layer label to **`uranium`**.



Select **B3:Uranium** and change layer label

2 Select the Green layer, choose the band **B4:Thorium_cps**, and enter the layer label **`thorium`**.

3 Select the Red layer, choose the band **B2:Potassium_cps**, and enter the layer label **`potassium`**.

4 The potassium, thorium and uranium data as an RGB image is displayed.

Next you need to adjust the contrast (transform) of each layer next to create a contrast-enhanced color image.

Adjust the transforms for the RGB layers to increase contrast

1 With the ‘potassium’ (red) layer selected, click on the post-formula **Edit Transform Limits** button in the process diagram.

The **Transform** dialog box opens showing the histogram for the potassium data.

2 From the **Limits** menu (in the **Transform** dialog), select **Limits to Actual**.

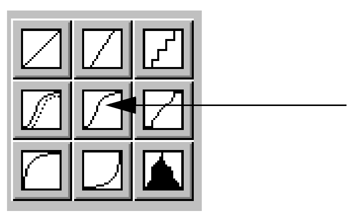
The X axis (input) limits are changed to match the range of the potassium data.

3 Click the **Move to next Green layer** G button, and select **Limits to Actual** from the **Limits** menu for the ‘thorium’ (green) layer.

4 Click the **Move to next Blue layer** B button, and select **Limits to Actual** from the **Limits** menu for the ‘uranium’ (blue) layer.

You now have a presentable image, but you can increase the contrast between the red (potassium), green (Thorium) and blue (uranium) components further by applying a histogram equalization transform to each layer.

5 For each layer, click the **Histogram equalize** button. (Move between them using the R, G and B buttons.)



The resulting RGB color composite image shows information about the relationships and relative strengths of each component. Radiometrics RGB displays can also be useful in geological mapping because different rocks types can often be recognized by their distinctive radioactive signatures.

Following are some general rules for interpreting colors in RGB images:

- Black, grey or white colors indicate that the proportional response from each component is relatively equal, i.e., one is not dominant. Black indicates very low values for all three components, grey colors are mid-level values for all three, and white are high values for all three.

- Red, green, or blue colors indicate that one of the three components has a much higher value relative to the other two. For example, where you see red colors potassium has a high value relative to the thorium (green) and uranium (blue) components.
- Cyan, magenta or yellow colors indicate that two of the components have relatively high values and the third has a low value. (The colors of two components combine to create a third color.) For example, magenta colors are produced in areas with high potassium (red) and uranium (blue) values, and low thorium (green) values. Cyan (light blue) colors indicate high uranium (blue and thorium (green), and yellow indicates high potassium (red) and thorium (green).

6 Click **Close** to close the **Transform** dialog box.

Add an Intensity layer to create an RGBI colordrape

1 From the **Edit** drop-down menu (in the **Algorithm** dialog), select **Add Raster Layer,** then select **Intensity**.

An Intensity layer is added to the algorithm. You will use this layer to create a shaded relief image of the magnetic data.

Load a sample magnetic dataset into the Intensity layer

1 In the **Algorithm** dialog, click the **Load Dataset** button.

The **Raster Dataset** file chooser dialog opens.

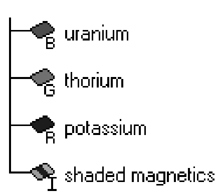
2 From the **Directories** menu, select the path ending with **\examples**.

3 Open the ‘Shared_Data’ directory, then double-click on the dataset named ‘Newcastle_Magnetics.ers’ to load it.

The magnetic dataset is loaded into the new Intensity layer.

4 Change the label for the Intensity layer to **`shaded magnetics`**.

Your algorithm layer list should now look like this:



5 With the ‘shaded magnetics’ layer selected, click the **Edit Realtime Sunshade** button in the process diagram.

6 Turn on the **Do sun-shading** option to turn on shading.

The shaded aeromagnetic data displays with the RGB color radiometrics image draped on top. Now the geological structures and trends in the magnetic dataset are clearly defined due to the sun angle shading, and you can see the relative proportions of potassium, thorium and uranium created by the RGB color layers.

7 Change the shade angle as desired to highlight structural features of interest.

8 Click **Close** in the **Edit Sun Angle** dialog to close it.

2: Draping radiometric classes over magnetics intensity layer

Objectives Learn to drape radiometric classes over magnetics Intensity layer displaying sun shaded magnetics structure.

Draping radiometric classes from classified image over magnetics intensity layer

1 Highlight the Red layer. Click the **Cut** button and delete it.

2 Highlight the Blue layer. Click the **Cut** button and delete it.

3 Highlight the Green layer. In the **Algorithm** window, click the **Load Dataset** button in the process stream diagram to open the file chooser.

4 From the **Directories** menu, select the path ending with the text **\examples\Miscellaneous**.

5 In the directory '**Tutorial**,' select the '10_class_Radiometrics_ISOCLASS' classified dataset. Click on the OK this layer only button to load it into the Green layer.

6 In the process diagram, click the pre-formula **Edit Filter (Kernel)** button. (Be sure to choose the button left of the **Formula** button.)

7 In the **Filter** dialog, click the **Filter filename** chooser button.

8 From the **Directories** menu, select the path ending with the text **\kernel**.

9 In the directory 'filters_ranking,' load the filter 'median_5x5.ker.'

10 Click on the Edit Formula button in the Algorithm window.

11 **Formula Editor** dialog appears.

12 In the **Formula Editor** dialog type in “ If i1 = 1 then 1 else null” in the generic formula window area.

Note: The formula tells ER Mapper to display class number 1 in green and see through all other areas. Since the class is displayed using the green layer of the Red Green Blue color mode the class is displayed in a translucent green and the underlying magnetics structure is still apparent. To view classes in solid color display them in Classification layer.

---

13 Change the formula to “ If i1 = 2 then 1 else null” to display class number 2 in translucent green.

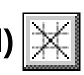
14 Change the formula to “ If i1 = 6 or i1 = 7 then 1 else null” to display class numbers 6 and 7 in translucent green.

Draping radiometric classes from ratioed images over magnetics intensity layer

1 Highlight the Green layer. In the **Algorithm** window, click the **Load Dataset**  button in the process stream diagram to open the file chooser.

2 From the **Directories** menu, select the path ending with the text **\examples\Miscellaneous**.

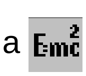
3 In the directory ‘**Tutorial**,’ select the ‘K_by_Th_VDS’ dataset. Click on the **OK this layer only** button to load it into the Green layer.

4 In the process diagram, click the pre-formula **Edit Filter (Kernel)**  button.

5 In the **Filter** dialog, select the **Delete this filter** option from the dropdown list of **Edit** menu and delete the ‘median_5x5.ker’ filter (applied to the classified image).

Note: ‘Median_5x5.ker’ filter is applied to the K/Th ratio image before saving it as a virtual dataset.

---

6 Click on the Edit Formula  button in the Algorithm window.

7 **Formula Editor** dialog appears.

8 In the **Formula Editor** dialog type in “ If i1 > 5 then 1 else null” in the generic formula window area.

Note: The formula tells ER Mapper to display DN higher than 5 as high K class in green and see through all other areas. Since the class is displayed using the green layer of the Red Green Blue color mode the class is displayed in a translucent green and the underlying magnetics structure is still apparent. To view classes in solid color display them in Classification layer.

---

9 Highlight the Green layer. In the **Algorithm** window, click the **Load Dataset**  button in the process stream diagram to open the file chooser.

10 From the **Directories** menu, select the path ending with the text **\examples\Miscellaneous**.

11 In the directory ‘**Tutorial**,’ select the ‘Th_by_KThU_VDS’ dataset. Click on the **OK this layer only** button to load it into the Green layer.

12 In the **Formula Editor** dialog type in “ If i1 >0.3 then 1 else null” in the generic formula window area.

Note: The formula tells ER Mapper to display DN higher than 0.3 as high Th class in green and see through all other areas. Since the class is displayed using the green layer of the Red Green Blue color mode the class is displayed in a translucent green and the underlying magnetics structure is still apparent. To view classes in solid color display them in Classification layer.

---

13 Highlight the Green layer. In the **Algorithm** window, click the **Load Dataset**  button in the process stream diagram to open the file chooser.

14 From the **Directories** menu, select the path ending with the text **\examples\Miscellaneous**.

15 In the directory ‘**Tutorial**,’ select the ‘U_by_KThU_VDS’ dataset. Click on the **OK this layer only** button to load it into the Green layer.

16 In the **Formula Editor** dialog type in “ If i1 >0.13 then 1 else null” in the generic formula window area.

Note: The formula tells ER Mapper to display DN higher than 0.13 as high U class in green and see through all other areas. Since the class is displayed using the green layer of the Red Green Blue color mode the class is displayed in a translucent green and the underlying magnetics structure is still apparent. To view classes in solid color display them in Classification layer.

Close the image window and the Algorithm dialog

1 Close both image windows using the window system controls:

- For Windows 95, click the **Close** button in the upper-right corner.
- For Windows NT, select **Close** from the window control-menu.
- For Unix systems, select **Close** or **Quit** from the window control menu in the upper-left corner (for systems with both options, select **Quit**).

2 Click **Close** in the **Algorithm** window and **Edit Sun Angle** dialog box to close them.

Only the ER Mapper main menu is now open.

What you learned...

After completing these exercises, you know how to perform the following tasks in ER Mapper:

- Create colordrape RGBI algorithms (RGBI)
- Display radiometric classes on top of magnetics intensity layer

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Satellite and Magnetic data Integration

This chapter shows you how to integrate satellite and magnetic datasets.

About integrating satellite and magnetic datasets

Providing that satellite images are cloud free or with minimum cloud and that vegetation is sparse you can use satellite images to identify certain surface materials. You can then correlate the surface classes with magnetic intensities and subsurface magnetic sturcture. You can drape classes of surface materials from satellite images over the magnetics.

Hands-on exercises

These exercises show you how to create RGBI algorithms with radiometrics RGB composite drape over magnetics intensity layer.

What you will learn...

After completing these exercises, you can perform the following tasks in ER Mapper:

- Creating RGBI colordrape algorithms with Landsat TM as RGB composite and magnetics in the intensity layer
- Draping surface geology over magnetics intensity layer

Before you begin...

Before beginning these exercises, make sure all ER Mapper image windows are closed. Only the ER Mapper main menu should be open on the screen.

1: Integrating Landsat TM and magnetics using RGBI algorithm

Objectives

Learn to drape three processed (ratio, PC etc.) components of a Landsat TM dataset as an RGB color composite image over an Intensity layer of a shaded magnetic dataset to create a combined RGB-Intensity (RGBI) colordrape image.

- To obtain reliable result from processing the Landsat data it is necessary to do calibration prior to processing. Calibrate and perform radiometric correction on Newcastle_Landsat.ers data and save it in the \examples\Miscellaneous\Tutorial directory as Newcastle_Landsat_calibrated.ers.

Directed Principal Components

Band ratio TM4/TM3 is a simple vegetation index to highlight vegetation. TM5/TM7 ratio is used by geologists to highlight clay rich soil. However there are signatures that are common in the two band ratios. You can run the Principal Component Analysis on the two band ratios (TM4/TM3 and TM5/TM7) and map out the common features from the two band ratios into the 1st Principal Component. The 2nd Principal Component will highlight the clay rich soil.

Both TM3/TM1 and TM3/TM2 will highlight iron rich soil. You can run the Principal Component Analysis on the two band ratios (TM3/TM1 and TM3/TM2) and map the iron rich soil signatures into the 1st Principal Component .

Note: Signatures registered in satellite images are scene dependent and caution should be taken in interpreting satellite images. Priori knowledge of the geology of the area of interest will be an advantage.

Create band ratios and save them in a Virtual Dataset

1 Click the **Edit Algorithm** button in the main menu window.

ER Mapper opens a new image window and the **Algorithm** dialog.

2 In the **Algorithm** dialog, click the **Load Dataset** button.

3 From the **Directories** menu, select the path ending with the text **\examples**.

4 Select **ER Mapper Raster Image (.ers)** from the "Files of Type" list in the **Raster Dataset** dialog.

5 Open the 'Application/Mineral_Exploration' directory, then double-click on the dataset named 'Newcastle_Landsat.ers' to load it.

Band 1 of the dataset is loaded into the Pseudo layer.

6 In the **Algorithm** dialog, click the **Edit Formula** button in the process diagram.

The **Formula Editor** dialog box opens and shows the default formula "INPUT1."

7 In the Generic formula window, edit the formula text to read:

```
(INPUT1-RMIN(,R1,I1))/ (INPUT2-RMIN(,R1,I2))
```

8 Click the **Apply changes** button in the **Formula Editor** dialog.

This formula tells ER Mapper to divide the dataset band assigned to input1 by the band assigned to input 2 (a ratio between the two inputs).

9 In the Relations window, select **B4:0.83_um** from the drop-down list next to "INPUT1," and select **B3:0.66_um** from the "INPUT2" drop-down.

Note: INPUT1 = TM band 4 (**B4:0.83_um**) and INPUT 2 = TM band 3 (**B3:0.66_um**). RMIN(,R1,I1) = the minimum value for a particular band within a region. Syntax:RMIN(dataset, region, band).

10 Click the **99% Contrast Enhancement** button.

Tip: Ratio formulas create different data ranges depending on the bands being used. Therefore, it is easiest to use the **99% Contrast Enhancement** button to process the algorithm so ER Mapper automatically adjusts the contrast suit to the data range produced by any particular ratio.

11 In the **Algorithm** dialog, change the Pseudo Layer's label to **`vegetation ratio (4/3)`**.

Create a new layer for an iron oxide ratio image

1 In the **Algorithm** dialog, click the **Duplicate** button.

ER Mapper creates a copy of the 'vegetation ratio' layer. Since the duplicate layer already contains the appropriate dataset and formula, you can easily modify it to create a different ratio image (iron oxides in this case).

2 In the Relations window (in the **Formula** dialog), select **B3:0.66_um** for "INPUT1" and select **B1:0.485_um** for "INPUT2."

Using the same Generic formula **`(INPUT1-RMIN(,R1,I1))/ (INPUT2-RMIN(,R1,I2))`**, you have now chosen the appropriate TM band ratio (3/2) to create a simple iron oxide image.

3 Change the label for the new (lower) layer to **`iron oxide ratio (3/1)`**.

4 Right-click on the 'vegetation ratio (4/3)' layer and select **Turn Off**.

5 Click the **99% Contrast Enhancement** button.

Your contrast enhanced iron oxide ratio image shows iron-rich rocks (higher ratio values) in light shades of grey, and iron-poor rocks in darker shades. This band combination takes advantage of high iron oxide reflectance in TM band 3 (reflected red light) and absorption in band 1 (blue light).

6 Similarly create a band ratio of TM3/TM2 and change the label to **`iron oxide ratio (3/2)`**.

Create a new layer for an clay minerals ratio image

1 Select the 'iron oxide ratio (3/2)' layer, then click the **Duplicate** button.

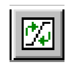
You will modify the copied layer with generic formula **`(INPUT1-RMIN(,R1,I1))/ (INPUT2-RMIN(,R1,I2))`**to create a clay minerals ratio image.

2 In the Relations window (in the **Formula** dialog), select **B5:1.65_um** for “INPUT1” and select **B7:2.215_um** for “INPUT2.”

You have now chosen the appropriate TM band ratio (5/7) to create a simple clay minerals image.

3 Change the label for the new (lowest) layer to **`clay ratio (5/7)`**.

4 Right-click on the ‘iron oxide ratio (3/2)’ layer and select **Turn Off**.

5 Click the **99% Contrast Enhancement**  button.

Your contrast enhanced clay ratio image shows clay-rich rocks (higher ratio values) in light shades of grey, and clay-poor rocks in darker shades. This band combination takes advantage of high reflectance of clay minerals in TM band 5 and strong absorption by clay minerals in TM band 7. This ratio can be useful for detecting the presence of clays associated with alteration zones.

You now have four layers in your algorithm, each displaying a different ratio image.

To view any ratio image, simply turn off the other two layers.

6 Click the **Close** in the **Formula Editor** dialog box to close it.

Save the Landsat ratios as a Virtual Dataset

1 In the **Algorithm** dialog, enter the text **`Landsat TM ratios`** in the ‘Description’ text field.

2 Delete the transform of all the 4 layers

Note: Deleting the transform from each of the layers maintains the dynamic range of the data value of the 4 bands without scaling or clipping.

---

3 On the Standard toolbar, click the **Save As**  button.

The **Save As** dialog box appears. This dialog lets you specify a path and name for your output disk file, and options for creating the new dataset.

4 In the **Files of Type:** field, select “ ER Mapper Virtual Dataset (.ers)”

5 From the **Directories** menu, select the path ending with the text **\examples\Miscellaneous**.

6 Double-click on the ‘Tutorial’ directory to open it.

7 In the **Save As:** text field, type a name for the algorithm file using your initials at the beginning, followed by the text ‘Newcastle_Landsat_ratios.’

8 Click **OK** to save the band ratios as Virtual Dataset.

Note: Calculate the statistics of the 'Newcastle_Landsat_ratios.ers' dataset prior to further processing.

Display ratio VDS dataset in RGB composite

1 Click the **Edit Algorithm** button in the main menu window.

ER Mapper opens a new image window and the **Algorithm** dialog.

2 In the **Algorithm** dialog, click the **Load Dataset** button.

3 From the **Directories** menu, select the path ending with the text **\examples\Miscellaneous**.

4 Select **ER Mapper Raster Image (.ers)** from the "Files of Type" list in the **Raster Dataset** dialog.

5 Open the 'Tutorial' directory, then double-click on the dataset named 'Newcastle_Landsat_ratios.ers' to load it.

Band 1 (**`vegetation ratio (4/3)`**) of the dataset is loaded into the Pseudo layer.

6 In the main menu window, from the Forestry Toolbar, click on the **Create RGB Algorithm** toolbar button to display the 'Newcastle_Radiometrics_ratios.ers' dataset as RGB composite.

Note: Delete the inactive Pseudo Layer in the data structure in the algorithm window by highlighting the Pseudo Layer and click the **Cut** button.

---

7 ER Mapper displays three bands of the Newcastle_Landsat_ratios dataset as an RGB image. You will apply formulas to the bands and adjust the contrast (transform) of each layer to create an enhanced color image.

Enter formulas and select appropriate bands for the RGB layers

1 Select the Red layer in the **Algorithm** dialog window and click on the Edit Formula button.

2 **Formula Editor** dialog appears.

3 In the **Formula Editor** dialog select **PC1 of TM bands 147** option from the drop down list of Principal Components menu.

4 The formula " SIGMA(I1..I3 | I? * PC_COV(I1..I3 | , R1, I?, 1))" appears in the generic formula window area.

5 Edit the formula to "SIGMA(I1..I2 | I? * PC_COV(I1..I2 | , R1, I?, 2))"

6 In the relationship window select INPUT1 as **`vegetation ratio (4/3)`** and INPUT2 as **`clay ratio (5/7)`** bands.

Note: The formula tells ER Mapper to calculate Principal Component number 2 from the vegetation ratio (4/3) and clay ratio (5/7) bands.

---

7 Click the **Move to next Green layer** button in the Formula Editor dialog box.

8 The default formula INPUT1 is displayed in the generic window.

9 In the relationship window, at the middle portion of the Formula Editor dialog box select INPUT1 to be **`vegetation ratio (4/3)`**.

10 Click the **Move to next Blue layer** button n the Formula Editor dialog box.

11 In the **Formula Editor** dialog select **PC1 of TM bands 147** option from the drop down list of Principal Components menu.

12 The formula " SIGMA(I1..I3 | I? * PC_COV(I1..I3 | , R1, I?, 1))" appears in the generic formula window area.

13 Edit the formula to "SIGMA(I1..I2 | I? * PC_COV(I1..I2 | , R1, I?, 1))"

14 In the relationship window select INPUT1 as **`iron ratio (3/1)`** and INPUT2 as **`iron ratio (3/2)`** bands.

Note: The formula tells ER Mapper to calculate Principal Component number 1 from the iron oxide ratios (3/1) and (3/2) bands.

---

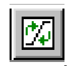
15 In the process diagram, click the post-formula **Edit Filter (Kernel)** button. (Be sure to choose the button right of the **Formula** button.)

16 In the **Filter** dialog, click the **Filter filename** chooser button.

17 From the **Directories** menu, select the path ending with the text **\kernel**.

18 In the directory 'filters_ranking,' load the filter 'median_5x5.ker.'

19 Apply ‘median_5x5.ker’ filter to all RGB layers.

20 Click the **99% Contrast Enhancement**  button and display PC2 (TM4/3 & TM5/7), TM4/3 and PC1 (TM3/1 & TM3/2) as an RGB image.

Note: Red areas are clay rich areas, green is vegetation and blue is iron rich soil. Other colors are mixture of two or three classes.

---

21 Click **Close** to close the **Transform** dialog box.

Add an Intensity layer to create an RGBI colordrape

1 From the **Edit** drop-down menu (in the **Algorithm** dialog), select **Add Raster Layer,** then select **Intensity**.

An Intensity layer is added to the algorithm. You will use this layer to create a shaded relief image of the magnetic data.

Load a sample magnetic dataset into the Intensity layer

1 In the **Algorithm** dialog, click the **Load Dataset**  button.

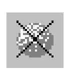
The **Raster Dataset** file chooser dialog opens.

2 From the **Directories** menu, select the path ending with **\examples**.

3 Open the ‘Shared_Data’ directory, then double-click on the dataset named ‘Newcastle_Magnetics.ers’ to load it.

The magnetic dataset is loaded into the new Intensity layer.

4 Change the label for the Intensity layer to **`shaded magnetics`**.

5 With the ‘shaded magnetics’ layer selected, click the **Edit Realtime Sunshade**  button in the process diagram.

6 Turn on the **Do sun-shading** option to turn on shading.

The shaded aeromagnetic data displays with the RGB color radiometrics image draped on top. Now the geological structures and trends in the magnetic dataset are clearly defined due to the sun angle shading, and you can see the relative proportions of clay rich, vegetation and iron rich soil created by the RGB color layers.

7 Change the shade angle as desired to highlight structural features of interest.

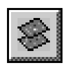
8 Click **Close** in the **Edit Sun Angle** dialog to close it.

9 The clay rich soil, vegetation, iron rich soil RGB composite drape over the sun shaded magnetics is displayed.

Note: Instead of using magnetics in the intensity layer you can use PC1 of landsat TM1-5&7 as an albedo backdrop image to display the hydroxyl, vegetation and iron rich soils over it.

2: Draping hydroxyl class over magnetics

Objectives Learn to drape hydroxyl class over magnetics in Intensity layer displaying sun shaded magnetics structure.

1 Click the **Edit Algorithm**  button in the main menu window.

ER Mapper opens a new image window and the **Algorithm** dialog.

Load and display ratio VDS dataset in RGB composite

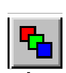
1 In the **Algorithm** dialog, click the **Load Dataset**  button.

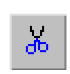
2 From the **Directories** menu, select the path ending with the text **\examples\Miscellaneous**.

3 Select **ER Mapper Raster Image (.ers)** from the “Files of Type” list in the **Raster Dataset** dialog.

4 Open the ‘Tutorial’ directory, then double-click on the dataset named ‘Newcastle_Landsat_ratios.ers’ to load it.

Band 1 (**`vegetation ratio (4/3)`**) of the dataset is loaded into the Pseudo layer.

5 In the main menu window, from the Forestry Toolbar, click on the **Create RGB Algorithm** toolbar button  to display the ‘Newcastle_Landsat_ratios.ers’ dataset as RGB composite.

Note: Delete the inactive Pseudo Layer in the data structure in the algorithm window by highlighting the Pseudo Layer and click the **Cut**  button.

---

6 ER Mapper displays three bands of the Newcastle_Landsat_ratios dataset as an RGB image. You will apply formulas to the Green layer and adjust its transform.

Apply directed Principal Component Analysis formula in the Green layer to highlight clay rich soils (alteration zones)

1 Highlight the Red layer. Click the **Cut** button and delete it.

2 Highlight the Blue layer. Click the **Cut** button and delete it.

3 Select the Green layer in the **Algorithm** dialog window and click on the Edit Formula button.

4 **Formula Editor** dialog appears.

5 In the **Formula Editor** dialog select **PC1 of TM bands 147** option from the drop down list of Principal Components menu.

6 The formula " SIGMA(I1..I3 | I? * PC_COV(I1..I3 | , R1, I?, 1))" appears in the generic formula window area.

7 Edit the formula to "SIGMA(I1..I2 | I? * PC_COV(I1..I2 | , R1, I?, 2))"

8 In the relationship window select INPUT1 as **`vegetation ratio (4/3)`** and INPUT2 as **`clay ratio (5/7)`** bands.

Note: The formula tells ER Mapper to calculate Principal Component number 2 from the vegetation ratio (4/3) and clay ratio (5/7) bands.

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9 Click the **99% Contrast Enhancement** button and display PC2 (TM4/3 & TM5/7) image.

Note: Bright green areas are clay rich areas which may indicate to be alteration zones.

---

10 Click on the post-formula **Edit Transform Limits** button in the process diagram.

The **Transform** dialog box opens showing the histogram for the PC2 of the TM4/3 and TM5/7 data. The Actual Input Limits fall between -4.706 to 162.365.

11 Find a threshold for high anomaly class of clay rich soil. Set the linear transform to 0.53 (vertical) and display the high anomaly areas of clay rich soil as green on the image.

12 Click **Close** to close the **Transform** dialog box.

Add an Intensity layer to create an RGBI colordrape

1 From the **Edit** drop-down menu (in the **Algorithm** dialog), select **Add Raster Layer,** then select **Intensity**.

An Intensity layer is added to the algorithm. You will use this layer to create a shaded relief image of the magnetic data.

Load a sample magnetic dataset into the Intensity layer

1 In the **Algorithm** dialog, click the **Load Dataset**  button.

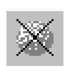
The **Raster Dataset** file chooser dialog opens.

2 From the **Directories** menu, select the path ending with **\examples**.

3 Open the ‘Shared_Data’ directory, then double-click on the dataset named ‘Newcastle_Magnetics.ers’ to load it.

The magnetic dataset is loaded into the new Intensity layer.

4 Change the label for the Intensity layer to **`shaded magnetics`**.

5 With the ‘shaded magnetics’ layer selected, click the **Edit Realtime Sunshade**  button in the process diagram.

6 Turn on the **Do sun-shading** option to turn on shading.

7 Change the shade angle as desired to highlight structural features of interest.

8 Click **Close** in the **Edit Sun Angle** dialog to close it.

9 The clay rich soil, in green layer drape over the sun shaded magnetics is displayed.

Note: Instead of using magnetics in the intensity layer you can use PC1 of landsat TM1-5&7 as an albedo backdrop image to display the hydroxyl clay rich soils over it.

---

10 Highlight the Green layer.

11 Click on the Edit Formula button in the Algorithm window.

12 Formula Editor dialog appears.

13 In the **Formula Editor** dialog type in “ If (SIGMA(I1..I2 | I? * PC_COV(I1..I2 | , R1, I?, 2))) > 0.53 then 1 else null” in the generic formula window area.

Note: The formula tells ER Mapper to display clay rich soil anomalous values higher than 0.53 in green and see through all other areas. Since the class is displayed using the green layer of the Red Green Blue color mode the class is displayed in a translucent green and the underlying magnetic structure is still apparent. To view classes in solid color display them in Classification layer.

---

14 Change the formula to “ If (SIGMA(I1..I2 | I? * PC_COV(I1..I2 | , R1, I?, 2))) > 0.52 then 1 else null” to display larger areas of clay rich soils in translucent green.

Note: Similarly you can display iron rich soils over the magnetics. You can also classify the Landsat TM of the area and display each class (using the formula “If i1 = 1 then 1 else null”) over magnetics or PC1 of Landsat TM1-5&7 in the intensity layer.

Close the image window and the Algorithm dialog

1 Close both image windows using the window system controls:

- For Windows 95, click the **Close** button in the upper-right corner.
- For Windows NT, select **Close** from the window control-menu.
- For Unix systems, select **Close** or **Quit** from the window control menu in the upper-left corner (for systems with both options, select **Quit**).

2 Click **Close** in the **Algorithm** window and **Edit Sun Angle** dialog box to close them.

Only the ER Mapper main menu is now open.

What you learned...

After completing these exercises, you know how to perform the following tasks in ER Mapper:

- Create colordrape RGBI algorithms (RGBI)
- Display clay rich on top of magnetics intensity layer

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Geolinking images

This chapter explains how to use ER Mapper's geopositioning controls to display images with exact geographic extents, and use the Geolinking controls to geographically link two or more image windows. Geolinking is a powerful visualization technique that can help you analyze the same geographic area using a variety of different datasets or processing techniques.

About Geopositioning

In ER Mapper, the term "geopositioning" refers to specifying the position and extents of an image in geographic coordinate space. This can be useful for creating maps that cover an exact area, for example. Once an image is registered to a map projection, its display can be controlled using ER Mapper's geopositioning options. If the image is not rectified to a map projection, its extents can be controlled in terms of the row and column numbers of the dataset pixels.

About Geolinking

In ER Mapper, the term "geolinking" refers to linking two or more image windows in geographic coordinate space. This can be useful for viewing the same geographic area with different types of datasets or processing algorithms, and other applications. Once an image is registered to a map projection, it can be geographically linked with other image windows using ER Mapper's geolinking options. ER Mapper provides the following geolinking modes:

Window	Link two or more image windows to show the same geographic extents. Zooming or panning in one window triggers the same operation in other linked windows.
Screen	Link image windows to one “master” image that acts like a virtual map sheet on the screen. Linked windows display the geographic extents of their datasets relative to the master window.
Overview Zoom	Link image windows to one “master” overview control window. Defining a zoom box on the control window causes the other windows to zoom to the defined area.
Overview Roam	Link image windows to one “master” control window. Dragging the mouse to pan in the control window causes other windows to pan (or “roam”) so their center point matches the mouse position in the control window.

The Algorithm Geoposition Extents Dialog Box

The **Algorithm Geoposition Extents** dialog box lets you precisely control the geographic extents and display resolution of images, and geographically link (geolink) two or more image windows together. The dialog has five tab pages that display different sets of functions as follows:

Zoom	Lets you use buttons to zoom or pan the image in the window by predefined amounts, or zoom to the extents of specific datasets, page extents, or page contents.
Geolink	Lets you set up geolinking between two or more image windows, and set the window size and display resolution of any image window.
Extents	Lets you view or specify geographic display extents for an image using Latitude/Longitude, Eastings/Northings, or dataset X (column) and Y (row) values.
Center	Lets you view or specify the center point for the image display using Latitude/Longitude, Eastings/Northings, or dataset X (column) and Y (row) values.
Mouse info	Shows quick help for using the mouse and keyboard keys to zoom and pan.

Hands-on exercises

These exercises introduce you to many of the basic features of the **Algorithm Geoposition Extents** dialog box and how to use them to control image display extents and set up geolinking between windows.

Note: The datasets used in the following exercises were previously rectified to the same datum and map projection. This is a requirement when different datasets are to linked in Window, Screen, Overview Zoom, or Overview Pan modes.

What you will learn...

After completing these exercises, you will know how to perform the following tasks in ER Mapper:

- Display images with exact geographic extents and display resolutions
- Link image windows to show the same geographic extents
- Link image windows to a virtual map sheet window
- Control interactive image zooming and panning functions from a master window

Before you begin...

Before beginning these exercises, make sure all ER Mapper image windows are closed. Only the ER Mapper main menu should be open on the screen.

1: Geopositioning images

Objectives

Learn how to use the Geoposition controls to display an exact geographic area of an image, specify an image center point, and change window sizes and display resolutions.

Load and display a Landsat image in RGB

1 On the main menu, click the **Open** button.

An image window and the **Open** dialog box appear.

2 From the **Directories** menu, select the path ending with the text **\examples**.

3 Open the 'Data_Types\Magnetics_And_Radiometrics' directory, then double-click on the algorithm 'Magnetics_Colordrape.alg' to open it.

This algorithm display total magnetic intensity in color over magnetics illuminated (sun shaded) from the northeast to highlight the NW-SE trending magnetic high. The data is from the Cape York Peninsula area in northeast Australia.

4 Make the image window larger by dragging its lower-right corner until it fills the left half of the screen.

5 Right-click over the image and select **Zoom to All Datasets** from the **Quick Zoom** menu.

The image size will increase to fill the enlarged image window.

Open the Algorithm Geoposition Extents Dialog Box

1 From the **View** menu, select **Geoposition...**.

The **Algorithm Geoposition Extents** dialog box appears. If needed, drag the dialog to the right side of the screen.

Tip: You can also open the **Algorithm Geoposition Extents** dialog by clicking the **Geoposition Window**  button on the **Algorithm** dialog.

Display an exact area by entering geographic values

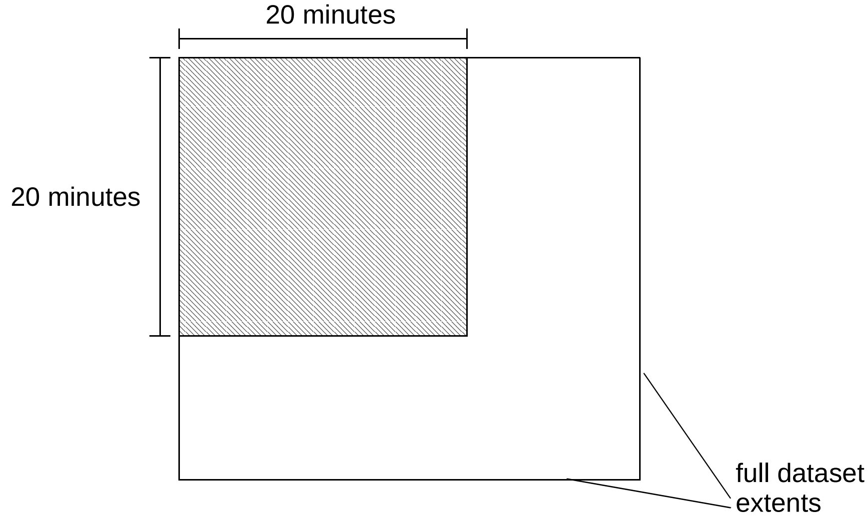
1 In the **Algorithm Geoposition Extents** dialog, select the **Extents** tab.

The contents of the dialog change to show a group of text fields for entering coordinate values.

2 Edit the values in the **Latitude** and **Longitude** fields under the **Size** column to read **`0:20`** then press Return Enter to validate the change. (ER Mapper fills out the text string to a full value of 0:20.0.0 when you validate.)

3 Click the **Apply** button to apply your new extents values.

ER Mapper reprocesses the algorithm with your new image extents and displays an area 20 minutes of Latitude by 20 minutes of Longitude. (The origin, or upper-left corner, stays the same.)



Display an exact part of the dataset by entering cell values

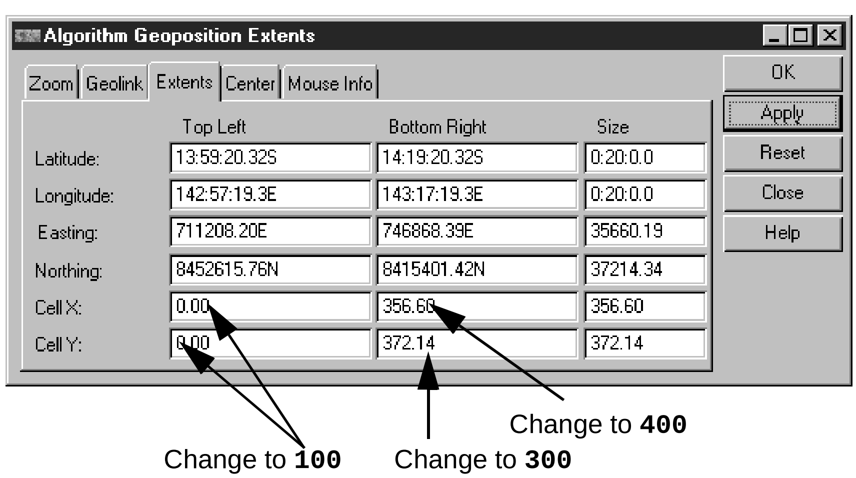
1 Edit the contents of the four fields as listed below to display an exact portion of the dataset using cell X (column) and cell Y (row) values:

Cell X/Top Left = **100**

Cell Y/Top Left = **100**

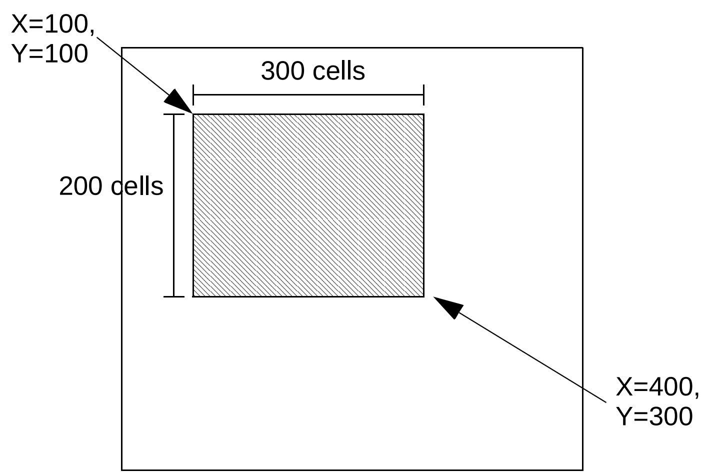
Cell X/Bottom Right = **400**

Cell Y/Bottom Right = **300**



2 Click the **Apply** button to apply your new values.

ER Mapper reprocesses the algorithm with your new dataset extents and displays an area 300 pixels (cells) wide by 200 pixels in height. The origin (upper-left corner) is at dataset cell column (X) 100 and dataset cell row (Y) 100.



Center the image on an exact point

1 In the **Algorithm Geoposition Extents** dialog, select the **Center** tab.

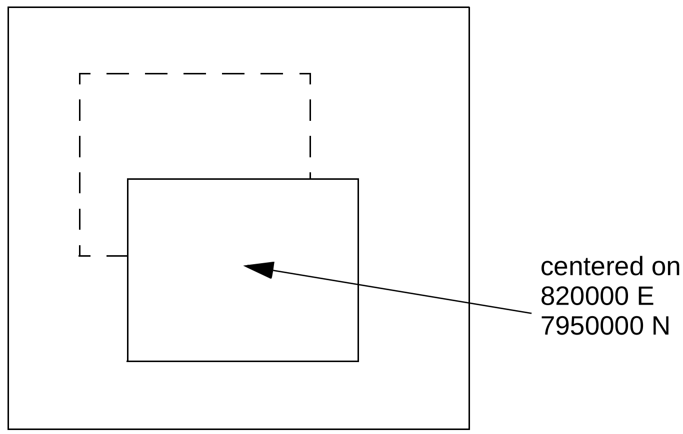
The contents of the dialog change to show a group of text fields for entering the center point of the image in geographic or dataset X and Y values.

2 Edit the value in the **Easting** field to read **`820000`** then press Return or Enter to validate the change. (Select all the existing text and type the new value; ER Mapper adds the “E” for you when you validate.)

3 Edit the value in the **Northing** field to read **`7950000`** then press Return or Enter.

4 Click the **Apply** button to apply your new center point values.

ER Mapper reprocesses the algorithm and centers the image on the location you defined (a portion of the mag feature in the lower-center of the image). Centering can be useful for viewing the exact center point of an image, or for focusing on an exact feature of interest for map making.



Set an exact image display resolution

1. In the **Algorithm Geoposition Extents** dialog, select the **Zoom** tab.
2. Click the **All Datasets** button.

   ER Mapper zooms out to show the entire extents of the mag dataset.
3. Select the **Geolink** tab.

   The contents of the dialog change to show geolink option buttons and text fields for defining window size and display resolution.
4. Edit the **Dataset cells per pixel** field to read **`0.5`**, then press Return or Enter.
5. Click the **Apply** button to apply your new display resolution.

   ER Mapper reprocesses the algorithm so that one pixel on the screen display represents two cells in the dataset (a “two to one” zoom factor).
6. Edit the **Dataset cells per pixel** field to read **`1.0`**, then press the Return or Enter key.
7. Click the **Apply** button to apply your new display resolution.

   ER Mapper reprocesses the algorithm at a “one to one” display resolution, so that every dataset cell in this part of the image is represented by one pixel on the screen display. This is often the optimal display resolution, but usually only part of the dataset can viewed at once. (Values greater than one cause subsampling of the dataset cell values, and less than one cause supersampling.)

Set an exact size for the image window

1 Edit the **Width in pixels** field to read **`400`** then press Return or Enter to validate the change.

2 Edit the value in the **Height in pixels** field to read **`400`** then press Return or Enter.

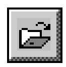
3 Click the **Apply** button to apply your new window size.

ER Mapper resizes the window to 400 by 400 pixels and redisplays the image.

2: Linking windows to common extents

Objectives Learn to link image windows in Geolink "Window" mode, so each linked window displays the same geographic extents.

Open a Landsat RGB algorithm

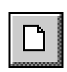
1 Click on the **Open**  button.

2 From the **Directories** menu, select the path ending with the text **\examples**.

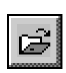
3 Open the 'Applications\Mineral_Exploration' directory, then open the algorithm named 'Landsat_TM_RGB_741.alg.'

This algorithm displays Landsat TM (30 meter resolution) image of an actively mined area of the Cape York Peninsula in northeastern Australia. Bands 7, 4 and 1 are displayed as an RGB color composite, so vegetated areas appear green and areas exhibiting mineralization are pink or white.

Open a second window and algorithm

1 On the main menu, click the **New**  button.

A second image window opens on the screen.

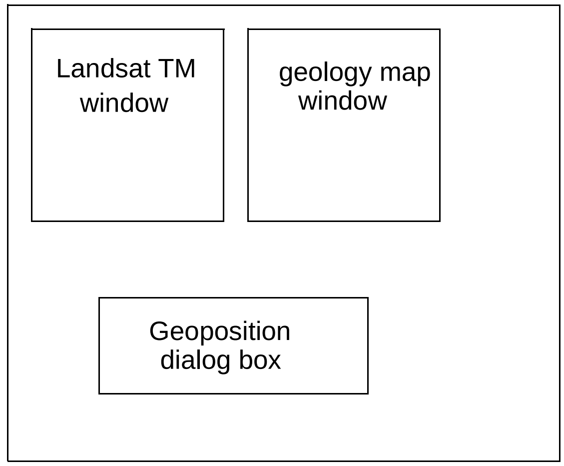
2 Click on the **Open**  button.

3 Open the algorithm "Scanned_Geology_Map.alg.'

This algorithm displays a scanned geology map covering approximately the same area as the Landsat image.

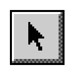
Resize and position the two windows

1 Resize and reposition the two windows as shown in the following diagram. (You must able to view the contents of each window clearly.)



You should now have two image windows of about the same size next to each other in the upper part of the screen, and **Geoposition** dialog below them.

Set the TM image window to Geolink Window mode

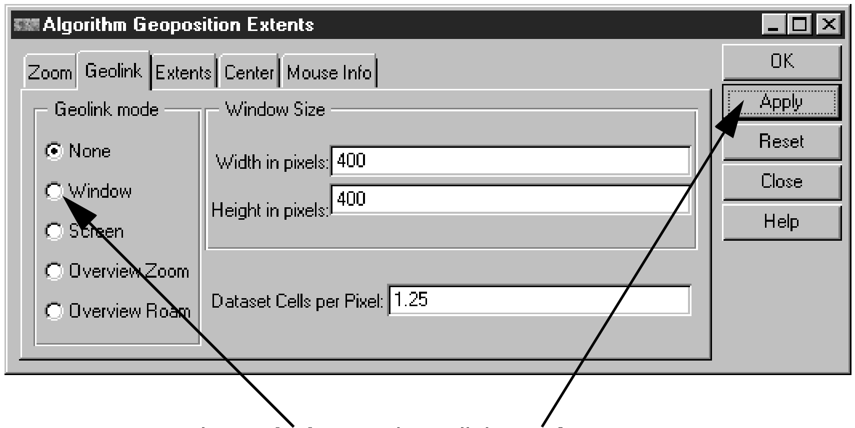
1 On the main menu, click the **Pointer Tool**  button.

2 On the **Algorithm Geoposition Extents** dialog, select the **Geolink** tab.

The contents of the dialog show Geolink mode option buttons on the left side.

3 Click inside the Landsat TM image window to activate it (three stars *** should appear next to the title).

4 In the **Geoposition** dialog, select the **Window** option button, then click **Apply**.



select **Window** option, click **Apply**

The window title indicates that it is now set to “WINDOW” geolink mode.

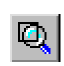
Set the Geology Map window to Geolink Window mode

1 Click inside the geology map image window to activate it.

2 Select the **Window** option button in the **Geoposition** dialog, then click **Apply**.

The Geology Map window is now linked to the Landsat TM window since both are set to Geolink Window mode. Any changes you make to the extents of one window will be automatically duplicated in the other.

Zoom and pan in both images

1 On the main menu, click the **Zoom Box Tool**  button.

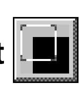
2 Inside the Landsat TM image window, drag a zoom box to magnify the lower-center portion of the image.

The images in both windows automatically zoom to share the same extents. You can now easily see spatial associations between surface cover and mineralization shown in the Landsat image and the interpreted geology in the area.

3 Click once inside the Geology Map image window to activate it, then click on the right part of the image to pan to the right.

Both images pan to the right.

4 On the **Algorithm Geoposition Extents** dialog, select the **Zoom** tab.

5 Under ‘Pan,’ click the **Pan upper-left**  button.

Both images pan 50% to the upper-left (the previous center point is now on the lower-right corner of the image).

6 Under ‘Set extents to,’ click the **Raster Datasets** button.

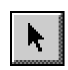
Both images zoom out to the full extents of the larger dataset (the geology map in this case).

Tip: When using geolink “Window” mode, you can also geolink windows displaying 3D views to windows containing 2D views. In this case, the extents of the 3D view are trimmed to match the extents of the 2D windows. (However, zooming or panning in the 3D window does not affect images in 2D windows.)

3: Linking windows to the screen

Objectives Learn to link image windows in Geolink “Screen” mode, so a “master” image window becomes a virtual map sheet on the screen. The screen assumes the coordinate space of the “master” image window, and other windows display the geographic extents of their datasets relative to the master window.

.Set both windows to Geolink None mode

1 On the main menu, click the **Pointer Tool**  toolbar button.

The mouse is now set as a pointer. (This prevents accidentally panning or zooming when you click inside a window to activate it.)

2 On the **Algorithm Geoposition Extents** dialog, select the **Geolink** tab. (It may already be chosen.)

3 Click inside the Landsat TM image window to activate it.

4 In the **Geoposition** dialog, select the **None** option, then click **Apply**.

The words “WINDOW:geolink” disappear from the window title, indicating that the window is no longer geolinked.

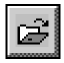
5 Click inside the Geology Map image window to activate it.

6 In the **Geoposition** dialog, select the **None** option, then click **Apply**.

Tip: Image windows can also be geolinked and unlinked using the **Quick Zoom** menu (by right-clicking in the window or using **View** menu).

Open two different algorithms

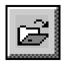
1 Click inside the left-hand image window (Landsat) to activate it.

2 Click the **Open**  button.

3 Double-click on the algorithm 'Newcastle_TM_741.alg' to open it.

This algorithm displays bands 7, 4 and 1 of a Landsat TM satellite image. The data is from the Newcastle area in southeastern Australia.

4 Click inside the right-hand image window to activate it.

5 Click the **Open**  button.

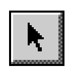
6 From the **Directories** menu, select the path ending with the text **\examples**.

7 Open the 'Data_Types' directory, then open the 'Magnetics_And_Radiometrics' directory.

8 Double-click on the algorithm 'Magnetics_Colordrape.alg' to open it.

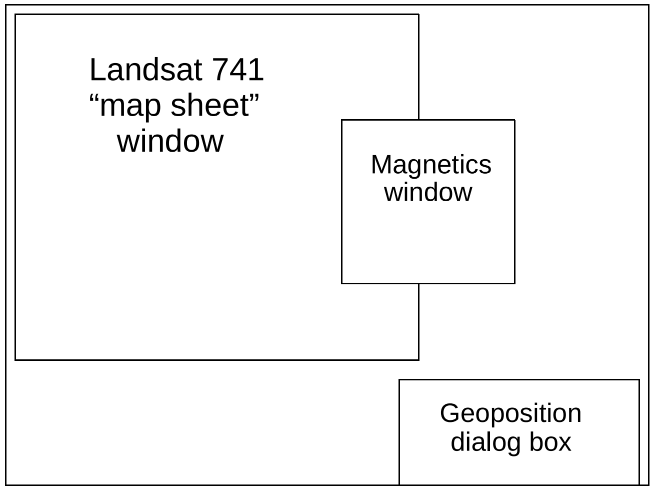
This colordrape algorithm displays total magnetic intensity in Pseudocolor over the Newcastle magnetics dataset illuminated from the northeast. Mag highs are displayed in red and yellow, mag lows in blue.

Resize and position the two windows

1 On the main menu, click the **Pointer Tool**  toolbar button.

The mouse is now set as a pointer. (This prevents accidentally panning or zooming when you click inside a window to activate it.)

2 Resize and reposition the two windows as shown in the following diagram. (You must be able to view the contents of each window clearly.)



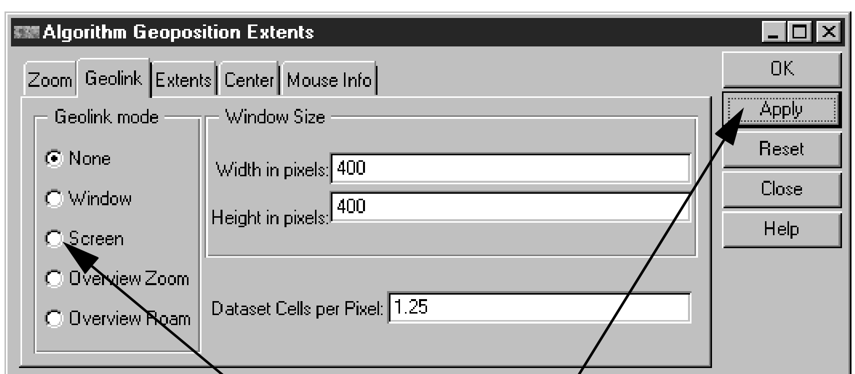
You should now have a smaller ‘Magnetics_Colordrape’ window partially overlaying a larger ‘Newcastle_TM_741’ window, and the **Geoposition** dialog in the lower-right corner.

Set the Newcastle TM 741 window to Geolink Screen mode

1 Click inside the large ‘Newcastle_TM_741’ window to activate it.

2 In the **Geoposition** dialog, select the **Zoom** option, then click **All Datasets**

3 In the **Geoposition** dialog, select the **Screen** option, then click **Apply**.



select **Screen** option, click **Apply**

The window title indicates that it is now set to “SCREEN” geolink mode. This is the *first* window assigned to Screen mode, so it becomes the master “map sheet” window and the entire screen assumes its coordinate space (shown later).

Set the colordrape image window to Geolink Screen mode

1 Click inside the smaller ‘Magnetics_Colordrape’ window to activate it.

2 Select the **Screen** option, then click the **Apply** button.

The ‘Magnetics_Colordrape’ window is now linked to the “master” window, and it automatically redraws to show its data in the corresponding geographic area of the master “map sheet” window.

Move the magnetics window over the Landsat master window

The green, roughly oval-shaped feature in the lower-center of the Landsat image is a volcanic caldera. Using Geolink Screen mode, you can easily see how changes in the magnetic field correspond with this feature.

1 Drag the smaller ‘Magnetics_Colordrape’ window by its title bar to the lower-central portion of the Landsat window.

The magnetics image automatically redraws to show its new extents in the context of the larger Landsat “map sheet” window. By comparing the two images, you can clearly see the associations between features shown in the Landsat data and gradients in the magnetic field.

2 Drag the smaller ‘Magnetics_Colordrape’ window to other areas of the Landsat window to see how the mag data compares with surface features.

This display technique can be very helpful for viewing and comparing multiple datasets or different processing techniques. You can add as many smaller “viewport” windows as needed.

Tip: It helps to think of the larger “master” window as a paper map sheet. Any other windows moved on top of the map sheet act like a “viewing port” into a different dataset or processing technique over the same geographic area.

Close one window and unlink the other

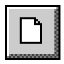
1 Activate the smaller ‘Magnetics_Colordrape’ window, then select **Close** from the **File** menu.

2 In the **Geoposition** dialog, select the **None** option, then click **Apply** to unlink the larger window.

4: Using Overview Zoom mode

Objectives Learn to link image windows in Geolink “Overview Zoom” mode, so you can define an area of interest on an overview window, and other linked windows automatically zoom to the defined area.

Open a different magnetics colordrape algorithm

1 Click the **New**  button.

A second image window opens. Drag it to the right side of the screen.

2 Click the **Open**  button.

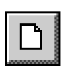
3 From the **Directories** menu, select the path ending with the text **\examples**.

4 Open the ‘Data_Types’ directory, then open the ‘Magnetics_And_Radiometrics’ directory.

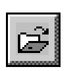
5 Double-click on the algorithm ‘Magnetics_1Q_Vertical_Derivative.alg’ to open it.

This algorithm displays a one-quarter grid spacing vertical derivative of the Newcastle magnetics data. Vertical derivatives enhance high frequency gradients (narrower features) that are usually associated with shallower magnetic bodies.

Open a third window and radiometrics algorithm

1 Click the **New**  toolbar button.

A second image window opens.

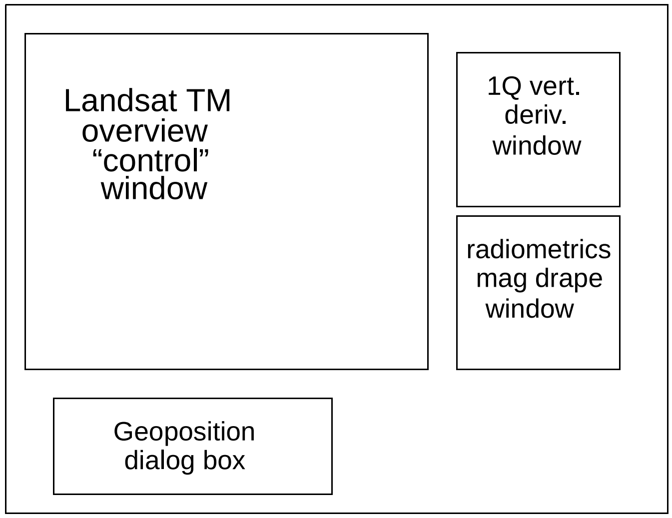
2 Click on the **Open**  button.

3 Double-click on the algorithm ‘Radiometrics_Magnetics_RGBI.alg.’

This algorithm shows radiometrics data in RGB draped over shaded magnetics to enhance structural features.

Resize and position the three windows

1 Resize and reposition the three windows as shown in the following diagram..



You should now have the two smaller image windows next to the larger window, and **Geoposition** dialog below them. The two smaller windows will be used as “zoom” windows to examine areas in more detail.

Set the large Landsat window to Overview Zoom mode

1 On the **Algorithm Geoposition Extents** dialog, select the **Geolink** tab.

2 Click inside the larger ‘Newcastle_TM_741’ image window to activate it.

3 In the **Geoposition** dialog, select the **Overview Zoom** option button.

4 Click the **Apply** button.

The window title indicates that it is now set to “OVERVIEW ZOOM” mode.

Note: When one window is set to **Overview Zoom** mode, any other image windows containing datasets in the same map projection are automatically linked to become “zoom” windows for that window. This is different to the way Window and Screen modes work, where all windows must be linked. (Windows containing datasets in different projections are not affected.)

Define an area of interest on the Landsat window

1 On the main menu, click the **Zoom Box Tool**  button.

The mouse is set to perform zoom and pan functions in image windows.

2 Inside the large Landsat TM image window on the left, drag a box to define an area of interest anywhere in the image.

Both of the smaller windows automatically zoom to show the same area you defined with the box. The larger master window remains unchanged because it is the “control” window. (In this mode, dragging a box does not zoom, but triggers zooming in the two smaller windows.)

3 Drag a box to define other areas of interest in the master window.

Both of the smaller “zoom” windows automatically zoom to magnify the area of interest. This makes it easy to view the vertical derivative or radiometrics data for any feature of interest you see in the Landsat overview window.

4 Click anywhere on the master image window.

Both of the smaller “zoom” windows pan to center on the area of interest. (By clicking, you can pan anywhere without changing the magnification level in the smaller zoom windows.)

Tip: **Overview Zoom** allows you quickly pick an area on an overview window and examine it in more detail in the zoom windows. This is an especially effective analysis technique when using different types, dates, or resolutions of imagery in the zoom windows. You can open as many zoom windows as you need.

Close image windows and dialogs

1 Close all three image windows using the window system controls:

- For Windows, click the  **Close** button in the upper-right window corner.

2 Click **Close** on the **Algorithm Geoposition Extents** dialog.

Only the ER Mapper main menu is now open.

What you learned...

After completing these exercises, you know how to perform the following tasks in ER Mapper:

- Display images with exact geographic extents and display resolutions
- Link image windows to show the same geographic extents
- Link image windows to a virtual map sheet window
- Control interactive image zooming and panning functions from a master window

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Raster data integration

This chapter shows you several common image processing and enhancement techniques for integrating two or more raster datasets in mineral exploration. Since mineral exploration requires analysis and synthesis of many different types of data, techniques that let you quickly see different relationships and associations are very valuable. You will learn integrate geophysical and geological data, highlight features or data ranges of interest over backdrop images, and use other ER Mapper features such as classification layers and scattergrams.

These exercises help show the ease with which ER Mapper can integrate very different types of data. Datasets with different data types can be displayed together without reformatting to a common type (for example, floating point real magnetics data and 8-bit integer Landsat data). Or, data with different cell sizes can be combined without resampling to a common cell size (e.g., 30m Landsat vs. 100m magnetics).

You will learn to create complex algorithms that use several layers, and to create various types of display techniques that let combine and integrate datasets data in different ways. This capability is one of the most powerful features of the "algorithms" concept, and is how you will use ER Mapper routinely when you become more comfortable with it.

Hands-on exercises

These exercises show you how to integrate and highlight information from two or more datasets using colordraping, classification layers, transparency between surfaces, and other techniques.

What you will learn... After completing these exercises, you can perform the following tasks in ER Mapper:

- Create multiple Intensity layers for use as backdrop images
- Use scattergrams to help analyze data and create color thematic overlays
- Define transparency between different 2D surfaces/images
- Combine various displays of magnetics, radiometrics, Landsat and vector GIS data in a single algorithm.

Before you begin... Before beginning these exercises, make sure all ER Mapper image windows are closed. Only the ER Mapper main menu should be open on the screen.

1: Geophysical data integration

Objectives Learn to create a single algorithm with many layers that allows you to quickly view different enhancements of a single dataset, and to integrate and view common combinations of different data types. Also learn to use scattergams and Classification layers to highlight specific ranges of data.

Load a magnetics Vertical Derivative algorithm

1 Click the **Edit Algorithm**  button.

An image window and the **Algorithm** dialog appear.

2 Click the **Open**  button.

3 From the **Directories** menu, select the path ending with the text **\examples\Data_Types**.

4 Open ‘Magnetics_And_Radiometrics’ directory.

5 In the **Files of Type:** field, select “ER Mapper Algorithm (.alg)”

6 Double-click on the algorithm ‘Magnetics_1Q_Vertical_Derivative.alg.’

The algorithm is one-quarter vertical derivative of the Newcastle magnetics dataset. The 1st vertical derivative is a high frequency enhancement of the magnetics data that highlights shallow structures. You will use this as a backdrop image on which to display other types of data.

7 Make the image window 50% larger by dragging a corner.

8 Change the Pseudo layer's label to **`structure (1Q VD)`**.

9 Right-click the 'structure (1Q VD)' layer and select **Intensity**.

The layer type change to Intensity. (Since the mag data will be used as part of a colordrape, you need to change it to an Intensity layer so other color layers will merge with it.)

10 For now, right-click the 'structure (1Q VD)' layer and select **Turn Off**.

Add a second Intensity layer for shaded magnetics

1 In the **Algorithm** dialog, select **Edit**, then **Add Raster Layer**, then **Intensity**.

A second Intensity layer is added to the algorithm layer list.

2 Click the **Load Dataset**  button in the process diagram.

3 Double-click on the dataset 'Newcastle_Magnetics.ers' to load it.

4 Click the **Edit Realtime Sunshade**  button in the process diagram, then turn on the **Do sun-shading** option in the **Edit Sun Angle** dialog.

Sun shading is applied to magnetics dataset to highlight structures.

5 Click **Close** in the **Edit Sun Angle** dialog to close it.

6 In the layer's description field, type **`structure (NE shade)`**.

You now have two different enhancements of the magnetics data–one to highlight shallow features and another to highlight gradients and structural features. You will alternate between using these two images as backdrops for other data.

7 For now, right-click the 'structure (NE shade)' layer and select **Turn Off**.

Add a Pseudocolor layer to view total magnetic intensity

1 In the **Algorithm** dialog, select **Edit**, then **Add Raster Layer**, then **Pseudo**.

A new Pseudocolor layer is added to the algorithm.

2 Click the **Load Dataset**  button in the process diagram.

3 Double-click on the dataset 'Newcastle_Magnetics.ers' to load it.

4 Click the **Surface** tab, then select **pseudocolor** from the 'Color Table' list.

5 The magnetics data in pseudocolor is displayed.

The magnetics data displays in color. Color images of total magnetic intensity (TMI) are often useful for highlighting gradients indicating the dip and depth of ore bodies. (This dataset has already been scaled into a 0-255 range, so no adjustments to the transform limits were necessary.)

6 Click the **Layer** tab.

7 Change the Pseudo layer's label to **`TMI (color)`**.

8 For now, right-click the 'TMI (color)' layer and select **Turn Off**.

Add a second Pseudo layer to view a Landsat iron oxide ratio

1 In the **Algorithm** dialog, select **Edit**, then **Add Raster Layer**, then **Pseudo**.

A new Pseudocolor layer is added to the algorithm.

2 Click the **Load Dataset** button in the process diagram.

3 From the **Directories** menu, select the **\examples** path.

4 Open the 'Application\Mineral_Explroration' directory, then double-click on the dataset 'Newcastle_Landsat.ers' to load it.

Enter the band ratio formula and display the image

1 Click the **Edit Formula** button in the process diagram.

The **Formula Editor** dialog box opens and shows the default formula "INPUT1."

2 In the Generic formula window, edit the formula text to read:

```
input1 / input2
```

3 Click the **Apply changes** button.

4 In the Relations window, select **B3:0.66_um** from the drop-down list next to "INPUT1," and select **B1:0.485_um** from the "INPUT2" drop-down.

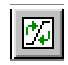
The 3/1 band ratio is a simple iron oxide minerals ratio.

5 Click the **99% Contrast Enhancement** button.

The iron oxide ratio image shows iron-rich rocks (higher ratio values) in yellow and red, and iron-poor rocks in blue and cyan.

6 Click **Close** in the **Formula Editor** dialog.

7 Change the Pseudo Layer's label to **`Landsat iron ratio`**.

Note: The **99% Contrast Enhancement**  button sets all active layers to a 99% clip transform. Any layers that are turned off (the first three in this case) are not affected. This can be desirable if you have other types of transforms set up for other layers and do not want them changed automatically.

Turn on the Landsat ratio off and the TMI layer on

1 Right-click the 'Landsat iron ratio' layer and select **Turn Off**.

2 Right-click the 'TMI (color)' layer and select **Turn On**.

3 The magnetics data in color is displayed.

View a scattergram of the radiometrics data

A *scattergram* allows you to graphically see the correlation between the data values in two dataset bands. These two numbers locate each pixel in the two-dimensional measurement space of the X-Y graph. In ER Mapper, you can also use scattergrams as an automated way to define and display color overlays of data thresholds using Classification layers.

1 From the **View** menu, select **Scattergrams...**.

The **Scattergram** and **New Map Composition** dialog boxes open.

2 Click **Cancel** in the **Map Composition** dialog to close it. (You do not need it for this exercise.)

The **Scattergram** dialog automatically references the dataset in the active layer ('Newcastle_Magnetics.ers'). You will choose to view scattergrams for the radiometrics dataset instead.

3 In the **Scattergram** dialog, click the **Setup...** button.

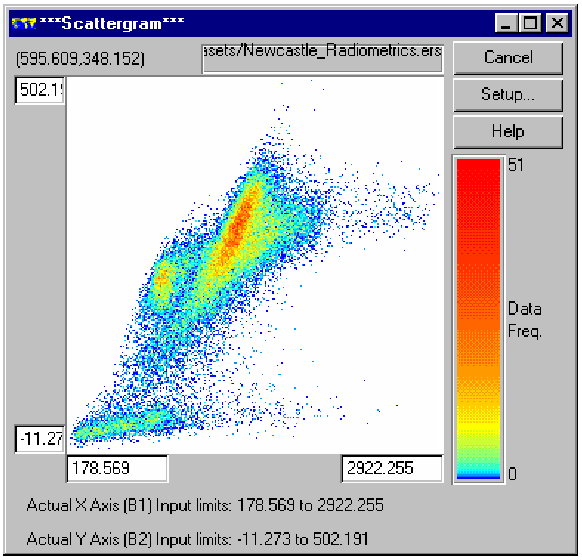
The **Scattergram Setup** dialog box opens. Move the two scattergram dialogs as needed to see them both and the the image window (you can cover the **Algorithm** window for now).

4 In the **Scattergram Setup** dialog, click the  button next to 'Dataset/ Algorithm.'

5 In the file chooser, double-click on the dataset 'Newcastle_Radiometrics.ers' to load it.

6 In the **Scattergram Setup** dialog, click the **Limits to Actual** button.

ER Mapper displays a scattergram of the radiometrics dataset in the **Scattergram** dialog..



The scattergram plots band 1 (Total Count) of the dataset on the X (horizontal) axis and band 2 (Potassium) on the Y (vertical) axis. The cluster of points is shown using various colors inside the scattergram window. The colors represent the *accumulated frequency* (or "density") of data values in both bands. Areas of the scattergram with the highest densities of points are shown in colors in the upper part of the color bar (red and yellow), and low density areas in the lower colors (blue and magenta).

7 Without depressing the mouse, move the cursor around inside the scattergram.

The current X-Y location of the cursor (relative to the range of values in each band) is shown in the upper-left corner of the **Scattergram** dialog.

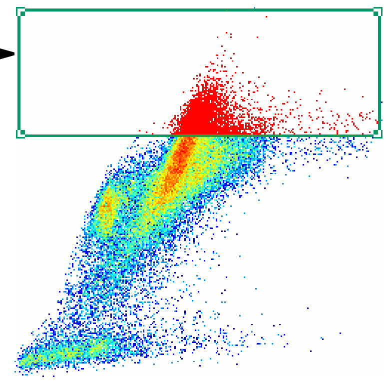
The wide dispersion of points indicates that there is only a moderate correlation between the Total Count and Potassium values. The frequency of points and shape of the scattergram can reveal anomalies in the dataset that may not be apparent when looking at the data in other ways.

Draw a box in the scattergram to highlight Potassium highs

By defining a region box in the scattergram, you can highlight the corresponding pixels in the image window. For example, suppose you want to highlight all the areas that exceed a certain threshold of Potassium values. The Potassium highs are the spread of points in the upper part of the scattergram window.

1 In the **Scattergram Setup** dialog, click the **Set Color** button, select a magenta (purple) color, then click **OK**.

2 In the **Scattergram** dialog, drag box around the uppermost spread of points (see the diagram below).



When you release the mouse, ER Mapper runs the algorithm and draws a magenta overlay showing all pixels in the image window whose data values fall within the box limits you defined in the scattergram (in this case potassium readings exceeding about 320 cps).

Revise the region box to highlight another data range

Notice that the region box in the **Scattergram** dialog is selected (it has “handles” at the four corners). You can move or resize the box by dragging the handles.

1 In the **Scattergram** dialog, resize and shape your region box by dragging the box or any of the four handles to enclose a range of data values.

For example, Potassium lows would be all the points at the bottom, Total Count high would be all the points on the right side, and so on.

2 After revising the box, ER Mapper updates the color overlay to highlight the range of time values falling within the box’s data limits.

3 Change the box location or size to highlight other clusters of pixels in the scattergram, the class will be highlighted in the image window.

Close the scattergram dialogs and examine the new layer

1 Click **Cancel** in the **Scattergram Setup** dialog to close it,

2 Click **Cancel** in the **Scattergram** dialog–when asked to delete scattergram layers, click **No**.

Notice that ER Mapper has added another layer to your algorithm named ‘Scatter Region.’ This layer is the type Classification and was automatically added by the Scattergram function to display the color overlay. Classification layers are a special type of raster layer that are designed for displaying thematic data in a single solid color.

3 Click the **Edit Formula** button in the process diagram.

The Scattergram function automatically added an “if-then-else” formula that defines upper and lower thresholds for the total count and potassium data. (These are the limits of the box you drew in the scattergram.) You can also manually define thresholds of any data by entering similar formulas and threshold values in a Classification layer.

4 Click **Close** in the **Formula Editor** dialog.

5 Change the the ‘Scatter Region’ layer’s label **`K highs (magenta)`**.

Display the potassium highs over the magnetics 1Q VD

1 Turn on only the two layers labelled ‘structure (1Q VD)’ and ‘K highs (red).’ (Make sure all other layers are off.)

The areas exceeding potassium values of 300 are highlighted in magenta over the 1Q VD image. This type of display lets you see spatial relationships between potassium-rich rocks (which sometimes indicate the presence of clays) and the shallower/narrower magnetic bodies.

Display the clay ratio over the shaded magnetics

1 Turn on only the two layers labelled ‘structure (NE shade)’ and ‘Landsat clay ratio.’ (Make sure all other layers are off.)

Areas of clay bearing soils are highlighted over the sun shaded magnetics image showing structure.

Display other image combinations

1 Turn on any desired layers to see different combinations of data and/or processing techniques.

A couple of hints to remember:

- Use only one Intensity layer at a time. If two or more Intensity layers are turned on, you will see only the data in the highest layer in the list. (If the data in the two layers covers different geographic extents, you will see the areas of lower layers where there is no overlap.)

- Classification layers *always* cover other raster layer types, regardless of their position in the algorithm layer list
- If you have two or more Classification layers turned on, the data in lower Classification layers will be covered by data in higher Classification layers where the colors overlap.

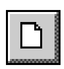
(optional) Save the integration algorithm

1 If desired, use **File/Save As** in the main menu window to save the algorithm in the \examples\Miscellaneous\Tutorial directory.

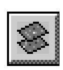
2: Landsat data integration

Objectives Learn to use data from a Landsat image as a backdrop with magnetics, radiometrics, and GIS vector data overlays. Landsat and other satellite or airphoto images are often combined with geophysical data such as magnetics and radiometrics to provide detailed geological context and surface alteration information.

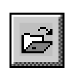
Create a Landsat TM greyscale algorithm

1 Click the **New**  button in the main menu window.

ER Mapper opens a new image window.

2 Click the **Edit Algorithm**  button.

An image window and the **Algorithm** dialog appear.

3 In the Algorithm window click the **Load Dataset**  button.

4 From the **Directories** menu, select the path ending with the text **\examples**

5 Double-click on the directory ‘Application\Mineral_Exploration’ to open it, then double-click on the dataset named ‘LandsatTM.ers’ to load it.

6 Click **OK** in the **Select a Dataset** dialog.

ER Mapper displays band 1 of the Cape York peninsula Landsat image.

7 From the **Band Selection** list (in the process diagram), select **B5:1.65_um**.

8 Click the **99% Contrast Enhancement** button.

ER Mapper renders band 5 of the Landsat image in the image window. Band 5 (mid infrared reflectance) provides good discrimination of structural geology features. (Band 4 is also used for this purpose.)

9 Make the image window 50% larger by dragging a corner.

10 In the Pseudo layer's description field, type **`TM5 (structure)`**.

11 Right-click the Pseudo layer and select **Intensity**.

(Since the TM data will be used as part of a colordrape, you need to change it to an Intensity layer so other color layers will merge with it.)

12 For now, right-click the 'TM5 (structure)' layer and select **Turn Off**.

Create an Intensity layer for a Landsat TM clay ratio image

1 In the **Algorithm** dialog, click the **Duplicate** button.

ER Mapper creates a copy of the 'TM 5 (structure)' layer.

2 Right-click the duplicated layer and select **Turn On**.

3 Change the duplicated layer's label to **`TM clays (structure)`**.

4 Click the **Edit Formula** button in the process diagram.

5 In the Generic formula window, edit the formula text to read:

```
input1 / input2
```

6 Click the **Apply changes** button.

7 In the Relations window, select **B5:1.65_um** from the drop-down list next to "INPUT1," and select **B7:2.215_um** from the "INPUT2" drop-down.

Ratioing TM bands 5 and 7 highlights clay-bearing soils in the image.

8 Click the **99% Contrast Enhancement** button.

The clay ratio image displays in greyscale. (If both Intensity layers were turned on, you would see the TM band 5 data since that layer is on top.)

Create a color layer for the magnetics data

1 In the **Algorithm** dialog, select **Edit**, then **Add Raster Layer**, then **Pseudo**.

A new Pseudocolor layer is added to the algorithm.

2 Click the **Load Dataset** button in the process diagram.

3 From the **Directories** menu, select the **\examples** path.

4 Open the ‘Shared_Data’ directory, then double-click on the dataset ‘Magnetics_Grid.ers’ to load it.

5 Click the **Surface** tab, then select **pseudocolor** from the ‘Color Table’ list.

6 Click the **Layer** tab again.

7 Change the Pseudo Layer’s label to **`Mag TMI (color)`**.

Display the magnetics data over the Landsat backdrops

1 Right -click and turn off the ‘TM clays (structure) Intensity layer, and turn on the ‘TM5 (structure)’ Intensity layer.

2 Click the **99% Contrast Enhancement** button.

The total magnetic intensity (TMI) data displays in color over the Landsat band 5 backdrop image. The Landsat image provides context to help evaluate trends in the magnetics data. The red and yellow colors show the mag high running diagonally through the image.

3 Turn on the Intensity layer labelled ‘TM clays (structure),’ and turn off the layer labelled ‘TM 5 (structure).’

The TMI data displays in color over the Landsat clay ratio image, so you can see the spatial relationship between clay-bearing soils (lighter parts of the image) and magnetic trends (in color).

Create a color layer for a radiometrics K/Th ratio

1 Select the ‘Mag TMI (color)’ layer in the layer list.

2 In the **Algorithm** dialog, select **Edit**, then **Add Raster Layer**, then **Pseudo**.

A new Pseudocolor layer is added to the algorithm.

3 Click the **Load Dataset** button in the process diagram.

4 From the **Directories** menu, select the **\examples** path.

5 Open the ‘Shared_Data’ directory, then double-click on the dataset ‘Radiometrics_Grid.ers’ to load it.

6 Change the lower Pseudo layer’s label to **`K/Th ratio (color)`**.

7 Click the **Edit Formula** button in the process diagram.

8 In the **Formula Editor** dialog, edit the formula text to read:

```
input1 / input2
```

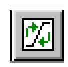
9 Click the **Apply changes** button.

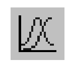
10 In the Relations window, select **B2:Potassium** from the drop-down list next to “INPUT1,” and select **B3:Thorium** from the “INPUT2” drop-down.

Ratioing Potassium and Thorium (K/Th) can also highlight clay-bearing soils.

Display the K/Th ratio over the Landsat clay ratio backdrop

1 Turn off the upper Pseudo layer labelled ‘Mag TMI (color).’

2 Click the **99% Contrast Enhancement**  button in the main menu window.

3 Click the post-formula **Edit Transform Limits**  button in the process diagram.

4 In the **Transform** dialog, click the **Histogram Equalize**  button.

ER Mapper applies a Histogram Equalize transform to increase the contrast between colors.

The K/Th ratio image displays in color over the Landsat clay ratios backdrop image. As shown, there is a strong spatial relationship between the K/Th highs (reds) and the Landsat clay ratio. You have combined two types of data to confirm the presence of clays in the area. (The brighter parts of the image created by high intensity should corresponds to the yellow and red colors of the K/Th highs.)

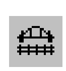
5 Click **Close** in the **Transform** dialog.

Add an ARC/INFO vector coverage of mine locations

1 Select the ‘K/Th (color)’ layer.

2 In the **Algorithm** dialog, open the **Edit** menu, select **Add Vector Layer,** then **ARC/INFO Overlay**.

An empty ARC/INFO coverage vector layer is added. This layer type lets you directly load, display and edit ARC/INFO vector coverages.

3 Click the **Dynamic Link Chooser**  button in the process diagram.

4 In the **ARC/INFO Chooser** dialog, click the  button next to the ‘Workspace’ field.

5 From the **Directories** menu (in the **ARC/INFO Workspaces** dialog), select the path ending with **\examples**.

6 Open the ‘Applications\Mineral_Exploration’ directory.

7 Click ***once*** on the ‘ARCINFO_Geology’ directory to select it, then click **Select**.

8 From the drop-down list next to ‘Coverage’ (in the **ARC/INFO Chooser** dialog), select **minloc**.

9 From ‘Line Width’ list, select **2.0**.

10 Click **OK** in the **ARC/INFO Chooser** dialog to close it.

11 In the ARC/INFO layer’s description field, type **`mine locations`**.

12 The algorithm with the ARC/INFO overlay is re-displayed.

The locations of mines are displayed as white crosses over the image. The mines occur along a fault that is shown by lithology changes in both the radiometrics and Landsat clay ratio images.

Display mag TMI over Landsat band 5 again

1 Turn on only the layers labelled ‘TM5 (structure)’ and ‘Mag TMI (color).’ (Turn the other three off.)

2 The magnetics TMI in color over a Landsat band 5 backdrop is displayed.

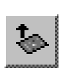
Open the geology map algorithm into a new surface

1 In the main menu window, select **Open into New Surface** from the **File** menu.

2 From the **Directories** menu (in the **Open into New Surface** dialog), select the path ending with **\examples**.

3 Open the ‘Application\Mineral_Exploration’ directory, then double-click on the algorithm ‘Scanned_Geology_1960.alg.’

The algorithm is opened into a new surface named ‘[RGB]:Scanned Geology Map 1960’ in the current algorithm.

4 Select the ‘[RGB]:Scanned Geology Map’ surface, then click the **Move Up**  button.

The surface (and its layers) move above the other surface and the image redraws to show the scanned geology map algorithm.

5 Click the **Surface** tab, then move the ‘Transparency’ slider to its midpoint.

The geology map image becomes partially transparent so the magnetics/Landsat colordrape image underneath becomes visible.

6 Adjust the ‘Transparency’ slider to try different combinations of the two images.

As you can see, transparency between surfaces (and images) can be a fast and easy way to find relationships and anomalies between different datasets.

Tip: Move the surface that you want to make transparent to the top of the data structure diagram. You can also set transparency for two or more surfaces at once, but this can become difficult to interpret.

(optional) Save the integration algorithm

1 If desired, use **File/Save** As to save the algorithm.

Close the image windows and Algorithm dialog

1 Close both image windows using the window system controls:

- For Windows, click the  **Close** button in the upper-right window corner.
- For Unix systems, select **Close** or **Quit** from the window control menu in the upper-left corner (for systems with both options, select **Quit**).

2 Click **Close** in the **Algorithm** dialog.

Only the ER Mapper main menu is now open.

What you learned...

After completing these exercises, you know how to perform the following tasks in ER Mapper:

- Create multiple Intensity layers for use as backdrop images
- Use scattergrams to help analyze data and create color thematic overlays
- Define transparency between different 2D surfaces/images
- Combine various displays of magnetics, radiometrics, Landsat and vector GIS data in a single algorithm

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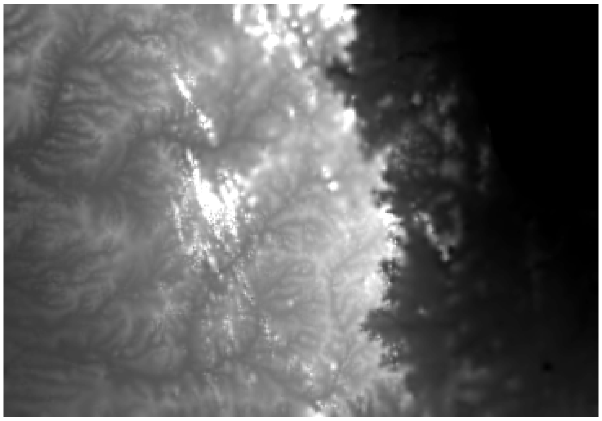
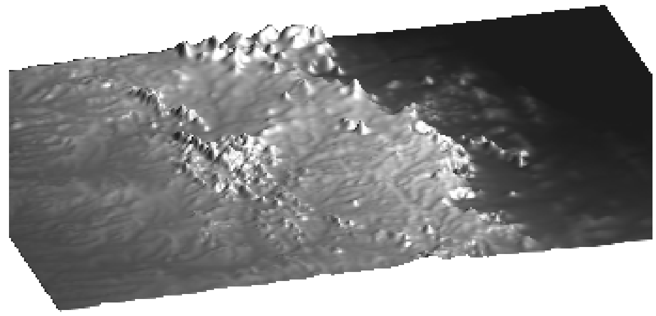
3-D perspective viewing

This chapter explains how to view and manipulate images in 3D perspective to gain a better understanding of terrain features, relationships, and other aspects of your data. ER Mapper lets you quickly change between 2D and 3D views of your data, stack multiple surfaces in a single view, set transparency between surfaces, and many other features.

About perspective viewing



Two-dimensional (planimetric) view



Three-dimensional perspective view

Viewing images in three-dimensional perspective is a valuable tool that helps increase understanding of features and relationships in datasets. Many types of earth science datasets can be integrated to create 3D scenes that show features and anomalies much more clearly than traditional two dimensional views. To create a 3D view, you simply add a Height layer to your 2D algorithm (such as a digital terrain model or magnetics dataset), then change the View Mode to 3D perspective or 3D flythrough.

ER Mapper's 3D viewing capabilities are extensive and easy to use, including:

- view any dataset in 3D, and quickly switch between 2D and 3D views
- use static 3D perspective or real-time "flythrough" modes
- stack multiple surfaces (for example, satellite and geophysical datasets) in a single view
- set transparency between surfaces to view underlying features
- incorporate vector data in 3D, such as interpreted faults or lease boundaries
- generate top quality, high resolution 3D hardcopy prints

Hands-on exercises

These exercises give you practice setting up algorithms for 3D viewing, and manipulating the images using the viewing and display controls in ER Mapper's 3D perspective viewer.

What you will learn...

After completing these exercises, you will know how to perform these tasks in ER Mapper:

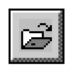
- Prepare an algorithm for 3D viewing by adding a Height layer
- Change the viewpoint, zoom level, and other 3D view parameters
- Use the 3D Flythrough viewing mode
- Stack multiple surfaces in a 3D view and set surface offset and transparency
- Merge separate algorithms into surfaces in a single algorithm

Before you begin... Before beginning these exercises, make sure all ER Mapper image windows are closed. Only the ER Mapper main menu should be open on the screen.

1: 3D viewing basics

Objective Learn to prepare an algorithm for 3D viewing by adding a Height layer that contains the desired elevation data. Also learn to use 3D perspective view mode, and control the viewpoint and display parameters of the 3D scene.

Create a color digital terrain algorithm

1 On the main menu, click the **Open**  button.

A new image window and the **Open** file chooser dialog box appear.

2 From the **Directories** menu (on the **Open** dialog), select the path ending with **\examples**.

3 Open the ‘Applications\Mineral_Exploration’ directory, then double-click on the dataset named ‘Digital_Terrain.ers’ to load it.

4 Click **OK** on the **Select a Dataset** dialog.

ER Mapper executes a batch script that displays the digital terrain dataset as a greyscale image.

5 From the **View** menu, select **Algorithm**.

6 On the **Algorithm** dialog, click the **Surface** tab, then select **pseudocolor** from the ‘Color Table’ list.

This algorithm displays digital terrain (elevation) data of the Cape York peninsula area of Australia in color. Low elevations are blue (sea level), highest elevations (about 450 meters) are red. The flat blue area in the upper right is the ocean (Princess Charlotte Bay) with the Great Dividing Range mountains shown in red and yellow running north-south.

Duplicate the Pseudo layer to create a Height layer

1 Click the **Layer** tab to show the process diagram again.

2 On the **Algorithm** dialog, click the **Duplicate** button.

ER Mapper makes an exact copy of the layer below the original.

3 Right-click on the copied layer, and select **Height**.

The Pseudo layer changes to a Height layer and ER Mapper sets the layer description to ‘Height layer.’ The layer is currently crossed out because it is not active until you switch to 3D perspective View Mode.

Note: You could also use the **Edit** menu to add a new Height layer and load the dataset, but duplicating and changing is easier because the layer already contains the desired dataset and transform limits.

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4 Click the post-formula **Edit Transform Limits** button in the process diagram.

5 On the **Transform** dialog, click the **Create default linear transform** button.

Note: When using data in a Height layer, *do not* apply transforms that clip the data as a general rule. Portions of the histogram that are clipped will appear as flat areas in the 3D perspective view.

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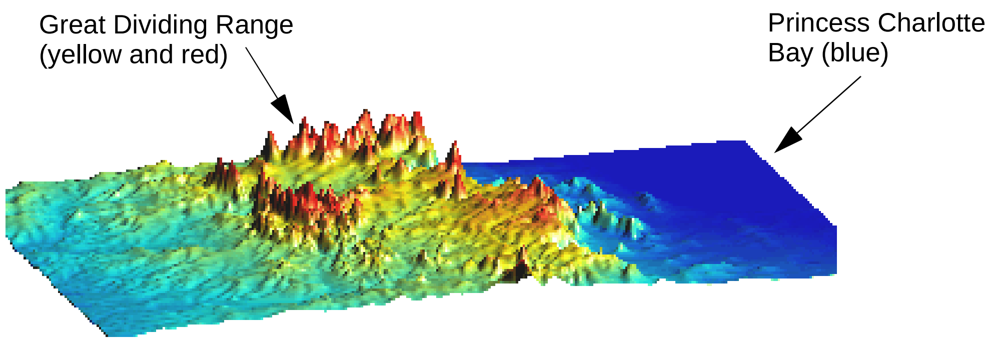
6 Click **Close** on the **Transform** dialog.

You have now duplicated the digital terrain layer and changed the layer type to create a elevation (height) component for your algorithm.

Select 3D Perspective mode to view the image in 3D

1 From the ‘View Mode’ menu (on the **Algorithm** dialog), select **3D Perspective**.

ER Mapper displays a message that the image is being processed, then displays a 3D perspective view of the image in color. The message “Regenerating Terrain” appears in the image window as ER Mapper performs iterations to increase the resolution (detail) in the 3D image.



The perspective view provides clear definition of the topography of the area, which can be important when interpreting data derived from geophysical and satellite images.

Tilt the image forward or backward

1 On the main menu, click the **Zoom Tool** button.

2 Point to lower edge of the terrain image and drag slightly downward.

The image moves into a more overhead view perspective, and regenerates detail when you release the mouse button.

3 Point to lower edge of the image and drag slightly upward.

The image moves into a flatter, side view perspective. Dragging the image up or down tilts the 3D model forward or backward (rotates it around its X axis).

Note: If you accidently change the 3D view too much, click the **3D View** tab in the **Algorithm** dialog, then click the **Reset View** button. This resets the the image to a standard default view.

Rotate the image around its center point

1 Point to lower edge of the image and drag slightly right.

The image rotates to the right around its center point.

2 Point to lower edge of the image and drag slightly left.

The image rotates to the left around its center point. Dragging the image left or right lets you view it from a side angle (rotate around the Z axis).

Zoom the image in and out

1 Drag the image window corner to make it 50% larger.

The 3D view enlarges with the window.

2 Point to the center of the image. Then press right mouse button and drag slightly upward.

As you drag, ER Mapper zooms out so the image redraws at a smaller size.

3 Point to the image center again, press right mouse button and drag slightly downward.

ER Mapper zooms in so the image redraws at a larger size.

Pressing the right mouse button and dragging up or left zooms the image out; dragging down or right zoom the image in.

4 Set the zoom extents for the image so it fills as much of the window as possible.

Rotate the image side to side

1 Point to the center of the image. First depress the left mouse button, then the right button (hold down both), then drag slightly to the right.

ER Mapper rotates the image to the right.

2 Point to the image center again, depress the left then the right mouse buttons, and drag slightly to the left.

The image rotates left. Pressing the left *then* the right mouse buttons and dragging left or right is how you rotate the image side to side (around its Y axis).

Pan (scroll) the image within the window

1 Point to the center of the image. First depress the right mouse button, then the left button (hold down both), then drag slightly upward.

ER Mapper pans (or scrolls) the image upward without changing the perspective.

2 Point to the image center again, depress the right then the left mouse buttons, and drag around inside the window.

The image repositions as you drag. Panning in 3D is useful when want to reposition the image in the window without changing the zoom factor or viewing perspective.

Summary of 3D movement procedures

- To tilt the image backward or forward, press left mouse button and drag toward the top of the image window (to tilt backward) or bottom (to tilt forward).
- To tilt the image side to side, press left mouse button followed by right mouse button and drag to the left (to tilt left) or right.
- To the zoom the image in or out, press right mouse button and drag toward the bottom of the image window (to zoom in) or top (to zoom out).
- To rotate the image around its center axis, press left mouse button and drag the left or right side of the image (or bounding box) toward the edge of the image window.
- To move the entire image within the window (without changing size or perspective), press right mouse button followed by left mouse button and drag to the desired location in the image window.

Change the color table for the 3D image

1 Click the **Surface** tab in the **Algorithm** dialog.

The **Surface** tab page now includes additional options for **Z scale** and **Z offset**. (These options only appear when 3D Perspective or 3D Flythrough is selected as the View Mode.)

2 From the ‘Color Table’ drop-down menu, select **rainbow1**.

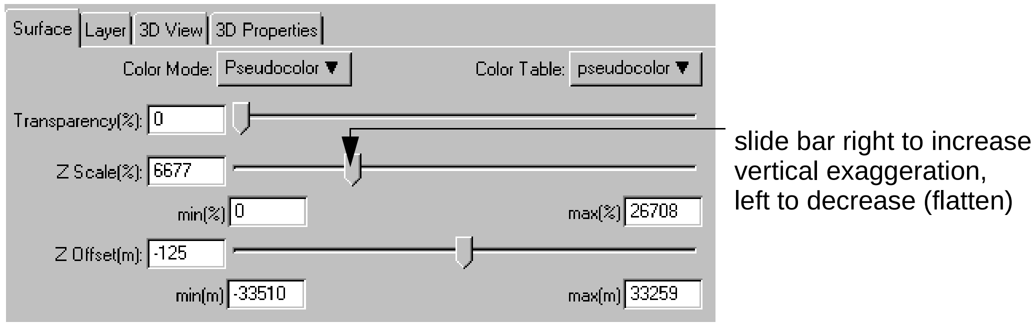
ER Mapper regenerates the 3D image using colors in the ‘rainbow1’ color table.

3 Click on the ‘Color Table’ menu, then select **pseudocolor** again**.**

ER Mapper lets you change many parameters of the image display while viewing in 3D mode. These include color tables, transforms, filters, formulas, sun angle shading, and more.

Increase the vertical exaggeration of the image

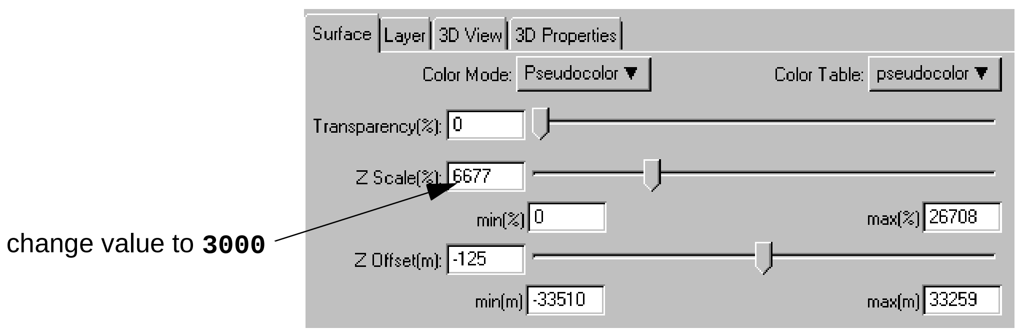
1 Move the **Z scale** slider bar slightly to the right.



The image redisplays with increased vertical exaggeration, so high and low elevations in the image become more apparent.

2 Try different exaggerations by moving the the **Z scale** slider bar.

3 Change the **Z scale(%)** value to **`3000`**.



Tip: ER Mapper interprets height values to be in the same units as X and Y distances. For example, if your X and Y distances are measured in meters (as in this case) and you set **Z scale(%)** to 100, a data value of 100 is interpreted as 10 meters (so elevation is true to geographic scale). However, much greater vertical exaggeration is usually needed to clearly bring out subtle topographic details.

Apply different rendering modes for the 3D image

1 Select the **3D View** tab in the **Algorithm** dialog.

The 3D View tab page provides draw mode, terrain detail, lighting, and other options. These setting affect the entire 3D image (which can contain multiple surfaces as you will see later).

2 From the **Draw Mode** drop-down list, select **WireFrame**.

ER Mapper redisplays the image as a mesh connected grid lines.

3 For **Draw Mode**, select **Textured**.

ER Mapper redisplays the image in blocks using a texture algorithm. (This mode requires the most calculations and may take some time for large images.)

4 For **Draw Mode**, select **Smooth Shaded** again.

ER Mapper redisplays the image with a smooth, solid fill. (Smooth shaded is generally the best choice for digital terrain or geophysical data.)

Use the Lighting and Bounding Box options

1 Turn off the **Lighting** option.

The image redraws without illumination from a light source.

2 Turn the **Lighting** option on again.

The image redraws with shading effects from a light source. (Lighting is recommended for digital terrain and geophysical datasets that have no natural shadowing.)

3 Turn on the **Bounding Box** option.

The image redraws with a bounding box surrounding it. The box shows the extents of the image in the X, Y and Z (vertical) directions.

4 Turn off the **Bounding Box** option.

Tip: The **Draw Mode** named **Auto** tells ER Mapper to choose a draw mode automatically based on the characteristics of your computer hardware. For digital terrain or geophysical data, Smooth Shaded mode with Lighting on is usually the best choice.

Adjust the Terrain Detail control

1 Move the **Terrain Detail** slider all the way to the right.

The image redraws with increased detail in the terrain.

2 Move the **Terrain Detail** slider all the way to the left again.

The image redisplays with decreased detail.

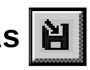
Terrain Detail refers to the resolution, or amount of detail, at which the image will be rendered. As you increase the detail, the rendering time and amount of system memory needed also increase. It is recommended that you start at low detail settings, then slowly increase the detail to get a more accurate, high resolution image.

Save the 3D algorithm

1 Adjust the viewpoint of the image to a pleasing position.

2 In the **Algorithm** dialog, change the **Description** field text to:

    `Cape York DTM in 3D perspective`

3 On the main menu, click the blue **Save As**  button.

4 In the **Save As** dialog **Files of Type** field, select ‘ER Mapper Algorithm (.alg)’.

5 From the **Directories** menu (on the **Save As** dialog), select the path ending with **\examples**.

6 Double-click on the ‘miscellaneous\tutorial’ directory to open it.

7 In the **Save As:** text field, enter your initials followed by the text **`Digital_terrain_3D`** and separate each word with an underscore (_).

8 Click **OK** to save the algorithm.

Your 3D perspective algorithm is now saved to an algorithm file on disk. The next time you open it, the image automatically displays in 3D with the same viewpoint and rendering parameters.

2: 3D flythrough basics

Objective Learn to view an image in 3D Flythrough mode, and control the viewpoint and flight parameters.

In 3D Flythrough mode, it is as though the ground is stationary and you move around it, exploring the terrain. You depress the mouse button to begin your flight through the image, and the area where you position the mouse cursor controls the direction and speed of your flight.

Select 3D Flythrough mode to move through the image in 3D

1 On the **Algorithm** dialog, click the **Reset View** button (on the **3D View** tab).

The viewpoint is reset to a default perspective. This is recommended before changing to 3D Flythrough view mode.

2 From the 'View Mode' menu (on the **Algorithm** dialog), select **3D Flythrough**.

Fly through at different directions and speeds

To fly through the image, depress the left mouse button and point to an area of the image window to control the direction and speed of the flight. As you fly through the image, the terrain will appear to move in the opposite direction of your motion.

1 Point to the lower center of the image window and depress the left mouse button.

You fly backward away from the image.

2 Point to the upper center of the image and depress the left button.

You fly forward toward the image.

3 Point to the right center of the image and depress the left button.

You fly toward the right side of the image.

4 Point to the left center and depress the left button.

You fly back toward the left side of the image.

5 Point to the lower-right corner of the window and depress the left button.

You fly backward *and* to the right away from the image.

6 Point slightly above the center point of the window and depress the left button.

You fly forward slowly into the image.

Tip: To fly slowly, point near the window center. To fly faster, point further out toward the window edges.

Change the viewing altitude

1 Point to the center of the image window and depress the right mouse button.

The mouse cursor changes to a double-headed arrow pointing up and down.

2 With the right button depressed, drag slightly upward.

Your altitude increases, so you look more down on the 3D image.

3 With the right button depressed, drag slightly downward.

Dragging up or down with the right button depressed lets you change viewing altitude.

Tip: If you become lost while flying around, click the **Reset View** button to return to the default viewpoint again.

Summary of 3D Flythrough controls

- To fly forward or backward, press the left mouse button in the top half of the image window (to fly backward) or bottom half (to fly forward).
- To fly left or right, press the left mouse button in the left half of the image window (to fly left) or right half (to fly right).
- To the change viewing altitude, press the right mouse button and drag up or down.
- To control the speed of flight, point close to the center of the window for slow speed, and further out toward the window edges for progressively faster speeds.

3: Viewing multiple surfaces in 3D

Objective Learn to view two or more surfaces in 3D perspective, and control the offset, transparency, and other parameters of the view.

Up until now, you have created algorithms that contained only one surface. .In a sense, you can think of each surface as a separate image, or a separate view of your data. Since you use an algorithm to create a certain type of image, you can copy or merge different types of algorithms as separate surfaces in a single algorithm and stack the images in a single 3D view. Stacking multiple surfaces into a single 3D view can be an especially powerful feature for analyzing different types of geophysical or satellite data because it lets you quickly see relationships.

Open a sample Landsat RGB=741 algorithm

1 On the main menu, click the **Open**  button.

2 From the **Directories** menu, select the **\examples** path.

3 In the ‘Applications\Mineral_Exploration’ directory, double-click on the algorithm ‘Newcastle_TM_741.alg.’

This algorithm displays bands 7, 4 and 1 of the Newcastle Landsat image in RGB. Vegetated areas are dominantly green.

Add the magnetics data as a Height layer

1 On the **Algorithm** dialog, select **Edit**, then **Add Raster Layer**, then **Height**.

An empty Height layer is added to the algorithm.

2 On the **Algorithm** dialog, click the **Load Dataset**  button in the process diagram.

3 From the **Directories** menu, select the path ending with **\examples**.

4 Open the ‘Shared_Data’ directory, then double-click on the dataset named ‘Newcastle_Magnetics.ers’ to load it.

5 From the ‘View Mode’ menu, select **3D Perspective**.

ER Mapper renders the image in 3D perspective.

6 Tilt the image down lightly to get a more overhead view.

7 Click the **3D View** tab, then turn off **Lighting**.

In this case, the elevation component is the magnetic field strength (not actual topography). The “valley” surrounding the oval-shaped vegetated area is therefore a mag low associated with a volcanic caldera.

Tip: Satellite images and airphotos have natural shadows in the data, so they usually look best in 3D perspective with Lighting turned off.

Open another algorithm into the current one as a second surface

You can easily add a surface to an existing algorithm by opening another algorithm into a separate surface.

1 On the main menu, select **Open into New Surface** from the **File** menu.

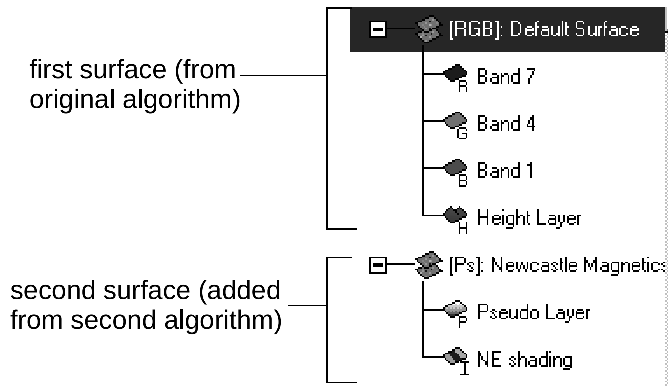
The **Open into New Surface** file chooser dialog opens.

2 From the **Directories** menu, select the **\examples** path.

3 Open the ‘Data_Types’ directory, then open the ‘Magnetics_And_Radiometrics’ directory.

4 Double-click on the algorithm ‘Magnetics_Colordrape.alg.’

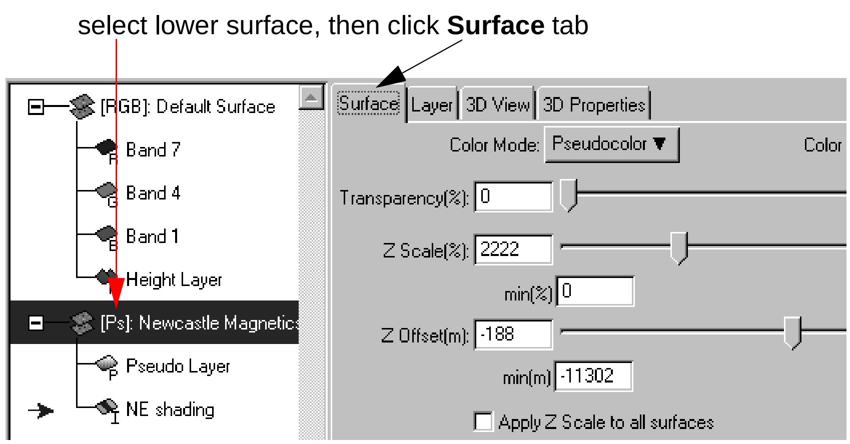
ER Mapper loads the algorithm into a second surface and renders the image on top of the Landsat 3D image. The new algorithm shows magnetics data draped in color over another magnetics layer. Your algorithm now has two surfaces:



Notice that the two surfaces have different color modes (indicated in the surface name–[Ps] for Pseudocolor and [RGB] for Red Green Blue).

Change the Z Offset to shift the surface in 3D space

1 On the **Algorithm** dialog, select the lower surface icon in the data structure diagram, then select the **Surface** tab.



2 Move the **Z Offset** slider all the way to the left.

The Potassium image created by the lower surface slides under the Landsat image.

3 Move the **Z Offset** slider to the far right.

The Potassium surface image slides above the Landsat image again. To move a surface relative to other surfaces in an algorithm, select the surface in the data structure diagram, then move the **Z Offset** slider.

4 Move the **Z Offset** slider all the way to the left again.

Note: As you've seen, surfaces can be moved above or below each regardless of which surface is on top in the data structure diagram.

Change the transparency of the top surface

1 If needed, tilt the 3D image downward slightly until the top surface partially covers the one below.

2 Select the top surface '[RGB]:Default Surface' in the data structure diagram.

3 Move the **Transparency** slider right to its midpoint.

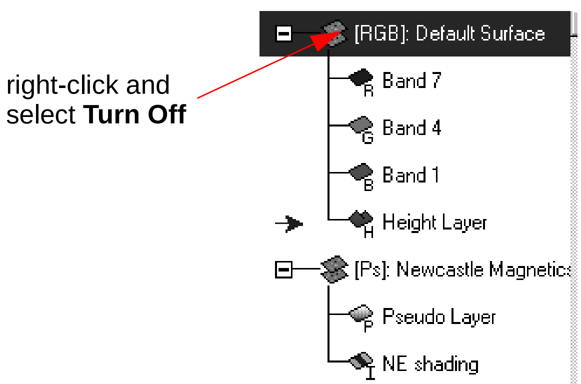
The Landsat image becomes semi-transparent, so the Potassium image below shows through.

The **Transparency** setting ranges from 0-100 to specify how the image is "blended" with other surfaces in the image window. Zero displays the full image, 50 represents 50% transparency, and 100 makes the image invisible. Each surface can have it own transparency setting independent of others.

4 Move the **Transparency** slider to the far left to make the image fully visible.

Turn individual surfaces on and off

1 Right-click on the icon for the top surface, and select **Turn Off** from the short-cut menu.:

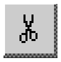


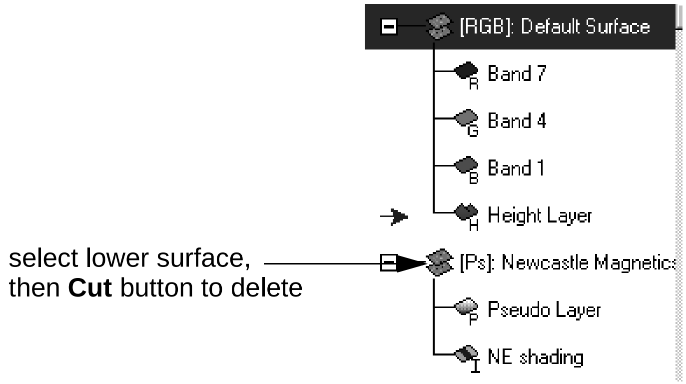
ER Mapper renders only the lower surface (Potassium) image.

2 Turn the top surface on again.

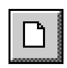
Both surfaces are again rendered.

Delete the lower surface from the algorithm

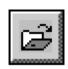
1 Select the lower surface in the data structure diagram, then click the **Cut**  button (above the diagram) to delete it.:



Open a second image window and algorithm

1 On the main menu, click the **New**  button.

Drag the new window down below the first one.

2 On the main menu, click the **Open**  button.

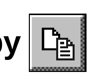
3 From the **Directories** menu, select the **\examples** path.

4 Open the ‘Data_Types’ directory, then open the ‘Magnetics_And_Radiometrics’ directory.

5 Double-click on the algorithm ‘Magnetics_Colordrape.alg.’

This is a colordrape image of the Newcastle magnetics data (in 2D view).

Copy and paste the surface into the first algorithm

1 Select the surface icon in the 2D algorithm, then click the **Copy**  button (above the data structure diagram).

The surface and its layers are copied into the clipboard.

2 Activate the 3D image window (click inside or on the title bar).

3 Click the **Paste**  button.

The surface and its layers are pasted into the algorithm as a second surface.

Tip: To add surfaces to an existing algorithm, you can choose **Open into New Surface** from the **File** menu, or copy and paste surfaces between image windows. You can also copy and paste layers or surfaces within the same algorithm and modify them as desired, or a new empty surface and load datasets and specify processing as needed (using **Edit/Add New Surface** on the **Algorithm** dialog).

Close all image windows and dialog boxes

1 Close all image windows using the window system controls:

- For Windows, click the **Close** button in the upper-right window corner.

2 Click **Close** on the **Algorithm** window to close it.

Only the ER Mapper main menu should be open on the screen.

What you learned...

After completing these exercises, you know how to perform the following tasks in ER Mapper:

- Prepare an algorithm for 3D viewing by adding a Height layer
- Change the viewpoint, zoom level, and other 3D view parameters
- Use the 3D Flythrough viewing mode
- Stack multiple surfaces in a 3D view and set surface offset and transparency
- Merge separate algorithms into surfaces in a single algorithm

General procedures and considerations

Notes about processing speed

ER Mapper can render very large image files quickly in 3D due to it’s progressive rendering technology (i.e., starting with a low resolution view and progressively increasing detail with subsequent processing iterations). However, large files can take much longer to render, especially at higher Terrain Detail settings and using Textured draw mode. The speed at which the image renders in 3D is proportional to the processing speed of your computer and the 3D capabilities of your graphics display card.

ER Mapper’s 3D viewer features are designed take full advantage of the latest 3D graphics hardware rendering technologies. If your graphics card has 3D acceleration, images will render much faster when using ER Mapper’s 3D view modes. Be sure to turn on 3D acceleration if your graphics card supports it.

Printing 3D images

To print a 3D image, simply choose **File/Print** or click the **Print** button while the image is displayed in the active window. Higher Terrain Detail settings produce more detail in your output print, but this is sometimes not necessary and may increase the print time significantly.

For perspective views of geophysical data (such as magnetics or radiometrics) and digital terrain data, best results are obtained using Lights turned on. This is because these images have no inherent shadows, so artificial lighting enhances detail.) Satellite images or airphotos look best without Lights off because these images have natural shadows.

You cannot draw annotation on an image in 3D Perspective or 3D Flythrough modes. One option is to save the 3D view as an algorithm, then display the 3D image as embedded algorithm in map composition (described later). Another alternative is to print the 3D image to an ER Mapper file, then display the resulting dataset in an RGB algorithm. You can then draw on the image but cannot change the perspective view.

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Satellite, Radiometrics, Magnetics and Vector data integration

This chapter explains how to optimize interpretation of satellite, radiometric and magnetics data by integrating vector layers created from the different raster data types.

About vector layers

Vector layers can be polylines representing boundaries of surface classes which maybe geological boundaries, geological structures or polygons representing surface classes. Using formulas you can define discreet classes or classes of mixture of different classes. You can display vector polygon classes drape over DTM, magnetics or PC1 and correlate them in delineating the area of interest for exploration.

You can also set vector attributes such as color, line style, fill pattern and text rotation, and group objects and change their display order (move back and front). Your annotations are saved in a separate ER Mapper format vector file (.erv), and can be loaded and displayed over any other image as desired, or exported to other vector formats for use in other software products.

About vector contouring

You can automatically creates vector contours for the whole or part of a raster dataset. Contours can be an effective way to communicate data, and are often overlaid on backdrop raster images to aid interpretation.

About GIS links

You can directly link to many external vector data formats, and display the data without the need for importing. This makes it very easy to integrate vector data from a wide variety of software products and formats. You can, for example, link directly to ARC/INFO coverages, and can edit vectors and save directly to the ARC coverage format.

Hands-on exercises

These exercises introduce you to many of the basic features of ER Mapper's annotation tools for drawing text, lines, and polygons on an image. You also learn to define and display regions of interest, generate vector contours, and to load and display external vector datasets such as ARC/INFO coverages.

What you will learn...

After completing these exercises, you will know how to perform the following tasks in ER Mapper:

- Creating vector polygons of hydroxyl minerals and iron rich soils classes
- Integrating hydroxyl and iron rich classes with magnetics
- Creating vector polygons of high anomaly classes of K, Th and U
- Integrating K, Th and U high anomaly classes with magnetics

- Creating contour lines from magnetics data
- Add layers to link directly to and display ARC/INFO coverages
- Viewing integrated datasets in multi-surfaces in 3D

Before you begin... Before beginning these exercises, make sure all ER Mapper image windows are closed. Only the ER Mapper main menu should be open on the screen.

1: Creating vector polygons of hydroxyl minerals and iron rich soils classes

Objectives Learn to define thresholds for hydroxyl minerals and iron rich soils, find the discreet areas for each class and areas of common signatures and use ER Mapper’s raster to vector conversion functionality to convert raster classes to vector polygon classes.

- Carryout atmospheric correction on LandsatTM.ers (Cape York) in the \examples\Miscellaneous\Shared_Data directory using information extracted from bivariate scattergram. Save it as CapeYork_Landsat_AtmCorrected.ers in the \examples\Miscellaneous\Tutorial directory. (Exclude TM6 in the process)
- Calculate statistics of the CapeYork_Landsat_AtmCorrected.ers dataset.
- Carryout ratios TM4/TM3, TM5/TM7, TM3/TM1, TM3/TM2 of the CapeYork_Landsat_AtmCorrected.ers dataset and save it as CapeYork_Landsat_ratios.ers in the \examples\Miscellaneous\Tutorial directory. (Use the “(i1 - rmin(,r1,i1)) / (i2 - rmin(,r1,i2))” formula applying the dark pixel correction on both the bands in the ratio formula.)
- Calculate statistics of the CapeYork_Landsat_ratios.ers dataset.

1 Click the **Edit Algorithm**  button in the main menu window.

ER Mapper opens a new image window and the **Algorithm** dialog.

Display ratio dataset in RGB composite

1 In the **Algorithm** dialog, click the **Load Dataset**  button.

2 From the **Directories** menu, select the path ending with the text **\examples\Miscellaneous**.

3 Open the ‘Tutorial’ directory, then double-click on the dataset named ‘CapeYork_Landsat_ratios.ers’ to load it.

Band 1 (**`vegetation ratio (4/3)`**) of the dataset is loaded into the Pseudo layer.

4 In the main menu, from the Forestry Toolbar, click on the **Create RGB Algorithm** toolbar button to display the 'CapeYork_Landsat_ratios.ers' dataset as RGB composite.

Note: Delete the inactive Pseudo Layer in the data structure In the algorithm window by highlighting the Pseudo Layer and click the **Cut** button.

---

5 ER Mapper displays three bands of the CapeYork_Landsat_ratios.ers dataset as an RGB image. You will apply directed Principal Component Analysis formulas in the Red and Green layers to create hydroxyl minerals (clay) and iron rich soils images.

Apply directed Principal Component Analysis formula in the Red layer to highlight clay rich soils (alteration zones)

1 Highlight the Blue layer. Click the **Cut** button and delete it.

2 Highlight the Green layer. Click the right mouse button on the Green layer and turn it off from the short-cut menu.

3 Select the Red layer in the **Algorithm** dialog window and click on the Edit Formula button.

4 **Formula Editor** dialog appears.

5 In the **Formula Editor** dialog select **PC1 of TM bands 147** option from the drop down list of Principal Components menu.

6 The formula " SIGMA(I1..I3 | I? * PC_COV(I1..I3 | , R1, I?, 1))" appears in the generic formula window area.

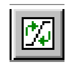
7 Edit the formula to "SIGMA(I1..I2 | I? * PC_COV(I1..I2 | , R1, I?, 2))"

8 In the relationship window select INPUT1 as **`vegetation ratio (4/3)`** and INPUT2 as **`clay ratio (5/7)`** bands.

Note: The formula tells ER Mapper to calculate Principal Component number 2 of the vegetation ratio (4/3) and clay ratio (5/7) bands.

---

9 Apply "Median_3X3.ker" filter in the \kernel|filters_ranking directory from the pre_formula button for both the 4/3 and 5/7 ratios.

10 Click the **99% Contrast Enhancement**  button and display PC2 (TM4/3 & TM5/7) image.

Note: Bright red areas are clay rich (hydroxyl minerals) areas which may indicate to be alteration zones.

---

11 Click on the post-formula **Edit Transform Limits**  button in the process diagram.

The **Transform** dialog box opens showing the histogram for the PC2 of the TM4/3 and TM5/7 data. The Actual Input Limits fall between -3.106 to 2.58.

12 Find a threshold for high anomaly areas of clay rich soil. Set the linear transform to -1.75 (vertical) and display the high anomaly areas of clay rich soil as green on the image.

You have defined -1.75 as the threshold to map high anomaly clay rich soil.

13 In the **Formula Editor** dialog edit the formula to "If (SIGMA(I1..I2 | I? * PC_COV(I1..I2 | , R1, I?, 2))) > -1.75 then 1 else null"

14 Click on the post-formula **Edit Transform Limits**  button in the process diagram.

The **Transform** dialog box opens.

15 In the **Transform** dialog box click on the **Create default linear transform** button and then select **Limits to Actual** option from the dropdown list of **Limits** menu.

The clay rich soil areas are displayed in faint red. In the transform dialog the limits now is 1.

16 In the **Transform** dialog box increase the linear transform in the Y axis to 200.

The clay rich soil areas are displayed in brighter red.

17 Click **Close** to close the **Transform** dialog box.

Apply directed Principal Component Analysis formula in the Green layer to highlight iron rich soils

1 Highlight the Red layer. Click the right mouse button on the Green layer and turn it off from the short-cut menu.

2 Highlight the Green layer. Click the right mouse button on the Green layer and turn it on from the short-cut menu.

3 In the **Algorithm** dialog window and click on the Edit Formula button.

4 Formula Editor dialog appears.

5 In the **Formula Editor** dialog select **PC1 of TM bands 147** option from the drop down list of Principal Components menu.

6 The formula " SIGMA(I1..I3 | I? * PC_COV(I1..I3 | , R1, I?, 1))" appears in the generic formula window area.

7 Edit the formula to "SIGMA(I1..I2 | I? * PC_COV(I1..I2 | , R1, I?, 1))"

8 In the relationship window select INPUT1 as **`iron ratio (3/1)`** and INPUT2 as **`iron ratio (3/2)`** bands.

Note: The formula tells ER Mapper to calculate Principal Component number 2 of the iron ratio (3/1) and iron ratio (3/2) bands.

---

9 Apply "Median_3X3.ker" filter in the \kernel|filters_ranking directory from the pre_formula button for both the 3/1 and 3/2 ratios.

10 Click the **99% Contrast Enhancement** button and display PC1 (TM3/1 & TM3/2) image.

Note: Bright green areas are iron rich areas.

---

11 Click on the post-formula **Edit Transform Limits** button in the process diagram.

The **Transform** dialog box opens showing the histogram for the PC1 of the TM3/1 and TM3/2 data. The dynamic range falls between 1 to 3.

12 Find a threshold for high anomaly areas of clay rich soil. Set the linear transform to 2 (vertical) and display the high anomaly areas of iron rich soil as green on the image.

You have defined 2 as the threshold to map high anomaly iron rich soil.

13 In the **Formula Editor** dialog edit the formula to "If (SIGMA(I1..I2 | I? * PC_COV(I1..I2 | , R1, I?, 2))) > 2 then 1 else null"

14 Click on the post-formula **Edit Transform Limits** button in the process diagram.

The **Transform** dialog box opens.

15 In the **Transform** dialog box click on the **Create default linear transform** button and then select **Limits to Actual** option from the dropdown list of **Limits** menu.

The iron rich soil areas are displayed in faint green. In the transform dialog the limits now is 1.

16 In the **Transform** dialog box increase the linear transform in the Y axis to 200.

The iron rich soil areas are displayed in brighter green.

17 Click **Close** to close the **Transform** dialog box.

Save high anomaly classes of clay and iron rich soils as a Virtual dataset

1 Change the label for the Red layer to **`clay rich class`**.

2 Change the label for the Green layer to **`iron rich class`**.

3 In the **Algorithm** dialog, enter the text **`Clay & Iron rich classes`** in the ‘Description’ text field.

4 Delete the transform of all the 2 layers

Note: Deleting the transform from each of the layers maintains the dynamic range of the data value of the 2 bands without scaling or clipping.

---

5 On the Standard toolbar, click the **Save As**  button.

6 From the **Directories** menu, select the path ending with the text **\examples\Miscellaneous**.

7 Double-click on the ‘Tutorial’ directory to open it.

8 In the **Save As:** text field, type a name for the algorithm file using your initials at the beginning, followed by the text ‘CapeYork_Clay_Iron_classes_VDS’

9 Click **OK** to save the band ratios as Virtual Dataset.

Display ratio VDS dataset in RGB composite

1 Click the **Edit Algorithm**  button in the main menu.

ER Mapper opens a new image window and the **Algorithm** dialog.

2 In the **Algorithm** dialog, click the **Load Dataset** button.

3 From the **Directories** menu, select the path ending with the text **\examples\Miscellaneous**.

4 Open the 'Tutorial' directory, then double-click on the dataset named 'CapeYork_Clay_Iron_classes_VDS.ers' to load it.

Band 1 (`clay rich class`) of the dataset is loaded into the Pseudo layer.

5 In the main menu window, from the Forestry Toolbar, click on the **Create RGB Algorithm** toolbar button to display the 'CapeYork_Clay_Iron_classes_VDS.ers' dataset as RGB composite.

Note: Delete the inactive Pseudo Layer in the data structure in the algorithm window by highlighting the Pseudo Layer and click the **Cut** button.

---

6 ER Mapper displays the RGB composite but there is no image displayed. You will apply formulas to the bands and adjust the contrast (transform) of each layer to create an enhanced color image.

Enter formulas and select appropriate bands for the RGB layers

1 Select the Red layer in the **Algorithm** dialog window and click on the Edit Formula button.

2 **Formula Editor** dialog appears.

3 The default formula INPUT1 is displayed in the generic window.

4 Edit the formula to "if i1 = 1 and isnull(i2) then 1 else null"

5 In the relationship window select INPUT1 as `clay rich class` and INPUT2 as `iron rich class` bands.

Note: The formula tells ER Mapper to map clay rich class and if there is overlap with iron rich class do not map it as clay rich class.

---

6 Click the **Move to next Green layer** button in the Formula Editor dialog box.

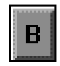
7 The default formula INPUT1 is displayed in the generic window.

8 Edit the formula to "if i1 = 1 and i2=1 then 1 else null"

9 In the relationship window select INPUT1 as **`clay rich class`** and INPUT2 as **`iron rich class`** bands.

Note: The formula tells ER Mapper to map a common class between clay and iron rich classes.

---

10 Click the **Move to next Blue layer**  button n the Formula Editor dialog box.

11 The default formula INPUT1 is displayed in the generic window.

12 Edit the formula to “if i1 = 1 and isnull(i2) then 1 else null”

13 In the relationship window select INPUT1 as **`iron rich class`** and INPUT2 as **`clay rich class`** bands.

Note: The formula tells ER Mapper to map iron rich class and if there is overlap with clay rich class do not map it as iron rich class.

---

14 Highlight the Red layer. Click on the post-formula **Edit Transform Limits**  button in the process diagram.

The **Transform** dialog box opens.

15 In the **Transform** dialog box click on the **Create default linear transform** button and then select **Limits to Actual** option from the dropdown list of **Limits** menu.

16 Similarly adjust the other two transforms (Green and Blue layers) to **Limits to Actual.**

The clay rich soil, the common (clay & iron) soil and iron rich soil areas are displayed in faint red, green and blue. In the transform dialog the limits now is 1.

17 Increase all the three **Transforms** of Red, Green and Blue layers to 200 in the Y axis.

The clay rich, common (clay & iron) and iron rich soil areas are displayed in brighter red, green and blue colors.

18 Click **Close** to close the **Transform** dialog box.

Save high anomaly classes of clay, common (clay & iron) and iron rich soils as a Virtual dataset

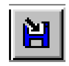
1 Change the label for the Red layer to **`clay rich class`**.

2 Change the label for the Green layer to **`common (clay & iron) class`**.

3 Change the label for the Blue layer to **`iron rich class`**.

4 In the **Algorithm** dialog, enter the text **`Clay, common & Iron rich classes`** in the ‘Description’ text field.

5 Delete the transform of all the 3 layers

6 On the Standard toolbar, click the **Save As**  button.

7 From the **Directories** menu, select the path ending with the text **\examples\Miscellaneous**.

8 Double-click on the ‘Tutorial’ directory to open it.

9 In the **Save As:** text field, type a name for the algorithm file using your initials at the beginning, followed by the text ‘CapeYork_Clay_Common_Iron_classes_VDS’

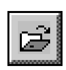
10 Click **OK** to save the band ratios as Virtual Dataset.

Convert the raster cells to vector polygons

Objectives Learn to use ER Mapper’s Raster to Vector conversion to create vector polygons of clay, common and iron rich soils classes.

1 From the **Process** menu, select **Raster Cells to Vector Polygons...**.

The **Raster to Vector Conversion** dialog box opens. This dialog contains options to vectorize specific bands or cells values in a dataset, to create polygons, polylines, or filled polygons, and to smooth (interpolate) vectors.

2 Click the **Input Raster Dataset**  chooser button.

3 From the **Directories** menu, select the path ending with the text **\examples\Miscellaneous**. Then open the ‘Tutorial’ directory and load the ‘CapeYork_Clay_Common_Iron_classes_VDS.ers’ dataset you just created.

4 Turn on the **Fill Polygons** option (to create polygons instead of polylines)

Tip: To smooth rugged edges of the ploygons turn on **Smooth** option.

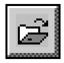
---

5 Click the **Output Vector Dataset**  chooser button.

6 From the **Directories** menu, select the path ending with the text **\examples\Miscellaneous**. Then open the ‘Tutorial’ directory and type a

name in the **Save As:** text field as follows, then click **OK** to close the chooser. For example, if your initials are "JT," type in the name:

`JT_clay_rich_polygons`

7 Click the **Band**  chooser button and select clay_rich_class band.

8 Edit the value in the **Cell Value** field to read `1` then press Enter or Return.

This tells ER Mapper to vectorize all pixels (cells) with the value 1 of clay_rich_class band in the Virtual Dataset. By default, ER Mapper will create vector polygons.

9 Click **OK** to start the raster to vector conversion.

ER Mapper displays a status dialog indicating the progress, then displays a confirmation dialog when the conversion is complete.

Note: Following the same procedures create vector (polygons) files for the common (Iron & Clay) and iron_rich_class bands.

Display the clay_rich_polygons vector class on top of magnetics raster image

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Note: Close all windows except the ER Mapper main menu window.

---

1 On the **Standard** toolbar, click on the **Edit Algorithm**  button.

An image window and the **Algorithm** window appear.

2 Click on the Layer Tab to view the settings for the layer.

3 In the **Algorithm** window, click the **Load Dataset** button  on the left side of the process stream diagram.

The **Raster Dataset** file chooser dialog box appears.

4 From the **Directories** menu, select the path ending with **\examples**.

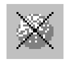
5 Open the ‘Shared_Data’directory, then double-click on the dataset named ‘Magnetics_Grid.ers’ to load it.

6 Click your right mouse button on the Pseudo Layer and from the short-cut menu change it to **Intensity** layer.

You will use this layer to create a shaded relief image of the magnetics data.

The magnetics dataset is loaded into the new Intensity layer.

7 Change the label for the Intensity layer to **`shaded magnetics`**.

8 With the ‘shaded magnetics’ layer selected, click the **Edit Realtime Sunshade**  button in the process diagram.

9 Turn on the **Do sun-shading** option to turn on shading.

Change the shade angle as desired to highlight structural features of interest.

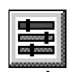
10 Click **Close** on the **Edit Sun Angle** dialog to close it.

11 The sun shaded magnetics is displayed.

Display clay_rich vector class over the sun shaded magnetics image

1 In the Algorithm window, select **Annotation/Map Composition** from the **Edit/Add Vector Layer** menu.

A new annotation layer is added to the algorithm.

2 Click the **Edit Layer Color**  button in the process stream diagram to choose a color for displaying the vectors.

3 Select a red color, and click **OK** to close the **Color Chooser**.

4 Click the **Load Dataset**  button in the process steam diagram.

5 From the **Directories** menu, select the path ending with the text **\examples\Miscellaneous**.

6 In the directory ‘Tutorial,’ double-click on the ‘clay_rich_polygons.erv’ dataset you created to load it.

ER Mapper first processes the sun shaded magnetics data, then draws the vector polygons in red.

7 Zoom to the area that covers clay_rich class.

Display the vector polygons alone

1 Turn off the intensity layer containing the sun shaded magnetics.

ER Mapper draws the clay rich vector polygons in red over an empty (black) backdrop image so your can see them more clearly. As you can see, vectorizing raster data in this way can save hours or days of digitizing feature outlines by hand, so it is especially valuable for updating vector information for use in GIS products.

Note: Choose Common_clay_iron_Polygons and Iron_polygons vector classes and display them individually over the sun shaded magnetics. You can also display all three vector classes over the sun shaded magnetics or over PC1 of LandsatTM image.

2: Creating vector polygons of Potassium, Thorium and Uranium classes with high anomaly

Objectives Learn to define thresholds for Potassium, Thorium and Uranium classes with high anomaly, find the discreet areas for each class and areas of common signatures. Use ER Mapper's raster to vector conversion functionality to convert raster classes to vector polygon classes.

- Carryout ratios K/Th, Th/(Th+K+U), U/(U+Th+K) of the Radiometrics_Grid.ers dataset in the \examples\Miscellaneous\Shared_Data directory and save it as CapeYork_Radiometrics_ratios.ers in the \examples\Miscellaneous\Tutorial directory. (Use the "(i1 - rmin(,r1,i1)) / (i2)" for K/Th and "(i1) /((i1)+(i2 - rmin(,r1,i2))+ (i3 - rmin(,r1,i3)))" for Th/(Th+K+U) and "(i1-rmin(,r1,i1)) /((i1-rmin(,r1,i1))+(i2)+ (i3 - rmin(,r1,i3)))" for U/(U+Th+K).)
- Calculate statistics of the CapeYork_Radiometrics_ratios.ers dataset.

1 Click the **Edit Algorithm**  button in the main menu window.

ER Mapper opens a new image window and the **Algorithm** dialog.

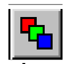
Load and display ratio dataset in RGB composite

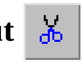
1 In the **Algorithm** dialog, click the **Load Dataset**  button.

2 From the **Directories** menu, select the path ending with the text **\examples\Miscellaneous**.

3 Open the 'Tutorial' directory, then double-click on the dataset named 'CapeYork_Radiometrics_ratios.ers' to load it.

Band 1 **`(K/Th)`** of the dataset is loaded into the Pseudo layer.

4 In the main menu window, from the Forestry Toolbar, click on the **Create RGB Algorithm** toolbar button  to display the 'CapeYork_Landsat_ratios.ers' dataset as RGB composite.

Note: Delete the inactive Pseudo Layer in the data structure in the algorithm window by highlighting the Pseudo Layer and click the **Cut**  button.

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5 ER Mapper displays (K/Th, Th/(Th+K+U), U/(U+Th+K)) of the CapeYork_Landsat_ratios.ers dataset as an RGB composite. You will apply formulas with thresholds to map anomalous high ratios of K/Th, Th/(Th+K+U) and U/(U+Th+K).

Apply formulas to map high anomaly classes from ratios of K/Th, Th/(Th+K+U) and U/(U+Th+K)

1 Highlight the Red layer.

2 Apply "Median_3X3.ker" filter in the \kernel\filters_ranking directory from the pre_formula button for the Red layer (K/Th ratio).

3 From the transform of the Red layer find out the threshold of high anomaly areas from the K/Th ratio image.

Take 5 as the threshold. Threshold is scene dependent, hence select appropriate threshold for your K/Th ratio dataset.

4 In the **Algorithm** dialog window click on the Edit Formula  button for the Red layer (K/Th).

5 **Formula Editor** dialog appears.

6 In the **Formula Editor** dialog type in the formula " if i1 > 5 then 1 else null" in the generic formula window area.

Note: The formula tells ER Mapper to map ratio values higher than 5 as high anomaly class of K/Th.

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7 Highlight the Green layer.

8 Apply "Median_3X3.ker" filter in the \kernel\filters_ranking directory from the pre_formula button for the Green layer (Th/(Th+K+U) ratio).

9 From the transform of the Green layer find out the threshold to map high ratio values of Th/(Th+K+U) as high Th class.

Take 0.4 as the threshold. Select appropriate threshold to map high Th class from your Th/(Th+K+U) image.

10 In the **Algorithm** dialog window click on the Edit Formula button for the Green layer (Th/(Th+K+U)).

11 **Formula Editor** dialog appears.

12 In the **Formula Editor** dialog type in the formula “ if i1 > 0.4 then 1 else null” in the generic formula window area.

Note: The formula tells ER Mapper to map ratio values higher than 0.4 as high anomaly class of Th/(Th+K+U).

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13 Highlight the Blue layer.

14 Apply “Median_3X3.ker” filter in the \kernel\filters_ranking directory from the pre_formula button for the Blue layer (U/(U+Th+K)) ratio).

15 From the transform of the Blue layer find out the threshold to map high ratio values of U/(U+Th+K) as high U class.

Take 0.16 as the threshold. Select appropriate threshold to map high U class from your U/(U+Th+K) image.

16 In the **Algorithm** dialog window click on the **Edit Formula** button for the Blue layer (U/(U+Th+K)).

17 **Formula Editor** dialog appears.

18 In the **Formula Editor** dialog type in the formula “ if i1 > 0.16 then 1 else null” in the generic formula window area.

Note: The formula tells ER Mapper to map ratio values higher than 0.16 as high anomaly class of U/(U+Th+K).

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19 The high anomaly classes of K/Th in red, Th(Th+K+U) in green and U/(U+Th+K) in blue are displayed.

20 Select Red layer. Click on the post-formula **Edit Transform Limits** button in the process diagram.

The **Transform** dialog box opens.

21 In the **Transform** dialog box click on the **Create default linear transform** button and then select **Limits to Actual** option from the dropdown list of **Limits** menu.

22 Set the transforms of the Green and Blue layers to **Limits to Actual**.

23 The areas of the high ratio values of of K/Th in red, Th(Th+K+U) in green and U/(U+Th+K) in blue are redisplayed.

24 In the **Transform** dialog boxes of the three Red, Green and Blue layers increase the linear transform in the Y-axis to 200.

The areas of the high ratio values of K/Th in red, Th(Th+K+U) in green and U/(U+Th+K) in blue are displayed in brighter colors.

25 Click **Close** to close the **Transform** dialog box.

Save high anomaly areas of K/Th, Th/(Th+K+U) and U/(U+Th+K) ratios as a Virtual dataset

1 Change the label for the Red layer to **`high K/Th class`**.

2 Change the label for the Green layer to **`High Th/(Th+K+U) class`**.

3 Change the label for the Blue layer to **`High U/(U+Th+K) class`**.

4 In the **Algorithm** dialog, enter the text **High anomaly `K, Th, U classes`** in the 'Description' text field.

5 Delete the transform of all the 3 layers

Note: Deleting the transform from each of the layers maintains the dynamic range of the data value of the 3 bands without scaling or clipping.

---

6 On the Standard toolbar, click the **Save As**  button.

7 From the **Directories** menu, select the path ending with the text **\examples\Miscellaneous**.

8 Double-click on the 'Tutorial' directory to open it.

9 In the **Save As:** text field, type a name for the algorithm file using your initials at the beginning, followed by the text 'CapeYork_high_KThU_classes_VDS'

10 Click **OK** to save the band ratios as Virtual Dataset.

Display ratio VDS dataset in RGB composite

1 Click the **Edit Algorithm**  button in the main menu window.

ER Mapper opens a new image window and the **Algorithm** dialog.

2 In the **Algorithm** dialog, click the **Load Dataset** button.

3 From the **Directories** menu, select the path ending with the text **\examples\Miscellaneous**.

4 Open the ‘Tutorial’ directory, then double-click on the dataset named ‘CapeYork_high_KThU_classes_VDS.ers’ to load it.

Band 1 (**`high K/Th class`**) of the dataset is loaded into the Pseudo layer.

5 In the main menu window, from the Forestry Toolbar, click on the **Create RGB Algorithm** toolbar button to display the ‘CapeYork_high_KThU_classes_VDS.ers’ dataset as RGB composite.

Note: Delete the inactive Pseudo Layer in the data structure in the algorithm window by highlighting the Pseudo Layer and click the **Cut** button.

---

6 ER Mapper displays the RGB (K/Th, Th/(Th+K+U), U/(U+Th+K) composite.

Enter formulas to map discreet high anomaly classes of K/Th, Th/(Th+K+U) and U/(U+Th+K) ratios for the RGB layers

1 Select the Red layer in the **Algorithm** dialog window and click on the Edit Formula button.

2 **Formula Editor** dialog appears.

3 The default formula INPUT1 is displayed in the generic window.

4 Edit the formula to “if i1 = 1 and isnull(i2) and isnull(i3) then 1 else null”

5 In the relationship window select INPUT1 as **`high K/Th class`** and INPUT2 as **`high Th/(Th+K+U) class`** and INPUT3 as **`high U/(U+Th+K) class`** bands.

Note: The formula tells ER Mapper to map high anomaly class of K/Th and if there is overlap with Th/(Th+K+U) and U/(U+Th+K) classes do not map it as high anomaly class of K/Th.

---

6 Click the **Move to next Green layer** button in the Formula Editor dialog box.

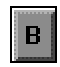
7 The default formula INPUT1 is displayed in the generic window.

8 Edit the formula to “if i1 = 1 and isnull(i2) and isnull(i3) then 1 else null”

9 In the relationship window select INPUT1 as **`high Th/(Th+K+U) class`** and INPUT2 as **`high K/Th class`** and INPUT3 as **`high U/(U+Th+K) class`** bands.

Note: The formula tells ER Mapper to map high anomaly class of Th/(Th+K+U) and if there is overlap with high anomaly classes of K/Th) and U/(U+Th+K) do not map it as high anomaly class of Th/(Th+K+U).

---

10 Click the **Move to next Blue layer**  button in the **Formula Editor** dialog box.

11 The default formula INPUT1 is displayed in the generic window.

12 Edit the formula to “if i1 = 1 and isnull(i2) and isnull(i3) then 1 else null”

13 In the relationship window select INPUT1 as **`high U/(U+Th+K) class`** and INPUT2 as **`high K/Th class`** and INPUT3 as **`high Th/(Th+K+U) class`** bands.

14 The formula tells ER Mapper to map high anomaly class of U/(U+Th+K) and if there is overlap with high anomaly classes of (K/Th) and Th/(Th+K+U) do not map it as high anomaly class of U/(U+Th+K).

15 Highlight the Red layer. Click on the post-formula **Edit Transform Limits**  button in the process diagram.

The **Transform** dialog box opens.

16 In the **Transform** dialog box click on the **Create default linear transform** button and then select **Limits to Actual** option from the dropdown list of **Limits** menu.

17 Similarly adjust the other two transforms (Green and Blue layers) to **Limits to Actual.**

18 Increase all the three **Transforms** of Red, Green and Blue layers to 200 in the Y-axis.

The high anomaly classes of K/Th, Th/(Th+K+U) and U/(U+Th+K) ratios are displayed in brighter red, green and blue colors.

19 Click **Close** to close the **Transform** dialog box.

Save high anomaly classes of K/Th, Th/(Th+K+U) and U/(U+Th+K) ratios as a Virtual dataset

1 Change the label for the Red layer to **`K/Th class`**.

2 Change the label for the Green layer to **`Th/(Th+K+U) class`**.

3 Change the label for the Blue layer to **`U/(U+Th+K) class`**.

4 In the **Algorithm** dialog, enter the text **`K,Th,U classes`** in the ‘Description’ text field.

5 Delete the transform of all the 3 layers

6 On the Standard toolbar, click the **Save As** button.

7 From the **Directories** menu, select the path ending with the text **\examples\Miscellaneous**.

8 Double-click on the ‘Tutorial’ directory to open it.

9 In the **Save As:** text field, type a name for the algorithm file using your initials at the beginning, followed by the text ‘CapeYork_discreet_KThU_classes_VDS’

10 Click **OK** to save the band ratios as Virtual Dataset.

Convert the raster cells to vector polygons

Objectives Learn to use ER Mapper’s Raster to Vector conversion to create vector polygons of clay, common and iron rich soils classes.

1 From the **Process** menu, select **Raster Cells to Vector Polygons...**.

The **Raster to Vector Conversion** dialog box opens. This dialog contains options to vectorize specific bands or cells values in a dataset, to create polygons, polylines, or filled polygons, and to smooth (interpolate) vectors.

2 Click the **Input Raster Dataset** chooser button.

3 From the **Directories** menu, select the path ending with the text **\examples\Miscellaneous**. Then open the ‘Tutorial’ directory and load the ‘CapeYork_discreet_KThU_classes_VDS.ers’ dataset you just created.

4 Turn on the **Fill Polygons** option (to create polygons instead of polylines)

Tip: To smooth rugged edges of the ploygons turn on **Smooth** option.

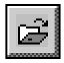
---

5 Click the **Output Vector Dataset** chooser button.

6 From the **Directories** menu, select the path ending with the text **\examples\Miscellaneous**. Then open the ‘Tutorial’ directory and type a

name in the **Save As:** text field as follows, then click **OK** to close the chooser. For example, if your initials are "JT," type in the name:

`JT_K_class_polygons`

7 Click the **Band**  chooser button and select K/Th_class band.

8 Edit the value in the **Cell Value** field to read **1** then press Enter or Return.

This tells ER Mapper to vectorize all pixels (cells) with the value 1 of K/Th_class band in the Virtual Dataset. By default, ER Mapper will create vector polygons.

9 Click **OK** to start the raster to vector conversion.

ER Mapper displays a status dialog indicating the progress, then displays a confirmation dialog when the conversion is complete.

Note: Following the same procedures create vector (polygons) files for the high anomaly classes of Th/(Th+K+U) and U/(U+Th+K).

Display polygons vector class of K/Th ratio on top of magnetics raster image

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Note: Close all windows except the ER Mapper main menu window.

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1 On the **Standard** toolbar, click on the **Edit Algorithm**  button.

An image window and the **Algorithm** window appear.

2 Click on the Layer Tab to view the settings for the layer.

3 In the **Algorithm** window, click the **Load Dataset** button  on the left side of the process stream diagram.

The **Raster Dataset** file chooser dialog box appears.

4 From the **Directories** menu, select the path ending with **\examples**.

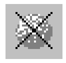
5 Open the ‘Shared_Data’directory, then double-click on the dataset named ‘Magnetics_Grid.ers’ to load it.

6 Click your right mouse button on the Pseudo Layer and from the short-cut menu change it to **Intensity** layer.

You will use this layer to create a shaded relief image of the magnetics data.

The magnetics dataset is loaded into the new Intensity layer.

7 Change the label for the Intensity layer to **`shaded magnetics`**.

8 With the 'shaded magnetics' layer selected, click the **Edit Realtime Sunshade**  button in the process diagram.

9 **Turn on** the **Do sun-shading** option to turn on shading.

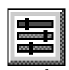
Change the shade angle as desired to highlight structural features of interest.

10 Click **Close** in the **Edit Sun Angle** dialog to close it.

Display clay_rich vector class over the sun shaded magnetics image

1 In the Algorithm window, select **Annotation/Map Composition** from the **Edit/Add Vector Layer** menu.

A new annotation layer is added to the algorithm.

2 Click the **Edit Layer Color**  button in the process stream diagram to choose a color for displaying the vectors.

3 Select a red color, and click **OK** to close the **Color Chooser**.

4 Click the **Load Dataset**  button in the process steam diagram.

5 From the **Directories** menu, select the path ending with the text **\examples\Miscellaneous**.

6 In the directory 'Tutorial,' double-click on the 'K_class_polygons.erv' dataset you created to load it.

ER Mapper first processes the sun shaded magnetics data, then draws the vector polygons in red.

7 Zoom to the area that covers high anomaly class of K/Th.

Display the vector polygons alone

1 Turn off the intensity layer containing the sun shaded magnetics.

ER Mapper draws the high anomaly class of K/Th vector polygons in red over an empty (black) backdrop image so your can see them more clearly. As you can see, vectorizing raster data in this way can save hours or days of digitizing feature outlines by hand, so it is especially valuable for updating vector information for use in GIS products.

Note: Choose Th/(Th+K+U)_Polygons and U/(U+Th+K)_polygons vector classes and display them individually over the sun shaded magnetics. You can also display all three vector classes over the sun shaded magnetics or over PC1 of LandsatTM image.

3: Overlaying contour lines and labels

Objectives Learn to add a Contours layer to an algorithm to automatically generate contour lines and labels.

Open the Newcastle magnetics colordrape algorithm

1. In the main menu window, click the **Open** button.
2. From the **Directories** menu, select the **\examples\Data_Types** path.
3. Open the 'Magnetics_And_Radiometrics' directory.
4. Double-click on the algorithm named 'Magnetics_Pseudocolor.alg.'
5. Click the **Surface** tab, then select **greyscale** from the 'Color Table' list.
6. Click the **Layer** tab again.

   The Newcastle magnetics data is now displayed in greyscale.

Add a Contours layer to the algorithm

1. In the **Algorithm** dialog, open the **Edit** menu, choose **Add Vector Layer**, then choose **Contours**.

   A 'Contours' layer is added to the algorithm layer list.

Specify the dataset and parameters for contouring

1. In the **Algorithm** dialog, click the **Dynamic Link Chooser** button in the process diagram.

   The **Contours from image file** dialog opens.

2. Click the 'File to Contour' file chooser button.
3. From the **Directories** menu, select the **\examples** path.

4 Open the directory ‘Shared_Data’ then double-click on the ‘Magnetics_Grid.ers’ dataset to load it.

5 Under ‘Contour and label color’ select **Single Color**.

6 For ‘Contour Interval’ enter **`30`** then press Enter or Return.

7 Click the **Finish** button.

8 In the process diagram, click the **Edit Layer Color** button.

9 Choose elevation, then click **OK**.

Contour lines are drawn over the image at 30 unit spacing in the color you specified. The lines have text labels to indicate the contour data values.

Change the contouring interval and coloring

1 Click the **Dynamic Link Chooser** button in the process diagram.

2 Under ‘Contour and label color’ select **Multi Color**.

3 For ‘Contour Interval’ enter **`20`** then press Enter or Return.

4 Click the **Finish** button.

5 Click the **Edit Layer Color** button in process diagram.

6 Choose elevation, then click **OK**.

Contour lines are drawn at 20 unit intervals with a different color for each interval. The set of contour colors comes from the color table selected in the **Contours from image file** dialog (pseudocolor by default). The label color comes from the color chosen for the layer using the **Edit Layer Color** button.

4: Linking to GIS vector data

Objectives Learn to use ER Mapper’s Dynamic Links feature to directly read and display data in an external format. In this case, you will display ARC/INFO coverages of interpretations that correspond to the magnetics dataset.

Open the Cape York magnetics colordrape algorithm

1 In the main menu window, click on the **Open** button.

2 From the **Directories** menu, select the path ending with **\examples\Data_Types**.

3 In the 'Magnetics_And_Radiometrics' directory, double-click on the algorithm 'Magnetics_Colordrape.alg' to display it.

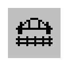
This algorithm displays total magnetic intensity (TMI) data from Cape York in color draped over magnetics illuminated from the northeast.

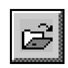
Add an ARC/INFO vector layer to the algorithm

1 In the **Algorithm** dialog, open the **Edit** menu, select **Add Vector Layer,** then **ARC/INFO Overlay**.

An empty ARC/INFO coverage vector layer is added. This layer type lets you directly load, display and edit ARC/INFO vector coverages.

Display a coverage of regional lithology

1 Click the **Dynamic Link Chooser**  button in the process diagram.

2 In the **ARC/INFO Chooser** dialog, click the  button next to the 'Workspace' field.

3 From the **Directories** menu (in the **ARC/INFO Workspaces** dialog), select the path ending with **\examples**.

4 Open the 'Application\Mineral_Exploration' directory.

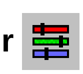
5 Click *once* on the 'ARCINFO_Geology' directory to select it, then click **Select**.

The coverage is loaded into the **ARC/INFO Chooser** dialog.

6 From the drop-down list next to 'Coverage,' select **regolith**.

7 From 'Line Width' list, select **1.0**.

8 Click **OK** in the **ARC/INFO Chooser** dialog to close it.

9 In the process diagram, click the **Edit Layer Color**  button.

10 Choose black, then click **OK**.

11 The algorithm with the ARC/INFO overlay is reprocessed and displayed.

The regional lithology is displayed as black vectors over the colordrape image. The vectors indicate the boundaries between different rock lithologies interpreted from maps or other collateral data.

12 In the new layer's description field, change the text to **`regional lithology`** then press Enter or Return.

Display a coverage of interpreted faults

1 In the **Algorithm** dialog, click the **Duplicate** button.

ER Mapper creates a copy of the first ARC/INFO layer.

2 Click the **Dynamic Link Chooser** button in the process diagram.

Since the layer was copied, it already points to a workspace directory.

3 From the 'Coverage' list, select **faults**.

4 From 'Line Width' list, select **1.5**.

5 Click **OK** in the **ARC/INFO Chooser** dialog.

6 In the process diagram, click the **Edit Layer Color** button.

7 Choose white, then click **OK**.

8 Right-click the 'regional lithology' layer and select **Turn Off**.

A vector coverage showing interpreted faults in the area displays as white vectors.

9 In the new layer's description field, and change the text to **`faults`** then press Enter or Return.

Display both coverages together

1 Right-click the 'regional lithology' layer and select **Turn On**.

The vectors for both coverages are displayed. Since the 'regional lithology' layer is higher in the algorithm layer list than the 'faults' layer, the black vectors cover the white vectors where there is overlap.

Reverse the layer priority

1 Select the 'faults' layer, then click the **Move Up** button.

The 'faults' layer moves above the 'regional lithology' layer in the list.

Now the black vectors are drawn first, and white fault vectors are drawn on top to cover them where there is overlap.

Note: Vector layers always cover all raster layers in an algorithm. The order of vector layers only affects priority with respect to other vector layers.

(optional) Display other vector coverages

1 Click the **Dynamic Link Chooser** button in the process diagram.

2 From the ‘Coverage’ list, select a coverage name, then click **OK**.

Tip: You can also edit vectors in ARC/INFO coverages, and save the results directly back to the coverage format. To do this, click the **Annotate Vector Layer** button in the process diagram and use the annotation tools to edit vectors as desired. When finished, save the annotation file with ‘ARC/INFO Coverage’ selected. You can then read the updated coverage directly in ARC/INFO.

Hide the Annotation toolbar again

1 In the main menu window, select **Annotation** from the **Toolbars** menu.

The annotation toolbar buttons are hidden.

5: Displaying processed images in multi-surfaces in 3-D

Objectives Learn to display processed satellite, radiometric and magnetics images in 3-D perspective, integrate with vector classes and correlate between them to assist in interpretation..

Display processed satellite images in 3-D perspective

1 Click the **Edit Algorithm** button In the main menu window.

ER Mapper opens a new image window and the **Algorithm** dialog.

2 In the **Algorithm** dialog, click the **Load Dataset** button.

3 From the **Directories** menu, select the path ending with the text **\examples\Miscellaneous**.

4 Open the 'Tutorial' directory, then double-click on the dataset named 'CapeYork_Clay_Common_Iron_classes_VDS.ers' to load it.

5 In the main menu window, from the Forestry Toolbar, click on the **Create RGB Algorithm** toolbar button to display the 'CapeYork_Clay_Common_Iron_classes_VDS.ers' dataset as RGB composite.

6 In the **Algorithm** dialog, select the Blue layer (if needed), then click the **Duplicate** button.

7 Click your right mouse button on the duplicated Blue layer and from the short-cut menu change it to **Intensity** layer.

8 In the **Algorithm** dialog, click the **Load Dataset** button. Load the 'Magnetics_Grid.ers' dataset from the \examples\Shared_Data directory into the intensity layer.

Note: Do not double click on the 'Magnetics_Grid.ers' file name or press **OK** button but click on the **OK this layer only** button in the Raster Dataset dialog box.

The magnetics dataset is loaded into the Intensity layer.

9 Highlight the Intensity layer (if needed). Click on the post-formula **Edit Transform Limits** button in the process diagram.

The **Transform** dialog box opens.

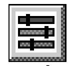
10 In the **Transform** dialog box click on the **Create default linear transform** button and then select **Limits to Actual** option from the dropdown list of **Limits** menu.

11 The clay and iron rich soils classes drape over magnetics is displayed.

Display clay_rich vector class over the magnetics image

1 In the Algorithm window, select **Annotation/Map Composition** from the **Edit/Add Vector Layer** menu.

A new annotation layer is added to the algorithm.

2 Click the **Edit Layer Color**  button in the process stream diagram to choose a color for displaying the vectors.

3 Select a red color, and click **OK** to close the **Color Chooser**.

4 Click the **Load Dataset**  button in the process steam diagram.

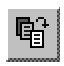
5 From the **Directories** menu, select the path ending with the text **\examples\Miscellaneous**.

6 In the directory 'Tutorial,' double-click on the 'clay_rich_polygons.erv' dataset you created to load it.

ER Mapper first processes the raster data, then draws the vector polygons in red.

7 If necessary zoom to the area that covers clay_rich class.

Change view mode to 3D perspective

1 In the **Algorithm** dialog, select the Intensity layer (if needed), then click the **Duplicate**  button.

2 Click your right mouse button on the duplicated Intensity Layer and from the short-cut menu change it to **Height** layer.

The Height layer has the magnetics dataset but since the view mode is now in 2D the Height layer has a red cross indicating view mode is incompatible.

Note: Height layer is used only in 3D perspective or in 3D Flythrough view modes.

---

3 Change the View Mode to 3D perspective and view images in the two surfaces in 3D perspective.

4 The image is displayed in 3D perspective.

Note: You can brighten the image by applying 99% clip transformation on the Intensity layer.

Display processed radiometric images in 3-D perspective

1 Highlight the first surface, click the surface with right mouse button and turn it off from the short-cut menu.

2 Change View Mode to 2D.

Tip: It is faster to load images and vectors in 2D View Mode. Set the algorithm in 2D mode and then change to 3D perspective to view the images in 3D View Mode.

---

3 Add a new surface from the Edit menu in the **Algorithm** dialog.

4 In the **Algorithm** dialog, click the **Load Dataset** button.

5 From the **Directories** menu, select the path ending with the text **\examples\Miscellaneous**.

6 Open the 'Tutorial' directory, then double-click on the dataset named 'CapeYork_discreet_KThU_classes_VDS.ers' to load it.

7 In the main menu window, from the Forestry Toolbar, click on the **Create RGB Algorithm** toolbar button to display the 'CapeYork_discreet_KThU_classes_VDS.ers' dataset as RGB composite.

8 In the **Algorithm** dialog, select the Blue layer (if needed), then click the **Duplicate** button.

9 Click your right mouse button on the duplicated Blue layer and from the short-cut menu change it to **Intensity** layer.

10 In the **Algorithm** dialog, click the **Load Dataset** button. Load the 'Magnetics_Grid.ers' dataset from the \examples\Miscellaneous\Shared_Data directory into the intensity layer.

Note: Do not double click on the 'Magnetics_Grid.ers' file name or press **OK** button but click on the **OK this layer only** button in the Raster Dataset dialog box.

The magnetic dataset is loaded into the Intensity layer.

11 Highlight the Intensity layer (if needed). Click on the post-formula **Edit Transform Limits** button in the process diagram.

The **Transform** dialog box opens.

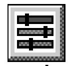
12 In the **Transform** dialog box click on the **Create default linear transform** button and then select **Limits to Actual** option from the dropdown list of **Limits** menu.

13 The high anomaly classes of K, Th and U draped over magnetics is displayed.

Display high anomaly K vector class over the magnetics image

1 In the Algorithm window, select **Annotation/Map Composition** from the **Edit/Add Vector Layer** menu.

A new annotation layer is added to the algorithm.

2 Click the **Edit Layer Color**  button in the process stream diagram to choose a color for displaying the vectors.

3 Select a red color, and click **OK** to close the **Color Chooser**.

4 Click the **Load Dataset**  button in the process steam diagram.

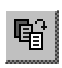
5 From the **Directories** menu, select the path ending with the text **\examples\Miscellaneous**.

6 In the directory ‘Tutorial,’ double-click on the ‘K_class_polygons.erv’ dataset to load it.

ER Mapper first processes the raster data, then draws the vector polygons in red.

7 If necessary zoom to the area that covers K_class.

Change view mode to 3D perspective

1 In the **Algorithm** dialog, select the Intensity layer (if needed), then click the **Duplicate**  button.

2 Click your right mouse button on the duplicated Intensity Layer and from the short-cut menu change it to **Height** layer.

The Height layer has the magnetics dataset but since the view mode is now in 2D the Height layer has a red cross indicating view mode is incompatible.

Note: Height layer is used only in 3D perspective or in 3D Flythrough view modes.

---

3 Highlight the first surface, click the surface with right mouse button and turn it on from the short-cut menu.

4 Change the View Mode to 3D perspective to view images in the two surfaces in 3D perspective.

5 The image is displayed in 3D perspective.

Note: You can brighten the image by applying 99% clip transformation on the Intensity layer.

Display magnetics colodrape image in 3-D perspective

1. Highlight the first and second surfaces, click the surfaces with right mouse button and turn them off from the short-cut menu.
2. Change View Mode to 2D.

Tip: It is faster to load images and vectors in 2D View Mode. Set the algorithm in 2D mode and then change to 3D perspective to view the images in 3D View Mode.

---

3. Add a new surface from the Edit menu in the **Algorithm** dialog.
4. In the **Algorithm** dialog, click the **Load Dataset** button. Double click the 'Magnetics_Grid.ers' dataset from the \examples\Shared_Data directory and load it into the Pseudo Layer.

   The magnetics dataset is loaded into the Pseudo Layer.
5. Click the **99% Contrast Enhancement** button in the main menu (or **Algorithm** dialog) and display the magnetics dataset in Pseudo color.
6. In the **Algorithm** dialog, select the Pseudo Layer (if needed), then click the **Duplicate** button.
7. Click your right mouse button on the duplicated Pseudo Layer and from the short-cut menu change it to **Intensity** layer.
8. Click on the post-formula **Edit Transform Limits** button in the process diagram.

   The **Transform** dialog box opens.
9. In the **Transform** dialog box click on the **Create default linear transform** button and then select **Limits to Actual** option from the dropdown list of **Limits** menu.

Load and display faults vector layer over the magnetics image

1 In the Algorithm window, select **ARC/INFO Overlay** from the **Edit/Add Vector Layer** menu.

A new ARC/INFO layer is added to the algorithm.

2 Click the **Dynamic Link Chooser** button in the process diagram.

3 In the **ARC/INFO Chooser** dialog, click the button next to the 'Workspace' field.

4 From the **Directories** menu (in the **ARC/INFO Workspaces** dialog), select the path ending with **\examples**.

5 Open the 'Application\Mineral_Exploration' directory.

6 Click *once* on the 'ARCINFO_Geology' directory to select it, then click **Select**.

The coverage is loaded into the **ARC/INFO Chooser** dialog.

7 From the drop-down list next to 'Coverage,' select **faults**.

8 From 'Line Width' list, select **1.5**.

9 Click **OK** in the **ARC/INFO Chooser** dialog.

10 In the process diagram, click the **Edit Layer Color** button.

11 Choose red, then click **OK**.

A vector coverage showing interpreted faults in the area displays as red vectors.

12 In the new layer's description field, and change the text to **`faults`** then press Enter or Return.

ER Mapper first processes the raster data, then draws the faults in red.

Change view mode to 3D perspective

1 In the **Algorithm** dialog, select the Intensity layer (if needed), then click the **Duplicate** button.

2 Click your right mouse button on the duplicated Intensity Layer and from the short-cut menu change it to **Height** layer.

The Height layer has the magnetics dataset but since the view mode is now in 2D the Height layer has a red cross indicating view mode is incompatible.

Note: Height layer is used only in 3D perspective or in 3D Flythrough view modes.

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3. Highlight the first and second surfaces, click the surfaces with right mouse button and turn them on from the short-cut menu.
4. Change the View Mode to 3D perspective to view images in the three surfaces in 3D perspective.
5. The images in the three surfaces are displayed in 3D perspective.

Note: You can brighten the image by applying 99% clip transformation on the Intensity layer.

Note: Adjust the Z Scale, Z Offset between the three surfaces. Set the cursor to Pointer mode and use point profile to correlate clay rich areas with K class and fault zones.

Close the image window and Algorithm dialog

1. Select **Close** from the **File** menu to close the image window.
2. Click **Close** in the **Algorithm** dialog.

   Only the ER Mapper main menu is now open.

What you learned...

After completing these exercises, you know how to perform the following tasks in ER Mapper:

- Creating vector polygons of hydroxyl minerals and iron rich soils classes
- Integrating hydroxyl and iron rich classes with magnetics
- Creating vector polygons of high anomaly classes of K, Th and U
- Integrating K, Th and U high anomaly classes with magnetics
- Creating contour lines from magnetics data
- Add layers to link directly to and display ARC/INFO coverages
- Viewing integrated datasets in multi-surfaces in 3D

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