



ENVI Tutorials



September, 2001 Edition
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An aerial photograph of a landscape, possibly a coastal or riverine area, with a semi-transparent blue overlay. The overlay covers the left and bottom portions of the image, creating a gradient effect. The text is overlaid on this blue area.

Tutorial 7: Mosaicking Using ENVI

The following topics are covered in this tutorial:

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Overview of This Tutorial

This tutorial is designed to give you a working knowledge of ENVI's image mosaicking capabilities. For additional details, please see the *ENVI 3.5 User's Guide* or the ENVI Online Help.

Files Used in this Tutorial

CD-ROM: *ENVI Tutorial and Data CD No. 1*

Path: `envidata/avmosaic`

File	Description
Pixel-Based Mosaicking	
<code>dv06_2.img</code>	AVIRIS Scene 02
<code>dv06_2.hdr</code>	ENVI Header for above
<code>dv06_3.img</code>	AVIRIS Scene 03
<code>dv06_3.hdr</code>	ENVI Header for above
<code>dv06a.mos</code>	Mosaic Template for end-to-end AVIRIS mosaic
<code>dv06b.mos</code>	Mosaic Template for feathered overlapping AVIRIS mosaic
<code>dv06_fea.img</code>	Feathered Mosaic image
<code>dv06_fea.hdr</code>	ENVI Header for above
Georeferenced Mosaicking	
<code>lch_01w.img</code>	Warped, histogram matched image
<code>lch_01w.hdr</code>	ENVI Header for above
<code>lch_01w.ann</code>	Cut-line feathering annotation for above
<code>lch_02w.img</code>	Warped, histogram matched image
<code>lch_02w.hdr</code>	ENVI Header for above
<code>lch_a.mos</code>	Mosaic Template for Georeferenced Image Mosaicking

File	Description
lch_mos1.img	Georeferenced mosaic result
lch_mos1.hdr	ENVI Header for above

Mosaicking in ENVI

Mosaicking is the art of combining multiple images into a single composite image. It can be used to combine pixel-based images, to lay out images for publication or map composition, or as a means for combining georeferenced images into an image covering a larger geographic area. ENVI provides interactive capabilities for placing pixel-based images within a mosaic, and automated placement of georeferenced images within a georeferenced output mosaic. The software provides tools for common mosaic requirements such as blending edges (feathering), image border transparency, and histogram matching. ENVI's Virtual Mosaic capability allows users to optionally create and display mosaics without creating large output files.

General Topics

The following sections walk you through some of the preparation required to make mosaics in ENVI. The actual exercises begin with the section [“Pixel-Based Mosaicking Example”](#) on page 183 or alternatively, for georeferenced mosaics, in the section [“Georeferenced Mosaicking Example”](#) on page 187.

Start ENVI

Before attempting to start the program, ensure that ENVI is properly installed as described in the installation guide.

- To open ENVI in UNIX, enter `envi` at the UNIX command line.
- To open ENVI from a Windows or Macintosh system, double-click on the ENVI icon.

The ENVI main menu appears when the program has successfully loaded and executed.

Preparing Images

Raw image data can be mosaicked together if desired (ENVI can be used to easily produce multiband mosaics of multiple data types), however, most mosaics are for output and usually require scaling (contrast stretching), and histogram matching to minimize image differences in the output mosaic.

The first step in creating a mosaic using ENVI is usually to contrast stretch the images. This is done by displaying the bands to be mosaicked and either using one of ENVI's quick (default) stretches or using ENVI's interactive contrast stretching capabilities.

Start in either of the following Pixel-Based (“[Steps for Creating a Pixel-Based Mosaic](#)” on page 180) or the Georeferenced Image Mosaic (“[Create the Georeferenced Mosaic Image](#)” on page 187) sections and open the appropriate images by navigating to the `avmosaic` subdirectory of the `envidata` directory on the *ENVI Tutorial and Data CD No. 1*, selecting the desired image file and opening it just as you would in any other application.

Open the Files

1. Select **File** → **Open Image File**. An **Enter Data Filenames** file selection dialog appears. Select the desired file.

Note

On some platforms you must hold the left mouse button down to display the submenus from the Main Menu.

2. Display the image(s) by selecting the desired bands in the **Available Bands List** and clicking **Load Band**.
3. Select **Enhance** → **[Image] Linear 2%** to stretch the displayed image, or select **Enhance** → **Interactive Stretching**.
4. Stretch the image to enhance the desired image features and output to memory or a new file by selecting **File** → **Save Image As** → **Image File** in the Main Display window.

Histogram Matching

When mosaicking two or more images that overlap, it is usually necessary to choose a base image and balance gray scale values in the rest of the images to match the base image. This is called histogram matching (Richards, 1993). ENVI provides an interactive tool to perform histogram matching. The procedure for performing the histogram matching is described below.

The following steps are provided for information and are not to be executed as part of this tutorial.

1. Display the two images to be histogram matched in two display windows. Select one of the images as the base image and stretch that image as desired using either the default stretches under the *Enhance* menu or **Enhance** → **Interactive Stretching**.
2. Identify the overlap areas, position the *Zoom* windows of both images within the overlap, and resize and/or reposition the *Zoom* window to cover exactly the same region in both images (try to cover as large an area as possible and a broad range of cover types).

3. Select **Enhance** → **Histogram Matching** from the Main Image Display menu bar of the image you want to match to the base image. The **Histogram Matching Input** dialog appears.
4. Select the display number of the base image to match, click on the **Zoom** radio button, and then click **OK**.

The output histogram from the base image is applied to the histogram of the second image and histogram matching is complete. The two images should now have the same gray scale characteristics.

5. Save the two contrast stretched images by selecting **File** → **Save Image As** → **Image File** in both Main Displays.
6. Select to save the stretched files either to memory or to new output files.
7. Repeat for additional overlapping images as required.

You may want to try the histogram matching yourself on the input file for the “[Georeferenced Mosaicking Example](#)” on page 187. However, for the purpose of this exercise, the pre-stretched, histogram-matched images `lch_01w.img` and `lch_02w.img` are provided as input to the georeferenced mosaicking function.

Feathering

It is often desirable to blend or blur the seams between mosaicked images. ENVI provides the capability of feathering the edges of overlapping areas using either edge feathering or outline feathering over a user specified distance. To use feathering when mosaicking images, import the bottom image without feathering. Import the overlapping images with feathering, either edge or outline, as desired.

Edge Feathering

Edge Feathering uses the distance specified in the **Edge feathering distance (pixels)** text box in the **Mosaic Entry Input Parameters** dialog to blend the image seams along the edges of the image. The edge feathering distance specified is blended using a linear ramp that averages the two images across that distance. For example, if the specified distance is 20 pixels, 0% of the top image is used in the blending at the edge and 100% of the bottom image is used to make the

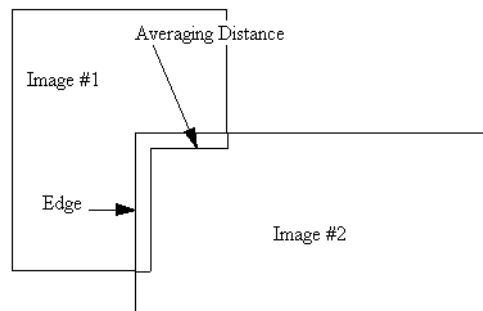


Figure 7-1: Edge Feathering

output image. At the specified distance (20 pixels) in from the edge, 100% of the top image is used to make the output image and 0% of the bottom image is used. At 10 pixels in from the edge, 50% of each image is used to make the output image.

Cut-Line Feathering

Cut-Line Feathering uses the distance specified in the **Cutline feathering distance (pixels)** text box and the annotation file selected from **Ann File** in the **Mosaic Entry Input Parameters** dialog to blend the image boundaries. Cutlines must be defined using the annotation tools prior to mosaicking. The annotation file must contain a polyline defining the cutline that is drawn from edge-to-edge and a symbol placed in the region of the image that will be cut off. The cutline distance specified is used to create a linear ramp that averages the two images across that distance from the cutline outwards. For example, if the specified distance is 20 pixels, 100% of the top image is used in the blending at the cutline and 0% of the bottom image is used to make the output image. At the specified distance (20 pixels) out from the cutline, 0% of the top image is used to make the output image and 100% of the bottom image is used. At 10 pixels in from the cutline, 50% of each image is used to make the output image.

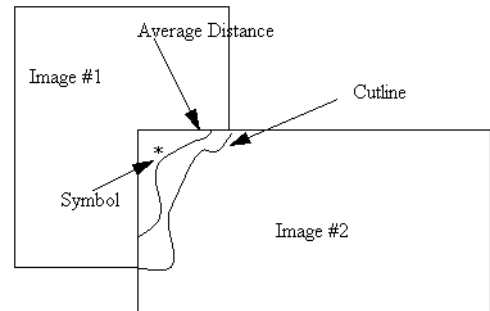


Figure 7-2: Cutline Feathering

Virtual Mosaics

ENVI allows use of the mosaic template file as a means of constructing a “Virtual Mosaic” — a mosaic that can be displayed and used by ENVI without actually creating the mosaic output file.

1. To create a virtual mosaic, create the mosaic and save the template file using **File** → **Save Template** in the **Image Mosaicking** dialog. This creates a small text file describing the mosaic layout
2. To use the virtual mosaic, select **File** → **Open Image File** from the ENVI main menu and open the mosaic template file. All of the images used in the mosaic are opened and their bands are listed in the **Available Bands List**. Display or process any of the bands in the virtual mosaic, and ENVI treats the individual images as if they were an actual mosaic output file. The new processed file has the specified size of the mosaic and the input files are in their specified positions within the mosaic.

Steps for Creating a Pixel-Based Mosaic

The following describes the steps required to create a pixel-based image mosaic.

Set up the Mosaicking Dialog

1. Select **Map** → **Mosaicking** → **Pixel Based** from the ENVI main menu.

The pixel-based option can also be used to place georeferenced images, where the georeferencing information will not be retained. Pixel-based images can also be placed within a georeferenced image using the **Map** → **Mosaicking** → **Georeferenced** option.

2. For pixel-based images, set the size of the output mosaic by entering the desired size in pixels in **X Size** (Samples) and **Y Size** (Line) parameters in the dialog.
3. Also set the “Snap” factor, which controls a grid to which images will be placed or snapped (for example, a snap of 5 means that pixel-based images will be placed at the nearest intersection of a pixel grid with 5 x 5 pixel spacing). Set the snap factor by selecting **Options** → **Set Snap Value**.

Import Images

Use one of the following methods to import images depending on the type of mosaic and whether the images have overlapping areas.

Importing Images Without Feathering

Images that do not overlap, or images that do not require blending should be imported using the Import file without feathering option as follows:

1. Select **Import** → **Import file without feathering** from the menu bar in the pixel-based or georeferenced **Mosaicking** dialog.
2. Open and select the desired image in the **Mosaic Input File** dialog and spectrally and/or spatially subset it if desired.

The image description will be listed in the dialog, and a graphic representing the image and its position in the mosaic will be displayed in the draw widget within the dialog.

3. Open and import the remaining images in the mosaic in the same fashion.

Importing Images With Feathering

Images that overlap may require feathering of the overlap areas to avoid obvious seams in the final mosaic.

1. Select **Import** → **Import file with feathering** from the menu bar in the Mosaicking dialog.

If cutline feathering is being used, the cutline must already have been drawn as a polyline annotation and saved to an annotation file as described in the section “[Cut-Line Feathering](#)” on page 179.
2. For both cutline and edge feathering, specify a distance over which to feather as described in “[Feathering](#)” on page 178.

Feathering blends adjoining images, but mosaicking with feathering is computationally intensive and requires a long time to run, especially for large mosaics.

Importing Images With a Background Value to Ignore

This option allows image transparency for overlapping images.

1. Select **Import** → **Import file with feathering** regardless of whether or not you want to feather the images. This allows you to set a background value to ignore when images overlay one another.
2. If feathering (which is used for mosaicking images with constant digital number value borders) is desired, enter the desired values, however, if feathering is not desired, leave the feathering values set to zero.
3. Enter the data value to be ignored in the labeled text box.

The overlap areas with this value will be transparent, allowing underlying images to show through. This value will also be ignored during the feathering process if selected.

Create a Virtual Mosaic or an Output Mosaic

Complete one of the following steps, either creating a template (virtual mosaic) or creating an output mosaic:

1. To create a virtual mosaic, described in “[Virtual Mosaics](#)” on page 179, select **File** → **Save Template**, enter the output filename, and click **OK**. To view this mosaic, select **File** → **Open Image File** from the ENVI main menu, choose the mosaic template file as the input file and click **Open**. Click on the mosaic band name in the **Available Bands List** and then **Load Band** to automatically

get the required images and display the virtual mosaic to the ENVI Image Display.

2. Alternatively, to actually create the mosaic as a new file, select **File** → **Apply** in the **Mosaic** dialog and enter an output filename. The output mosaic is a standard ENVI file and can be displayed using the **Available Bands List**.

Pixel-Based Mosaicking Example

This section leads you through creation of pixel-based mosaics using ENVI's mosaicking tools.

1. Start the ENVI pixel-based mosaic function by selecting **Map** → **Mosaicking** → **Pixel Based** from the ENVI main menu.
2. The **Pixel Based Image Mosaicking** dialog appears.

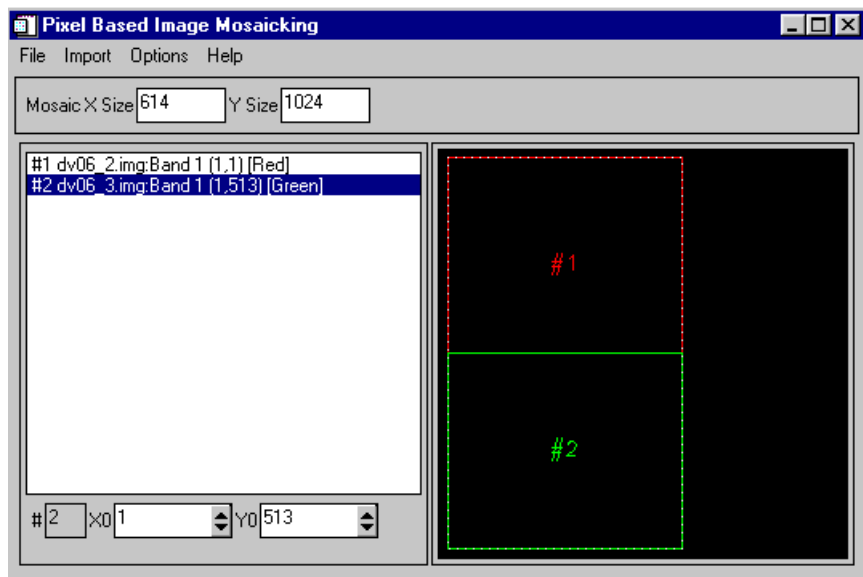


Figure 7-3: The Pixel Based Image Mosaicking Dialog

Import and Position Images

To position pixel-based images:

1. Import each of the following two images, `dv06_2.img` and `dv06_3.img`, by selecting **Import** → **Import file without feathering** from the **Pixel Based Image Mosaicking** dialog.
2. Specify the mosaic size by entering the 614 for the **X Size** and 1024 for the **Y Size** in the text boxes at the top of the **Pixel Based Image Mosaicking** dialog.
3. Click on the second image in the list of images in the dialog (`dv06_3.img`).

The current position of the image in pixels will be listed in the text box at the bottom of the dialog.

4. Change the image position by entering the desired **XO** (x offset) and **YO** (y offset) values in pixels in the corresponding text boxes. Enter a value of 513 for the **YO** for `dv06_3.img` to place it directly below `dv06_2.img`.

Note

Images can also be positioned by clicking and holding the left mouse button on the desired image in the mosaic diagram on the right side of the dialog, dragging the selected image to the desired location, and releasing the left mouse button to place the image.

5. Select **File** → **Apply** from the **Pixel Based Image Mosaicking** dialog menu and enter the output filename `dv06.img` and click **OK** to create the mosaic.
6. Choose **File** → **Save Template** from the **Pixel Based Image Mosaicking** dialog and enter the output filename `dv06a.mos`.
7. Display the mosaicked image by clicking on the `dv06a.mos` band name in the **Available Bands List** and then clicking **Load Band**.

The second part of this example shows positioning of the two images into a composite mosaic image, accomplished by either entering the **XO** and **YO** values, or dragging the images to the desired locations within the dialog. The example also includes edge feathering.

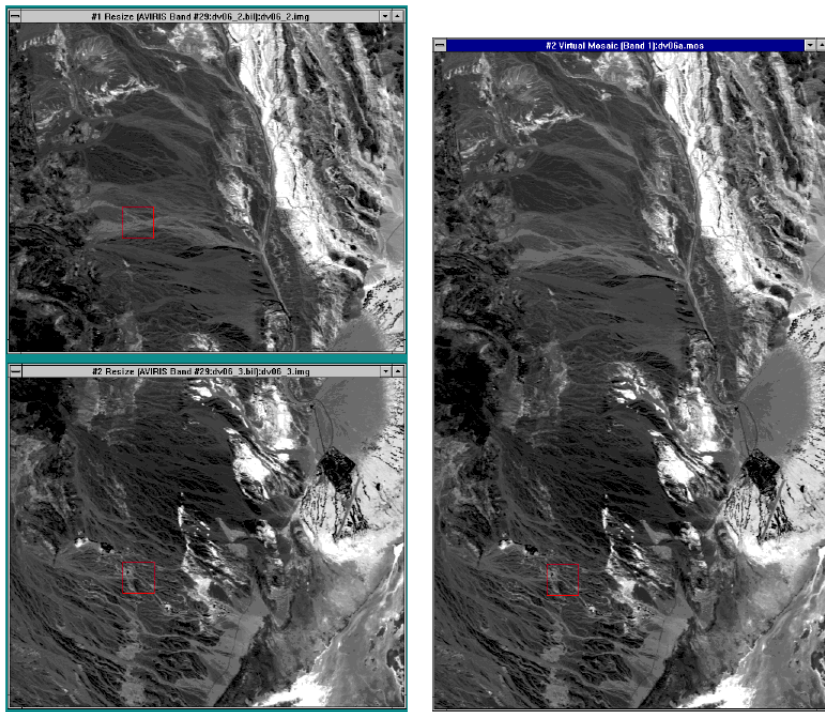


Figure 7-4: Two Single-band AVIRIS Images (left) and the Final Seamless Join of the Two (right)

1. Using the images already displayed, enter a value of 768 into both the Mosaic **X Size** and **Y Size** text boxes to change the size of the output mosaic
2. Left-click within the green graphic outline of image #2 in the **Pixel Based Image Mosaicking** dialog. Drag the #2 image to the lower right hand corner of the diagram.
3. Edit the mosaic characteristics by selecting **Options** → **Edit Entry** in the **Pixel Based Image Mosaicking** dialog. Enter a value of 25 for the **Edge Feathering Distance** and a **Background Data Value to Ignore** of 0, and click **OK**. Repeat for the second image.
4. Choose **File** → **Save Template** and enter the output filename `dv06b.mos`. Click on the mosaic template name in the **Available Bands List** and select

- Load Band** to display it. No feathering is performed when using virtual mosaic.
5. Now make the same image as a feathered mosaic by actually creating the output file. In the **Pixel Based Image Mosaicking** dialog, select **File** → **Apply** and click **OK**.
 6. Enter an output filename, and a **Background Value** of 255, then click **OK**. Display the mosaic now listed in the Available Bands List in a new display window.
 7. Compare the virtual mosaic and the feathered mosaic using image linking and dynamic overlays.

The following figure shows the feathered output mosaic produced by overlapping the two AVIRIS scenes as described above.

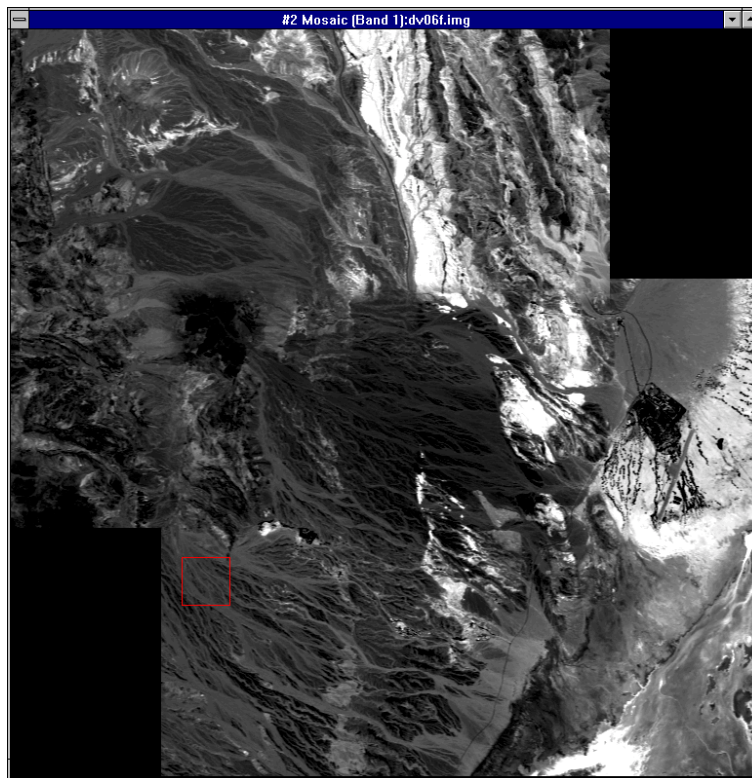


Figure 7-5: The Final Feathered Mosaic

Georeferenced Mosaicking Example

Putting together georeferenced, overlapping images requires considerable preparation, including histogram matching and usually feathering. The following sections of this tutorial describe some of the requirements and how to accomplish these using ENVI.

Create the Georeferenced Mosaic Image

1. Start the ENVI Georeferenced Mosaic function by selecting **Map** → **Mosaicking** → **Georeferenced** from the ENVI main menu.

Load the Mosaic Template

Select **File** → **Restore Template** and select the file `lch_a.mos`. This opens the files and restores the mosaic parameters necessary for a georeferenced, feathered mosaic.

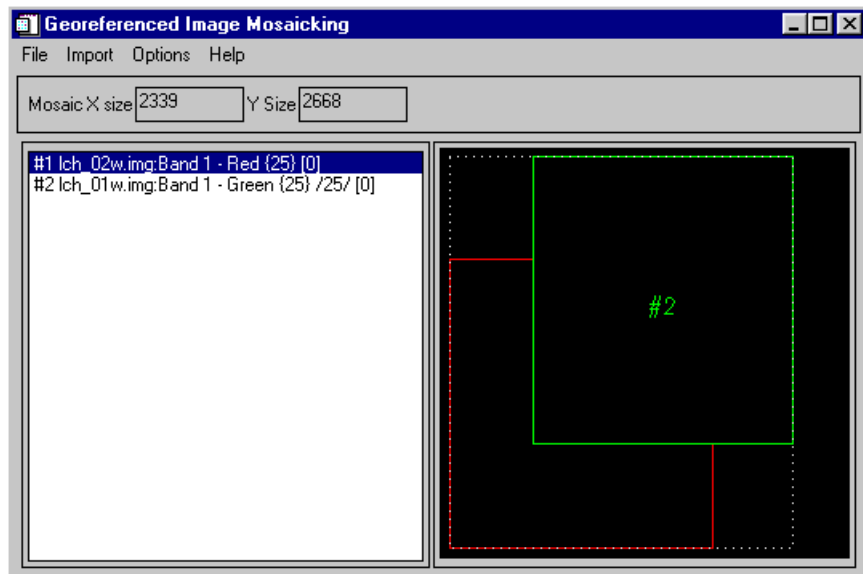


Figure 7-6: The Georeferenced Image Mosaicking Dialog

Optionally Input and Position Images

Optionally, to manually position the georeferenced images and set the feathering options, import the images individually. Images will automatically be placed in their correct geographic locations. The location and size of the georeferenced images will determine the size of the output mosaic.

View the Top Image, Cutline and Virtual, Non-Feathered Mosaic

1. In the **Available Bands List**, select the file `lch_01w.img` and display as a gray scale by clicking on the band name and then the **Load Band** button.
2. Choose **Overlay** → **Annotation** from the Main Image Display menu bar to start the Annotation dialog.
3. Select **File** → **Restore Annotation** and choose the file `lch_01w.ann` to display the cutline used to blend the two images in this mosaic.
4. Display the second image `lch_02w.img` and examine the nature of the cutline with respect to this image.
5. View the virtual, non-feathered mosaic. Select **File** → **Open Image File** from the ENVI main menu and choose `lch_a.mos` as the input file. Load this image to a new display using the **Available Bands List** and examine the non-feathered edge between the two images used to create the mosaic.

Create the Output Feathered Mosaic

1. Select **File** → **Apply** in the **Georeferenced Image Mosaicking** dialog and enter the output filename `lch_mos.img` and click **OK** to create the feathered mosaic.
2. Close the two Image Display Windows containing the individual warped images and load the mosaic image into a new display.
3. Compare the feathered mosaic to the non-feathered mosaic using image linking and dynamic overlays.

In the following figure, the left images show the warped, histogram-matched images with the cutline selected. The right image is the mosaic resulting from using cutline feathering.

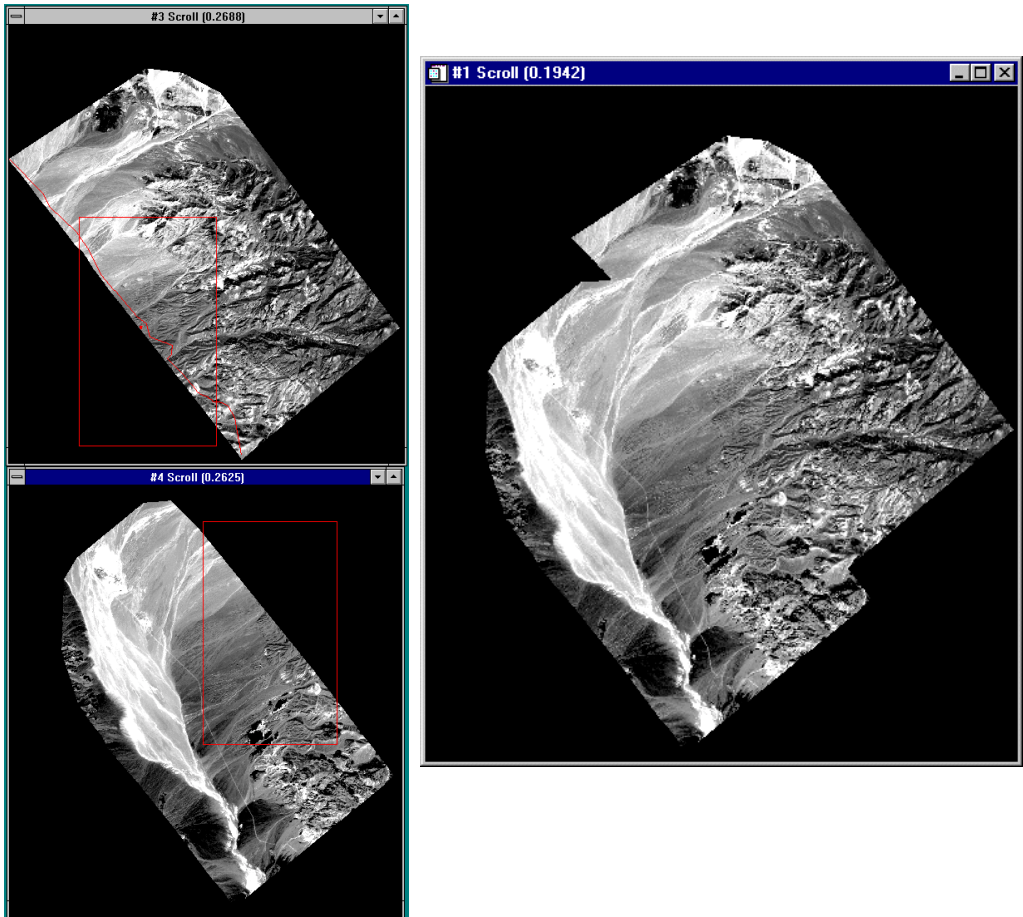


Figure 7-7: Examples of Georeferenced Image Mosaicking

Additional Options in the Pixel Based and Georeferenced Mosaicking Dialogs

The following list describes additional options when using the mosaicking dialogs:

- To edit the characteristics of an image, such as modifying feathering distances, setting the Background Data Value to Ignore (transparency), or changing the X and Y image offsets, select **Options** → **Edit Entry** and enter the desired values.
- To replace an image currently in a mosaic with another image of the same size, select the image to be replaced, and select **Options** → **Replace Entry** and select the image to use for the replacement.
- To delete the currently selected image from the mosaic, select **Options** → **Delete Entry**.
- To remove all images from the mosaic and clear the mosaic, select **Options** → **Clear All Entries**.

The following **Pixel Based Image Mosaicking** dialog options are available only for pixel-based images:

- To float the pixel-based image to the top of the stack of overlapping images, click on the image in the list, or the mosaic diagram, and select **Options** → **Percolate Entry**.
- To center all of the current images in the mosaic as a group, select **Options** → **Center Entries**.
- To place an image as if their upper left corner has the x, y coordinates of (1,1), select **Options** → **Do Not Use Image Offset**.

Do this for images which were previously created as subsets from other larger images and which have an image offset value. This means that the upper left corner of the image has X and Y values corresponding to its position in the original image.

- To place images in the mosaic at the location specified by its location in the original image from which it was subset, select **Options** → **Use Image Offset**.

End the ENVI Session

You can quit your ENVI session by selecting **File** → **Exit (Quit on UNIX)** in the ENVI main menu, then click **Yes** to end the session. If you are using ENVI RT, quitting ENVI will take you back to your operating system.