User Guide for GeoMapApp version 3.7.1

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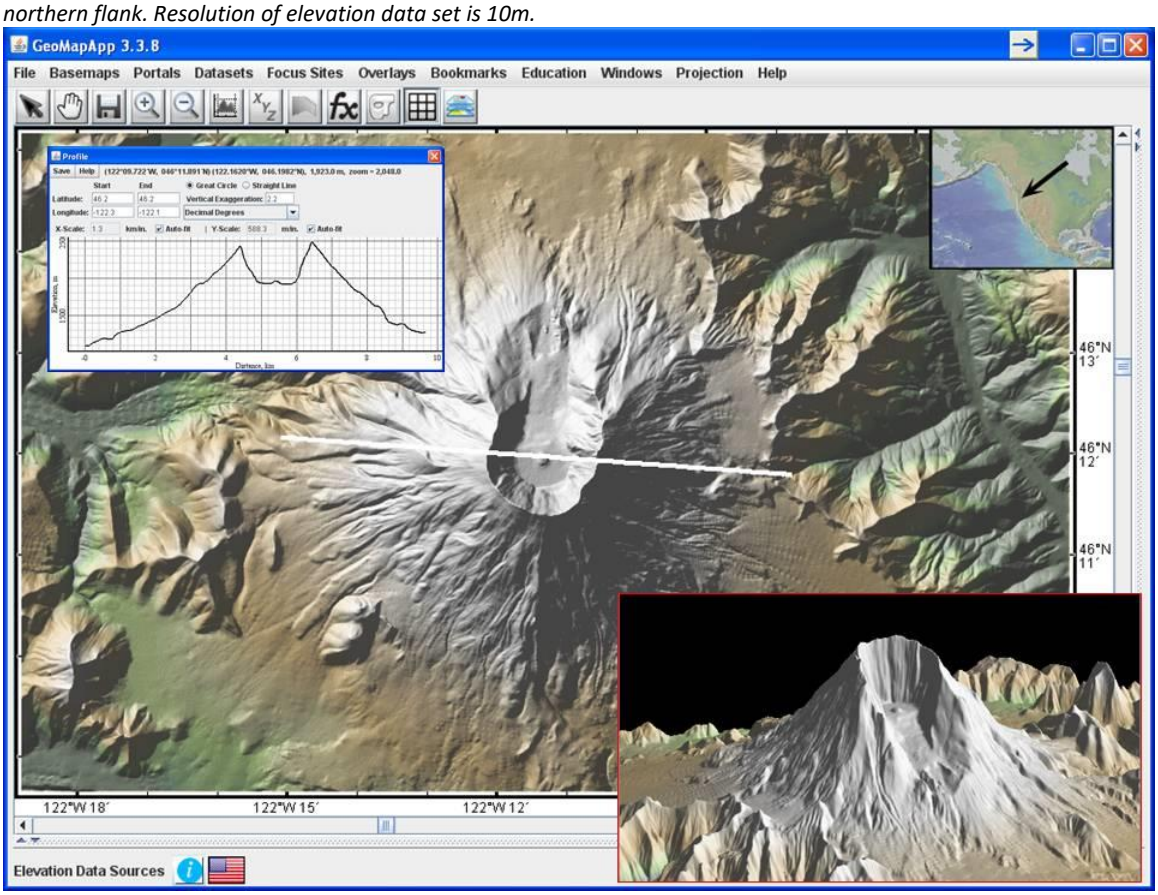
Figure: The GeoMapApp base map reveals striking features of Mt. St. Helens, a stratovolcano in the Cascade Range. Inset, top left: Profile taken across the summit caldera. Inset, lower right: 3-D perspective plot looking south towards the blasted away northern flank. Resolution of elevation data set is 10m.



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A note about screen capture images

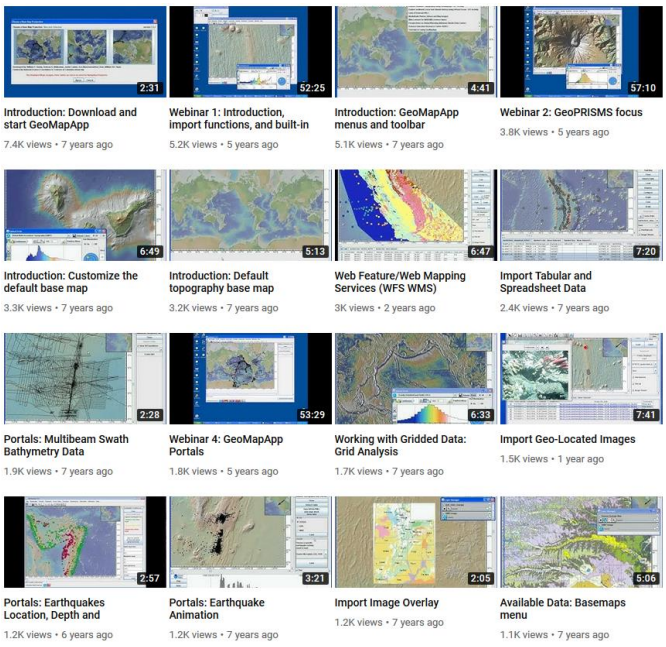
Where necessary, screen capture images in this guide have been updated to reflect current functionality. Older images may be present for unchanged functionality.

1) About GeoMapApp

GeoMapApp is an application created for the discovery, exploration, manipulation, visualization and analysis of a large choice of built-in and user-imported geoscience data. The application is coded in Java and runs on the Windows, Mac, Linux, and UNIX operating systems. GeoMapApp is free and can be downloaded at http://www.geomapapp.org/. The development of GeoMapApp is funded by the US National Science Foundation and by the Trustees of Columbia University.

The GeoMapApp interface provides users with access to many built-in data sets as well the ability to import their own locally-stored data sets. The GeoMapApp tool bar provides a number of useful functions and shortcuts, including zoom and panning, a profile tool and a mask function, and a digitizer. When viewing grids, the grid pop-up window offers convenient tools for changing the color palette, sun illumination and vertical exaggeration, for drawing contours and creating profiles, and for generating a 3-D perspective view. A Save Session function allows an instance of GeoMapApp to be saved and shared with students and colleagues. At all times, the GeoMapApp layer manager allows layers to be toggled off and on, their transparency altered, and their order switched. For example, varying the transparency is useful when comparing co-located data sets, and, when viewing multiple data sets, the user can specify which layer is topmost. A number of built-in data sets are shapefiles. The shapefile manager allows individual components of built-in and imported multi-shape shapefiles to be selected.

A collection of short GeoMapApp video tutorials is posted on YouTube, under the GeoMapApp channel, as captured in this screen shot:

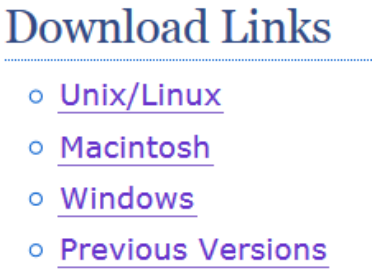


Also, answers to a list of frequently-asked questions are given on the GeoMapApp web page and are routinely updated.

2) Download and start GeoMapApp

See video tutorial on YouTube

On the GeoMapApp web page (http://www.geomapapp.org/), look in the left pane and choose the platform you are using from the Download Links area.



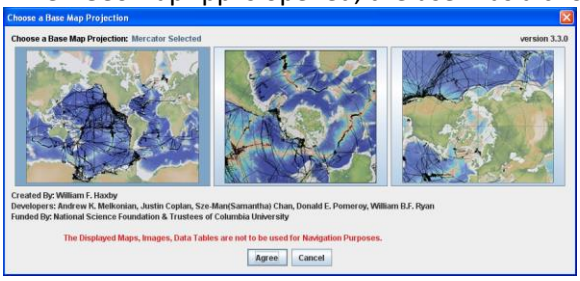
Click Agree and save the application to the local computer. Double-click on the icon to start the application.

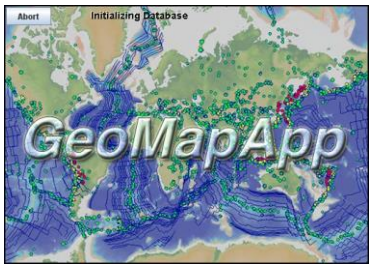
Alternatively, if GeoMapApp was downloaded as a jar file (GeoMapApp.jar), it can be opened from a terminal window by changing to the directory containing the application and typing, for example: *java -jar -Xmx1028m GeoMapApp.jar* In this example, 1028 Mbytes are allocated as application memory (the default is 512 Mbytes). Specifying a larger memory size is useful when importing very large (many 100s MBytes) grids or data sets from the local disk drive.

A third way of opening GeoMapApp is to use a Java WebStart link. The WebStart link is given on the GeoMapApp home web page and allows GeoMapApp to be opened directly from the internet using a Java-enabled web browser.

2.1) Choosing a Map Projection

When GeoMapApp is opened, the user has a choice of three map projections as shown below, left.





The Mercator projection – the leftmost panel – is the pre-selected default as shown by the outlined blue border. Click the center panel for the southern hemisphere polar projection or the rightmost panel for the northern hemisphere polar projection. Click the 

button to proceed. An initialisation screen (above, right) is displayed briefly before the GeoMapApp window appears.

Most of the built-in data sets are common to all three projections although some data sets are unique to certain projections.

The Mercator projection conforms to the map projection standard called European Petroleum Survey Group code 3395, the Southern hemisphere polar projection to EPSG code 3031 and the Northern hemisphere projection to EPSG code 32661. The default Mercator projection extends from 81°S to 81°N.

2.2) The GeoMapApp window

After the GeoMapApp window has opened, the default map on display is shaded color topographic relief from the Global Multi-Resolution Topography (GMRT) synthesis of the Marine Geoscience Data System. Here are screenshots of the three projections.

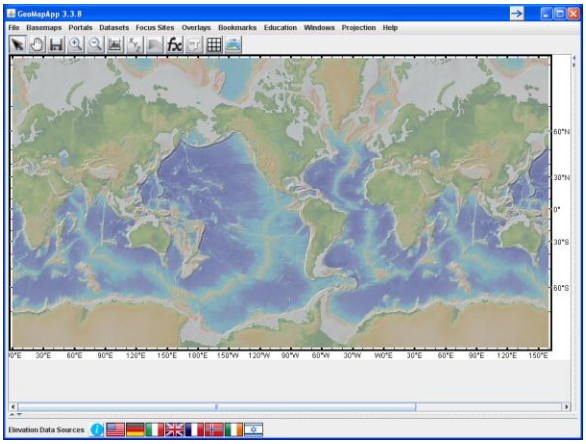


Figure: Mercator projection base map (default)

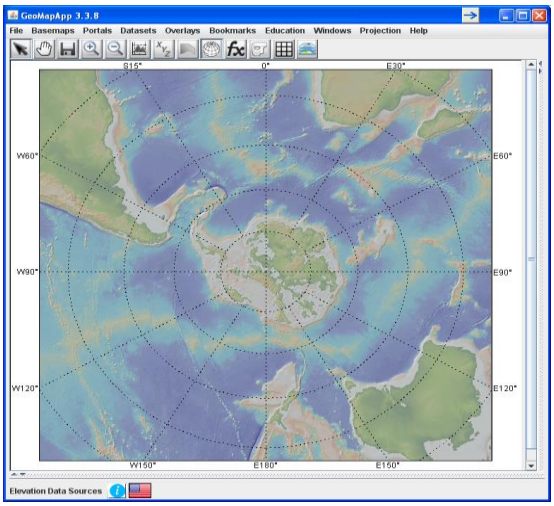


Figure: Southern hemisphere projection

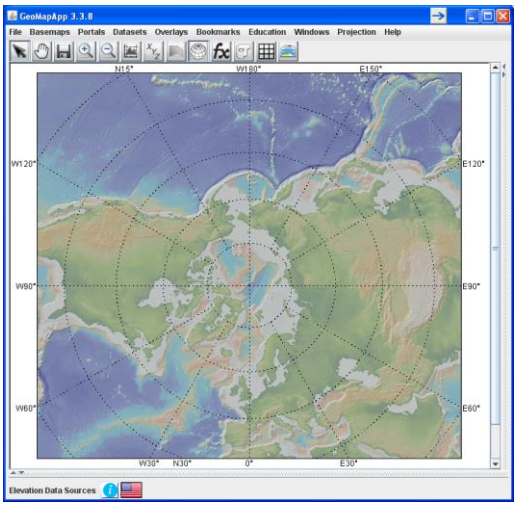


Figure: Northern hemisphere projection

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3) Global Multi-Resolution Topography (GMRT)

The GMRT global elevation synthesis (Ryan et al., 2009) is the default base map in GeomapApp.

GMRT includes multibeam swath bathymetry from more than 1,000 research cruises. In the oceans, the default maximum horizontal resolution on a global scale is ~100m, with 50m grid spacing in some shelf areas, and even higher resolutions in concentrated study areas such as hydrothermal vent fields.

For land areas, high-resolution elevation data from the Shuttle Radar Topography Mission and USGS NED model are included.

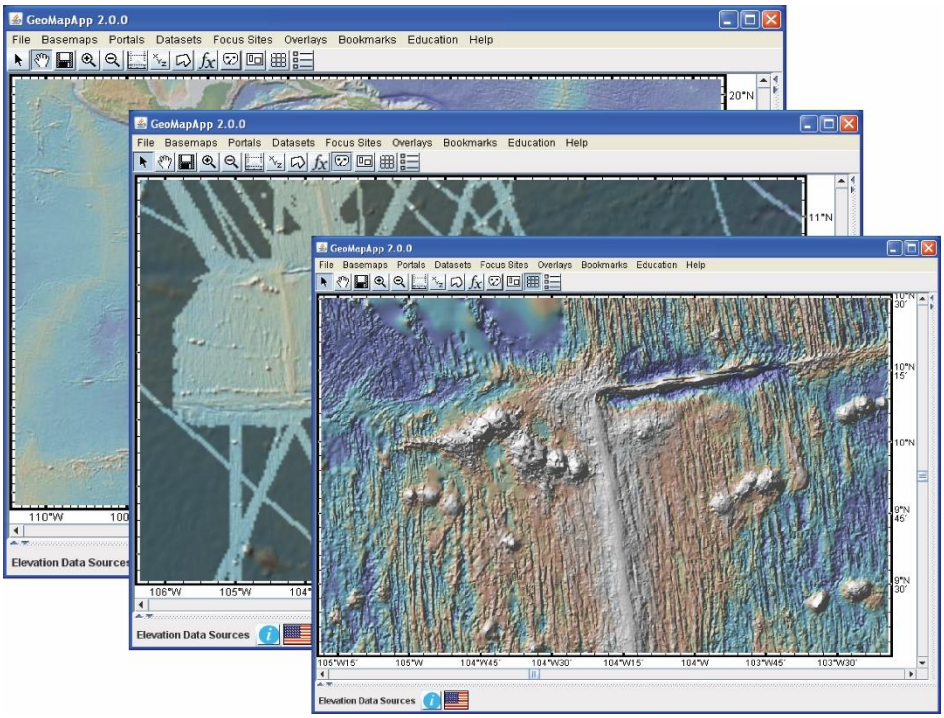

Figure: Examples of the GMRT compilation at the East Pacific Rise 9N site. Progressively higher resolution is shown to the lower right. The mask function (middle image) uses transparency to indicate areas with multibeam swath bathymetry data. The underlying GMRT grid can shaded to highlight the strong abyssal hill fabric (lower right).

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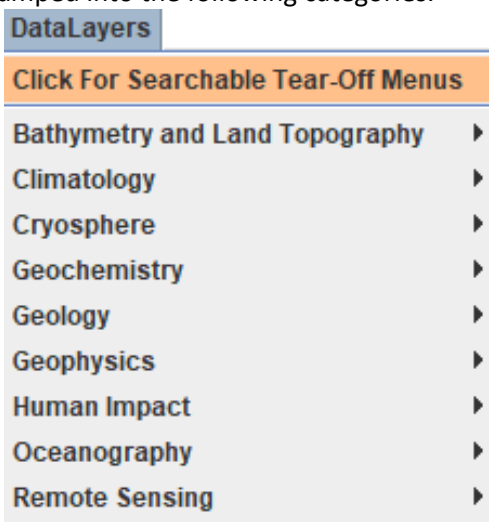
4) The Menu Bar - Introduction

Built-in and imported data sets and many other functions are accessed through the menu bar.

The **File** menu (File) provides user import options for Excel™ spreadsheets, data tables, grids, shapefiles, and images and offers Web Service connections to data from a number of national and institutional data repositories including IRIS, NASA, JPL, UNAVO, NSIDC. Various save and export options are available, including Save Session.

The **DataLayers** menu (DataLayers) presents a wide range of built-in global, regional and local data sets. The menu items clumped into the following categories.



The categories were chosen to reflect big-picture geoscience fields and themes. For example, Cryosphere includes data sets related to polar ice studies and glaciations; Geophysics includes data sets ranging from lithospheric plate deformation, earthquake catalogues, gravity and magnetic anomalies, tomographic seismic velocity models, to heat flow data. The Geology category includes geological maps and interpretations, volcano catalogues, and seafloor characteristics.

Two examples of the many built-in data sets available under the DataLayers menu are given in the figure below.

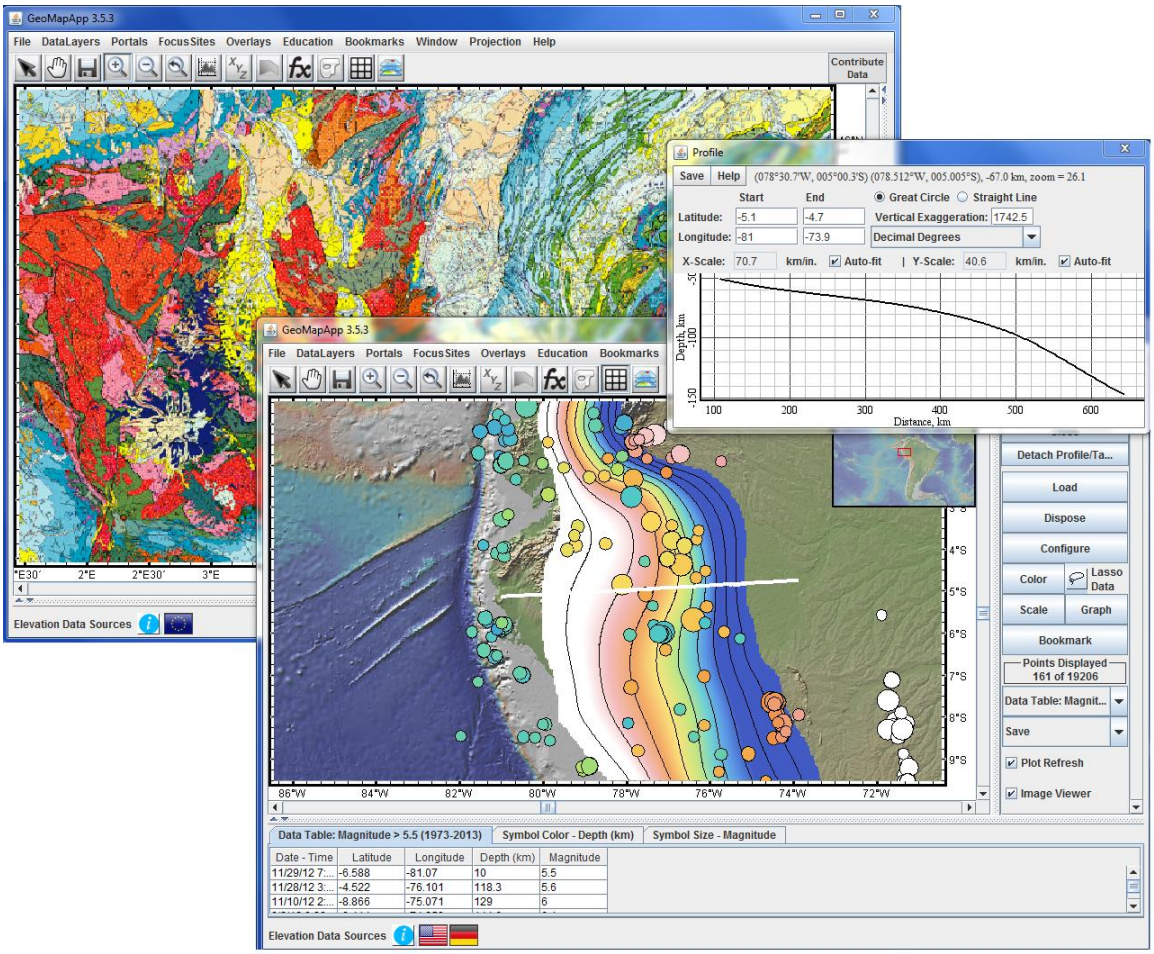


Figure: Examples of built-in GeoMapApp data sets. (clockwise from upper left): Geology map of France; Cross-section of the subducting slab interface beneath the Andes (Syracuse and Abers, 2006) with the profile taken across the white E-W-trending line shown in the lower map. Also plotted on that map are global earthquakes (1973-2013) with magnitude > 5.5 in which epicenter locations are colored on focus depth (cooler colors are shallower) and scaled on magnitude.

The **Portals** menu (Portals) offers customized interfaces to access and manipulate specific data types. For example, the Digital Seismic Reflection Profiles interface allows users to view and digitize Multi-Channel Seismic Reflection profiles; the Ocean Floor Drilling interface provides customized profiling and searching of sediment core data from the DSDP, ODP and IODP programs; the Seafloor Photographic Transects portal offers seafloor dive photos arranged along dive tracks; and, the GPS Velocity Vectors portal allows users to plot user-defined velocity vectors on the map.

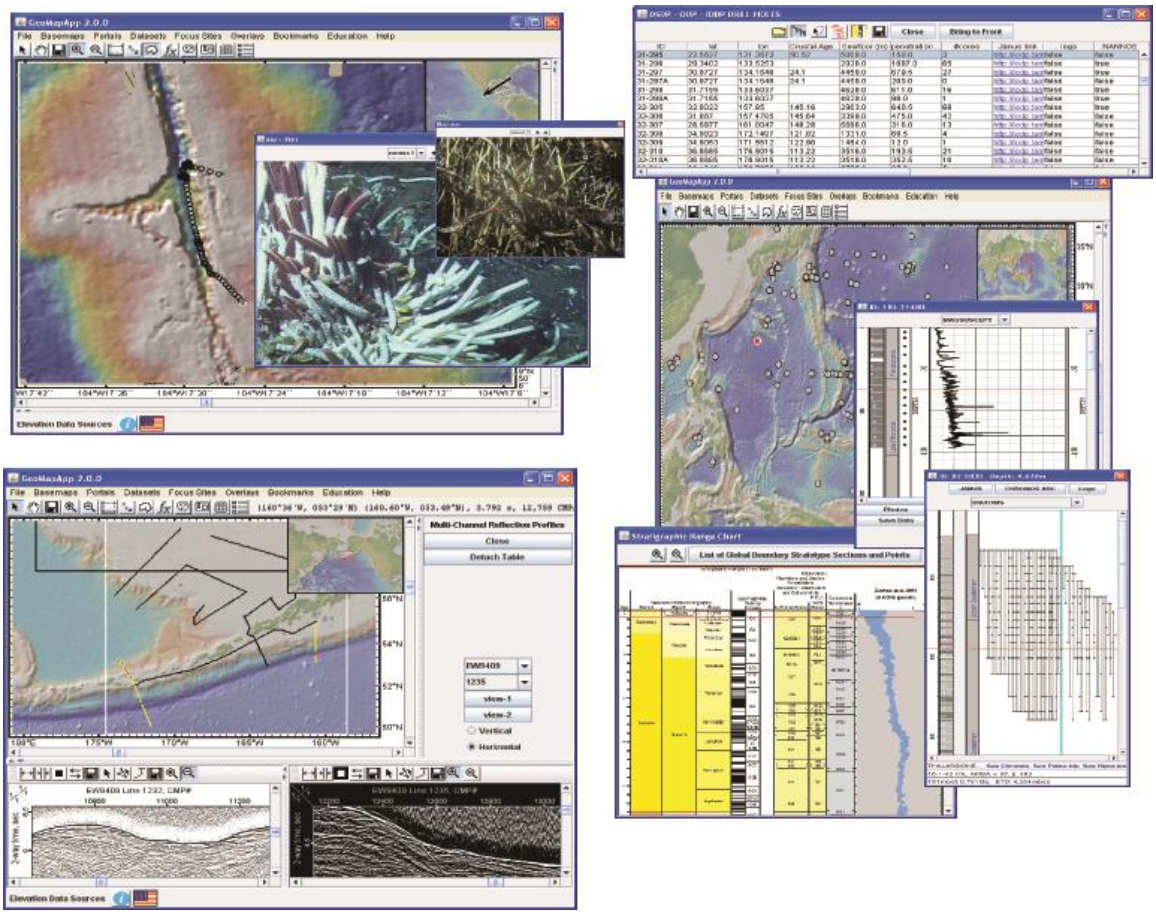


Figure: Examples of customized interfaces available under the Portals menu: (Clockwise from upper left) Seafloor dive photos on high-resolution bathymetry for the EPR 9N Ridge 2000 study site; the DSDP/ODP interface includes species range charts, down-hole physical measurements and stratigraphic information; Multi-Channel Seismic reflection profiles across the Aleutian trench.

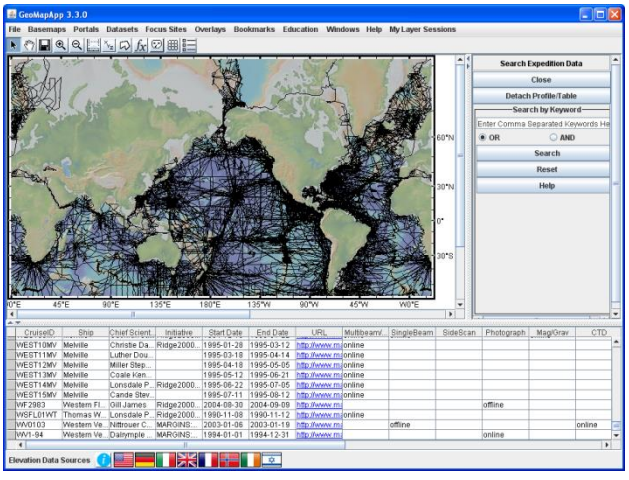


Figure: The Search Expedition Data portal provides a convenient map interface to search on cruise-related data. An alternative map-based cruise data search interface is now also available at http://www.marine-geo.org/tools/new_search/search_map.php

The **Focus Sites** menu (Focus Sites) provides quick links to GeoPRISMS, Ridge 2000, and MARGINS Focus Site data sets as well as to data sets for other selected areas.

In the **Overlays** menu (Overlays), various overlays can be selected and toggled on/off, including a distance scale, the inset map, coastlines, lakes and rivers, latitude/longitude grid lines, and geographic/political names and boundaries.

The **Bookmarks** menu (Bookmarks) allows the current view to be saved as a bookmark, provides zooming capability to user-specified areas, and a shortcut to zoom out to the global view.

Education-related links are given under the **Education** menu (Education).

The **Windows** menu (Windows) can be used to bring-to-front any of the GeoMapApp pop-up or control windows that are currently open.

The **Projection** menu (Projection) offers a shortcut to switch from one GeoMapApp projection to another without needing to close and re-open the program.

The **Help** menu (Help) points users to this user guide document, to a wide range of GeoMapApp video tutorials hosted on YouTube, to an FAQ page, and to other help-related resources.

When the Save Session function is active, a new menu item called **My Layer Sessions** (My Layer Sessions) appears at the end of the menu bar:

The Save Sessions function currently offers basic capability useful for collaboration and teaching. For example, educators can preserve a pre-loaded state of GeoMapApp, and, when shared with a class, the saved file allows every student to open GeoMapApp at exactly the same starting point from which to begin their data explorations.

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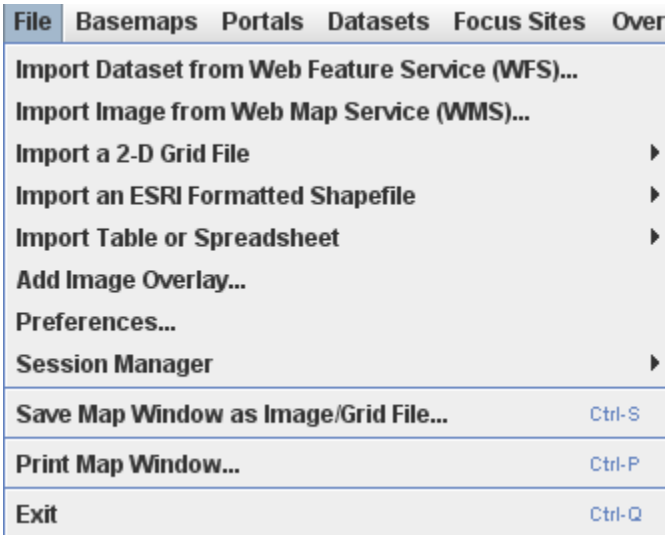
5) The Menu Bar - Details

In this section are the details of each of the menus.

5.1) File

Functions under the **File** menu include data import, save options, Save Session, and GeoMapApp settings preferences.



5.1.1) Import data sets – Import Dataset from Web Feature Service (WFS)

Provides real-time web connection to a wide range of database and repository holdings, including those at NGDC, IRIS, the Antarctic Master Directory, the PetDB petrological database and SedDB sediment geochemistry database, DSDP, and others.

When a WFS data set is loaded, all functionality associated with tabular data sets is available, such as choice of plotting symbol, symbol coloring and scaling, graphing, and lasso selection.

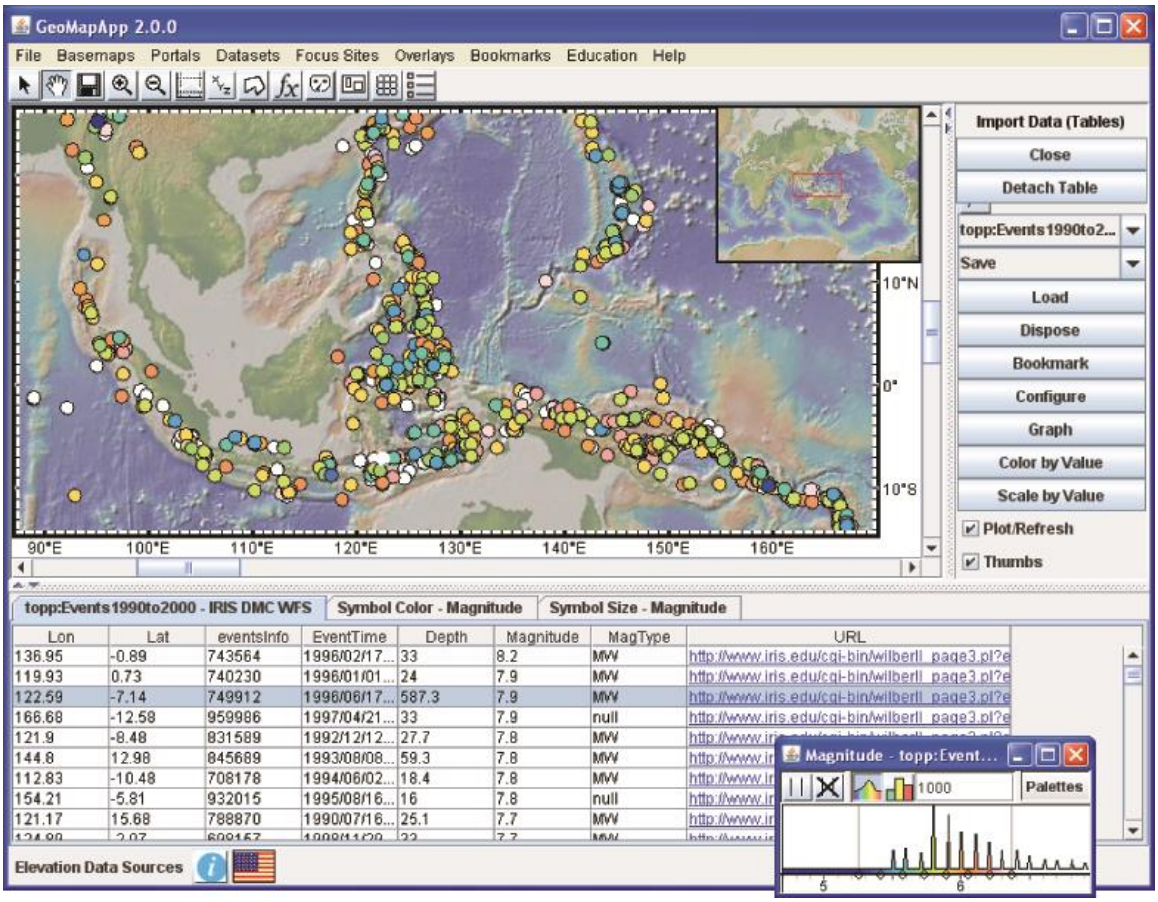


Figure: An IRIS Web Feature Service (WFS) data set for earthquake locations showing those around Indonesia, colored according to magnitude.

To graph the down-hole measurements associated with the DSDP WFS, see the data set Special Functionality section.

5.1.2) Import data sets – Import Image from Web Map Service (WMS)

Provides real-time web connection to a number of agencies serving images and maps via WMS, including NASA, JPL and NSIDC. OGC standard WMS versions 1.0.0, 1.1.0, 1.1.1 and 1.3.0 are supported. To specify a particular version, add it to the GetCapabilities URL. Example: http://coastalmap.marine.usgs.gov/cmgp/National/gloria/MapServer/WMSServer?request=GetCapabilities&service=WMS&version=1.3.0

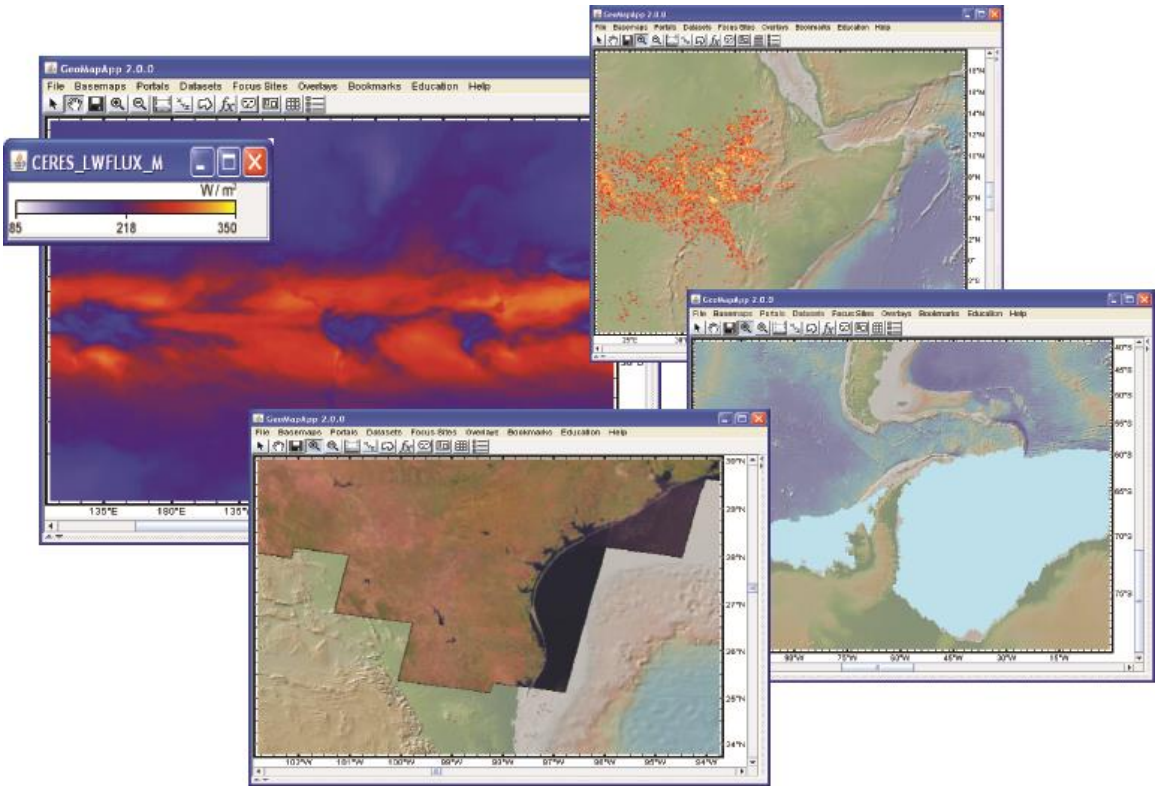


Figure: Web Map Service examples. Clockwise from upper left: Outgoing long wave radiation (NASA, CERES); One month of fires across eastern Africa (NASA, Terra/MODIS); Extent of sea ice in austral summer (NSIDC, for December 1979-2007); Landsat5 pseudo-color mosaic (JPL, CONUS data set).

5.1.3) Import data sets – Import a 2-D Grid File

See video tutorial on YouTube

With this function, users may import their own grids and have full capability for zooming, grid manipulation and profiling. Various formats of grids can be imported, including the GMT netCDF and ESRI ASCII/binary formats. Multiple grids can be imported at once.

5.1.4) Import data sets – Import Shapefile

See video tutorial on YouTube

Use this option to import shapefiles. The required shapefile components are the .shp, .shx and .dbf files as described here.

5.1.5) Import data sets – Import Table or Spreadsheet

See video tutorial on YouTube

Users can import data tables that are in ASCII and Excel™ formats as well as tables stored on the clipboard or at a given web URL. Excel™ spreadsheets must be in a recent format such as Microsoft 1997-2007 or .xlsx format. The data table must contain a column for longitude (in decimal degrees) and a column for latitude (in decimal degrees). The imported points are plotted on the map and can be manipulated as for any tabular data set – colored, scaled, graphed, linked to URLs, and so on.

Additionally, specific symbol colors can be predefined by including a column of RGB (Red,Green,Blue) values in the data table. The RGB values need to be listed as comma-separated triples such as 255,140,67. Upon import, the RGB column is specified in the import Config window.

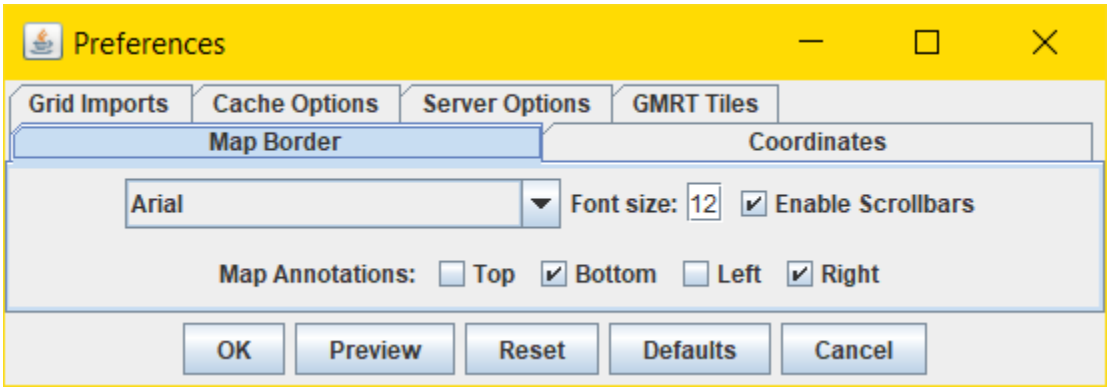
5.1.6) Import data sets – Add Image Overlay

See video tutorial on YouTube

Imported images are displayed in the GeoMapApp window. The transparency function in the Layer Manager can be used to compare the imported image with underlying data sets.

5.1.7) Preferences

The preferences window contains functions that control the border annotation location and style as well as the ability to turn off and on and clear the caching of menus and portal databases.

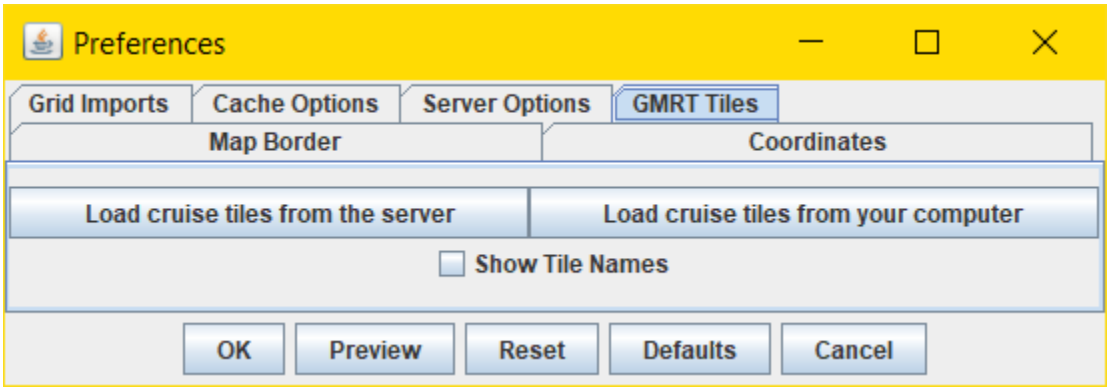


For border annotations, select the Map Border tab, and tick or untick boxes to turn items on and off. Select font type from the drop-down menu. Type a new font size in the box Font size: 12. To check the appearance of changes to the annotations, select Preview Then, to accept the changes, select Ok.

The caching options, listed under the Cache Options tab Cache Options, are turned on by default since they typically greatly reduce the time taken for GeoMapapp to start and for certain portal interfaces to load. For example, with no caching, the Multibeam swath bathymetry portal may take up to 2-3 minutes to fully load. When portal caching is turned on, subsequent re-loads of the portal takes just 2-3 seconds.

The menus are cached by default but can be cleared with the Clear Menus Cache button. The next time GeoMapApp is started a fresh copy of the current menus will be obtained automatically from the server.

The GMRT Tiles tab is used for previewing and assessing edited multibeam swath bathymetry tiles as part of the GMRT work flow. This tab is mainly used for internal purposes by the GMRT team.



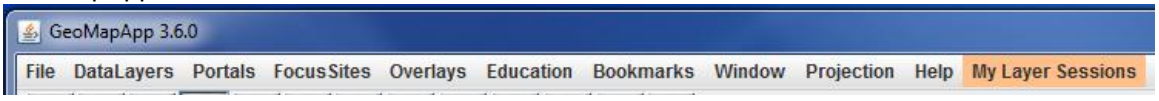
The Server Options tab is for internal use.

5.1.8) Session Manager

The Session Manager allows a pre-loaded state of GeoMapApp to be preserved. When the saved session file is later imported – for instance, by students or colleagues – GeoMapApp automatically opens to the same state with the same data layers loaded, the same color palettes and layer transparency settings, and with the same zoom. Sharing a saved session file could be useful in a classroom setting to have all students open GeoMapApp at exactly the same state. The Session Manager menu offers the following options:

Save the current display using *Save Current Session.* The information is stored in a simple XML file on the local machine.

Use *Import Saved Session (.xml)* to bring up a navigation window that provides access to saved sessions. When a saved session has been selected and imported, a new menu item pops up in the top of the GeoMapApp window:



Click on *My Layer Sessions* to see the list of imported sessions. Each listed item shows the individual component data sets of that saved session. When one of the component data sets is selected, it is loaded in GeoMapApp.

Refresh Imported Sessions will re-read the list of saved sessions to ensure that it is up-to-date. **Close and Discard the Sessions Menu** removes the **My Layer Sessions** menu from the top of the GeoMapApp window.

See also the My Layer Sessions section and the How to Save a Session section.

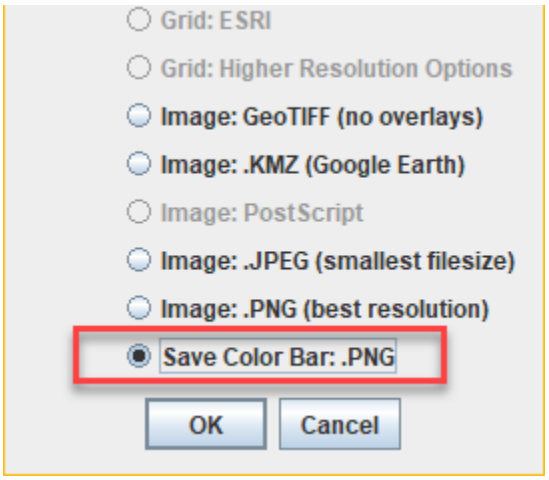
5.1.9) Save Map Window as Image/Grid File

The current map view (including any symbols, grids, tracks and so on that are displayed) can be saved in various image formats including JPEG, PNG, KMZ (Google Earth™-compatible), and GeoTIFF. The image can also be stored as a PDF file (see Print option below).

When the GMRT base map is loaded, the **Grid: Higher Resolution Options** save function allows the GMRT base map to be saved in a gridded format at user-specified scales of resolution.

When ***any*** grid has been loaded, the range of grid save options includes GMT netCDF, ESRI ASCII/binary, and GeoTIFF formats.

The Color Scale bar for the base map or for any loaded grid may also be saved using the Save Color Bar option in this menu, as shown here:



5.1.10) Print Map Window

Sends current map view to a printer or to a PDF file. Click the Printer 

button to choose the destination printer (or to save to PDF). Paper orientation and margins can also be specified.

5.1.11) Exit

Close GeoMapApp.

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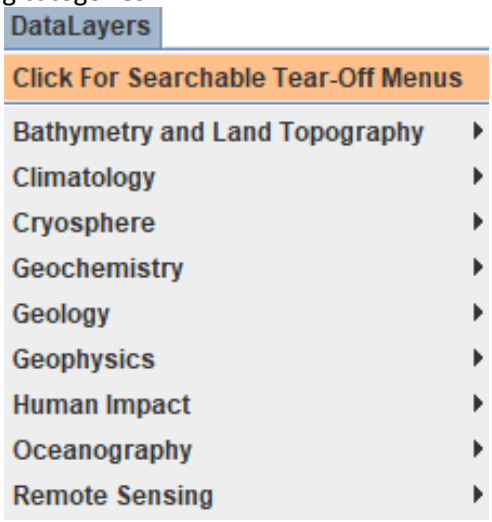
5.2) DataLayers

A wide range of built-in global, regional, and local data sets covering many geoscience disciplines are available through the new **DataLayers** menu.

The *DataLayers* menu presents thousands of research-grade geoscience data layers that have been arranged in the following categories.



The categories were chosen to reflect big-picture geoscience fields and themes. For example, Geophysics includes data sets ranging from lithospheric plate deformation, earthquake catalogues, gravity and magnetic anomalies, tomographic seismic velocity models, to heat flow data. The Geology category includes geological maps and interpretations, volcano catalogues, and seafloor characteristics. Cryosphere includes data sets related to polar ice studies and glaciations, whilst Climatology contains hurricane data, palaeo-climate reconstructions, and land/ocean temperatures.

In general, the data sets within each menu are organised from the global scale down to the regional and local scale. For example, the *Bathymetry and Land Topography* menu includes global elevation models such as GMRT and GEBCO; regional-scale data sets; and many high-resolution data sets for small study areas. Land elevations include very-high-resolution LiDAR data sets such as 3m-horizontal-resolution topographic elevations for some Cascade volcanoes, and a 1-foot data set of New York City.

New data sets are added to the *DataLayers* menus throughout the year. Existing data sets are also updated as needed. They additions and updates are listed on the Recently-Added Data Sets web page. The GeoMapApp menus automatically update during start-up to include new additions.

5.2.1) Layer Manager

A Layer Manager window opens automatically when any data set is loaded. It can be used to turn the loaded layer off and on, to alter its transparency, to change the ordering of loaded layers, and to discard it entirely. If the Layer Manager window is not visible, activate it by clicking the icon in the GeoMapApp toolbar.

5.2.2) Gridded Data

When a **gridded** data set is loaded, a grid dialog window appears. For grids that comprise a multi-shape shapefile, a Shapefile Manager also comes up, allowing individual shapefile components to be selected.

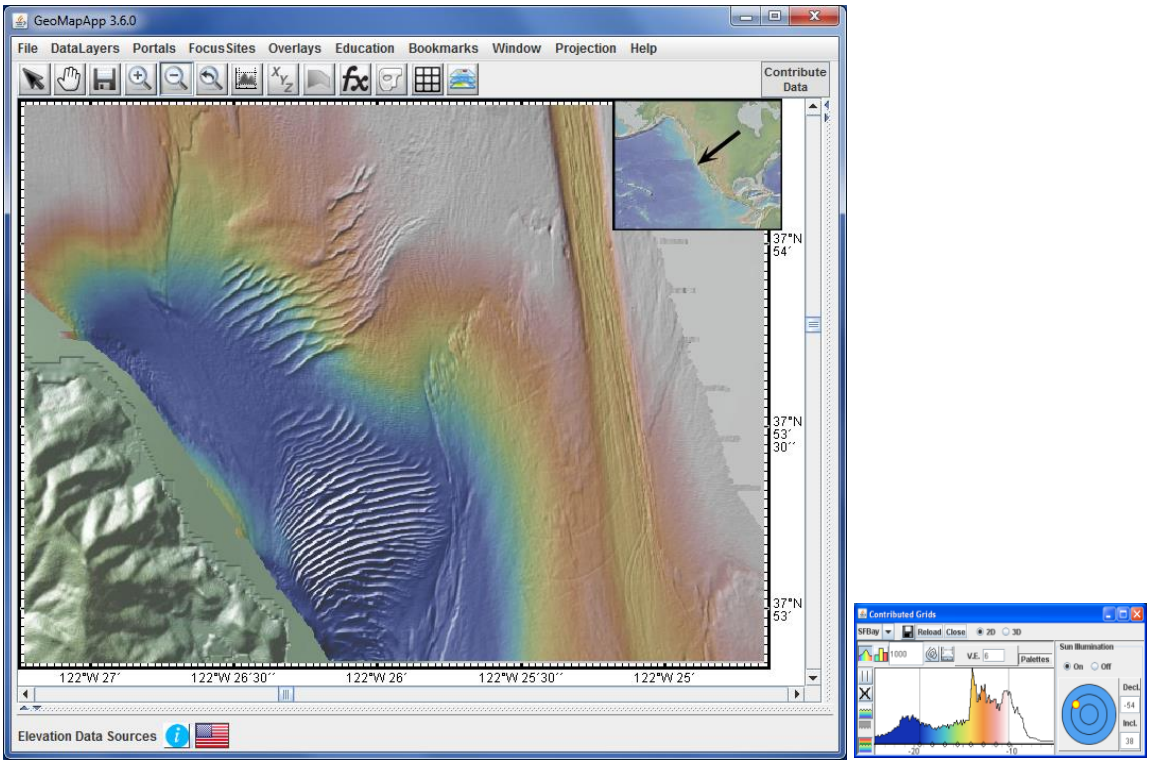


Figure: High-resolution bathymetry of San Francisco Bay shows fine detail of bay bottom ripples and a dredge channel. The grid dialog window (shown to the right) provides functions to manipulate the grid including changing the colors, sun illumination, contours, and taking profiles. This bathymetry data set is available through DataLayers > Bathymetry and Land Topography > Bathymetry - By Region > US Bays, Coast, Estuaries, and Harbours > Washington, Oregon, and California (Q-Z) > San Francisco Bay Interior (5m resolution).

See video tutorial on YouTube

5.2.3) Tabular Data (Spreadsheet, Table, CSV file, etc)

See video tutorial on YouTube See also section (10) of this User Guide for more details on handling and manipulating tabular data.

Spreadsheets, tab-separated ASCII files, and CSV files are examples of tabular data formats. The *DataLayers* menu contains many built-in data sets that are in a tabular format. Common to all of these tabular data sets is that each record in each tabular data set is geographically-referenced by longitude and latitude. This allows individual points to be queried and manipulated.

All tabular data manipulation functions described below and in section (10) apply to the built-in tabular data sets and to any imported tabular data set, whether imported as a spreadsheet, ASCII table, or from the clipboard.

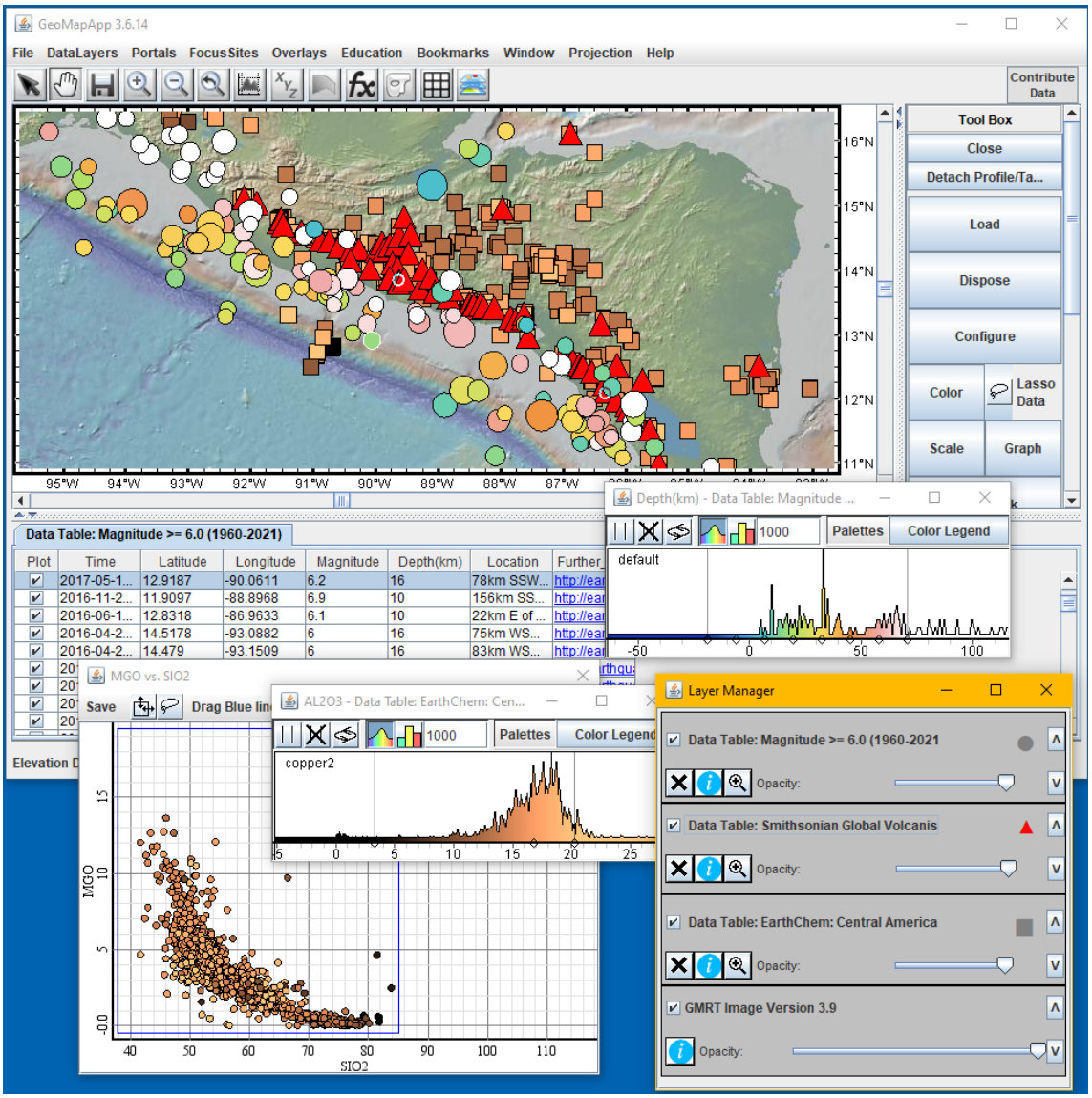
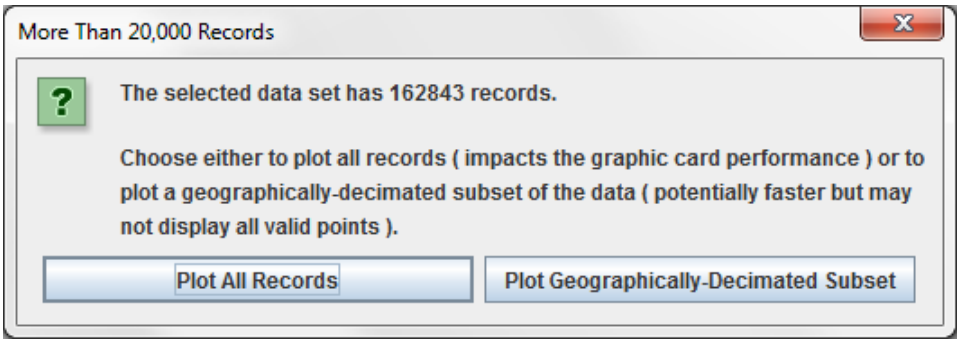


Figure: Example of three built-in tabular data sets displayed in GeoMapApp. Red triangles show volcanoes from the Smithsonian Global Volcanism Program, v4.3.4. Earthquakes from the USGS catalogue for the period 1960-2021 are shown as circles that are coloured on hypocentral depth and scaled on magnitude. Squares are EarthChem geochemical data coloured on Al_2O_3. The graph window shows an EarthChem scatter plot with MgO plotted against SiO_2. The colors are easily changed by moving the grey vertical lines in the colour histogram windows. The colour legends can be saved. In the lower right is the Layer Manager window. The symbol chosen for each tabular data set (circle, square, triangle or star) is displayed next to the up/down arrows in the Layer Manager. For symbols that are dynamically coloured, the symbol in the layer Manager will be grey. For symbols that are uniformly coloured using the Configure colouring options, those symbols are show in the Layer Manager with the specified colour.

For large data sets, GeoMapApp displays a notice if there are more than 20,000 points asking if all points should be plotted or if only a decimated sub-set should be shown. In this example, the data set contains 162,843 records:



If *Plot All Records* is chosen, all of the points will be plotted on the map. For very large data sets, more memory may need to be allocated to GeoMapApp – see the details in the Download and start GeoMapApp section.

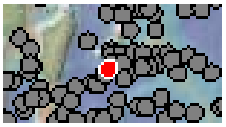
If *Plot Geographically-Decimated Subset* is chosen, all of the records will be read into operating memory but no more than 20,000 points will be plotted in the map window. The displayed decimated points are chosen to be representative of the geographical distribution of the entire data set although some quirks are known to occur. Upon zooming in, more of the points become visible.

Although most modern computers tend to contain high-performance graphics cards, the decimation option is still provided for very large data sets.

Once the tabular data set has loaded, the data records are displayed beneath the map. Points can be selected either by clicking one row in the table (the row will turn to a blue color, example:

VM34-140	VM0034140P	16/11/1977	-23.417

) or by clicking one of the symbols on the map which will turn red and will, in turn, highlight the corresponding record in the table:



To select more than one point, either shift-click to select multiple consecutive points in the table, ctrl-click to select multiple non-consecutive points in the table, or, use the Lasso Tool (Lasso Tool) to draw around points on the map. Various options are provided for saving the selected records.

Some tabular data sets contain many columns so scroll to the right in the table to see all of the cells. Many of the data set tables contain URL hyperlinks to more information. The link is often given at the end of the row so scroll to the right.

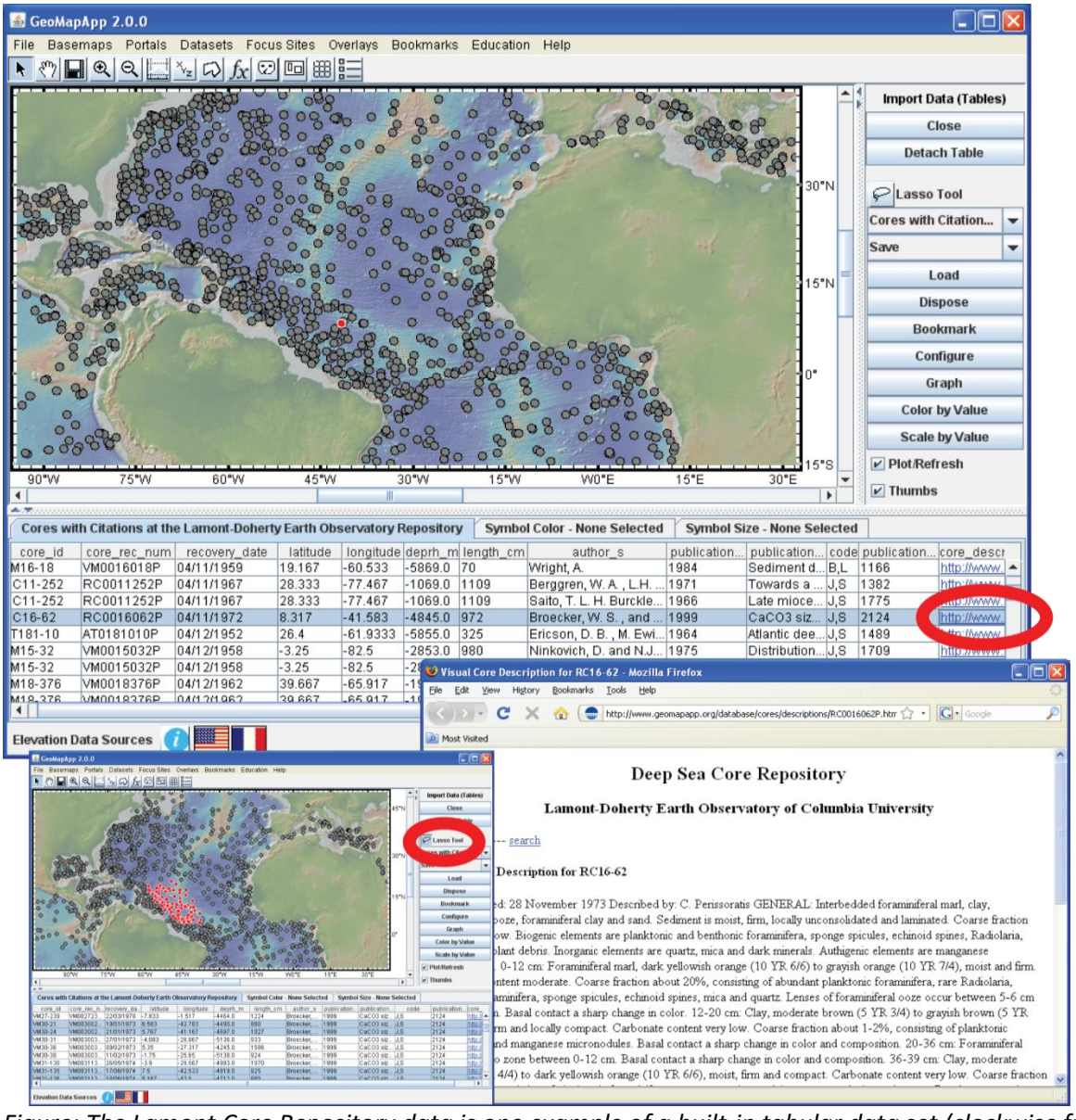


Figure: The Lamont Core Repository data is one example of a built-in tabular data set (clockwise from top left): After selecting one point (highlighted as a red dot north of Brazil), the URL at the end of the row opens a web page containing more information (bottom right). In the lower left image, the Lasso Tool (Lasso Tool) has been used to select multiple points - all selected points are shown in red.

Sort a column by clicking the column header. Drag columns to the left or right to rearrange them. Change the column width by moving the column separators sideways.

Basic functions allow numerical columns in the built-in or imported data sets to be manipulated, including colored by value, scaled, and graphed. The display parameters are preserved each time a new data set is loaded. This allows multiple tabular data sets to be displayed at once.

When symbols are colored, the color histogram window offers a Color Legend button. More than sixty color palettes are currently available. Clicking the button generates a color legend in a separate window. The legend can be saved as a JPEG image with the Save Legend button.

See video tutorial on YouTube and here for examples of manipulating data sets.

5.2.4) Legends

A number of built-in data sets, such as the state geological maps, have an associated legend. Some legends are automatically loaded, as in the example below.

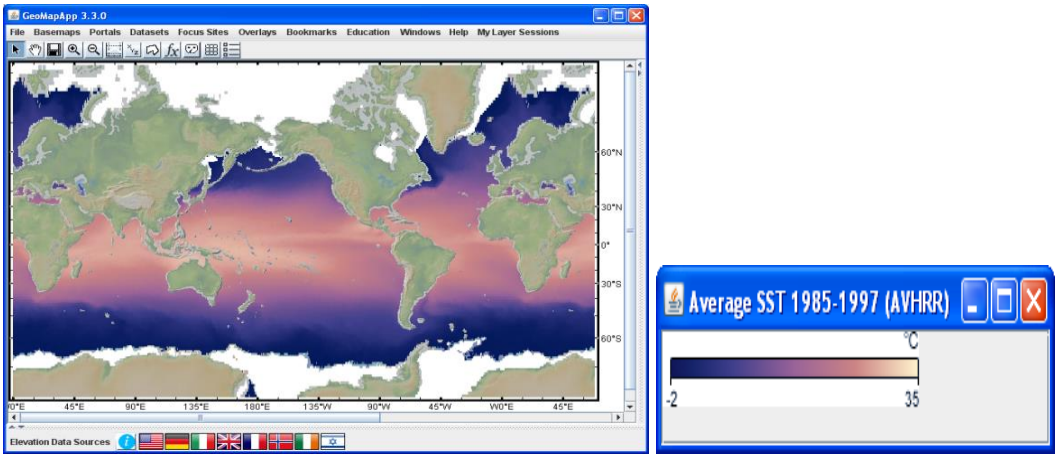
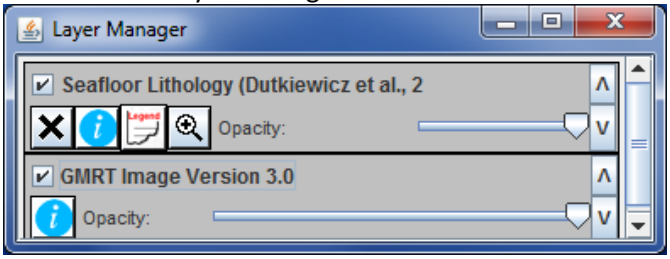


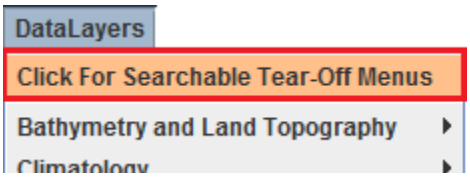
Figure: AVHRR sea surface temperature data set loaded in GeoMapApp. Zoom in to see finer detail. The map legend appears automatically and can be resized and moved.

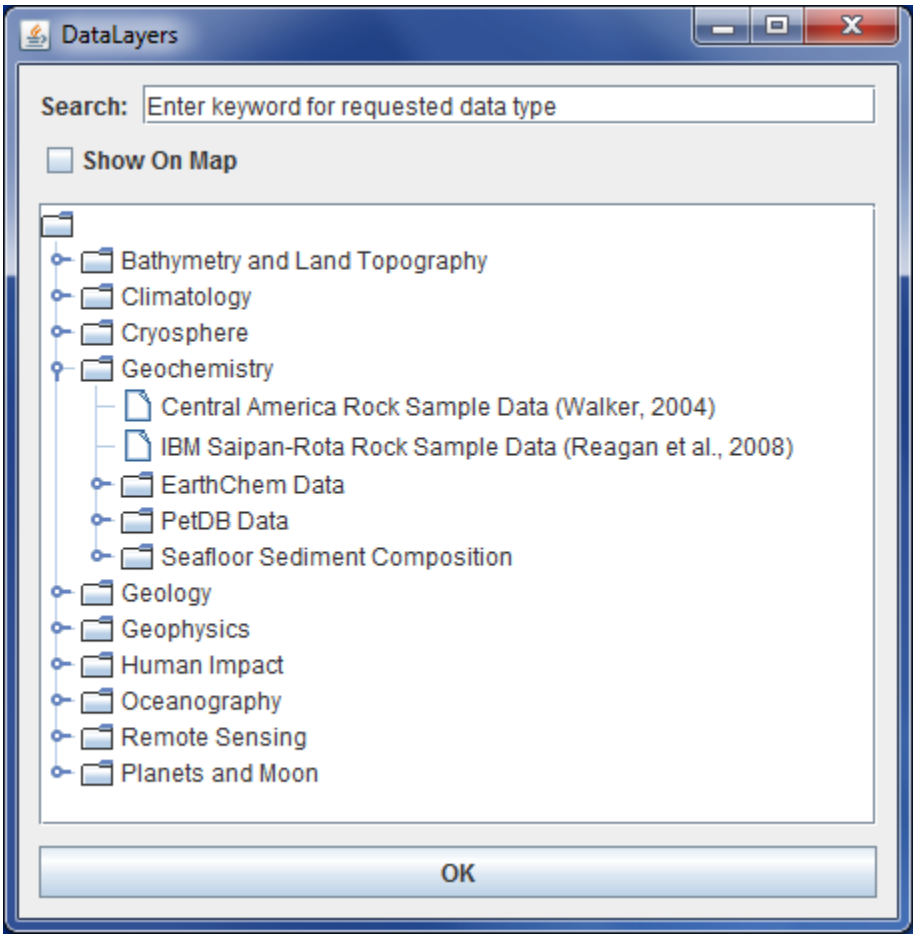
Other legends will be displayed if there is a Legend button in the Layer Manager window and it is clicked. The legend button, if present, is sited between the Information button and the Zoom button in the Layer Manager:



5.2.5) Tear-Off Menus

Items in the DataLayers, Portals, FocusSites, Overlays, and Education menus, can be selected either by following the cascading drop-down menus or by selecting the tear-off menu option. The latter opens a separate menu window that may offer easier navigating. The tear-off menu option, colored orange, is the first item in each menu, as show in this example:

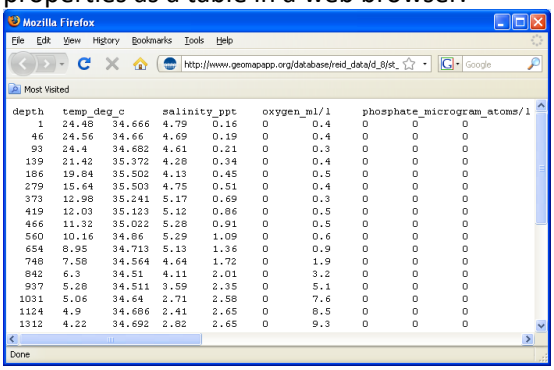




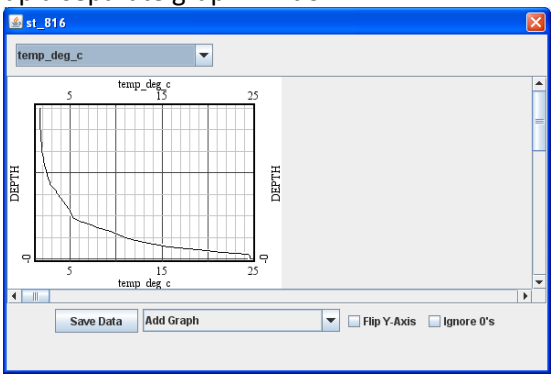
See the How to use the Tear-Off Menus for more details on the tear-off menus, and menu searching.

5.2.6) Special functionality for some tabular data

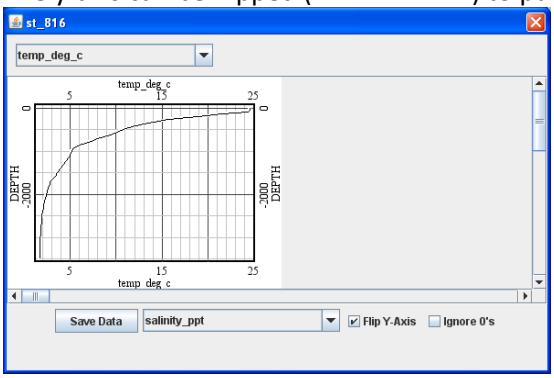
Under the *DataLayers* menu, the *Water Column Properties* > *World Data set of Temperature, Salinity, Oxygen, Nutrient Profiles (Reid and Mantyla, 1994)* data records are each associated with a number of water column properties. Click once on a URL in the txt_link column to display the water column properties as a table in a web browser.



To plot these properties as profiles, select one record in the table and control-shift-click on the URL (hold down the control and shift keys, and at the same time click the URL with the mouse). This brings up a separate graph window.



The y-axis can be flipped (☑ Flip Y-Axis) to put the sea surface at the top.



To compare profiles side-by-side, select the Add Graph menu (Add Graph) and choose which parameter to plot. The new graph can be deleted by clicking ☒ (upper right corner). Add more graphs as needed. The water column values can be saved to a tabular text file (Save Data button).

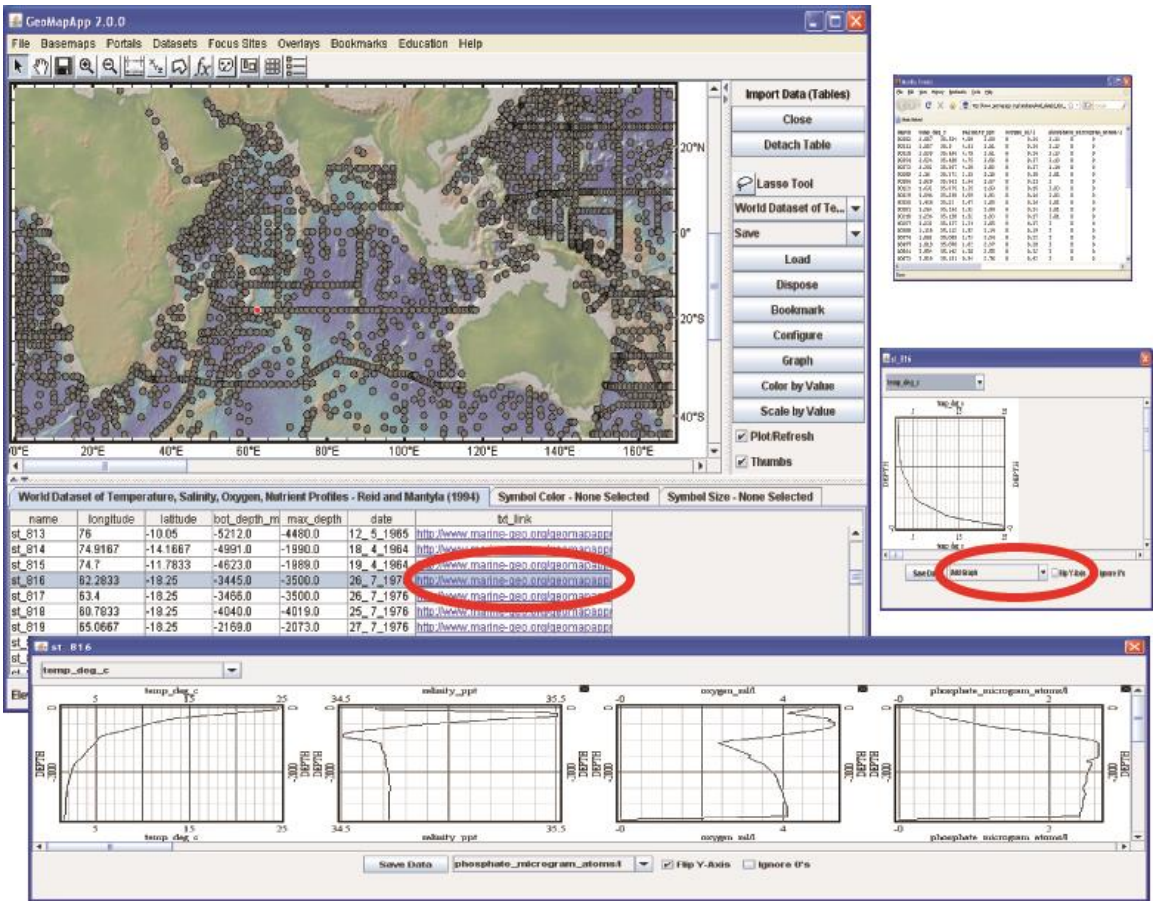


Figure: Reid and Mantyla's water column properties compilation interface offers enhanced functionality. Click once on the URL to open the table of data (upper right). Press control-shift-click on the URL to open the graphing window (right middle). Flip the y-axis (Flip Y-Axis) to put the ocean surface at the top of the graph, and add more graphs (Add Graph). Multiple profiles are plotted side-by-side (bottom).

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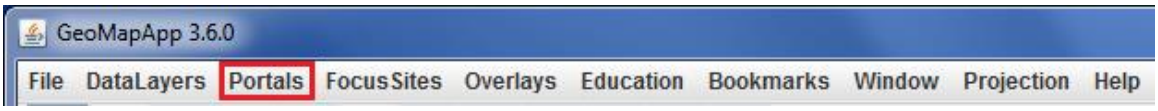
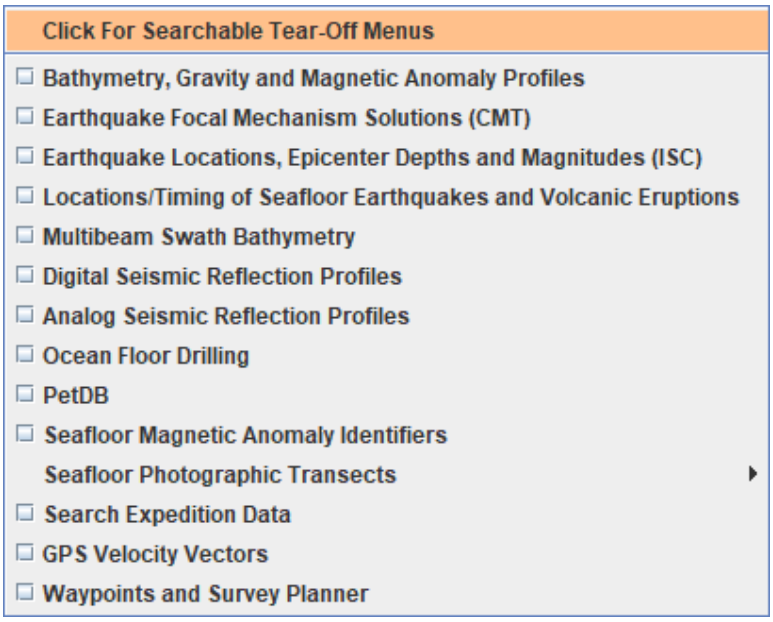
5.3) Portals



The Portals menu provides customized interfaces for a number of specific data types shown in the menu below. The expanded functionality of each Portal allows greater data manipulation and access.



In the following sections, the functionality of each portal is described in detail.

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5.3.1) Bathymetry, Gravity and Magnetic Anomaly Profiles

See video tutorial on YouTube

This customized interface allows users to view underway along-track geophysical profiles of gravity, magnetics and bathymetry data for more than 8,700 research cruises spanning decades of exploration from the underway collections of NCEI/NGDC, LDEO, USAP, and SIOExplorer.

Select this interface from the Portals menu (Portals) to display the ship tracks. The default view displays the NCEI/NGDC holdings of cruise tracks with any gravity, magnetics or bathymetry data. Click the LDEO or USAP or SIO button to display that catalogue. To select cruises for a particular data type, use the check boxes to the right of the map: tick only those boxes for which data is required.

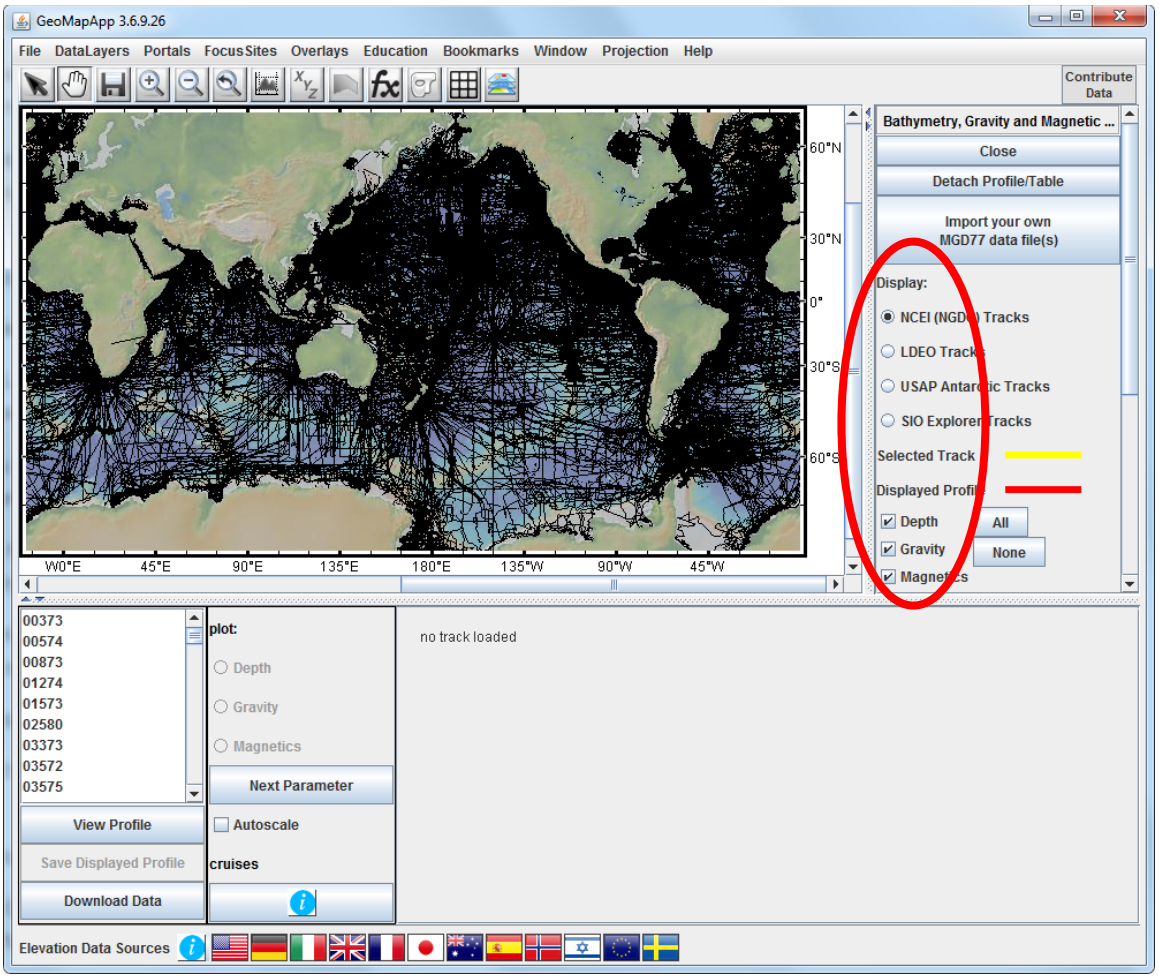


Figure: Use the tick boxes and radio buttons on the right to choose which data collection and data type are displayed on the map.

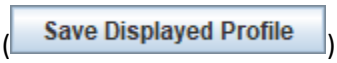
Zoom to an area and click on a track of interest. The selected track turns white and the cruise ID is highlighted in the list in the lower left. Note that only those cruises falling both within the map area and having the selected data type are displayed in the cruise list in the lower left.

Select View Profile (

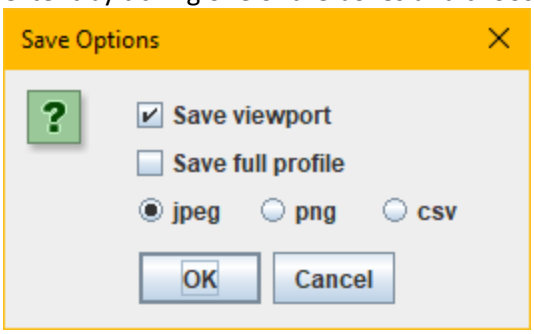
) to load the underway along-track geophysical data. The selected track line on the map turns yellow. The red part of the track shows the extent of the profile displayed in the lower pane. Note that it may be necessary to scroll horizontally through the profile window to see profiles for incomplete data sets.

Download the underway along-track geophysical data set for the selected cruise in either MGD77 or CSV comma-separated ASCII format using the Download Data button (

). To download data for multiple cruises, use shift-click or ctrl-click to select the cruises from the list in the lower left.

The Save Displayed Profile button (

) allows the profile to be saved as an image and allows the profile data to be saved as a CSV ASCII file. Either the full along-track profile for the entire cruise or just the segment displayed in the profile window (the "viewport") may be saved. Choose the extent by ticking one of the boxes and choose the output format by clicking one of the radio buttons.



Note that when zoomed in, the profile may need to be scrolled sideways to see the data. If no data is visible in the profile window, the downloaded CSV file will be empty.

Use the 

button to import an MGD77 file. Both the legacy MGD77 format and the newer tab-delimited MGD77T format are supported. Header and data files may be imported separately and file name extensions of .a77, .m77, .m77t, .mgd77, .mgdt77, .h77 and .h77t are automatically identified.

Save the track map as an image using 

.

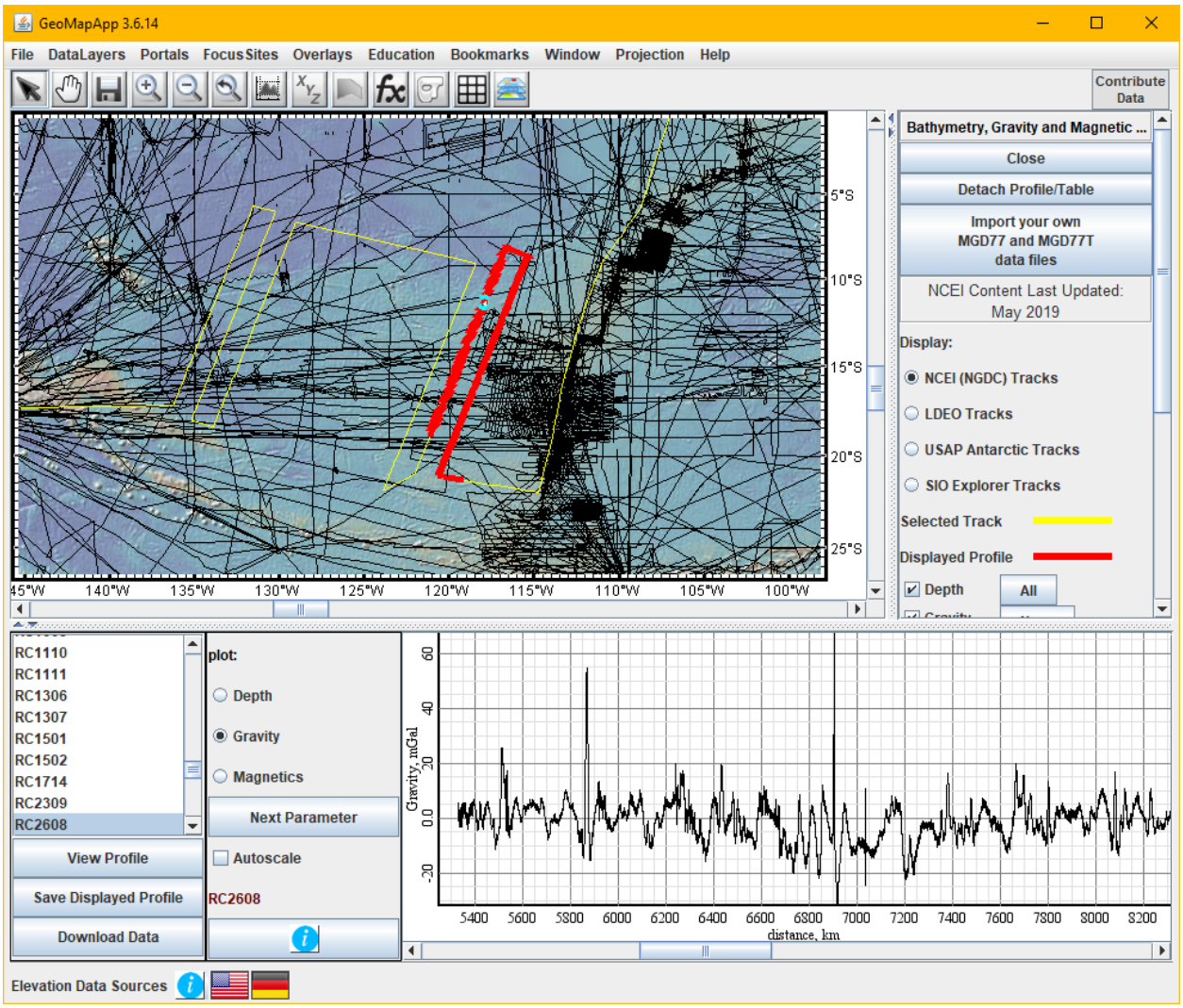


*Figure: In this example, Conrad cruise RC2608 was selected by clicking the track line in the map window (it could also have been chosen from the list in the lower left). The View Profile button (*View Profile*)* loads the data in the profile window. Use *the gravity, magnetics, bathymetry radio buttons to display that data set for the selected track. In this case, gravity is displayed in the profile to reveal the gravity undulations thought to be due to small-scale convection in this part of the south-central Pacific. In the profile pane, use the horizontal scroll bar to scroll through the along-track data. The Save Displayed Profile and Download Data buttons in the lower left may be used to save one or more cruises or just the portion of data visible in the profile window. Along-track data may be downloaded in MGD77 format and comma-separated CSV ASCII format, and profile images may be saved in JPEG and PNG formats. Import an MGD77/MGD77T file using the Import button in the upper right.*

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5.3.2) Earthquake Focal Mechanism Solutions (CMT)

Display and explore CMT focal mechanism **final** solutions from the Global CMT Project for more than 43,000 events dating back to 1976. The database is updated about four times per year. When the portal is loaded, CMT solutions appear as blue symbols on the map. Zoom in to display the "beachball" solutions.

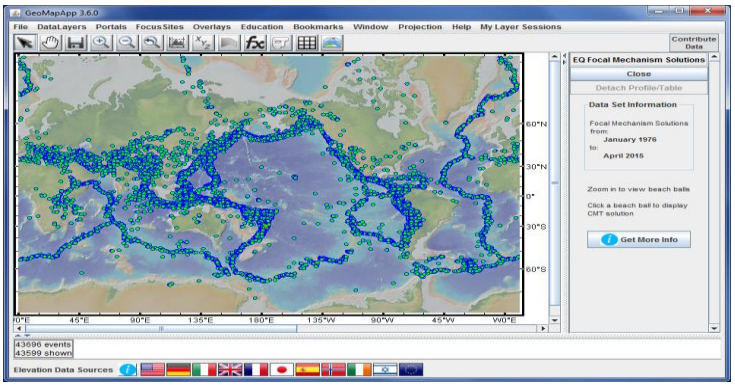

Figure: When zoomed out, the moment tensor solution "beachball" images are displayed as blue symbols on the map. Zoom in to plot the beachballs.

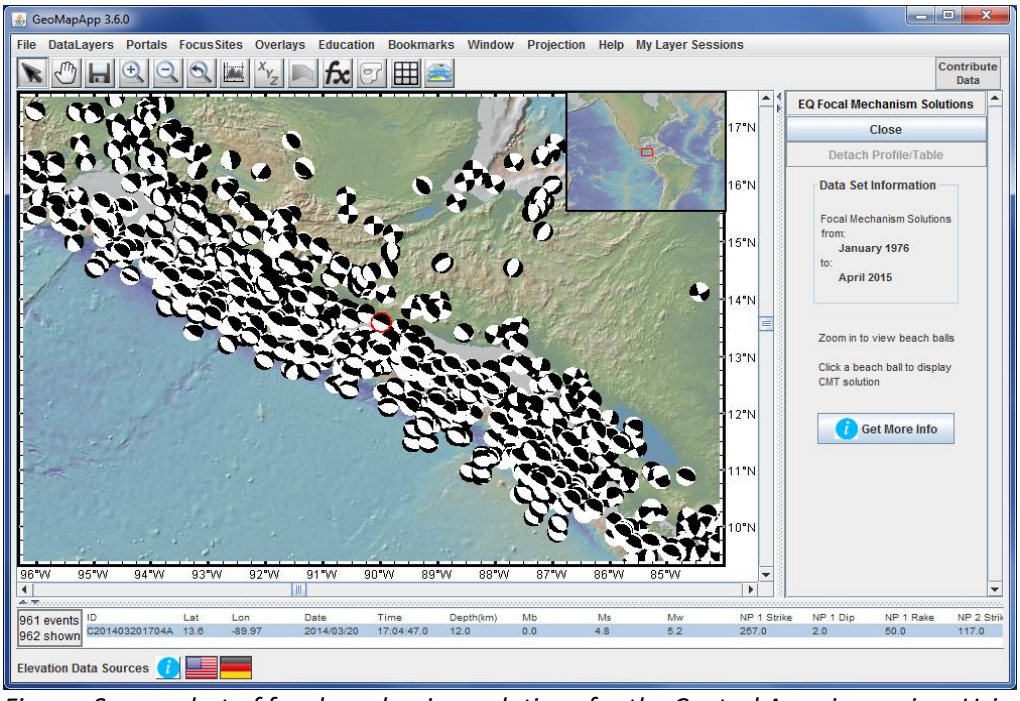

Figure: Screen shot of focal mechanism solutions for the Central America region. Using the cursor, one symbol was selected. It is circled in red near the centre of the map. The focal mechanism solution for that event is listed across the bottom of the GeoMapApp window and gives information on date, time, position, magnitude and nodal plane. The map can be saved under the File > Save map Window menu.

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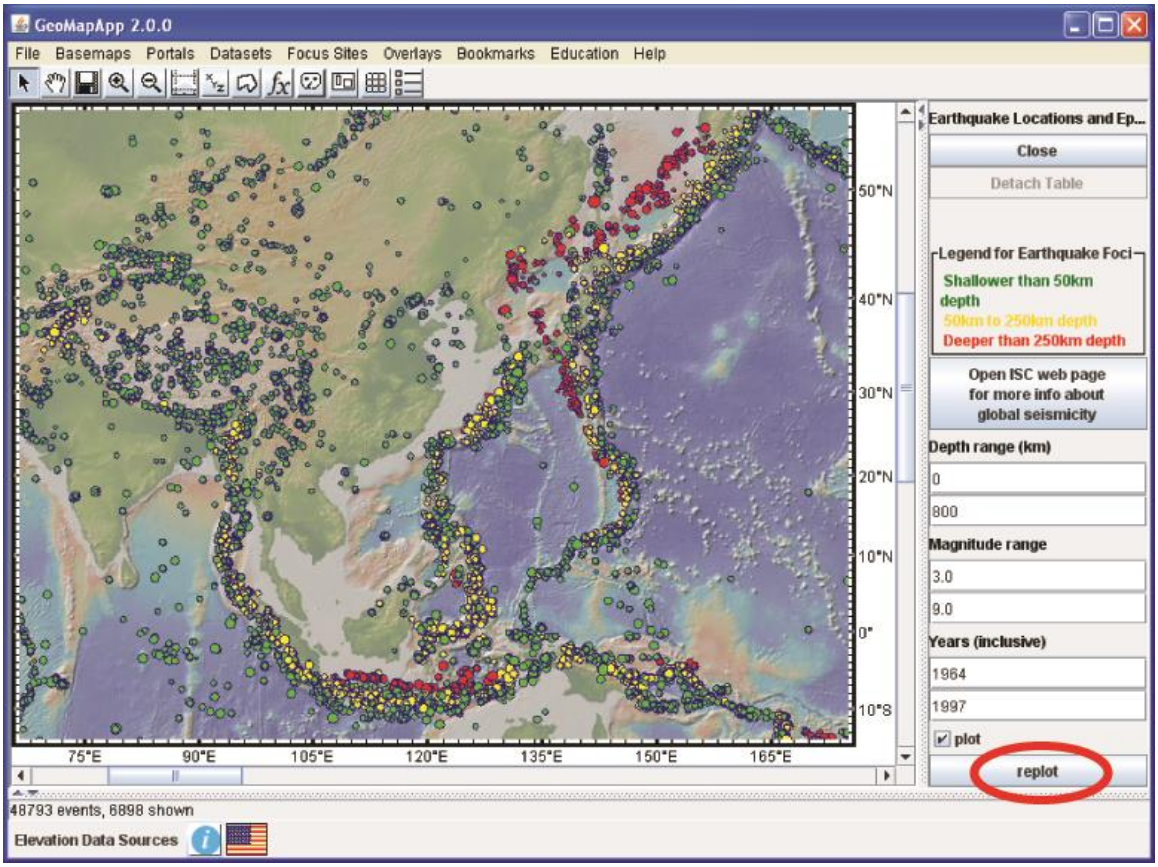
5.3.3) Earthquake Locations, Epicenter Depths and Magnitudes (ISC)

See video tutorial on YouTube

Display and filter earthquakes from the International Seismological Centre.



Use the filters on the right for **Depth range (km)**, **Magnitude range**, **Years (inclusive)** to change the displayed range of earthquake depth, magnitude and year. Click the **replot** button each time a range is adjusted. Epicenters are color-coded as green = shallow, yellow = intermediate and red = deep.

Save the map as an image using *File > Save map Window* menu.

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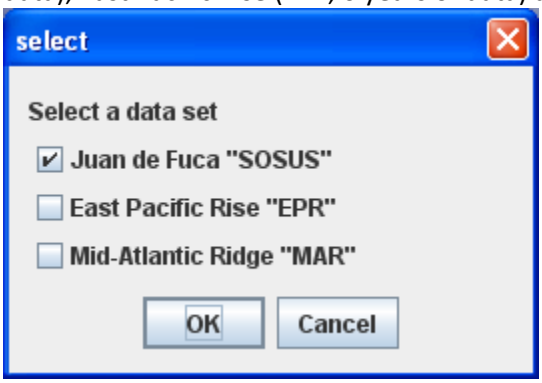
5.3.4) Location and Timing of Seafloor Earthquakes and Volcanic Eruptions

See video tutorial on YouTube

Create movie animations of earthquake activity during user-specified time windows for various NOAA/PMEL data sets.

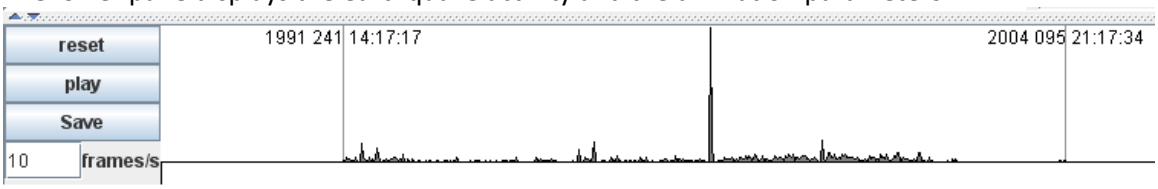
Three data sets are available: the Sound Surveillance System deep-water array (SOSUS, 17 years of data), East Pacific Rise (EPR, 6 years of data) and Mid-Atlantic Ridge (MAR, 4 years of data).



Choose one of the three data sets by ticking the appropriate box (☑) then click OK to load the selected data set.

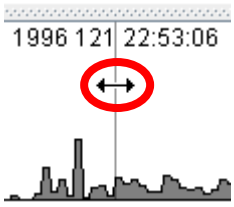
Once the portal has been loaded, the data set on display can be switched by selecting it (☑)from the "areas" box in the right pane – see image below. Load the new data set by then clicking the load button.

The lower pane displays the earthquake activity and the animation parameters.



The histogram shows the number of earthquakes (vertical axis) plotted against time (horizontal axis). Change the time range as follows: Move the cursor over one of the grey vertical lines. The cursor

becomes a double-headed arrow as shown in the image below. Click and drag the grey vertical lines left or right.



Use the reset button to reset the time period that is displayed in the histogram window. Date values are given in (*year, day-of-year, time*) format. An animation viewing speed of 5 frames/second usually looks good.

Start the animation with the play button. Save the animation as either an MPEG4 or QuickTime ".mov" file.

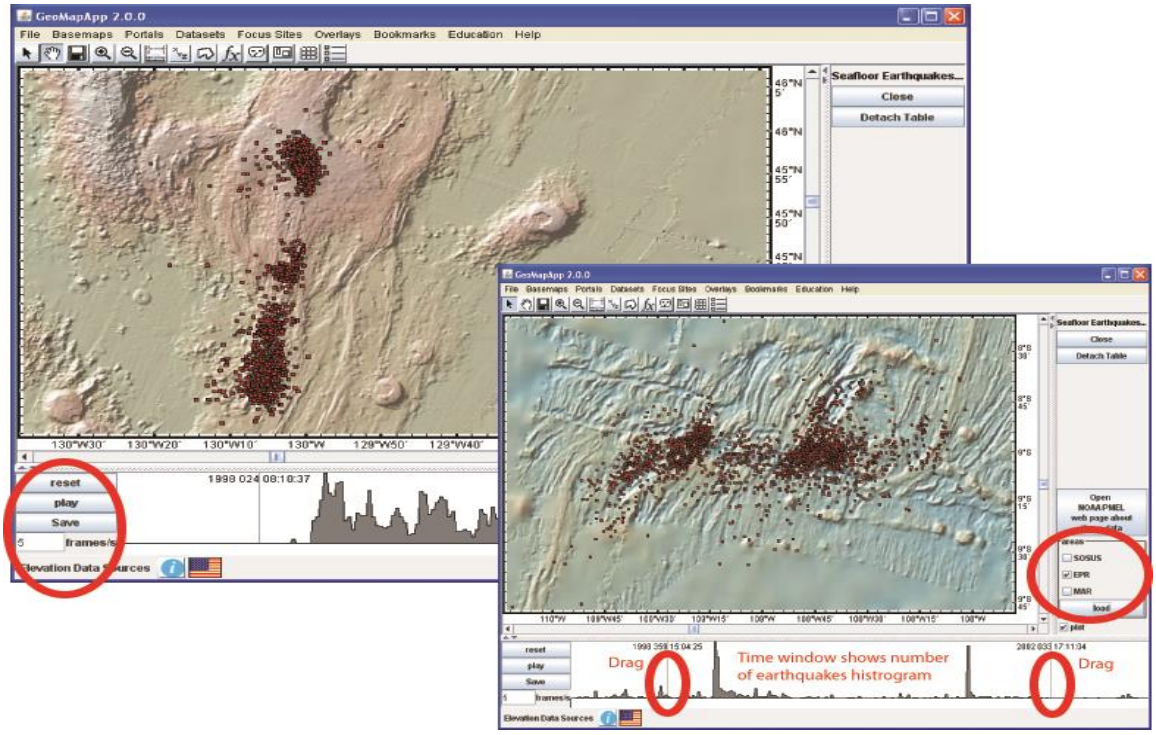


Figure: (Left) Watch an earthquake swarm propagate over ten days in 1998 along the Juan de Fuca ridge axis at 45.75° N. (Right) View two earthquake swarms at the Wilkes Fracture Zone that occurred between 1999-2001. The epicentres are superimposed upon striking EPR axial topography mapped with multibeam echo-sounders.

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5.3.5) Multibeam Swath Bathymetry

See video tutorial on YouTube

Use a map of ship tracks to quickly identify and download multibeam swath data files.

When this portal is loaded, ship tracks are displayed in the map window. Zoom and click on a track of interest. The chosen ship track turns white. The red part of the track shows the extent of the individual swath file for which the file name is listed in the lower left. Note that the red part of the track may be very short depending upon zoom factor and duration of particular swath files.

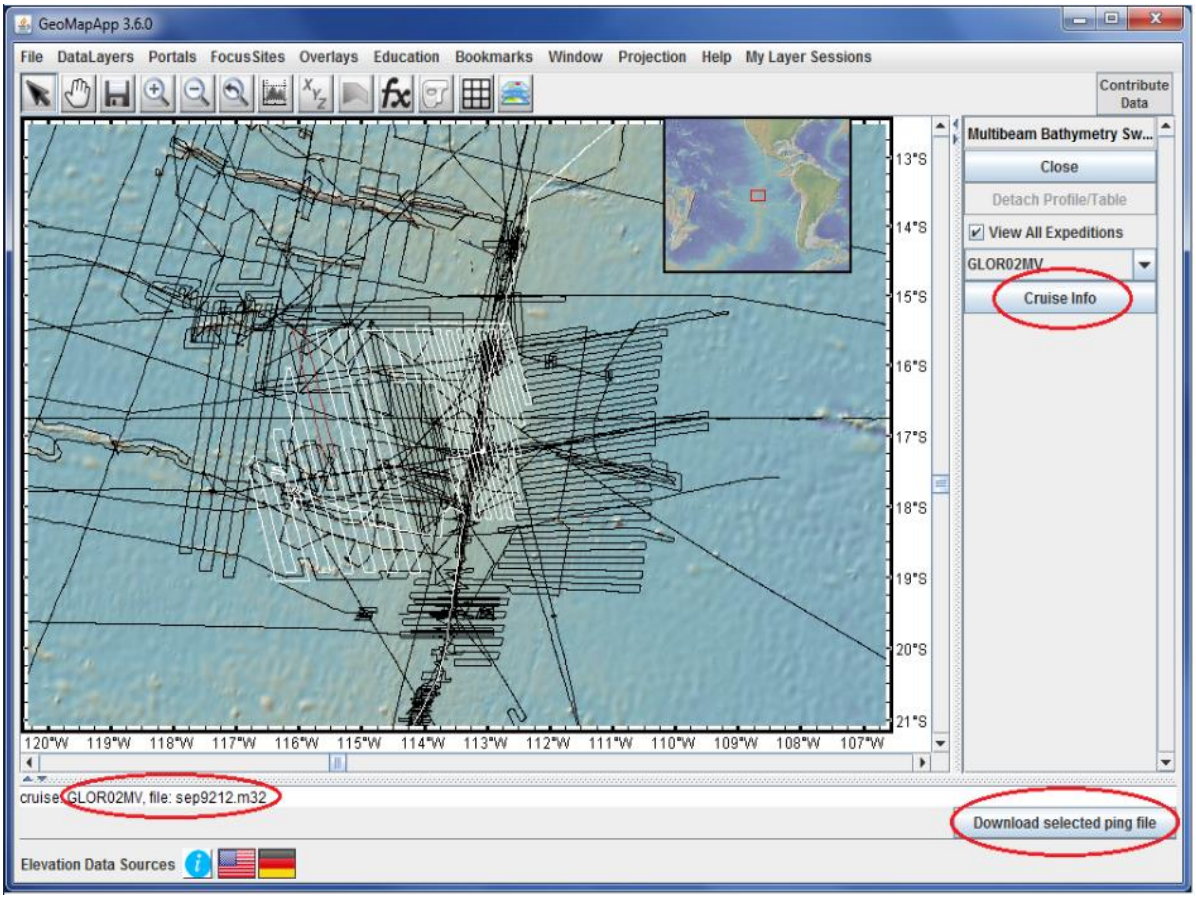
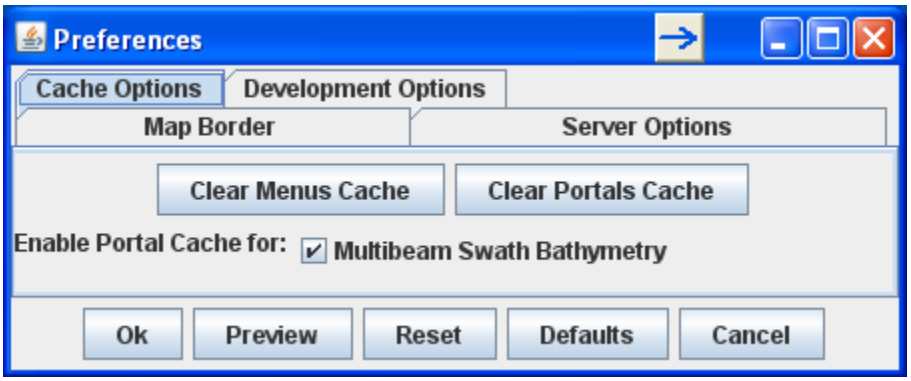


Figure: The individual ping file is coloured red on the map and is listed in the lower left. All other ping files for that particular cruise are drawn in white on the map.

Use the **Download selected ping file** button to download the selected multibeam swath file in its native format (all are compatible with MB-SYSTEM).

The **Cruise Info** button opens the MGDS web page for this cruise, if available. Save the map as an image using the *File > Save map Window* menu.

To help speed the loading time of this portal, a caching system has been implemented.



The caching options, listed under the Cache Options tab, are turned on by default and when the portal is first loaded, the information is cached locally. Next time the portal is opened, it will load much quicker, typically about 50x faster. The cache can be deleted with the Clear Portals Cache button or disabled with the ☐ box.

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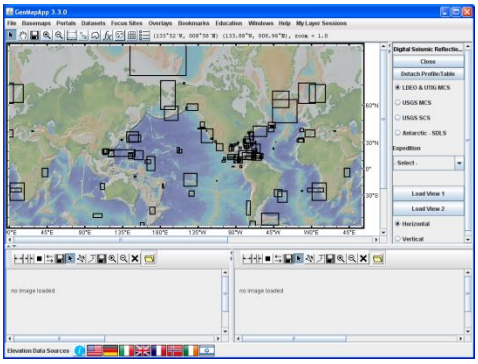
5.3.6) Digital Seismic Reflection Profiles

See video tutorial on YouTube

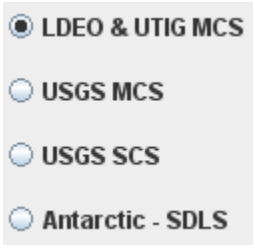
Use this interface to view, compare, digitize, annotate, and extract digital Multi-Channel Seismic (MCS) and Single-Channel Seismic (SCS) reflection profiles from four sets of seismic data holdings. There are profiles from more than 120 cruises in the Lamont and UTIG Academic Seismic Portal collections; more than 35 USGS MCS cruises, 170 USGS SCS cruises and about 20 cruises for the Antarctic Seismic Data Library System.

When the portal loads, geographical bounding boxes on the map show the extent of available seismic profiles.

By default, profiles from the Lamont and UTIG MCS holdings are displayed on the map.



To change the data holdings on display, select the appropriate radio button in the right pane, shown here:



Zoom to your area of interest and click inside one of the boxes to display the seismic lines within that geographical bounding box. Each cruise has its own bounding box. In the map window click a line to select it, or use the drop-down menus at right to choose a cruise and a seismic line. The chosen line turns white.

Select 

to load the seismic profile in panel 1. The portion of the seismic profile that is displayed in the lower panel is shown as red on the map of seismic profile lines. To load a second line,

click on another profile track in the map and select 

. Toggle between 

and 

to display the profiles side-by-side or one above the other.

Scroll through the seismic profile using the horizontal and vertical scroll bars () next to the profiles. Note that the red portion of the seismic line moves with each horizontal scrolling action. Zoom in or out of the profile using the zoom buttons  in the profile pane. The profile axes show two-way travel time in seconds (vertical axis) and Common Mid-Point gather number (horizontal axis).

Flip the profile laterally using the twin arrows button ().Switch to inverse video using the  button.

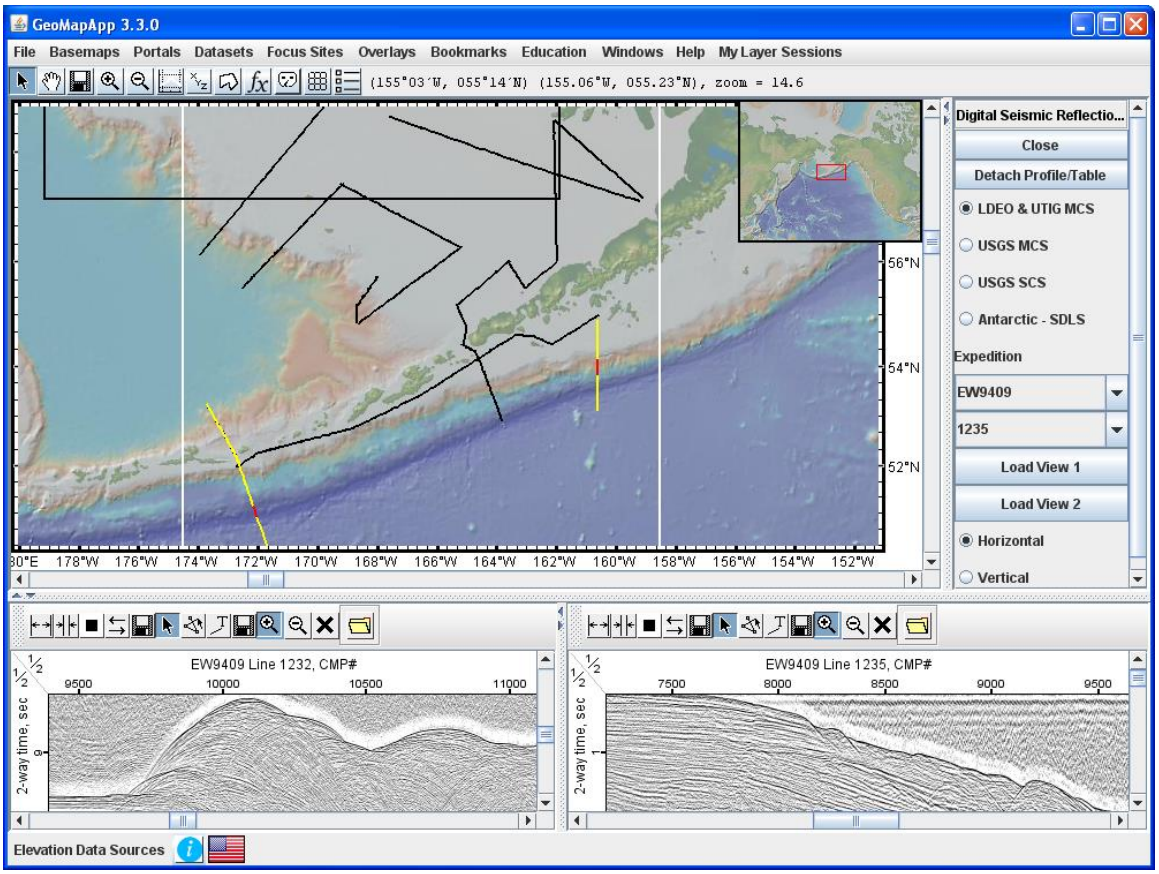
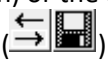
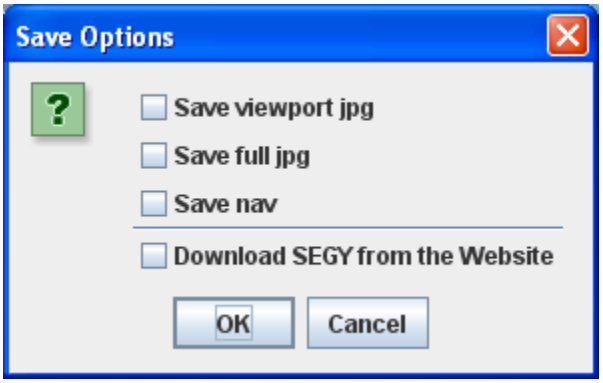


Figure: Comparing two Aleutian Trench MCS profiles that lie 800 km apart. Both are from Ewing cruise EW9409, with line 1232 in the left pane, line 1235 in the right pane.

5.3.6.1) Save profile function

Save the profile on display (“viewport” option) or the entire scanned profile (“full” option) using the left-most diskette button next to flip-axis button (). The diskette button () also allows the seismic

line navigation to be saved, and provides a link to download the SEG-Y file, if available. The options are shown here:



5.3.6.2) MCS digitizing function

Reflector horizons can be digitized, annotated and saved to a file using the buttons directly above the profile display.

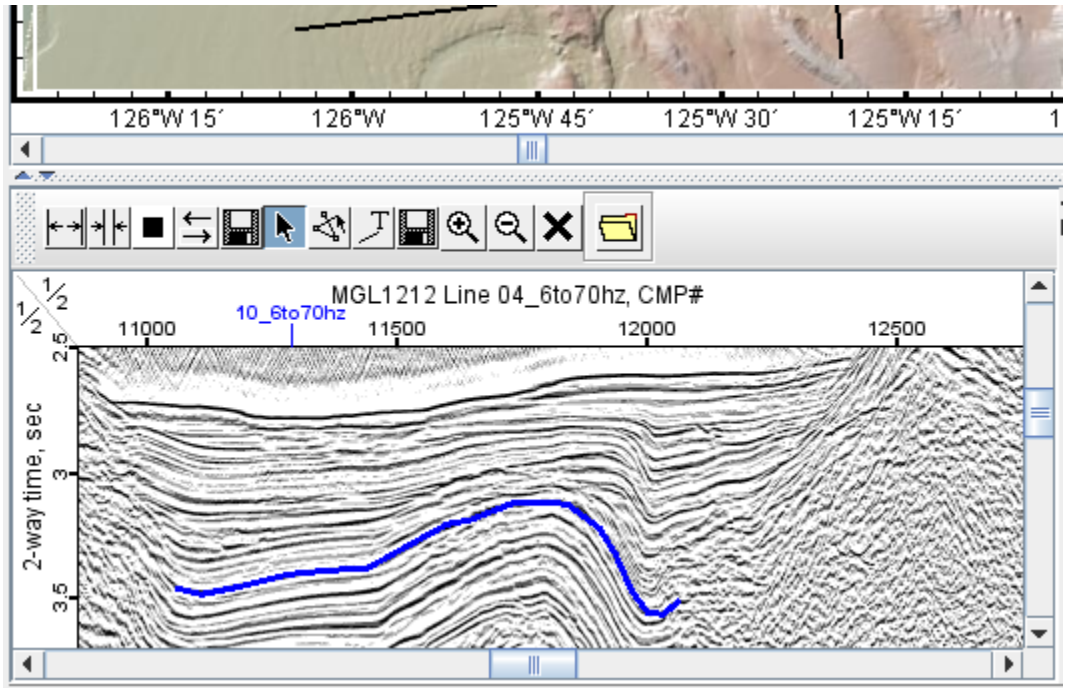
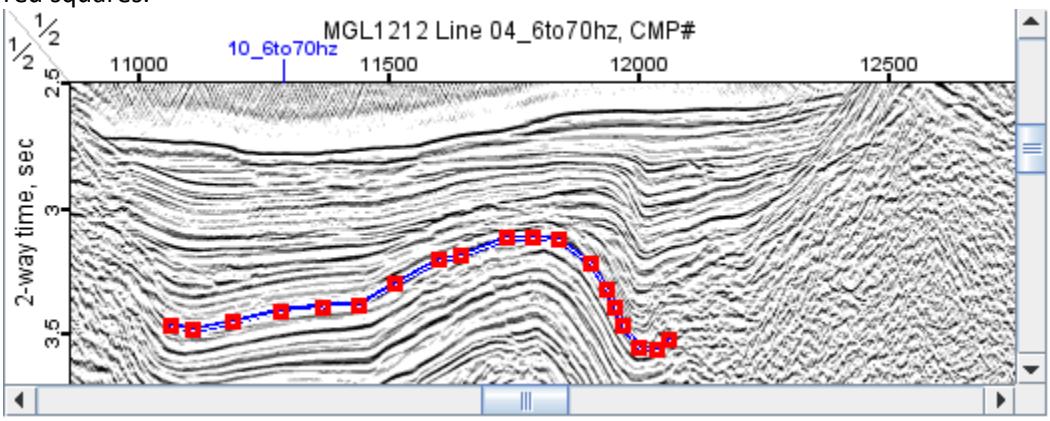


Figure: Manually digitized horizon (blue line). The control buttons that trigger the Digitize ( ), Text annotation ( ) and Save Digitized Points ( ) functions are located in the toolbar above the profile.

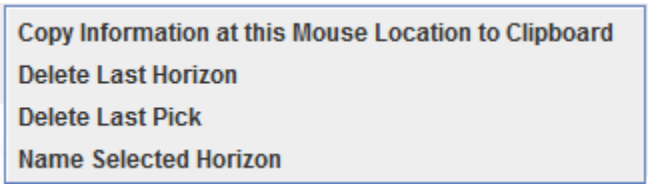
Activate the Digitize function by selecting . Click firmly with the mouse to digitize the points. Right-click to delete the last digitized point or the most-recently digitized horizon. Digitized points can be

moved with the cursor to refine their locations, as follows. To move a digitized point, click the Select Cursor/Pointer button and click on the profile to activate it. The digitized points will be displayed as red squares.

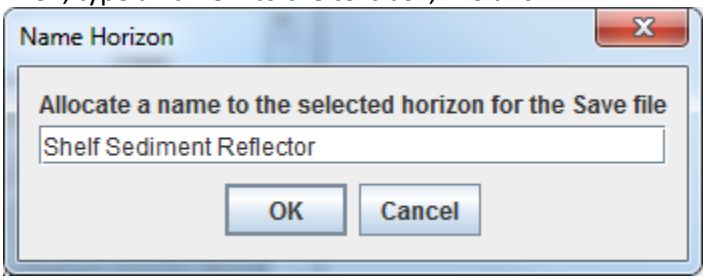


Click and drag any of the red squares to move them to new positions.

To name the digitized horizon right-click on the profile to bring up the menu and click “Name Selected Horizon”:

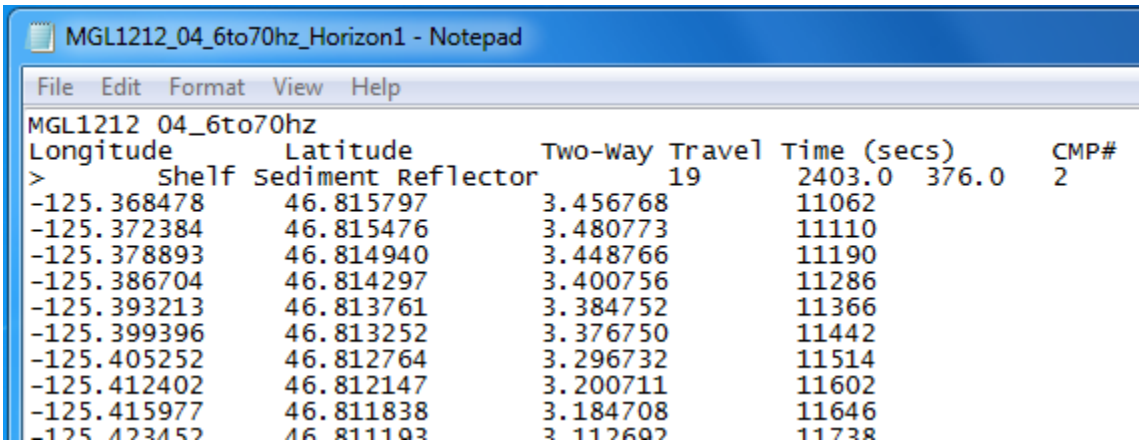


Then, type a name into the text box, like this:



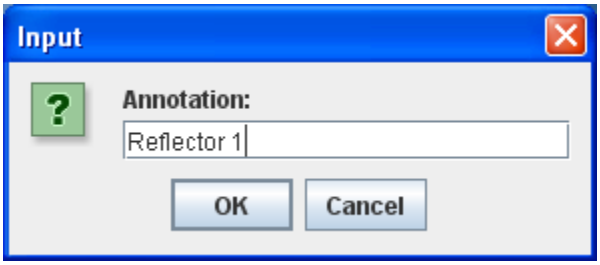
That name will be attached to the digitized points when saved. If the digitized horizon is not named, a default name of “Default” will be assigned.

Save the digitized points with the right-most diskette button ( ) which is next to the profile zoom buttons, . The saved ASCII file contains four tab-separated columns giving longitude, latitude, Two-Way Travel Time, and CMP number, as shown below.



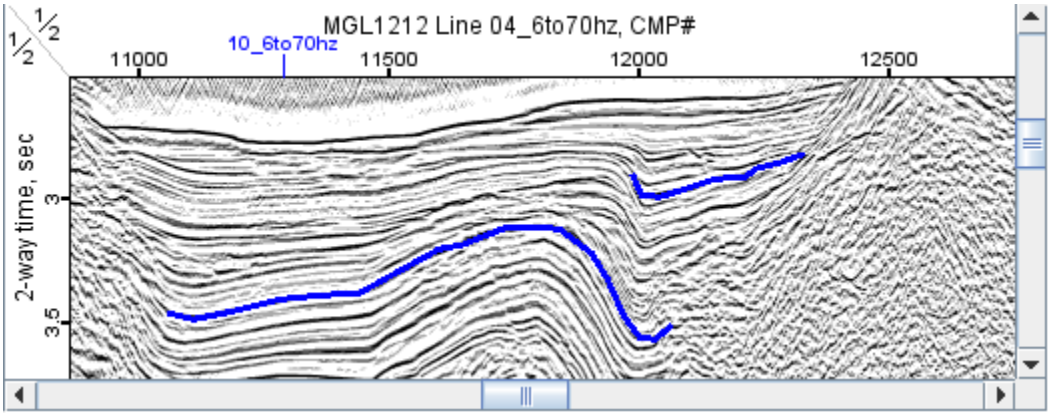
Note that on the segment-separator line of the saved file, eight values are listed to the right of the horizon name. The first of these values is the number of digitzed points. This and the remaining seven values are required in order for GeoMapApp to import the saved file at a later time. If those values are manually changed or deleted, the imported file will not be read correctly.

Add text annotations to the seismic profile by selecting the text () button, clicking twice in the profile window at the desired location, and typing the text in the text box that pops up, as displayed in this example:



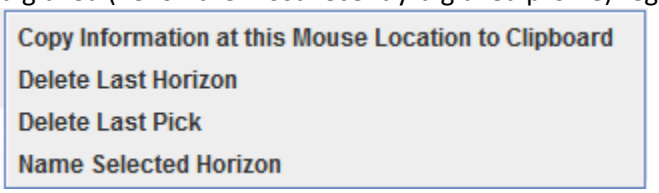
Select  to accept the text.

To digitize another horizon, click the Digitizer button  once again and repeat the steps above. The first digitized profile will remain unchanged. In this example, two reflectors have been digitized.



Saving the digitized points will save all points for all digitized horizons to a single file. In the saved file, the ">" symbol separates the digitized horizons. Toggle between the digitized profiles by clicking on a profile to activate it. Whenever a digitized profile has been activated, the points can be moved as described above.

In the right-click menu, "Delete Last Horizon" and "Delete Last Pick" operate on the last profile to be digitized (i.e. on the most-recently-digitized profile) regardless of which profile is active.



To import previously-digitized points for this particular seismic line, click the Import folder icon  and select the appropriate saved digitized file. GeoMapApp will automatically zoom in and plot the digitized horizon.

Exit the digitizer mode by clicking the adjacent arrow cursor button  .

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5.3.7) Analog Seismic Reflection Profiles

As part of a data rescue effort, about 260 scanned Single-Channel Seismic (SCS) reflection profiles can be viewed, digitized, annotated and extracted using this interface. The profiles were collected on cruises of Lamont-Doherty's research vessels Robert D. Conrad (for the years 1963-1978), Eltanin (1965-1972) and Vema (1960-1980).

There are two ways to view a profile. Either, click on a track line in the map window. The selected cruise track turns white and its name is highlighted in the cruise list at right. Or, click on a cruise name from the list at right. Note that all of the SCS cruises remain in the list when zooming or panning.

Once a track has been selected, click 

to load the SCS profile in the lower pane. The vertical axis gives two-way travel time in seconds. The horizontal axis is distance along profile. The length of profile shown in the lower pane is displayed in red on the track map.

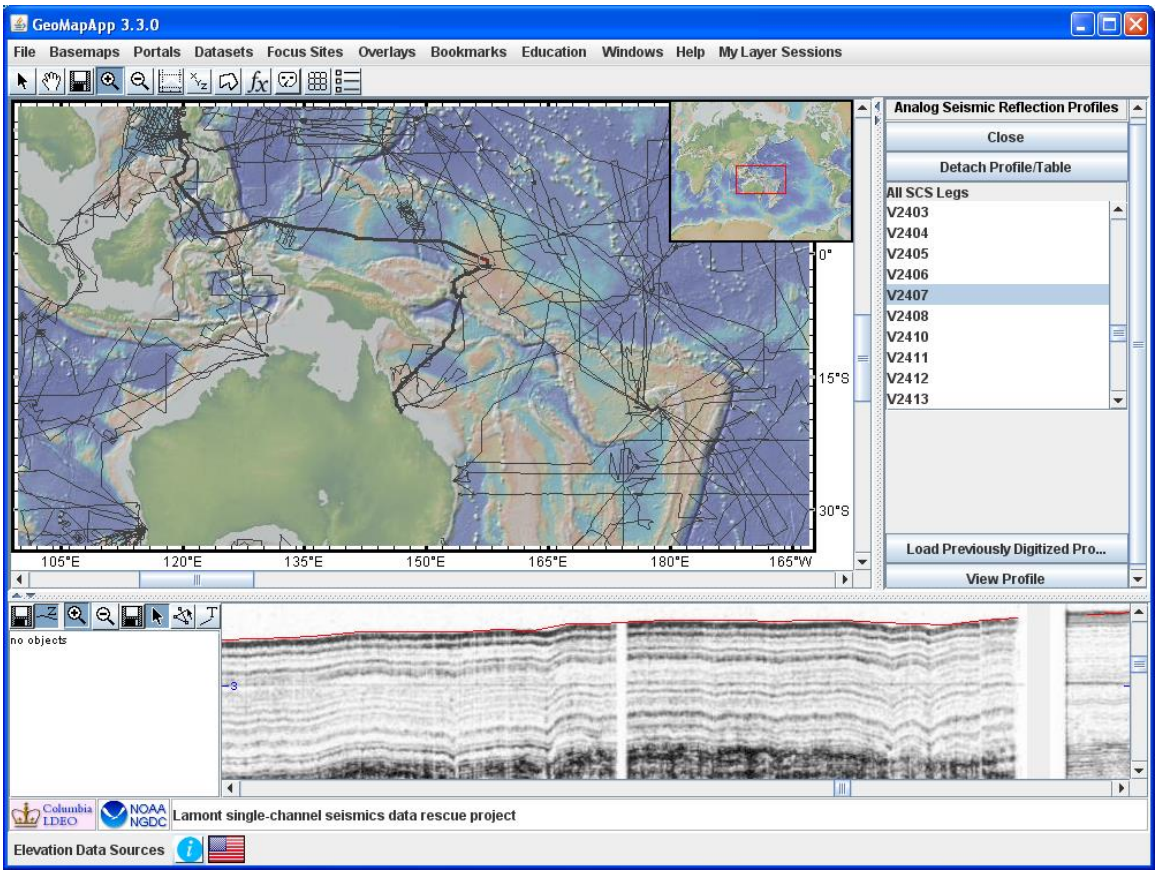
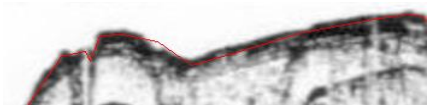


Figure: Reflectors in the SCS profile for 1967 western Pacific Vema cruise V2407, around (157.2E, 1S). The thin red line at the top of the reflectors represents PDR depth.

The thin red line that appears at the top of the reflection profile – see example image below – is the seafloor depth taken from the precision depth recorder (PDR) data. This line delineating PDR seafloor depth can be turned off and on by clicking the toolbar PDR button:  is on, and  is off.



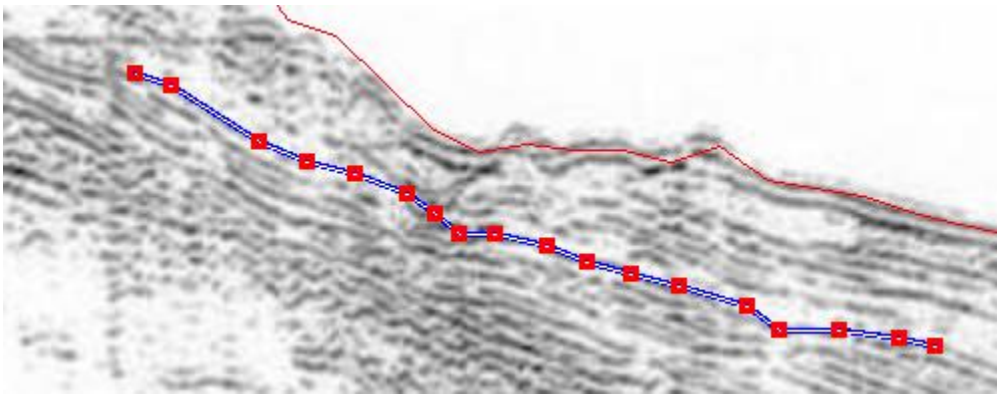
5.3.7.1) SCS save profile function

Save the profile on display – or the entire scanned profile – using the right-most diskette button () located between the profile zoom buttons,  and the cursor button,  .

5.3.7.2) SCS digitizing function

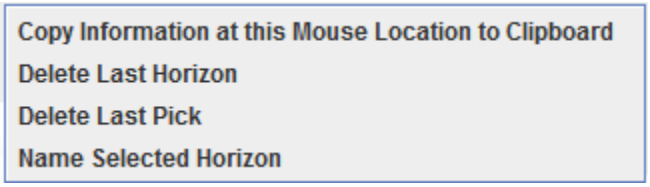
Reflector horizons can be digitized, annotated and saved to a file using the  and  buttons to the left of the SCS profile display.

Activate the Digitize function by selecting  . Click firmly with the mouse to digitize the points. Right-click to delete the last digitized point or the most-recently digitized horizon. Digitized points can be moved with the cursor to refine their locations, as follows. To move a digitized point, click the Select Cursor/Pointer button  and click on the profile to activate it. The digitized points will be displayed as red squares.

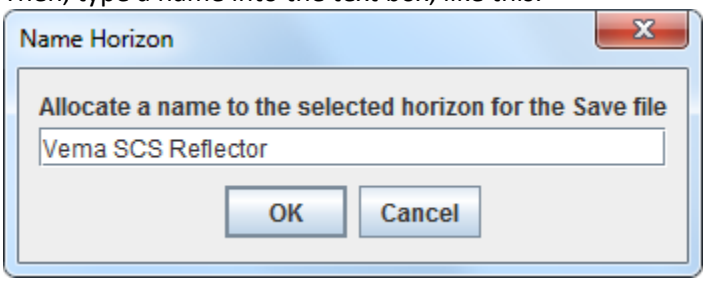


Click and drag any of the red squares to move them to new positions.

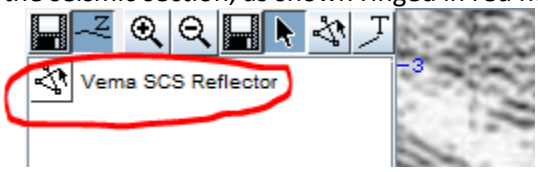
To name the digitized horizon right-click on the profile to bring up the menu and click “Name Selected Horizon”:



Then, type a name into the text box, like this:

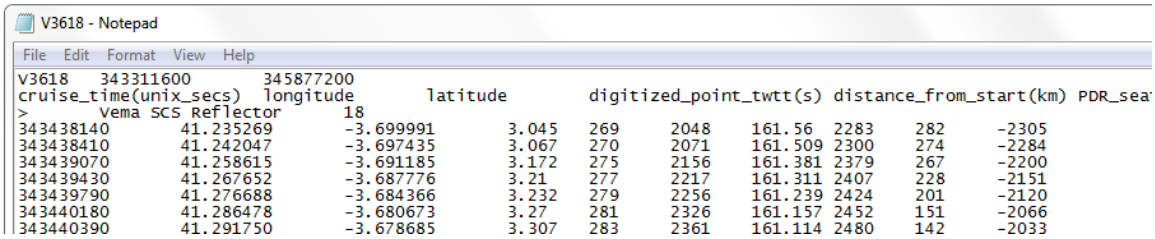


That name will be attached to the digitized points when saved. It is also listed in the area to the left of the seismic section, as shown ringed in red here:



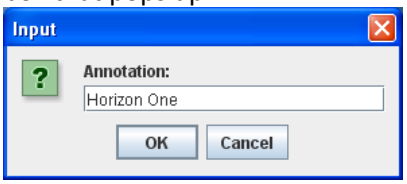
If the digitized horizon is not named, a default name of “Default” will be assigned.

Save the digitized points with the left-most diskette button () which is next to the PDR toggle button  . The saved ASCII file contains ten tab-separated columns giving UNIX time, longitude, latitude, Two-Way Travel Time of the digitized point, distance from start, PDR depth, Seafloor age if available, and digitized point depth, sediment thickness and backtrack depth, as shown below.

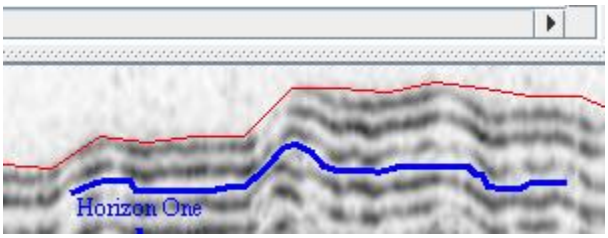


Note that, if named, the name of digitized horizons will be listed on the segment-separator line. To the right of the horizon name is given the number of digitized points.

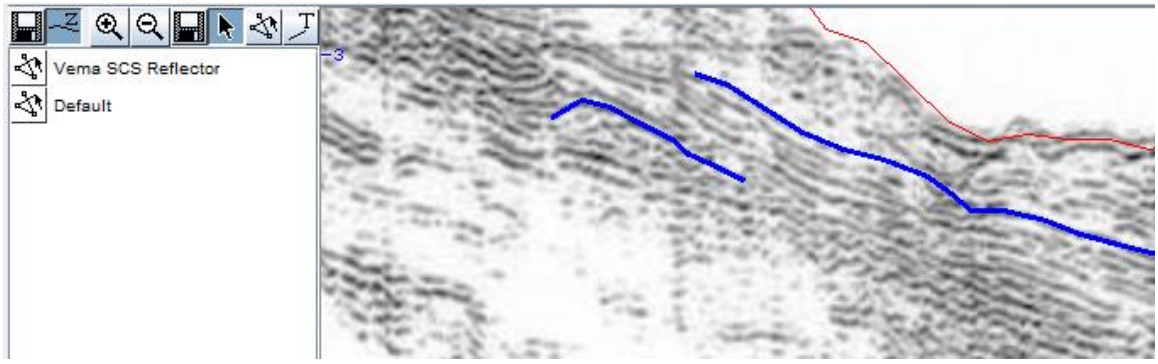
Annotate with the text () button by clicking twice in the profile window and typing text in the text box that pops up.



Here is an example of a digitized, annotated reflector:

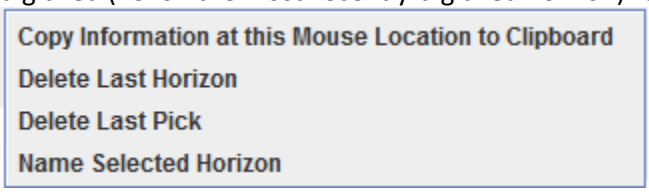


To digitize another horizon, click the Digitizer button  once again and repeat the digitization steps outlined above. The first digitized horizon will remain unchanged, and the additional digitized horizons will be listed on the left.

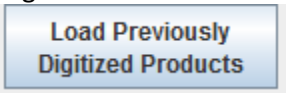


Saving the digitized points will save all points for all digitized horizons. In the saved file, the ">" symbol separates the digitized horizons. Toggle between the digitized horizons by clicking on a horizon to activate it. Whenever a digitized horizon has been activated, the points can be moved as described above.

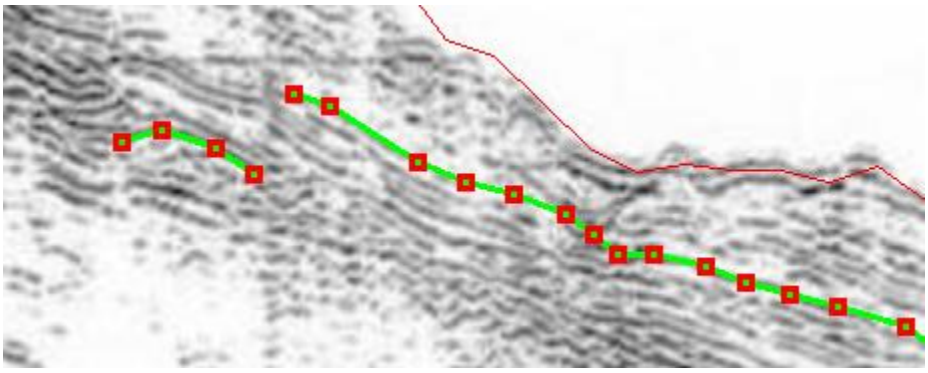
In the right-click menu, "Delete Last Horizon" and "Delete Last Pick" operate on the last horizon to be digitized (i.e. on the most-recently-digitized horizon) regardless of which horizon is active.



To import previously-digitized points for this particular seismic line, click the "Load Previously Digitized Products" button located on the right beneath the list of cruises and select the appropriate saved digitized file:



GeoMapApp will plot the imported digitized horizons as a green lines with the imported digitized points as red squares, like this:



Note that the display may not automatically zoom in to the exact portion of the seismic profile. The profile window may need to be scrolled and/or zoomed to find the imported digitized points.

Exit the digitizer mode by clicking the adjacent arrow cursor button  .

Summary of SCS toolbar buttons controlling SCS profile options:  . From left to right: Save digitized points  ; Turn off/on PDR seafloor depth  ; Zoom in  ; Zoom out  ; Save profile image  ; Pointer/Cursor  ; Digitizer  ; Text annotator  .

5.3.7.3) Note on zooming in the SCS profile window

If the zoom in () or zoom out () button is active, it can be deactivated *only* by clicking the same button again. The background color of the button indicates zoom active (darker color ) or inactive (lighter color ).

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5.3.8) Ocean Floor Drilling

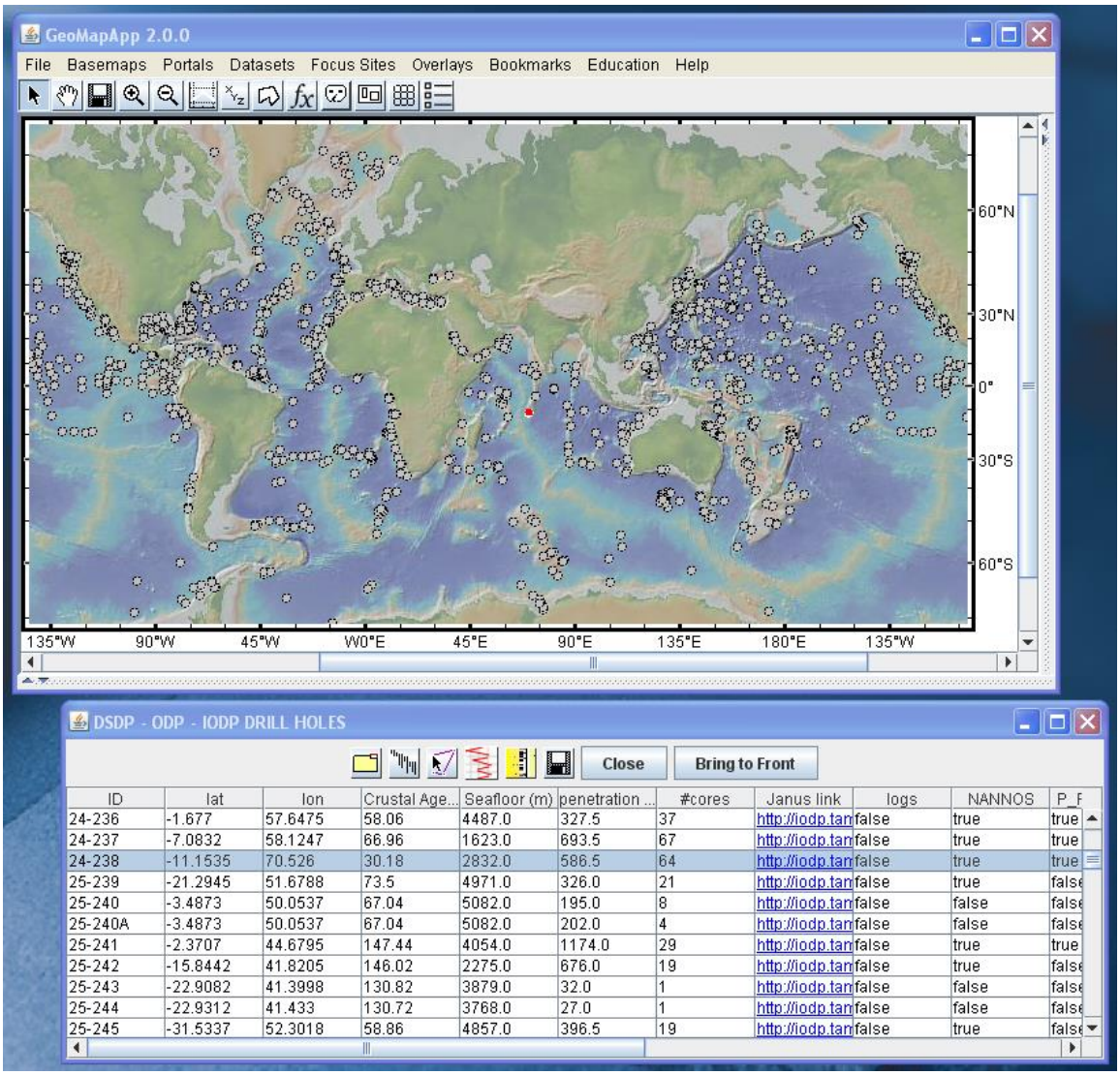
See video tutorials on YouTube

- Introduction
- Data Types
- Range Charts
- Age-Depth Models
- Physical-Chemical Data and Core Photos
- Geological Timescale, Keeping Track of Age and Depth

The Ocean Drilling portal offers a wealth of data for drill holes of the Deep Sea Drilling Project (**DSDP** Legs 1-96), the Ocean Drilling Program (**ODP** Legs 100-210) and the Integrated Ocean Drilling Program (**IODP** Legs 301-312).

When the portal is selected, the location of all drill holes in those three programs is plotted in the map window. A new window also appears. It displays a scrollable list all of the holes in the current map view.

To select a hole, either click a hole in the map window (turns red), or click a row in the table (turns blue). Multiple holes can be selected by using shift-click in the table.



ID	lat	lon	Crustal Age...	Seafloor (m)	penetration ...	#cores	Janus link	logs	NANNOS	P_F
24-236	-1.677	57.6475	58.06	4487.0	327.5	37	http://iodp.tan	false	true	true
24-237	-7.0832	58.1247	66.96	1623.0	693.5	67	http://iodp.tan	false	true	true
24-238	-11.1535	70.526	30.18	2832.0	586.5	64	http://iodp.tan	false	true	true
25-239	-21.2945	51.6788	73.5	4971.0	326.0	21	http://iodp.tan	false	true	false
25-240	-3.4873	50.0537	67.04	5082.0	195.0	8	http://iodp.tan	false	false	false
25-240A	-3.4873	50.0537	67.04	5082.0	202.0	4	http://iodp.tan	false	false	false
25-241	-2.3707	44.6795	147.44	4054.0	1174.0	29	http://iodp.tan	false	true	true
25-242	-15.8442	41.8205	146.02	2275.0	676.0	19	http://iodp.tan	false	true	false
25-243	-22.9082	41.3998	130.82	3879.0	32.0	1	http://iodp.tan	false	false	false
25-244	-22.9312	41.433	130.72	3768.0	27.0	1	http://iodp.tan	false	false	false
25-245	-31.5337	52.3018	58.86	4857.0	396.5	19	http://iodp.tan	false	true	false

Figure: DSDP hole 24-238 in the central Indian Ocean has been selected. In the map window, the symbol showing its location has turned red, and, in the record table window, the row is highlighted in blue.

Scroll to the right in the table to see columns of common fauna found in cores (nannofossils, foraminifera, diatoms, and so on). In those columns, the “true”/“false” labels indicate the existence of a range chart for that particular fauna in that particular core. To display all holes with range charts of, say, diatoms, click *twice* on the diatom column header DIATOMS to sort those records and highlight all holes with diatom range charts. Their locations turn red in the map window.

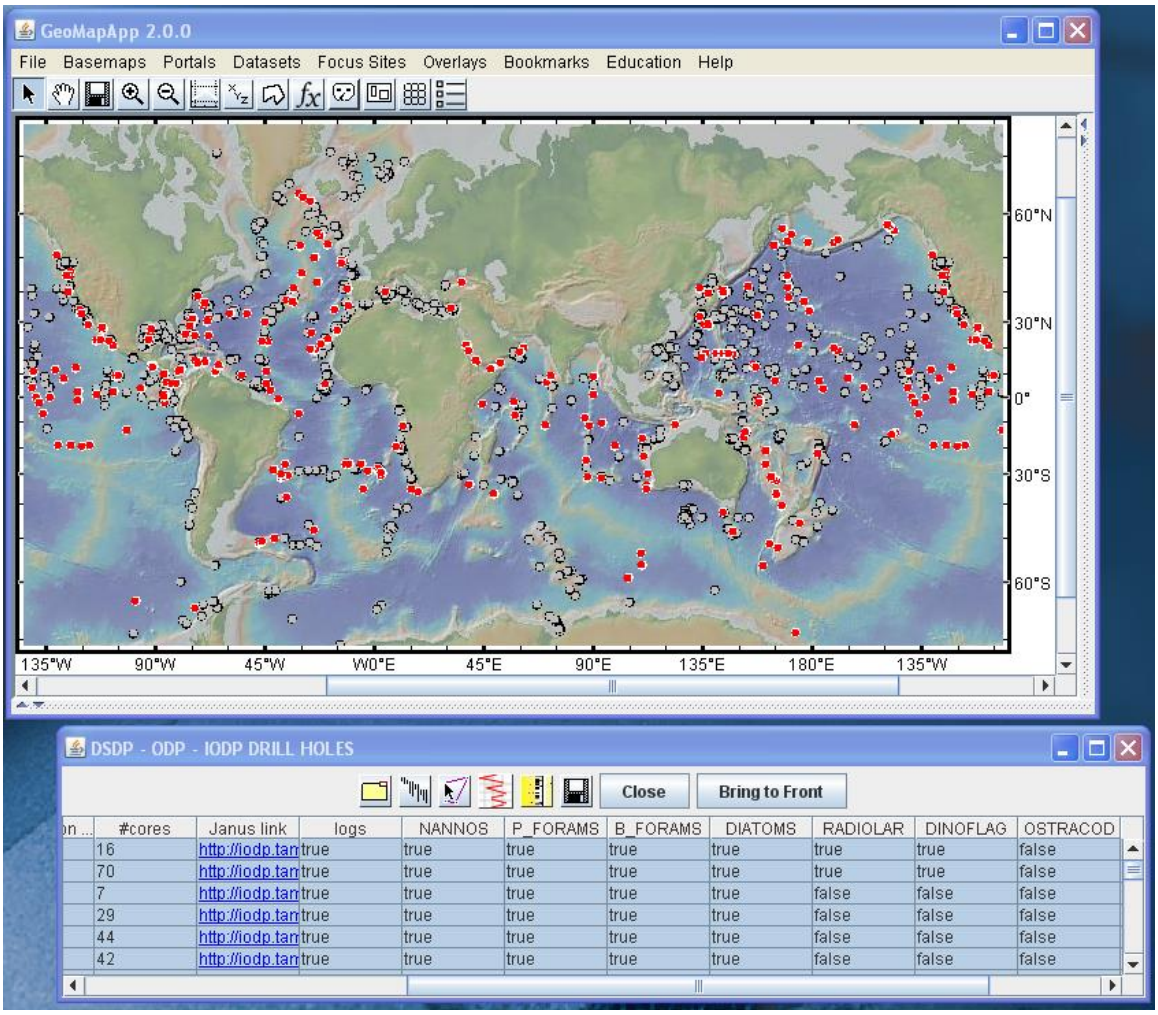


Figure: Holes with diatom range charts.

Note that, at times, the drill hole location symbols may be hidden under the symbols of other data sets or under images of other base maps. Click the Bring to Front button make them reappear.

Click Close to exit this DSDP-ODP-IODP portal.

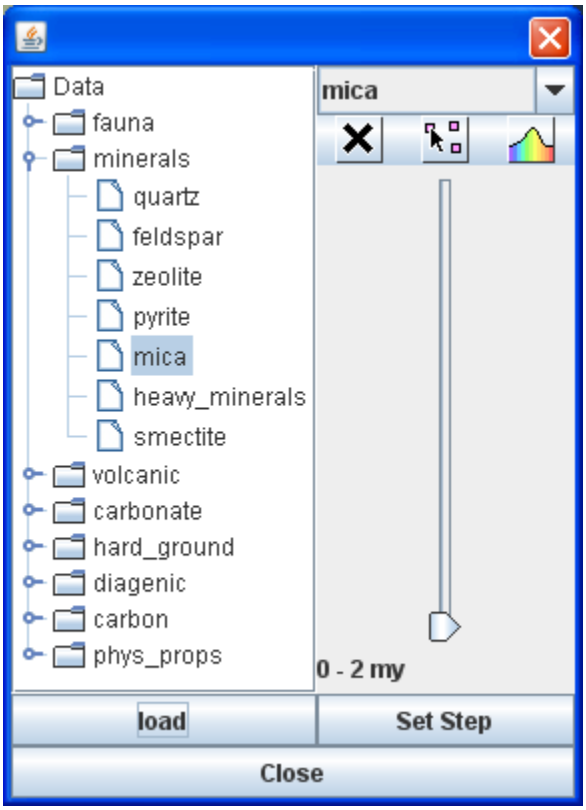
5.3.8.1) Additional functionality within the Ocean Floor Drilling interface

Enhanced features are triggered by these icons  in the DSDP-ODP-IODP tool bar.

5.3.8.2) Data types folder 

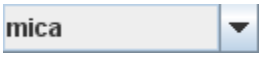
See video tutorial on 

The folder icon  opens a new window, as shown here.



In the left pane is a list of various data types. In the right pane are control parameters, including a slider bar to specify age range.

Choose a data type from the drop-down menus and press  to illuminate in the map window all holes reporting that data type within the specified age range. In the example shown at right, holes with mica in the 0-2 Ma range have been selected.

The name of the selected data type is given in the upper right corner of the folder window 

Click and drag the slider bar  to change the age range. This allows relative abundances to be visualized through time. The highlighted holes in the map window change with each chosen age range: only those containing the selected data type in the specified age range are displayed. Change the time range increment by clicking the  button.

Holes that do not contain that data type in the specified age range can be turned off and on using the  icon.

The color icon  uses a color table to display the relative percentage of the data type for the chosen age range. Red indicates high values, blue indicates low values.

More than one data type can be loaded although only one at a time can be visualized. The loaded data types are listed in the drop-down menu in the upper right. Switch between loaded data types by selecting them from the drop-down menu. Click the discard icon  to remove the selected data type from this list.

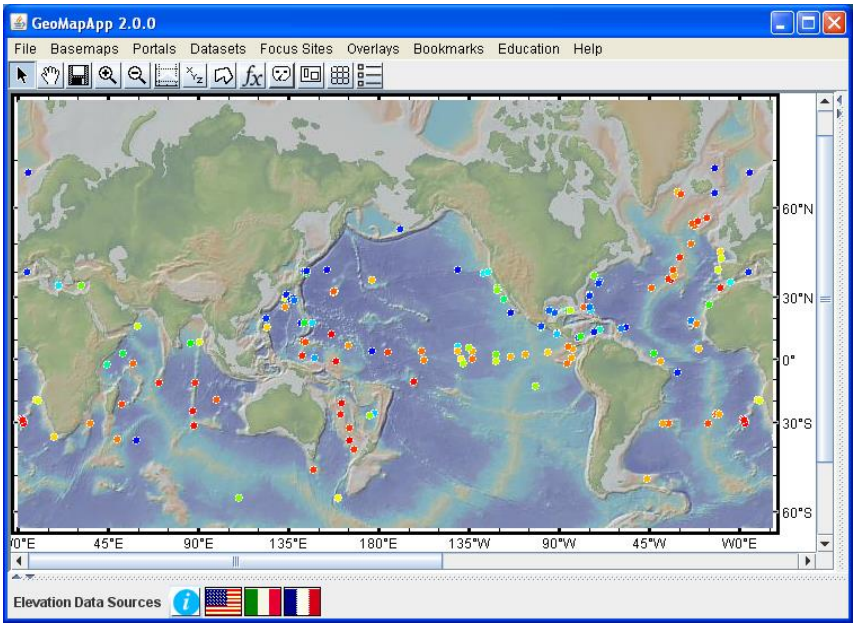


Figure: Colored hole symbols showing the relative abundance of carbonate in the 6-8 Ma time range.

Currently, quantitative measurements are available in GeoMapApp for DSDP legs 1-96.

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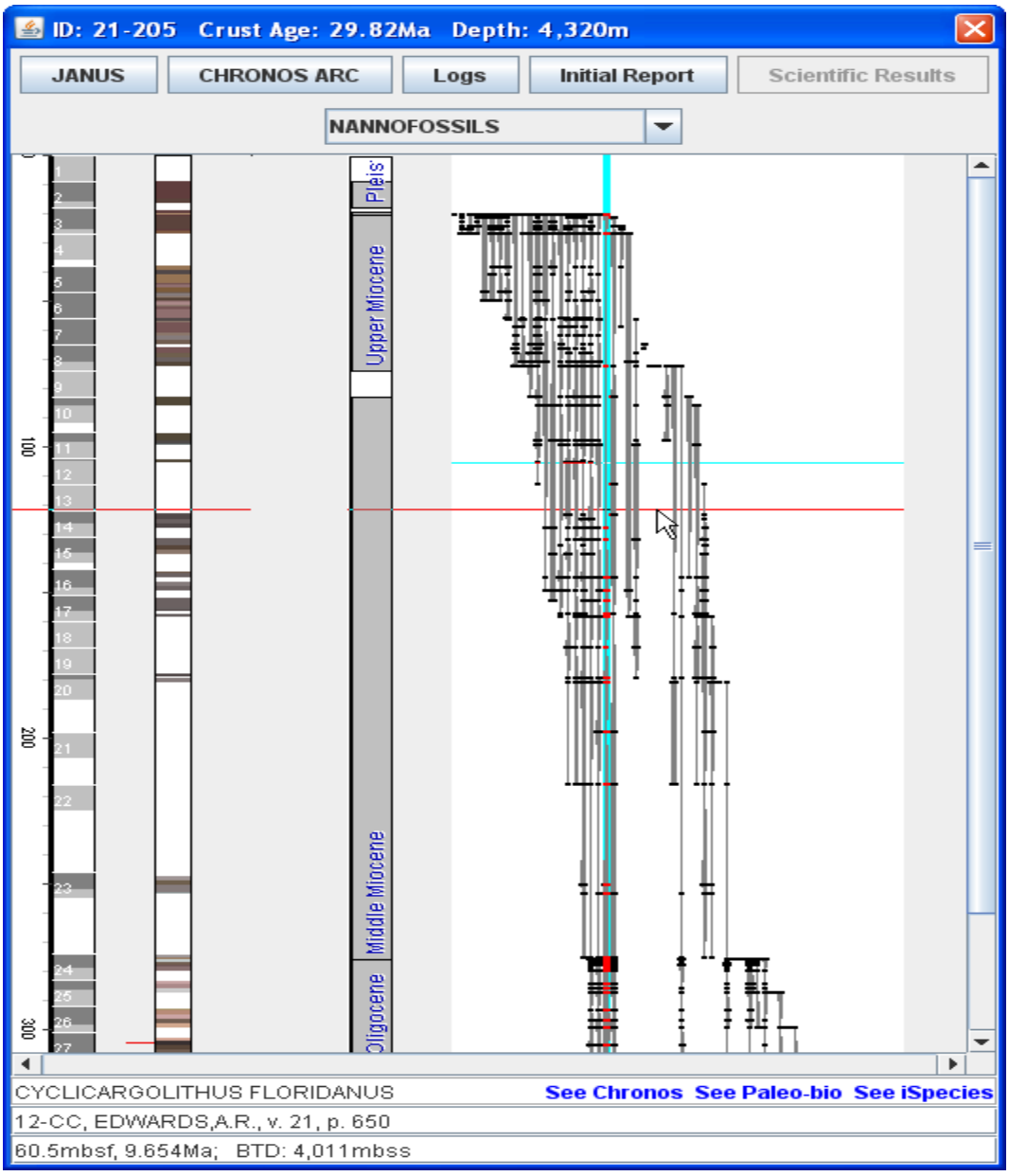
5.3.8.3) Faunal Range Charts

See video tutorial on YouTube

The range chart icon opens a window with faunal range information.



Using the drop-down menu NANNOFOSSILS choose the type of fauna and flora to display in the range chart, if reported for the selected hole.

The graphical part of the window contains four areas.

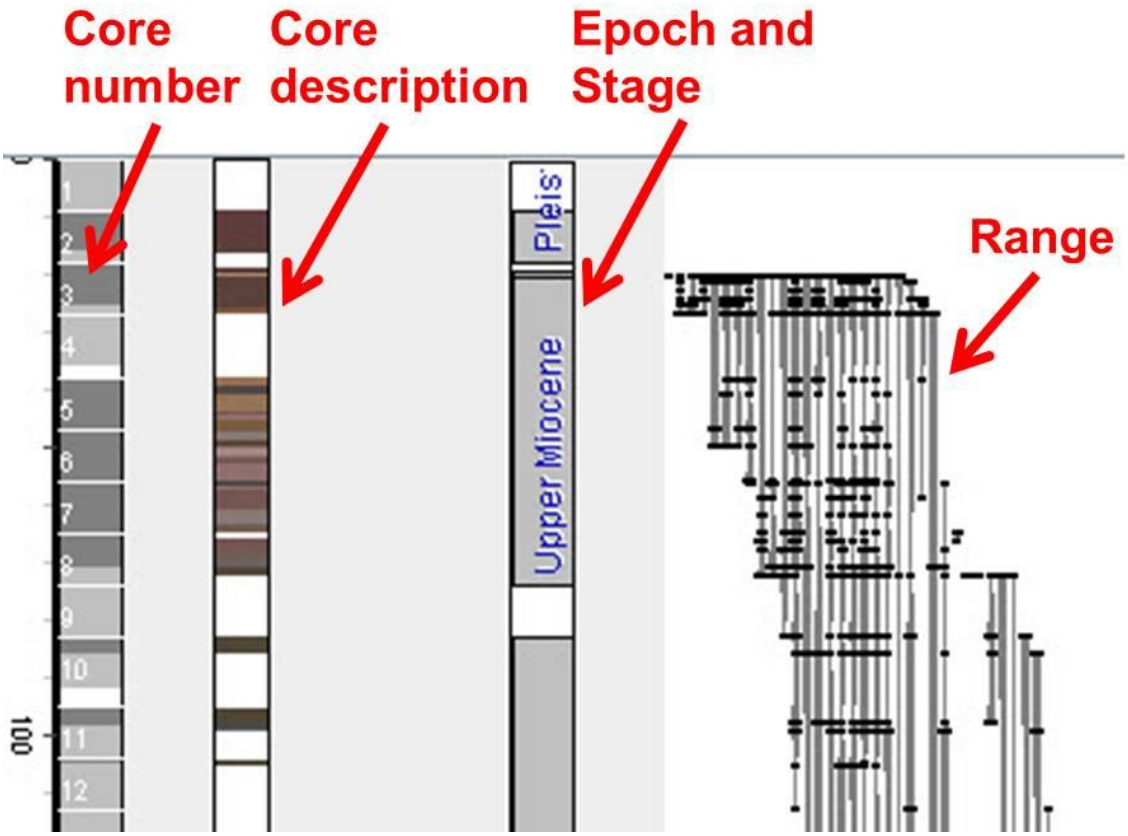
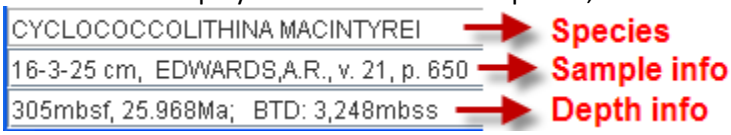


Figure: Range chart structure. On the left, shaded grey boxes show the presence of cores at their respective depths (in meters) below the sea floor. The next column will activate a function that brings up core descriptions. It should be active in a future release of GeoMapApp. In the middle are the epoch and stage ages with name. Faunal ranges are shown on the right, as thin grey vertical lines.

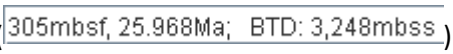
In the faunal range, black dots () represent the core sample depths.

Click a dot to display information about a species, in the lower part of the window.



In detail, the following information is presented.

- The species name ().
- Location of sample within the core (). Here, 16-3-25 cm refers to the core number (16), section (3), and depth in section (25 cm). Followed by reporting author (A.R. Edwards), report volume (21), and page number (650).

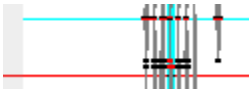
- Depth information (

) lists depth in meters below sea floor (305 mbsf), age at that depth in millions of years before present (25.968 Ma). BTD (3248 mbss) gives the back-track depth of the sea **floor** of that age expressed in meters below the paleo sea **surface** (mbss). It is calculated by removing the thermal subsidence since that time and by unloading the lithosphere by the weight of the sediments that have accumulated since that time.

- Further information contained in external databases about this species is given under the three hyperlinks (

).

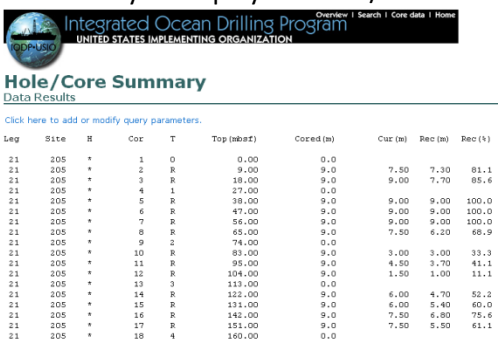
The selected species is highlighted in light blue in the range chart. As the cursor is moved in the window, a horizontal red line tracks the cursor giving updated depth/age information.



The four buttons 

across the top of the range chart window provide links to more information. The Janus button 

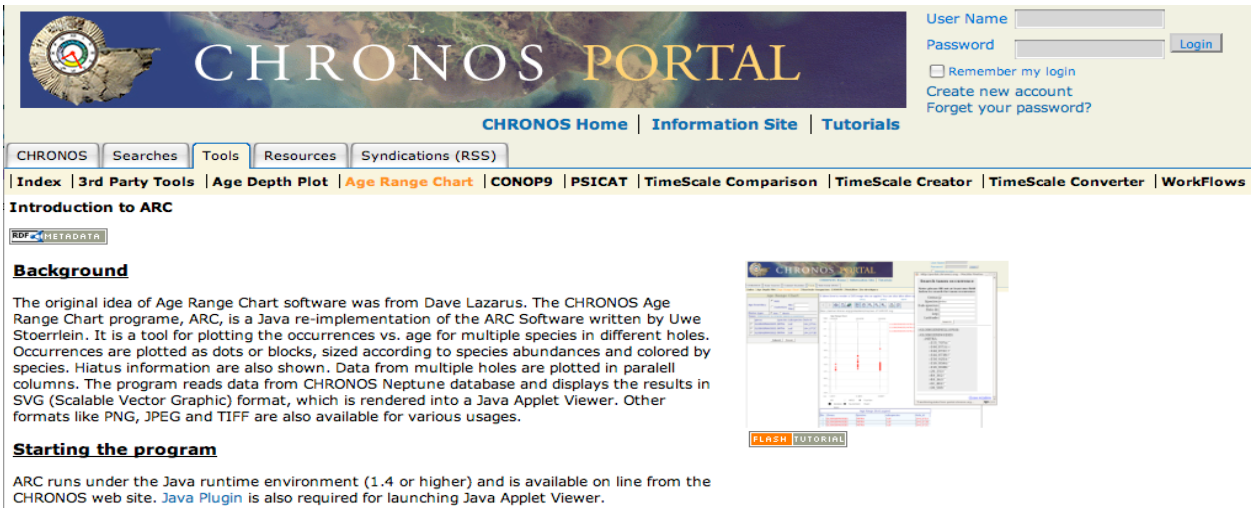
links to the JANUS database at Texas A&M University to display the Hole/Core summary results.



The CHRONOS ARC button 

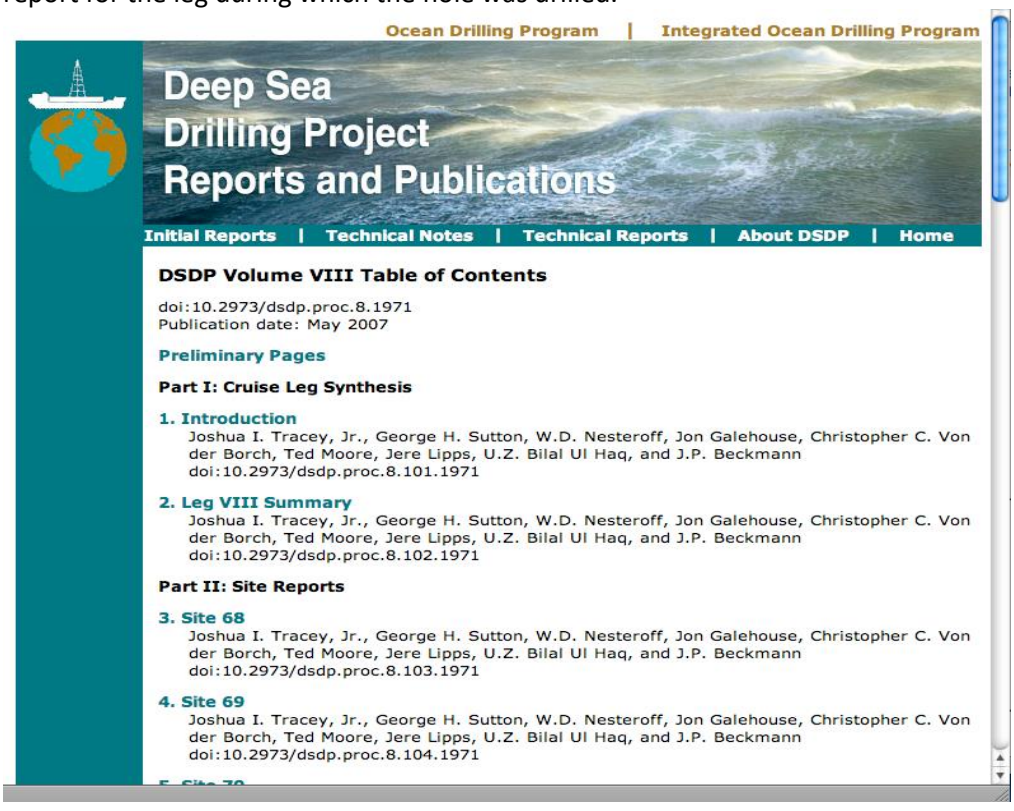
goes to the CHRONOS portal and displays age model information for the selected hole.

.



The Logs button  is currently inactive.

The Initial Report button  displays the table of contents and links to chapters of the report for the leg during which the hole was drilled.



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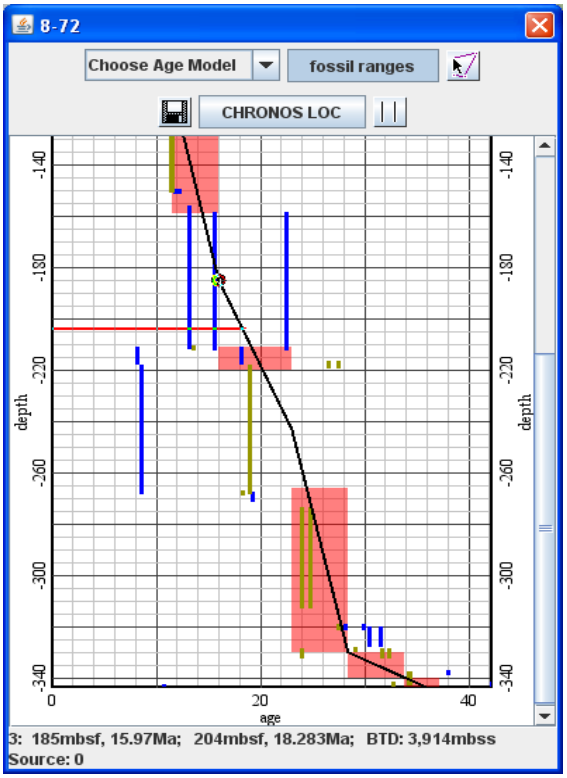
5.3.8.4) Age-Depth Models

See video tutorial on YouTube

When a hole has been selected, the age-depth model button opens a graph in a new window.



The horizontal axis gives the sediment age, and depth is given in meters below seafloor (mbsf) on the vertical axis. Orange rectangles mark the epoch/stage boundaries. Fossil ranges are shown as blue and green lines. The extent of the blue and green lines defines the first and last occurrence.

As the cursor moves down the graph, age-depth control points appear as red circles on the depth-age line. These age-depth values can be saved in a text file using the save button.

To change the age range displayed on the horizontal axis move the cursor to hover over either the left or right vertical axis line. When the cursor symbol changes to a double-headed arrow, drag the cursor sideways to change the range. The graph scaling can be reset by clicking the normalizing button.

The fossil ranges, as defined by their first and last occurrence, are turned off and on with the fossil ranges button. The CHRONOS LOC button opens a web page giving CHRONOS portal Line-of-Correlation information.

Users can modify the age-depth model by clicking the  icon. When active, click on an age-depth control point and drag it with the mouse to change its age and depth value. To create a new control point, click at the new location in the graph window. The age-depth curve will instantly adjust to include this new control point. The new set of age-depth values can be saved in a text file with the save button  . Clear the new points with the graph reset button  .

Previously-stored age-depth models created in earlier GeoMapApp sessions can be accessed using the drop-down menu at the top of the window, 

. The default age-depth model can be reloaded by selecting "**Default**" from the menu. The current age-depth model can also be saved under this menu. The saved file is stored in the user's GeoMapApp home directory, or can be stored elsewhere using the file navigation buttons.

The text display (

) at the base of the graph lists six pieces of information about the control points and age-depth model – three values for the control points, and three values for the age-depth model. From left to right these values are: (a) The number of the control point nearest the cursor; (b) its depth in meters below seafloor (mbsf); (c) its assigned age (Ma). These are followed by three values for the age-depth model at the location of the cursor: (d) the depth in meters below seafloor (mbsf) of the cursor position; (e) the corresponding sediment age from the age-depth model (Ma); and, (f) the calculated back-tracked depth (BTD) in meters below the paleo sea surface (mbss).

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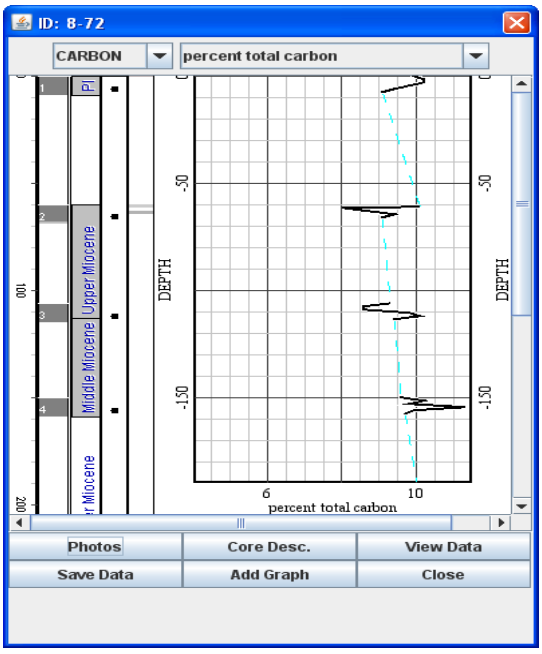
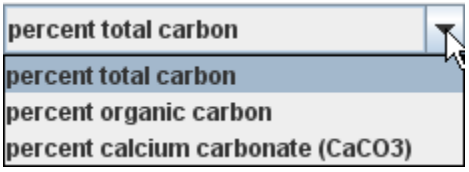
5.3.8.5) Physical-Chemical Measurements Graphs and Core photos 

See video tutorial on YouTube

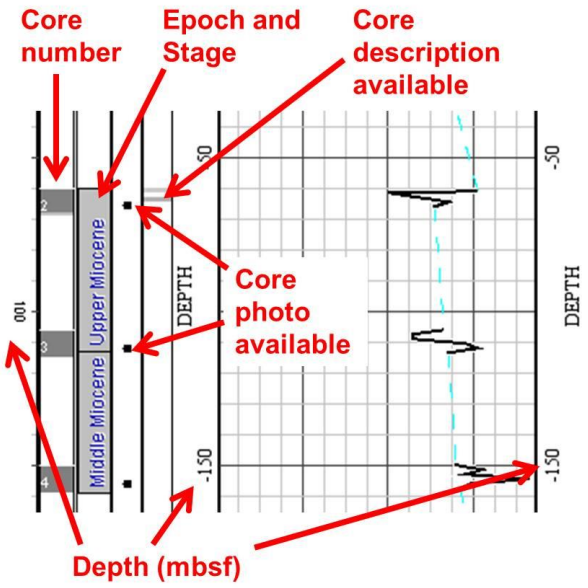
For each drill core, a range of physical and chemical measurements were made on the recovered core and, in many cases, photos of the cores were taken. These can be viewed using the graphing function  which opens a window like this:



Measured categories are listed in the left-most drop-down menu. Shown in this example is Carbon. Types of measurements within that category are listed in the right-most drop-down menu. Here, “percent total carbon” has been selected and graphed.

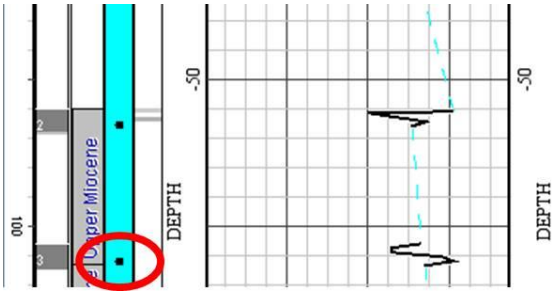


The figure below describes the structure of the window.

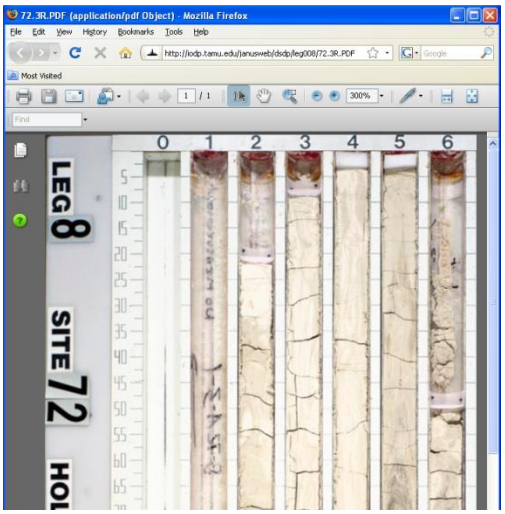


To access the core photos, click the 

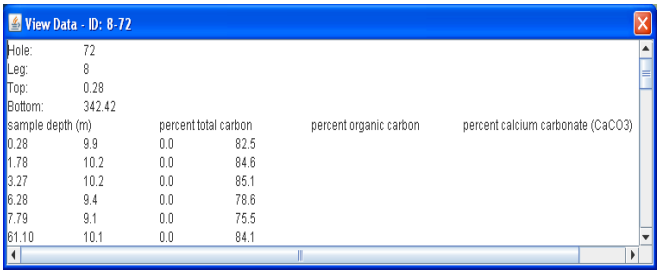
button in the lower left corner of the graph window. A blue column appears in the graph window between the epoch/stage names and the depth axis.



If hand-drawn visual core descriptions are available, another column of squares appears, one for each core section to display the description. Click one of the small black squares to bring up the core photo in a browser window.



The ASCII data table from which the graph is drawn can be viewed using the View Data button which opens a text editor.



The tabular data values are saved to a file using the Save Data button.

Where a measurement category has multiple data types, the graph for each type can be viewed side-by-side using the Add Graph button. From the pop-up menus choose the category and data type to plot. A new graph will be plotted next to the first one as shown below. Individual graphs can be discarded by clicking the small ☒ in the upper right corner of each additional graph.

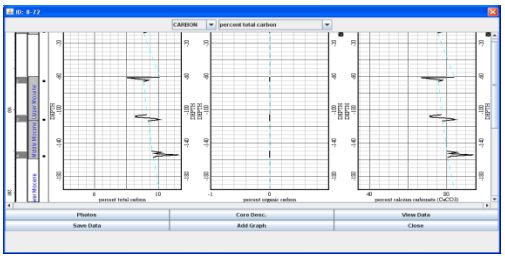


Figure: Graphs of total carbon, organic carbon and $CaCO_3$ plotted side-by-side. The new graphs can be deleted by clicking ☒ (upper right corner).

The graphing window is discarded with the Close button.

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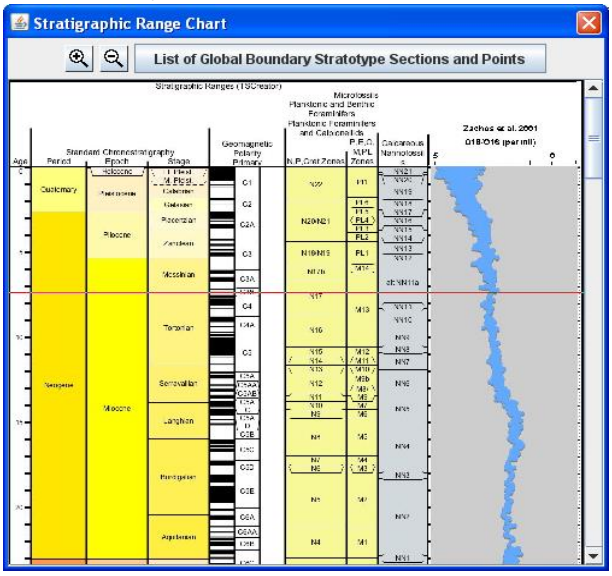
5.3.8.6) Geological Timescale

See video tutorial on YouTube

The Geological Timescale icon opens a window displaying Period, Epoch and Stage boundaries, the geomagnetic polarities time scale and faunal zonal boundaries for foraminifera and calcareous nannofossils, and the delta ^{18}O curve of Zachos *et a*l., 2001.



A horizontal red line tracks up and down in this window corresponding to the age of the sediment derived from the age-depth model. This allows the range chart and physical/chemical measurement for the selected hole to be directly correlated with the standard chronology and internationally-recognized epoch/stage boundaries and magnetic reversal time scale. Use in the top-left to zoom on the timescale.

5.3.8.7) Zooming on graphs

When viewing the graphs (range charts, age-depth graph, and physical-chemical measurements graph) zoom functionality is available: To zoom in, hold down the control key and click the cursor within the graph. To zoom out, hold down the control and shift keys and click the cursor within the graph.

5.3.8.8) Keeping track of depth in the core section

The vertical position of the cursor creates a horizontal red line that moves in synchronization in all the windows to indicate the same depth below the seafloor. This can assist in correlation between the various data types being graphed. Even if graphs have been zoomed, the red line still shows the corresponding depth in each graph.

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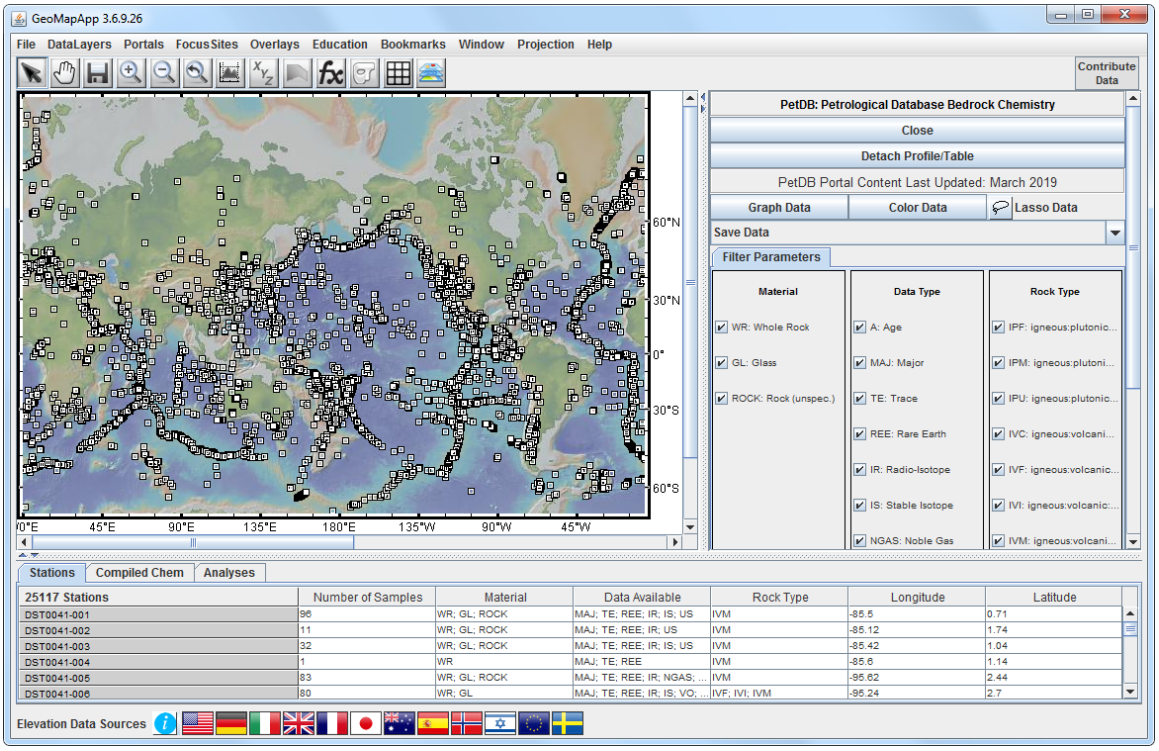
5.3.9) PetDB (Composition of the Oceanic Volcanic Crust)

Explore geochemical analyses and sample locations for samples in the PetDB petrological database. The data content is updated about four times each year; the date of the most recent update is given in the upper right.



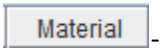
PetDB sample locations are plotted as squares on the map. Samples and data are displayed on different tabs beneath the map. Filter parameters and color/selection options are available on the right.

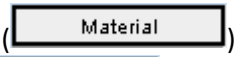
5.3.9.1) Overview

Click a symbol on the map (it turns red); the data record for this symbol is highlighted in the lower table. When the Stations tab is active 

the columns in the table list the following information:

- Number of samples associated with the chosen station

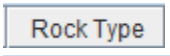


- Type of material analyzed. Codes are listed in right panel (

)

- Data type codes are listed in right panel (

)



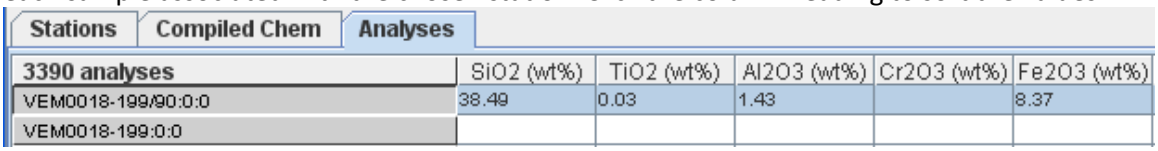
- Type of rock analyzed. Codes are listed in right panel (

)

- Coordinates of sample location.

The Analyses tab 

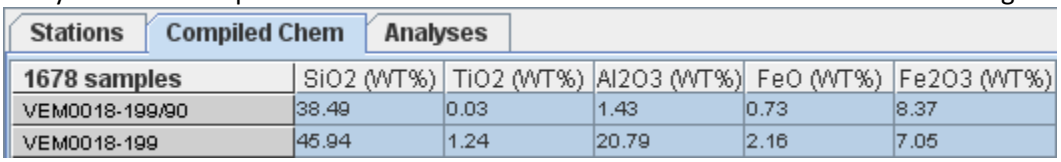
lists the individual geochemical analyses for each sample associated with the chosen station. Click the column heading to sort the values.



3390 analyses	SiO2 (wt%)	TiO2 (wt%)	Al2O3 (wt%)	Cr2O3 (wt%)	Fe2O3 (wt%)
VEM0018-199/90:0:0	38.49	0.03	1.43		8.37
VEM0018-199:0:0					

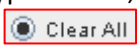
The Compiled Chem tab 

lists the compiled geochemistry analyses for all samples associated with the chosen station. Click the column heading to sort the values.



1678 samples	SiO2 (WT%)	TiO2 (WT%)	Al2O3 (WT%)	FeO (WT%)	Fe2O3 (WT%)
VEM0018-199/90	38.49	0.03	1.43	0.73	8.37
VEM0018-199	45.94	1.24	20.79	2.16	7.05

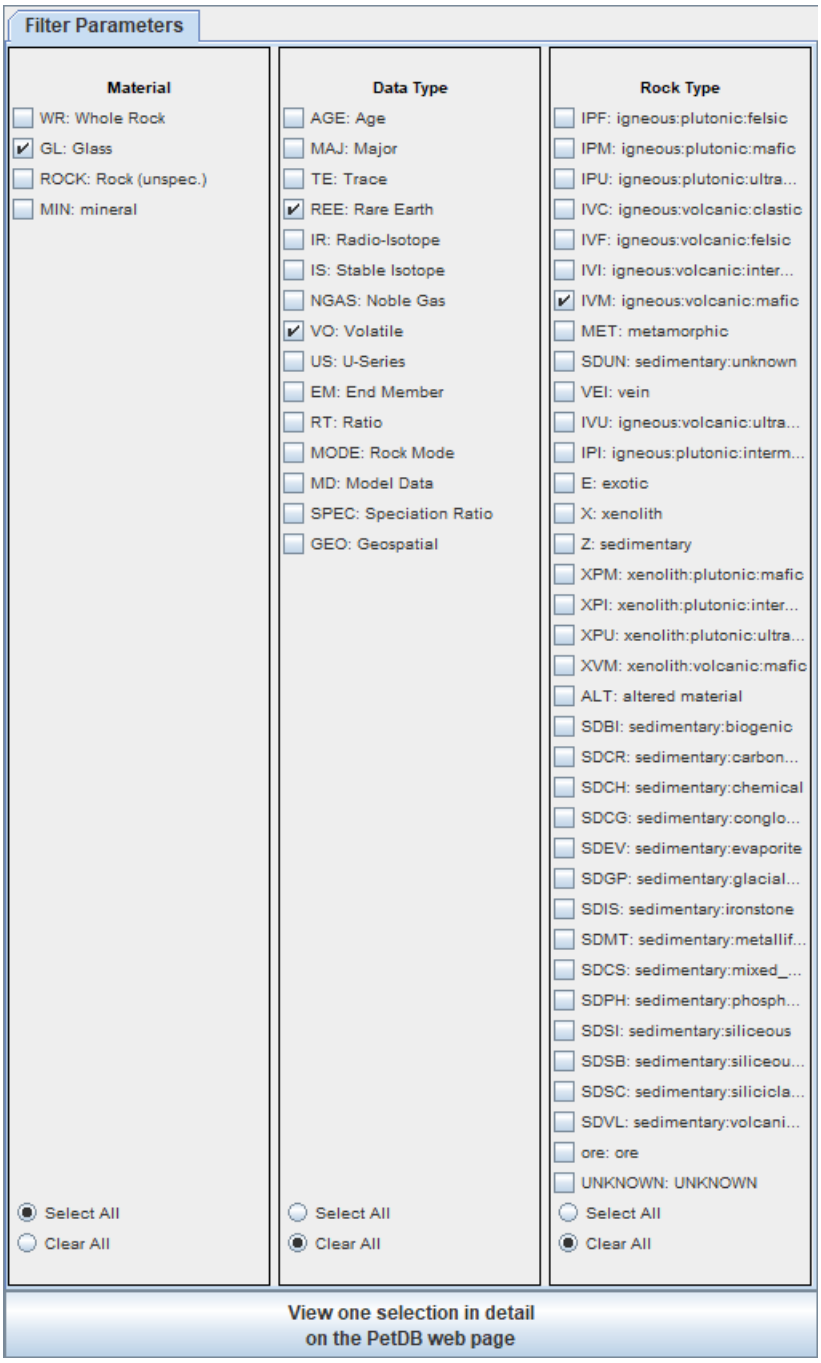
5.3.9.2) Filtering the PetDB samples

By default, all samples are displayed. The right-hand panel provides the capability to filter the samples by type of material, type of data, and type of rock. Click the tick box of an item in the list to select (☑) or de-select (☐) it. Click 

to de-select all items; click 

to select all items.

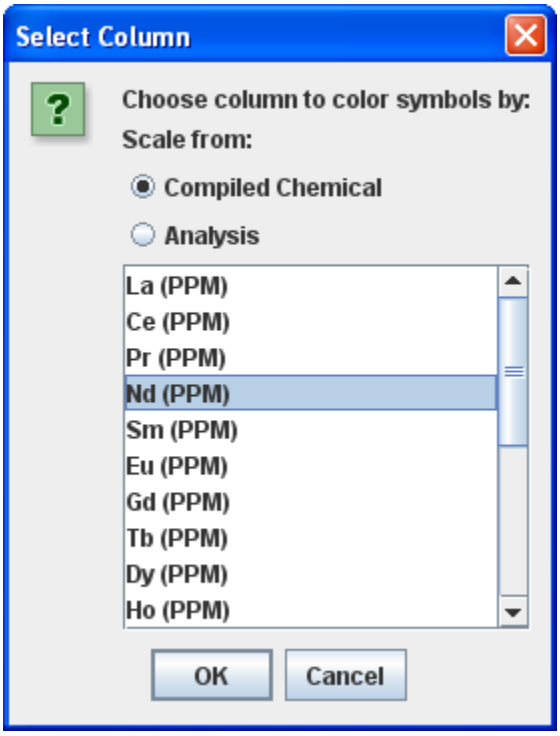
In the following example, basaltic glasses with REE and volatiles analyses have been manually selected. Only those samples that satisfy these parameters are plotted on the map.



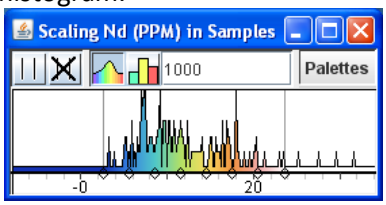
The PetDB web page for the selected samples can be accessed by clicking this button beneath the filter parameters: 

5.3.9.3) Color, Graph and Lasso data

The Color Data button opens a pop-up window in which the column to color is chosen from the list.



Select an item (in the example shown above we chose Nd). Click OK to open the color palette histogram.



Slide the grey lines in the color histogram to the left or right to change the symbol color range displayed in the map window.

To plot any two numerical columns, click Graph Data and select the x-axis and y-axis variables from the drop-down lists. If symbols have been colored (on any column) that coloration is preserved in the graph.

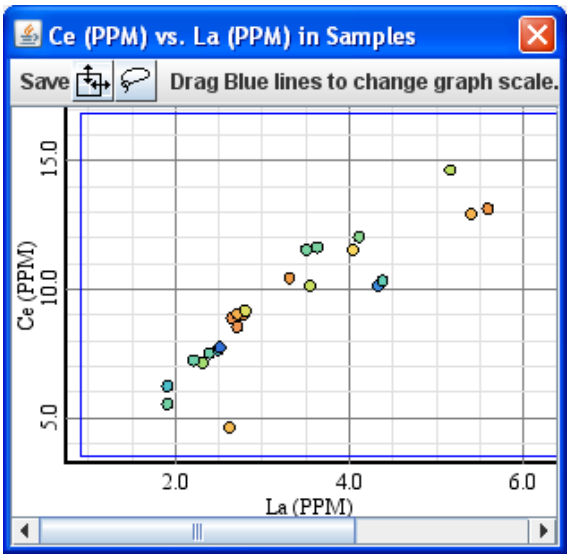
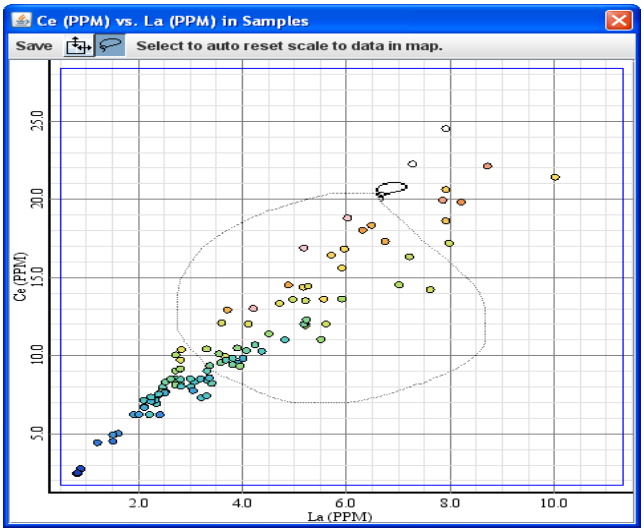


Figure: Compiled chemistry for sample 208NMNH113716: Graph shows Ce plotted against La, with coloring on Nd.

In the Graph window, the axes can be re-scaled as follows: Move the cursor onto a blue line near the graph edge. When the cursor turns into a double-headed arrow, drag the cursor left or right. The axis will rescale instantly.

The Lasso Tool is found in both the right-hand panel (

) and in the graph window () and is used to capture specific samples of interest. Click to activate then use the cursor and free-hand drawing to draw a line that captures points of interest. The Lassoing can be done in either the map window or in the Graph window, as shown here.



When the cursor is released, all of the selected samples are highlighted in the table in blue, and the selected points are ringed in red in both the map window and the Graph window.

PetDB data can be saved using the options listed in the right pane under the 

button.

See this section for more information on coloring and graphing data points.

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5.3.10) Seafloor Magnetic Anomaly Identifiers

See video tutorial on YouTube

Explore isochrons of seafloor magnetic anomalies using Mueller et al's compilation.

When the portal interface has loaded, zoom and select an isochron of interest. Two things happen: The selected isochron turns white in the map window, and the isochron name and age are displayed in the lower left.

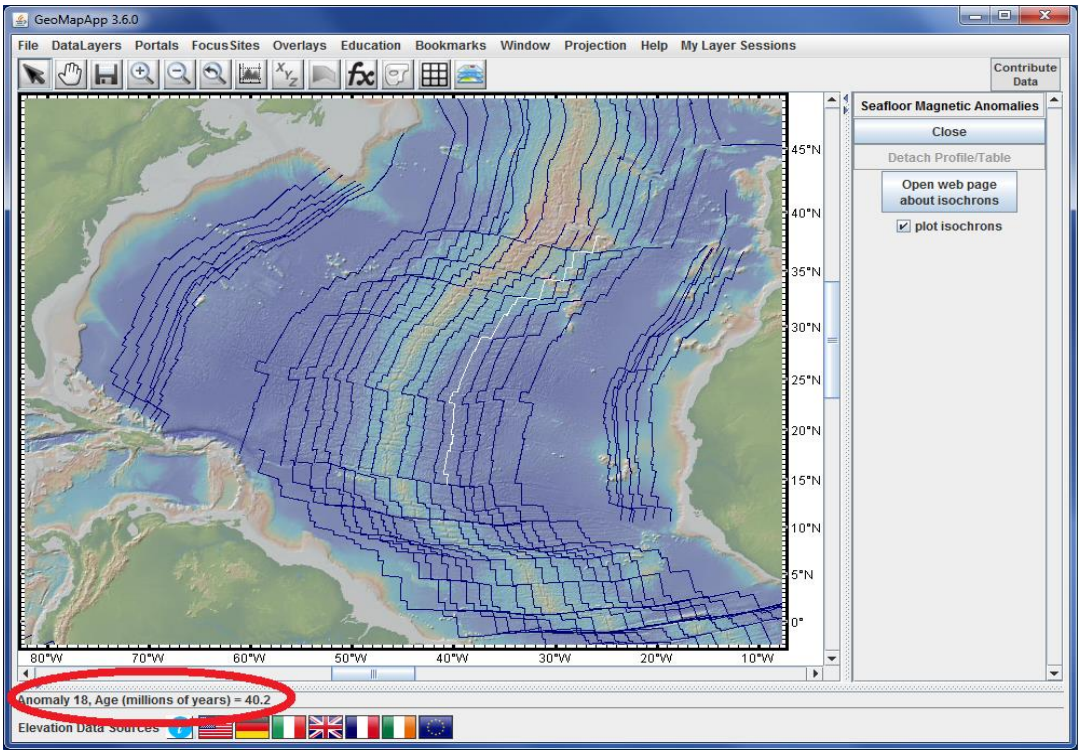

Figure: Isochrons in the north Atlantic. Anomaly 18 has been selected. Its age is listed in the lower left.

Click on the web page link Open web page about isochrons to open an information page describing the data set. The isochrons can be turned off and on by ticking/unticking ☑ plot isochrons.

Education suggestion: The magnetic isochron data can be combined with the profile-distance tool to determine distance and age from a spreading ridge, and thus the spreading rate. See this education module for suggestions.

Data set reference: Müller, R.D., Roest, W.R., Royer, J.-Y., Gahagan, L.M. and Sclater, J.G., 1997, Digital isochrons of the world's ocean floor, *Journal of Geophysical Research*, 102, 3211-3214.

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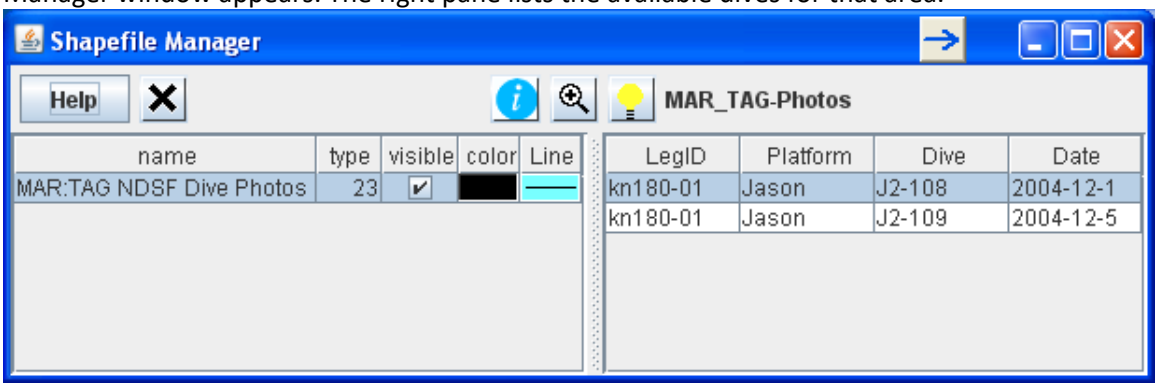
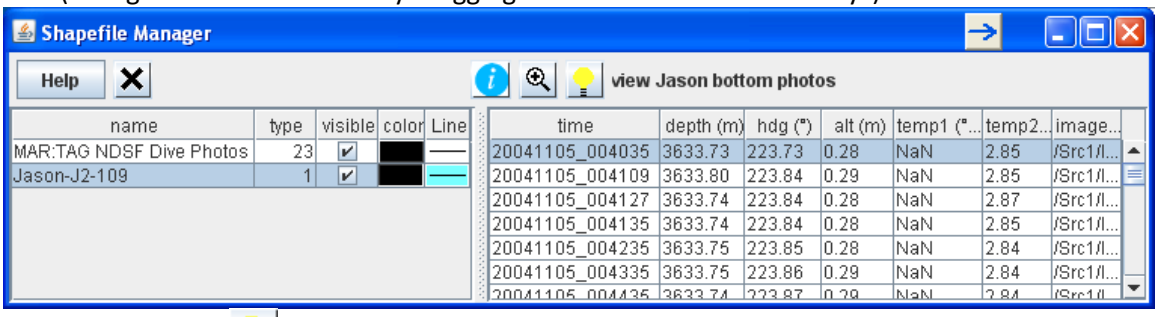
5.3.11) Seafloor Photographic Transects

This portal provides still photographs from the dives of deep sea vehicles Alvin and Jason operated by Woods Hole's National Deep Submergence Facility. The track of each dive is displayed in the GeoMapApp map window and separate windows are used to view the dive photos.

The menu list is grouped by geographical area. After choosing one dive from the menu, a Shapefile Manager window appears. The right pane lists the available dives for that area.



Click to highlight one of the dive records then click the light bulb to list all photos available for that dive (change the column width by dragging the column borders sideways):



Click the light bulb to open a photo display window. Alvin carries two cameras so the light bulb can be clicked twice to bring up two photo viewing windows. Jason has four cameras and four clicks produces four viewing photo windows.

For each photo display window, use the drop-down menu 

at the top to select the camera and use the arrow buttons to scroll through the available photographs. With each click the photos displayed in all windows are changed. To jump to a particular time, click the corresponding row in the right pane of the Shapefile Manager.

The zoom function will zoom the map to the area of the selected dive. The button opens a web page containing more information about the parent cruise.

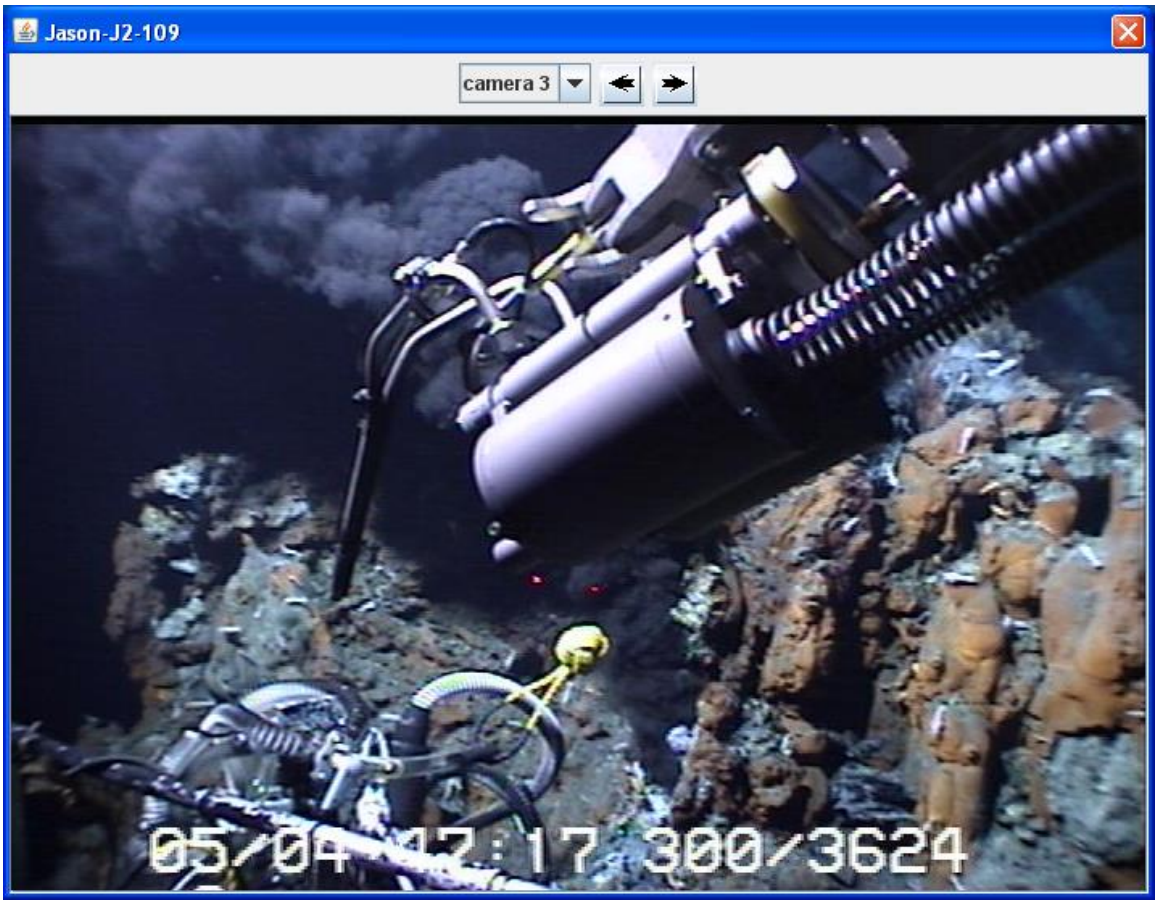
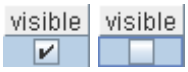
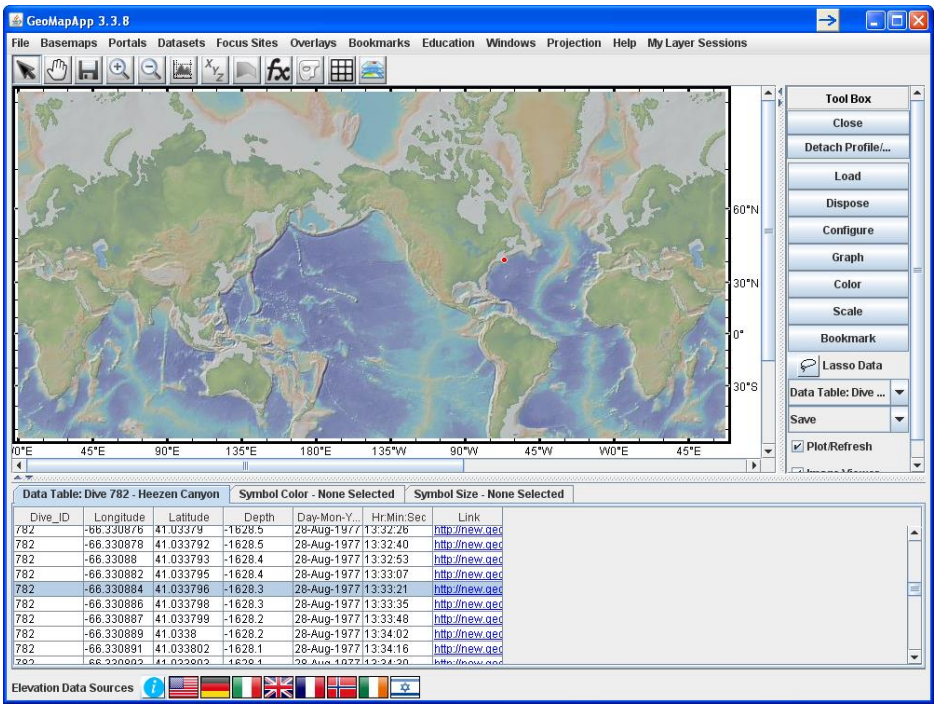


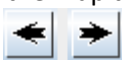
Figure: Example of a dive seafloor photo in this case collected with the WHOI NDSF Jason II ROV during cruise KN180-01 to the Mid-Atlantic Ridge TAG hydrothermal site.

Additional dives can be loaded. They will appear as layers in the left side of the Shapefile Manager and only photos from the selected dive will be displayed. The shapefile can be toggled on and off using the visibility buttons 

. Discard the shapefile using  .

For the five Alvin dives listed for the New England Canyons, the photo locations are presented in the same interface used for tabular data, as shown in the example below.



Click any row in the table or any dot on the map to generate a thumbnail image of the photograph at that locality and use the arrow buttons  to scroll through the available photographs.

Click a hyperlink in the Links column in the table to display the full-resolution image in a web browser.

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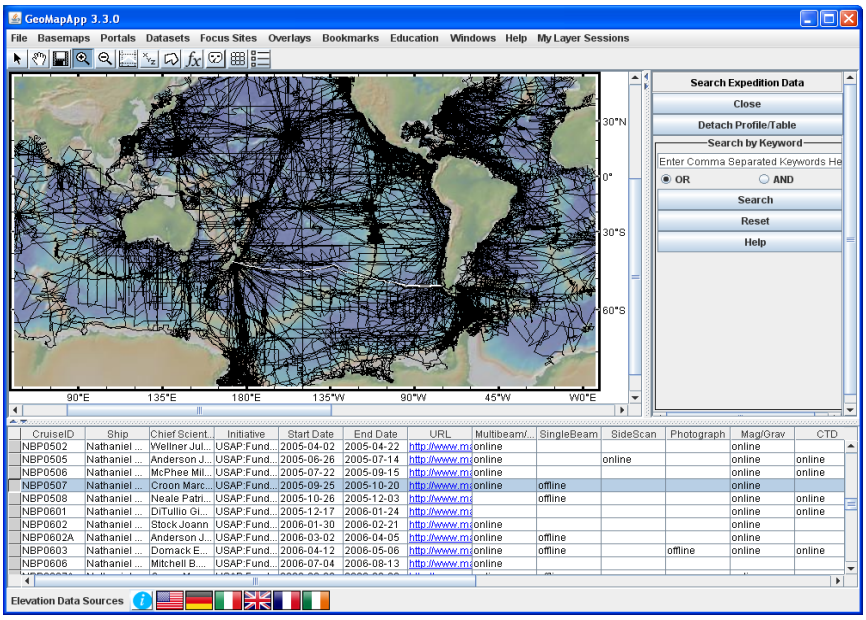
5.3.12) Search Expedition Data

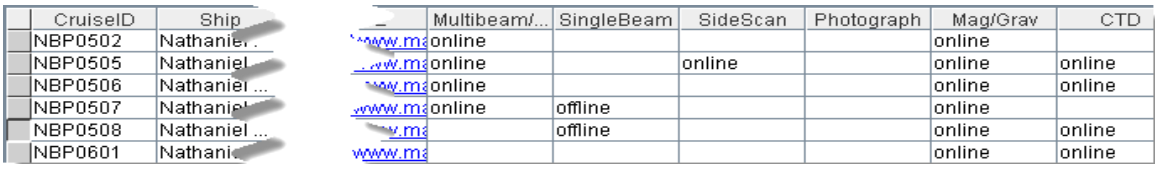
See video tutorial on YouTube

This portal allows searching of data associated with more than 2,200 field programs and data compilations in the MGDS database.



Select a cruise track in the map window by clicking on an individual track line with the cursor. The track will turn white and the cruise record is highlighted in the record table beneath the map. Alternatively, select a row from the table – the record is highlighted and the cruise track will turn white in the map window.

Only records for cruise tracks falling within the displayed map area are listed in the table. Columns can be sorted by clicking the column header. The width of columns is changed by dragging the column header boundary left or right.



CruiseID	Ship		Multibeam/...	SingleBeam	SideScan	Photograph	Mag/Grav	CTD
NBP0502	Nathaniel ...		online				online	
NBP0505	Nathaniel ...		online		online		online	online
NBP0506	Nathaniel ...		online				online	online
NBP0507	Nathaniel ...		online	offline			online	
NBP0508	Nathaniel ...			offline			online	online
NBP0601	Nathaniel ...						online	online

In addition to basic information about the field programs, the columns in the right side of the table, as displayed in the image above, report the status of cruise-related data. The columns are coded as follows:

- "online": Data files are available on-line by clicking the URL link in the URL column.
- "offline": Data files are currently unavailable.
- blank cell ( ): No data collected.

BOOLEAN-based searching for data is done using the controls in the right pane. Comma-separated search terms are typed into the text box.

In the example below, only those cruises collecting Multibeam and Gravity data during year 2001 will be displayed when the Search button is clicked.

Selecting instead the OR radio button would return all cruises that collected Multibeam or collected Gravity data or operated during year 2001.

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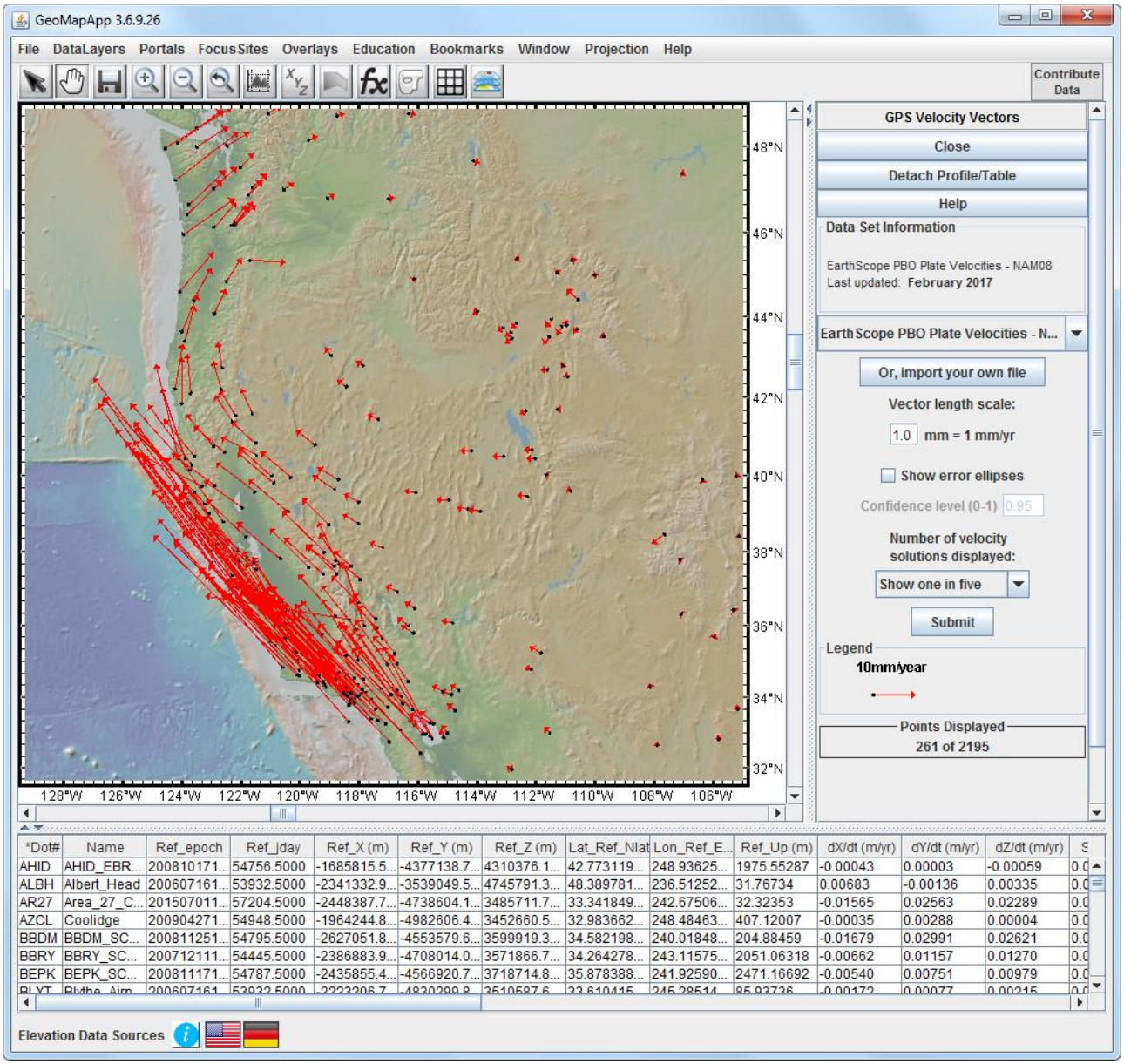
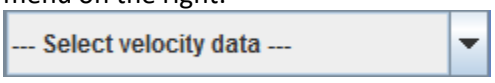
5.3.13) GPS Velocity Vectors

This portal displays geodetic horizontal plate motion velocity vectors using either the built-in EarthScope Consortium (UNAVCO) geodetic solutions or user-imported geodetic data.

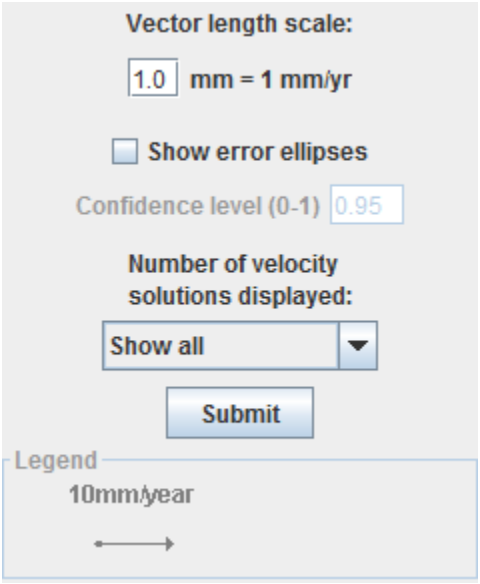


The built-in data sets are updated at intervals. They are listed in the *Select Velocity Data* drop-down menu on the right:

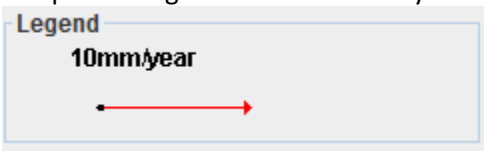


The built-in UNAVCO EarthScope PBO solutions are in both IGS08 and NAM08 reference frames, and the solutions from both Central Washington University and New Mexico Tech are in NAM08.

After selecting a data set, the vector display parameters can be specified as shown below.

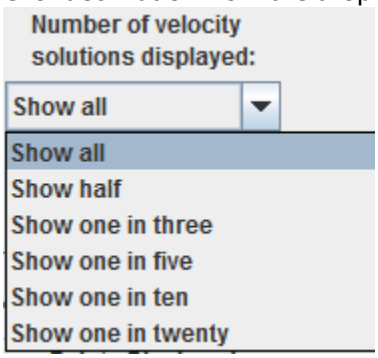


- **Vector length scale**: Specify the length scale for the vector arrows. Default is 1.0 millimeter = 1mm/year of plate motion When the vectors are displayed on the map, the Legend shows the length of a vector representing a horizontal velocity of 10mm/year, like this:



- **Show error ellipses**: Tick the Show error ellipses box to draw velocity solution error ellipses at the head of each arrow. Default is no ellipses. If error ellipses are chosen, the *confidence ellipse* value can be specified by changing the Confidence level number. Default is 0.95 for 95%.

- **Number of velocity solutions displayed**: Decimate the number of vectors drawn on the map by choosing the level of decimation from the drop-down menu:



The default is to display all vectors. For areas with dense station coverage, such as southern California, a decimation level that shows one in five or one in ten may yield a clearer map display. Every time the decimation is changed, the Submit button must be clicked.

Once the Submit button is clicked, the velocity vectors are drawn on the map and the solutions are displayed in the table beneath the map. On the map, the stations are shown as small block dots and the velocity vectors are drawn as red arrows. 

The number of solutions displayed is given in the Points Displayed box, like this:

Click on a black dot to highlight that station record. The arrow and dot will change from red to yellow on the map and, in the table beneath the map, the chosen solution will be highlighted in blue. Conversely, click one or more records in the table to highlight the corresponding vectors on the map.

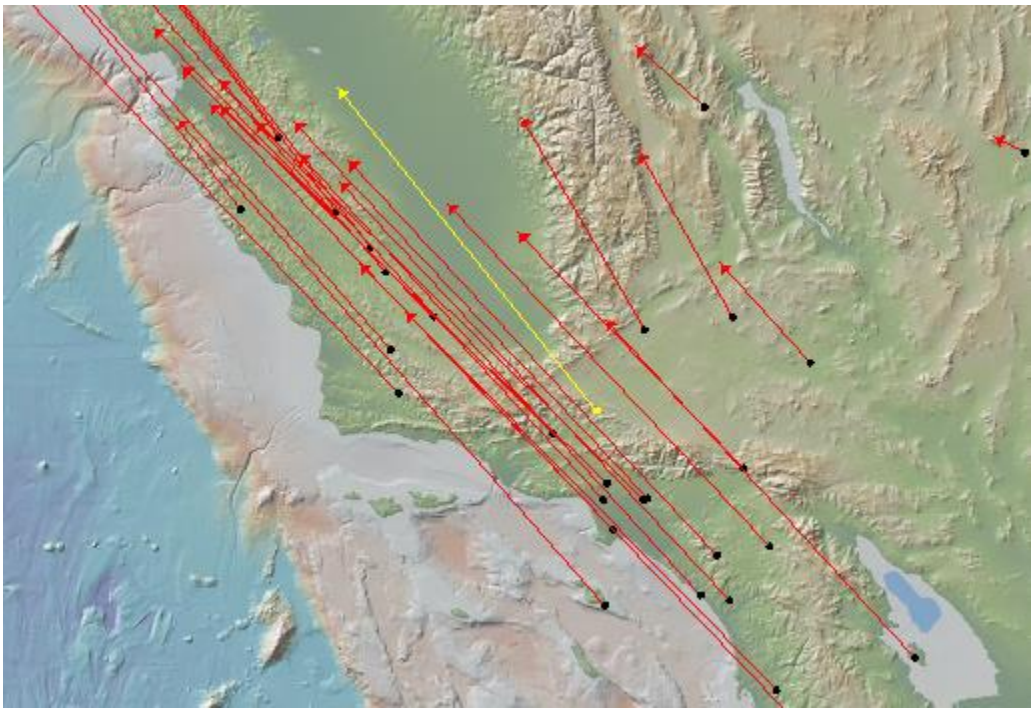


Figure: An example of decimated (one-in-twenty) velocity vectors in southern California. One selected vector is highlighted in yellow on the map and in blue in the table beneath the map.

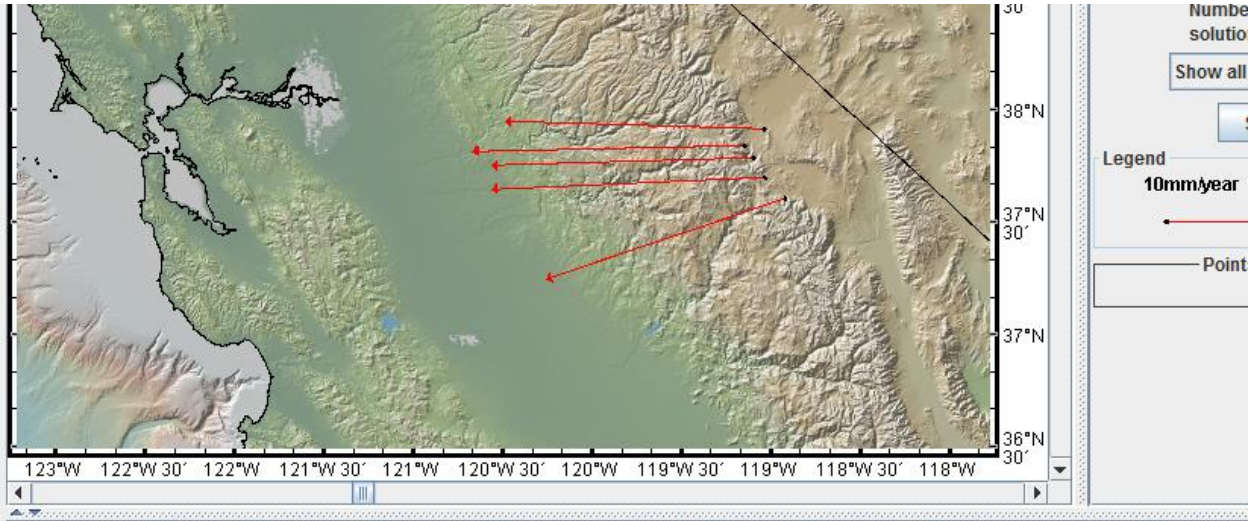
Velocity Vector data can also be imported. The imported file needs to be in tab-separated ASCII format and must at a minimum contain the following columns with the specified column header (header label is not case sensitive):

- Latitude column (in decimal degrees). Header label "lat"
- Longitude column (in decimal degrees). Header label "lon"
- North velocity column. Header label "dn/dt", "north velocity" or "vel_n"
- East velocity column. Header label "de/dt", "east velocity" or "vel_e"
- North velocity standard deviation column. Header label "snd", "n. vel std dev" or "sig_n"
- East velocity standard deviation column. Header label "sed", "e. vel std dev" or "sig_e"
- North/East velocity correlation coefficient column. Header label "rne" or "rho_en".

This import format is similar to the GMT psvelo minimum format. Here is an example of a file that is successfully imported in GeoMapApp. It contains the minimum columns listed above along with additional columns for the vertical velocity components.

```
DOT     Name    lat     lon     vel_n   vel_e   vel_up  snd     sed     sud     rne
P631    Laurel_CrkCS2006        37.6053252      241.0840601     -0.0071 -0.02088        0.00618 0.00114 0.00011 0.00148 0.000
P632    JuneLake__CS2006        37.78566508     240.9139252     -0.00062        -0.02298        0.00152 0.00011 0.00031 0.00046 0.000
P633    MonoDomesNCS2008        37.91346041     240.9670124     0.00067 -0.02253        0.00165 0.0003  0.00024 0.00064 0.000
P634    Deer_MountCS2007        37.69659235     240.9742198     -0.00098        -0.02388        0.00315 0.00014 0.00072 0.00095 0.000
P635    Grant_LakeCS2007        37.83931393     240.8620096     -0.00047        -0.02378        0.00245 0.00008 0.00032 0.00056 0.000
```

When imported, the solutions are plotted on the map and are tabulated beneath the map. These stations lie in eastern California, close to the California/Nevada state border (load the state boundaries from Overlays > Local Administrative Boundaries > United States > US State Boundaries):



DOT	Name	lat	lon	vel_n	vel_e	vel_up	snd	sed	sud	rne
P631	Laurel_Crk...	37.6053252	241.08406...	-0.0071	-0.02088	0.00618	0.00114	0.00011	0.00148	0.000
P632	JuneLake_...	37.785665...	240.91392...	-0.00062	-0.02298	0.00152	0.00011	0.00031	0.00046	0.000
P633	MonoDom...	37.913460...	240.96701...	0.00067	-0.02253	0.00165	0.0003	0.00024	0.00064	0.000
P634	Deer_Mou...	37.696592...	240.97421...	-0.00098	-0.02388	0.00315	0.00014	0.00072	0.00095	0.000
P635	Grant_Lak...	37.839313...	240.86200...	-0.00047	-0.02378	0.00245	0.00008	0.00032	0.00056	0.000

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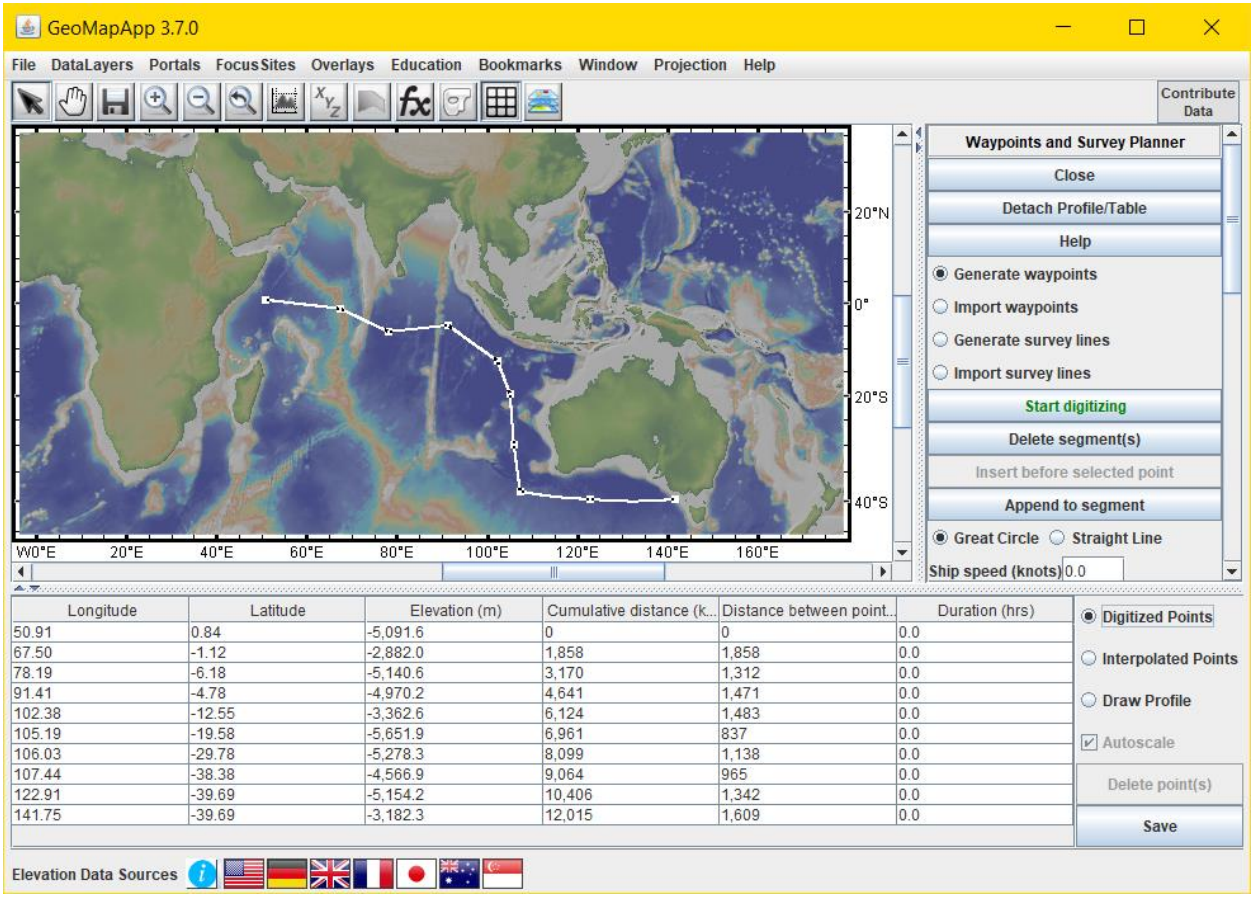
5.3.14) Waypoints and Survey Planner

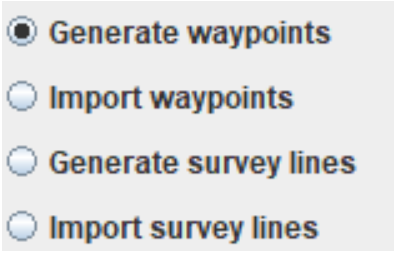
This portal allows generation and manipulation of waypoints and survey lines and provides basic information including distance between waypoints, track length, along-track distance, sailing time, and cumulative distance. The portal is also useful for sampling any loaded grid at user-specified points.



Longitude	Latitude	Elevation (m)	Cumulative distance (k...	Distance between point...	Duration (hrs)
50.91	0.84	-5,091.6	0	0	0.0
67.50	-1.12	-2,882.0	1,858	1,858	0.0
78.19	-6.18	-5,140.6	3,170	1,312	0.0
91.41	-4.78	-4,970.2	4,641	1,471	0.0
102.38	-12.55	-3,362.6	6,124	1,483	0.0
105.19	-19.58	-5,651.9	6,961	837	0.0
106.03	-29.78	-5,278.3	8,099	1,138	0.0
107.44	-38.38	-4,566.9	9,064	965	0.0
122.91	-39.69	-5,154.2	10,406	1,342	0.0
141.75	-39.69	-3,182.3	12,015	1,609	0.0

Figure: In this example, a series of waypoints has been generated in the Indian Ocean. The digitized waypoints are displayed beneath the map. Use the radio buttons on the right to draw the elevation profile along the digitized track segments.

The Waypoints and Survey Planner Portal operates in one of two modes: Waypoints mode or Survey Line mode. Choose the mode using the radio buttons in the right pane:

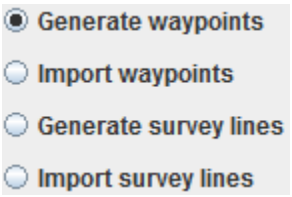


5.3.14.1) Waypoints mode

Interactive waypoints may either be (a) generated within the portal or (b) imported from a file.

5.3.14.1a) Generate Waypoints

To generate waypoints, click the *Generate Waypoints* button in the right pane.



Click the green Start Digitizing button 

and click on the map to generate waypoints. A square will be displayed at each waypoint. By default, a great circle track is drawn between pairs of waypoints. Switch between great circle and straight line segments in the right pane.

To stop digitizing either double-click the last point or click the red Stop Digitizing button.

The digitized points are displayed in the table beneath the map.

Longitude	Latitude	Elevation (m)	Cumulative distance (k...	Distance between point...	Duration (hrs)
153.56	30.99	-	0	0	0.0
-175.50	37.50	-	2,920	2,920	0.0
-144.00	26.05	-	6,138	3,218	0.0
-120.94	25.04	-	8,452	2,314	0.0

Use the Great Circle/Straight Line buttons to switch between great or small circle tracks between points.

As an option, enter a ship speed to calculate the travel time between points. This will fill in the Duration column in the table:

Longitude	Latitude	Elevation (m)	Cumulative distance (k...	Distance between point...	Duration (hrs)
153.56	30.99	-	0	0	0.0
-175.50	37.50	-	2,920	2,920	157.67
-144.00	26.05	-	6,138	3,218	331.43
-120.94	25.04	-	8,452	2,314	456.37

In the lower right, use the Draw Profile button to generate an interpolated elevation profile between the points from the GMRT global elevation synthesis.

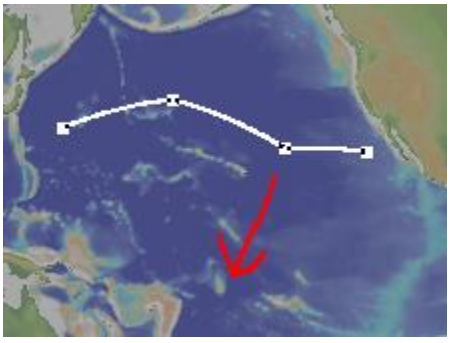
The elevation values are extracted from the GMRT elevation model by interpolating 100 intermediate points between each pair of digitized points so that a smooth profile is generated. The interpolated

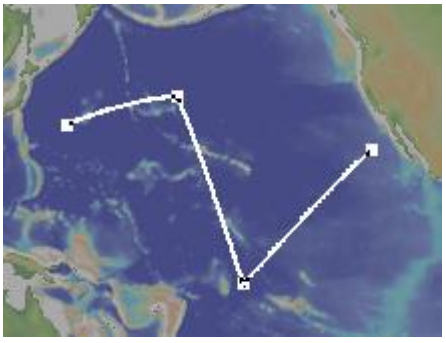
points are displayed when the ◉ Interpolated Points button is clicked. The profile can be saved as an image using the Save button in the lower right. Note that the Draw Profile option ◉ Draw Profile must be active in order to save the profile as an image.

Clicking the ◉ Digitized Points button shows that the Elevation column in the table has been filled in:

Longitude	Latitude	Elevation (m)	Cumulative distance (k...	Distance between point...	Duration (hrs)
153.56	30.99	-5,836.9	0	0	0.0
-175.50	37.50	-4,883.7	2,920	2,920	157.67
-144.00	26.05	-4,945.1	6,138	3,218	331.43
-120.94	25.04	-4,064.2	8,452	2,314	456.37

The digitized points are interactive - drag the points on the map or manually edit the Latitude or Longitude values in the table to move points (double-click the table cell to edit a value). In the example below, one of the points is dragged to the SSW. The table and profile are updated instantly to reflect the new positions.



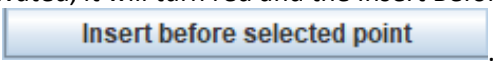


The ability to move the points either by dragging them on the map or manually editing the Lat/Lon values in the table allows the positions to be defined precisely.

Save the table or profile using the Save button in the lower right. Any interpolated points will also be written to the saved file when the save table option is chosen. Example:

```
#NOT TO BE USED FOR NAVIGATION PURPOSES
Longitude       Latitude        Elevation (m)   Cumulative dista
Digitized points
153.562 30.993  -5836.9 0       0       0.0
-175.500        37.496  -4883.7 2920    2920    157.67
-156.938        -10.626 -5160.6 8610    5690    464.9
-120.938        25.038  -4064.2 14173   5563    765.28
Interpolated points
153.562 30.993  -5836.9 0       0       0.0
153.848 31.095  -5839.7 29      29.494  1.57
154.134 31.197  -5772.8 59      29.494  3.19
```

There are two ways to continue adding waypoints to the ones that have already been generated. To add new points **to the end** of an existing digitized segment, click the Append to Segment button: Append to segment. Doing so will re-activate the digitizing function.

To add new points **within** an existing digitized segment, first activate one of the digitized points: Do this either by clicking on the point on the map or selecting a row from the table beneath the map. Once an existing point has been activated, it will turn red and the Insert Before Selected Point button is now available in the right pane: 

. Click that button and a message pops up to notify the user that the digitized points will temporarily disappear from the table whilst the new points are added. Click on the map to add new intermediate points. To finish adding new intermediate points, either double-click the point just added or click the red Stop Digitizing button.

To delete specific waypoints click on the point on the map or select a row from the table beneath the map and then click the Delete Points button in the lower right: 

Delete the entire set of waypoints with the Delete Segment button


5.3.14.1b) Import Waypoints

A file containing waypoints may be imported and manipulated – points moved, profiled, etc - just as if the waypoints had been generated in the portal as described above.

The imported file needs to be an ASCII file with either comma-, tab-, or pipe-separated columns and must contain at least a latitude column and a longitude column. Additional columns are allowed. The first row must be a header using the words "Lat", "Latitude", "Lon" or "Longitude" to define those latitude and longitude column labels. Any additional columns must also have a header label, too.

Each waypoint is defined by a longitude and latitude value in decimal degrees, one waypoint per row. Use negative values for south and west coordinate values.

Here is an example of a tab-separated file containing waypoints and some additional columns:

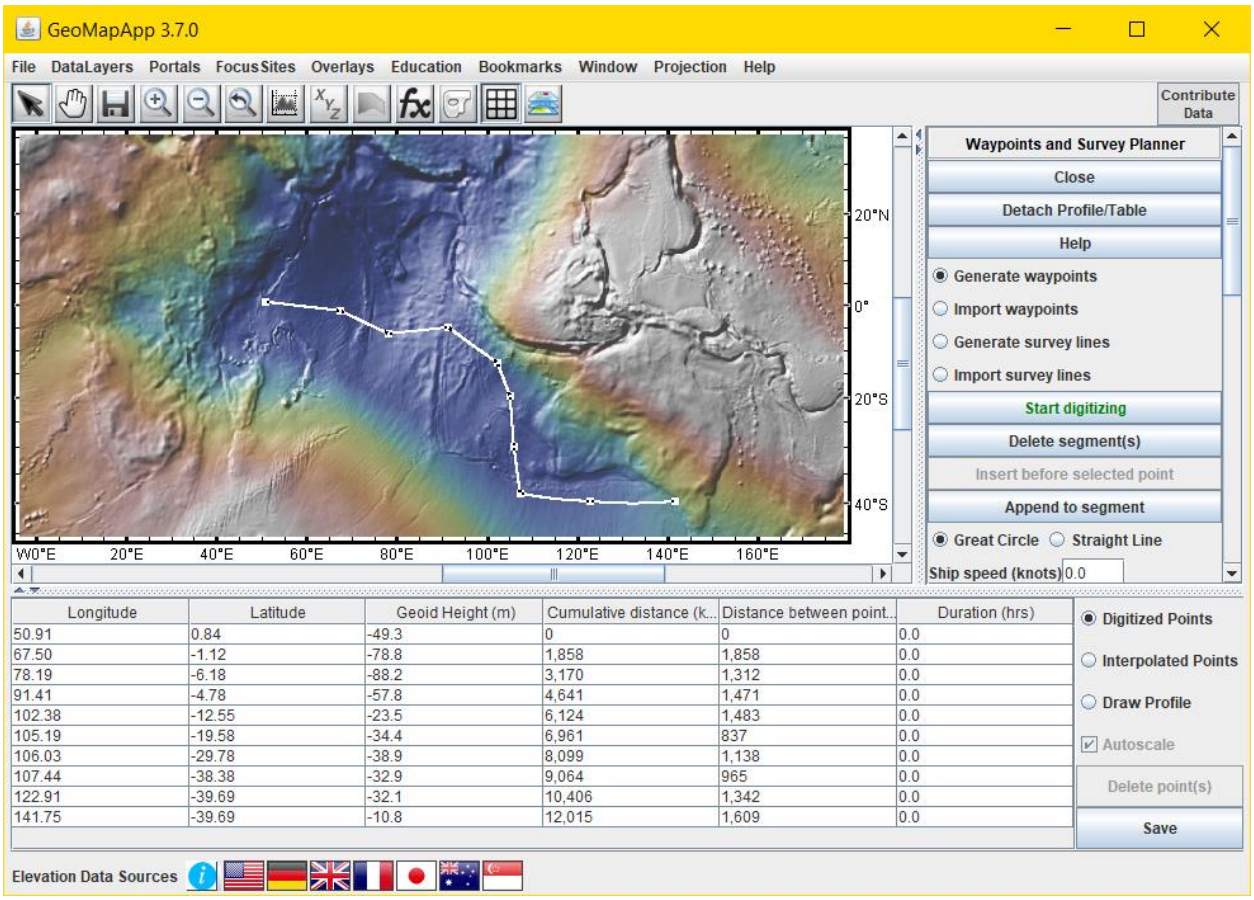
Time_stamp	Longitude	Latitude	Image_depth (m)
10/15/2011 20:00	-104.311683	9.93014657	2510.713
10/15/2011 22:27	-104.2917611	9.84009762	2514.083
10/16/2011 22:44	-104.2635537	9.80408058	2611.819
10/19/2011 03:16	-104.2126845	9.20128449	2587.876
10/19/2011 07:26	-104.285605	9.25432729	2566.997
10/19/2011 07:42	-104.3166719	9.23485241	2568.039

Imported waypoints are interactive - drag the points on the map or manually edit Lat/Lon values in the table by double-clicking the table cell. See also the information above.

5.3.14.1c) Sampling any grid using waypoints

By default, the digitizing function in the Waypoints and Survey Planner table will sample the GMRT global elevation model at the locations of the waypoints. But, if any other grid is loaded in the base map window, the digitized points will sample that grid instead. This functionality, in fact, applies to any loaded built-in grid or imported grid. This allows the GeoMapApp waypoints portal to provide a grid sampling capability that is similar to the 2-D grid sampling function offered by the GMT grdtrack program. In addition, the grid sampling works on both imported and generated waypoints.

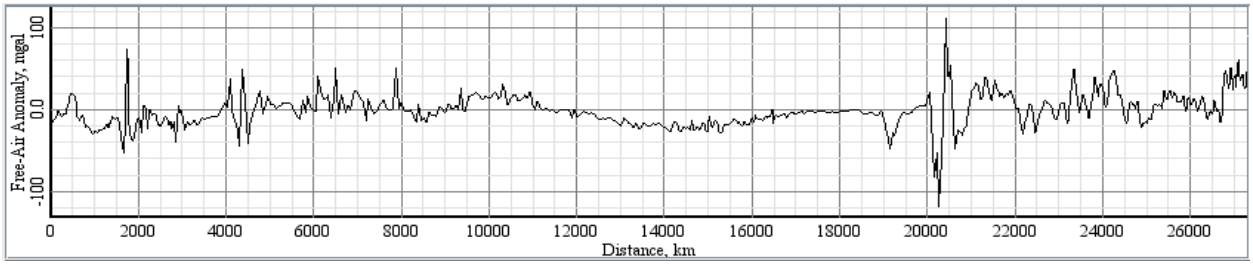
Example: In the screenshot below, the global Geoid Heights data from Sandwell and Smith (v9.2) has been loaded from the *DataLayers* menu. In the table beneath the map, the Elevation column that was previously displayed is now replaced with the geoid height values.



Longitude	Latitude	Geoid Height (m)	Cumulative distance (k...	Distance between point...	Duration (hrs)
50.91	0.84	-49.3	0	0	0.0
67.50	-1.12	-78.8	1,858	1,858	0.0
78.19	-6.18	-88.2	3,170	1,312	0.0
91.41	-4.78	-57.8	4,641	1,471	0.0
102.38	-12.55	-23.5	6,124	1,483	0.0
105.19	-19.58	-34.4	6,961	837	0.0
106.03	-29.78	-38.9	8,099	1,138	0.0
107.44	-38.38	-32.9	9,064	965	0.0
122.91	-39.69	-32.1	10,406	1,342	0.0
141.75	-39.69	-10.8	12,015	1,609	0.0

And, here's an example of both the table and the extracted profile for a set of waypoints that is used to sample and profile a gravity free-air anomaly (FAA) grid.

Longitude	Latitude	Free-Air Anomaly (mgal)	Cumulative distance (k...	Distance between point...	Duration (hrs)
153.56	30.99	-12.8	0	0	0.0
-175.50	37.50	-4.8	2,920	2,920	157.67
-156.94	-10.63	-3.0	8,610	5,690	464.9
-120.94	25.04	-18.8	14,173	5,563	765.28
-108.00	1.12	-6.8	17,173	3,000	927.27
-61.31	-6.18	-24.5	22,419	5,246	1210.53

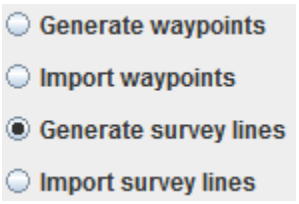


5.3.14.2) Survey Line mode

Interactive survey lines may either be (a) generated within the portal or (b) imported from a file.

5.3.14.2a) Generate Survey Lines

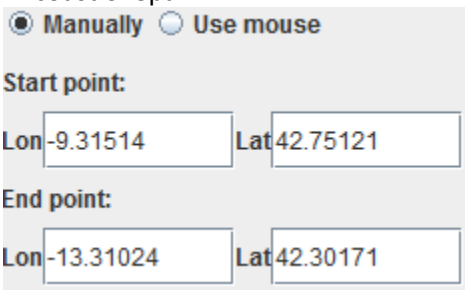
To generate survey lines, click the *Generate Survey Lines* button in the right pane.



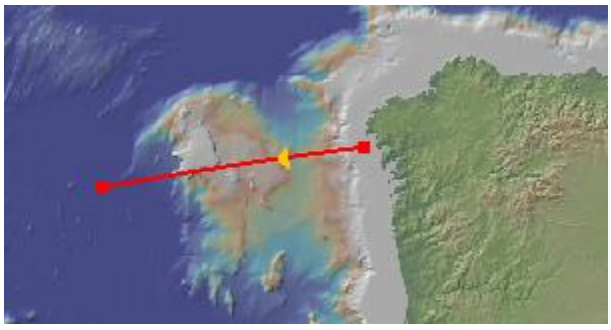
A survey line is specified in one of two ways: either manually by giving start/stop coordinates or by using the cursor/mouse to draw a line on the map.

Use start/stop coordinates Ensure that *Manually* has been selected. 

Then, type the start/stop coordinates in decimal degrees into the text boxes using negative values for south/west coordinates and hit Submit (you may have to scroll to see the Submit button). This example defines a track off the NW coast of Spain:



Once the Submit button has been clicked, a **red track line** is displayed on the map. A small yellow arrow on the track indicates the direction of travel from the start point to the stop point.



Use cursor to draw survey line Ensure that *Use Mouse* has been selected 

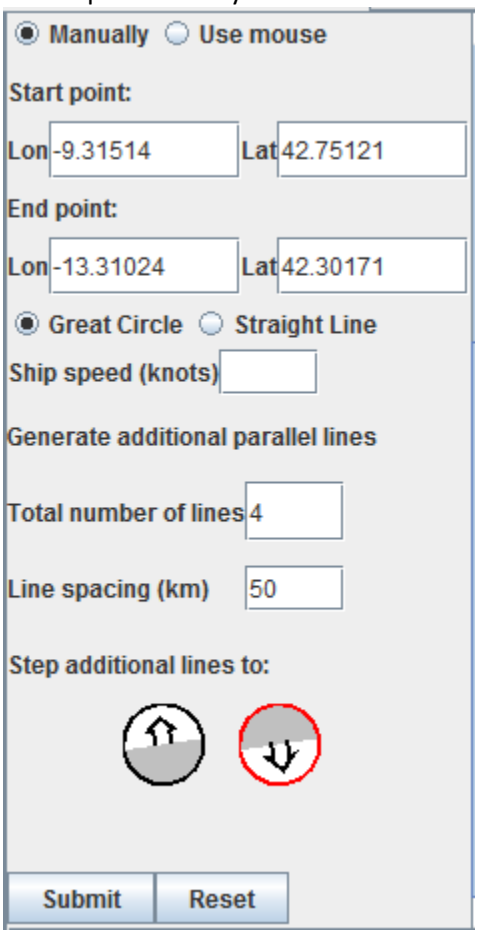
Then, click and drag on the map to draw a line and hit Submit (you may have to scroll to see the Submit button). The coordinates are automatically filled in and a **red track line** is displayed on the map. A small yellow arrow on the track indicates the direction of travel from the start point to the stop point.

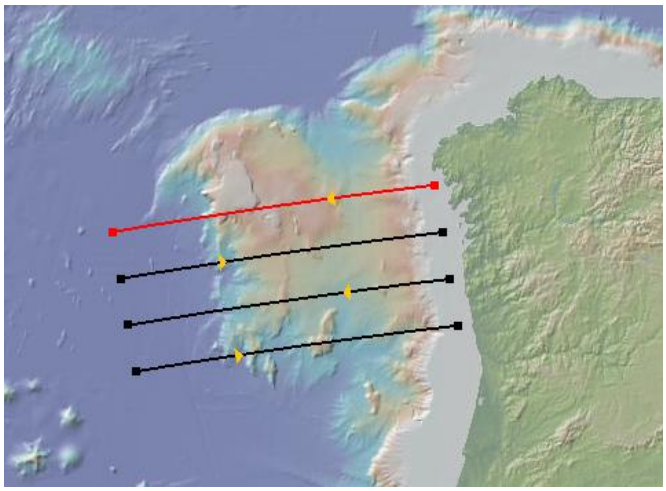
By default, the track between the two points is a great circle route. Use the Great Circle/Straight Line buttons to switch between great or small circle tracks between points.

The lines are interactive - drag the end points on the map to change their positions or manually edit the Lat/Lon values by double-clicking Lat/Lon cells in the table beneath the map.

Additional **parallel** survey lines may be generated automatically as follows. In the right pane boxes enter the total number of survey lines and their desired line spacing (km), and use the arrow buttons to define the perpendicular trend of the additional lines relative to the first line. Hit Submit. The first track line is shown in red.

In the following example, three additional lines (making a total of 4), each 50km apart, trending to the Southeast have been defined. When the Submit button is clicked, the additional lines will be drawn on the map and small yellow arrows on the tracks indicate the direction of travel.





The survey line coordinates are displayed in the table beneath the map:

Line Number	Start Longitude	Start Latitude	Start Elevation	End Longitude	End Latitude	End Elevation	Km Cumulativ...	Duration (hrs)
1	-9.315	42.751	0.0	-13.310	42.302	0.0	331	0.0
2	-13.205	41.859	0.0	-9.209	42.308	0.0	664	0.0
3	-9.105	41.865	0.0	-13.101	41.416	0.0	1000	0.0
4	-12.999	40.973	0.0	-9.002	41.422	0.0	1338	0.0

Enter a ship speed (e.g. 10 knots) to calculate distances and duration. Ship speed (knots) 10

Line Number	Start Longitude	Start Latitude	Start Elevation	End Longitude	End Latitude	End Elevation	Km Cumulativ...	Duration (hrs)
1	-9.315	42.751	0.0	-13.310	42.302	0.0	331	17.88
2	-13.205	41.859	0.0	-9.209	42.308	0.0	664	35.89
3	-9.105	41.865	0.0	-13.101	41.416	0.0	1000	54.02
4	-12.999	40.973	0.0	-9.002	41.422	0.0	1338	72.28

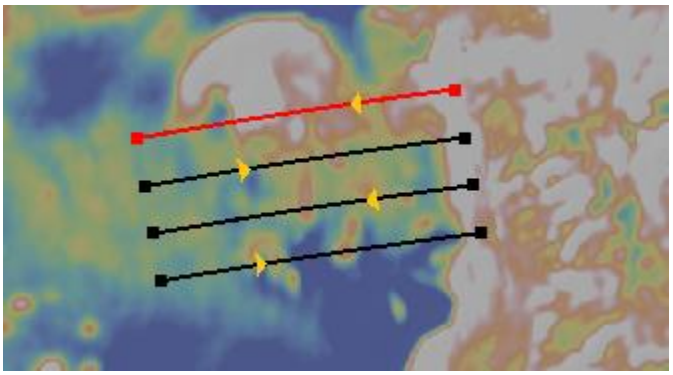
To fill in the start/end elevations, it is necessary to load the underlying GMRT global elevation model.

For that, click the grid load shortcut in the toolbar: 

Once the GMRT base map grid has loaded, the start/end elevation values are displayed in the table beneath the map:

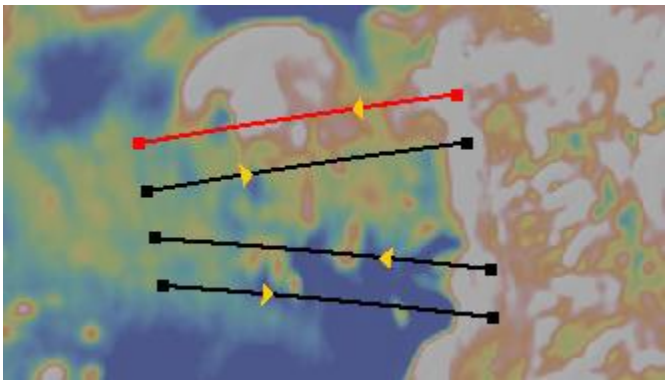
Line Number	Start Longitude	Start Latitude	Start Elevation	End Longitude	End Latitude	End Elevation	Km Cumulativ...	Duration (hrs)
1	-9.315	42.751	-119.0	-13.310	42.302	-5331.0	331	17.88
2	-13.205	41.859	-5354.0	-9.209	42.308	-150.0	664	35.89
3	-9.105	41.865	-118.0	-13.101	41.416	-5385.0	1000	54.02
4	-12.999	40.973	-5347.0	-9.002	41.422	-82.0	1338	72.28

If any other grid is loaded, the values in the elevation columns will instead be filled with the Z values from that loaded grid. In the example below, a gravity free-air anomaly grid has been loaded (DataLayers > Geophysics > Gravity Anomalies and Geoid Heights). The gravity grid is displayed in the map and the free-air anomaly values are listed in the table, like this (note, though, that the column header labels in the table are still called Elevation):



Line Number	Start Longitude	Start Latitude	Start Elevation	End Longitude	End Latitude	End Elevation	Km Cumulativ...	Duration (hrs)
1	-9.315	42.751	54.0	-13.310	42.302	-9.0	331	17.88
2	-13.205	41.859	-4.0	-9.209	42.308	76.0	664	35.89
3	-9.105	41.865	56.0	-13.101	41.416	-3.0	1000	54.02
4	-12.999	40.973	-9.0	-9.002	41.422	35.0	1338	72.28

As with the waypoints, the lines on the map may be edited either by dragging the start/end points on the map or by double-clicking a lat/lon cell in the table and manually changing the values. The changes are instantly reflected in the map display and in the table values beneath the map. In the example below, the two southerly lines have been moved:



Use the Add Row to Table button or Delete Row(s) button in the lower right to add or delete rows. When adding rows, additional survey lines in any orientation may be generated by manually adding a row to the table: After clicking the Add Row to Table button in the lower right, double-click the Lat/Lon cells to enter the coordinates, then hit enter.

Save the table as a comma-separated ASCII file using the Save button.

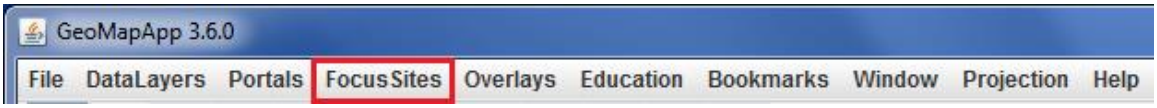
5.3.14.2b) Import Survey Lines

Import a comma-, tab-, or pipe-separated ASCII file with "StartLat", "StartLon", "EndLat", "EndLon" column headers. The survey lines will be drawn on the map and line numbers and cumulative distances will be calculated automatically in the table beneath the map. To calculate survey line duration, enter a ship speed in the Ship Speed box and hit Submit.

5.3.14.2c) Sampling any grid using survey lines

By default, when the GMRT global elevation model is loaded, the elevation values at the start/end of the survey lines are sampled and displayed in the table beneath the map. This functionality, in fact, applies to any loaded built-in or imported grid. An example using geoid heights and using gravity free-air anomaly data is given earlier in this section.

5.4) Focus Sites



This menu provides quick links to data and information for the GeoPRISMS, MARGINS and Ridge 2000 focus sites, as well as to other geographical study areas.

Examples of available data and information include: high-resolution multibeam bathymetry grids, seismic interpretations, grids of magnetization; field station and instrument locations, geochemistry data and EarthChem tables, and vehicle dive photos. When viewing dive photos under the Focus Site menu, refer to the Seafloor Photographic Transects section.

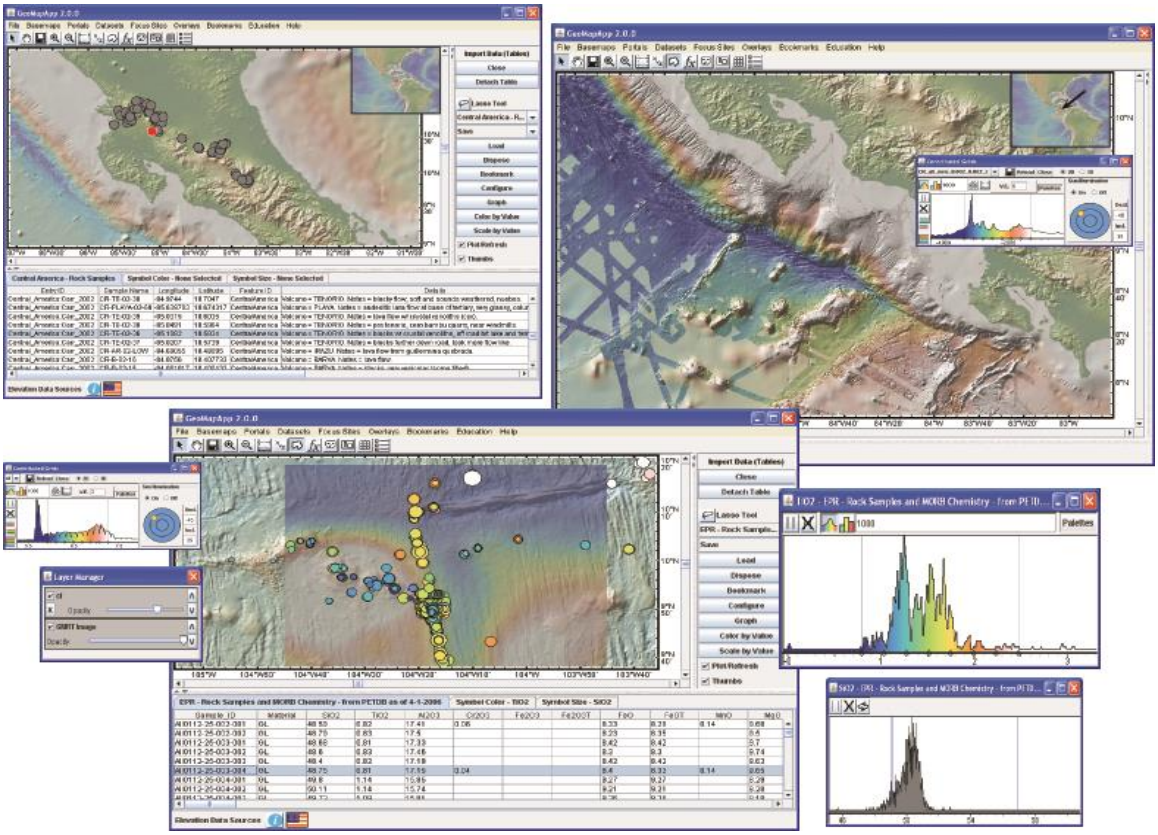


Figure: Examples of focus site data sets available directly from the Focus Sites menu. (Upper left: Central America rock samples giving collection information and field descriptions. (Upper right: Weinrebe's 2008 multibeam bathymetry compilation grid covering the Costa Rican margin, with sun illumination from the NW. (Bottom: At the Ridge 2000 EPR 9N study site, the seismic layer thickness grid of Canales et al. (2003) is made semi-transparent and overlain on the underlying multibeam bathymetry. PetDB rock sample analyses are colored by TiO_2 value and scaled by silica content.

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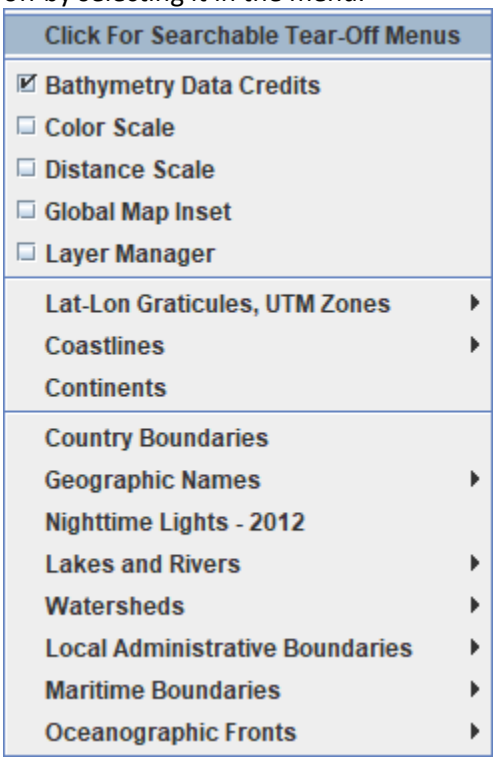
5.5) Overlays

Look in the Overlays menu to plot distance/color scale bars, coastlines, lakes, rivers and geographical boundaries, latitude/longitude grid lines, UTM zones, and inset map controls. Toggle a feature on and off by selecting it in the menu.



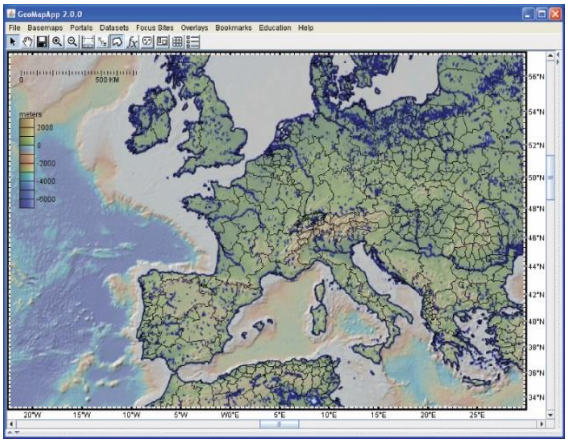


Figure: Overlain on this view of Europe are major lakes and rivers, coastlines, province boundaries, a color scale bar and a distance scale. The inset map and bathymetry credits have been turned off. The

distance scale is latitude-dependent and automatically changes when the cursor is used to move the scale to a different position.

Some Overlay menu selections under Country Boundaries and Local Administrative Boundaries are controlled by a Shapefile Manager window which allows added functionality. If the Shapefile Manager does not automatically appear, click the Shapefile Manager icon  in the tool bar.

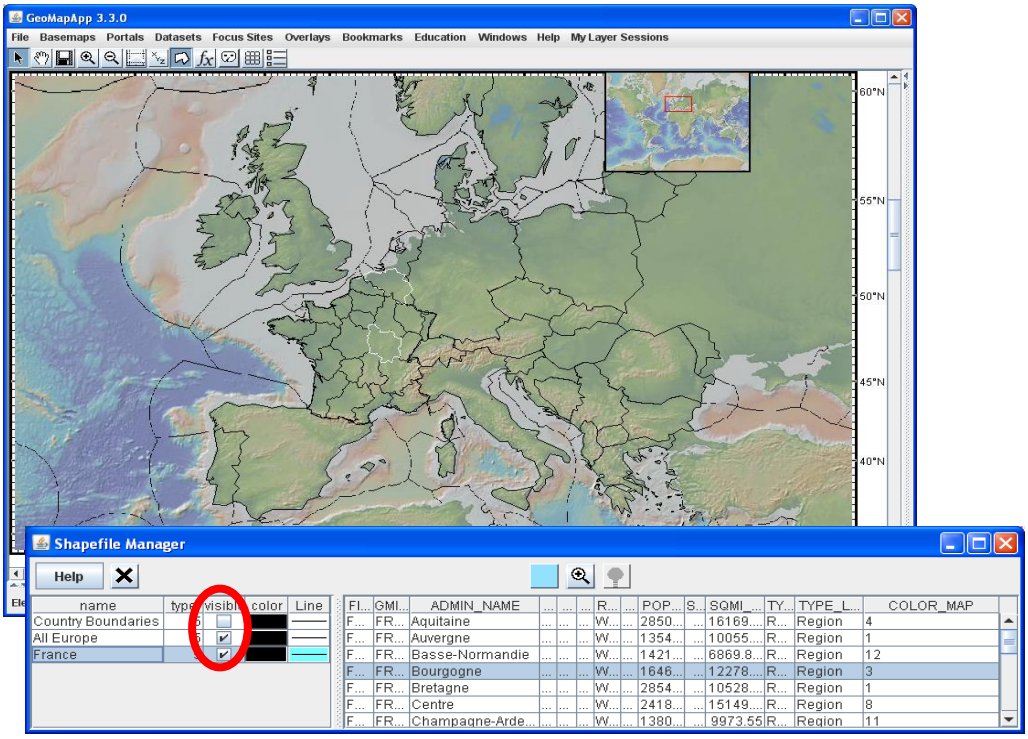
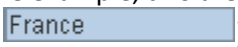
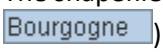


Figure: Using the Shapefile Manager window, the province of Bourgogne and the country of Belgium have been highlighted. The 200 n. mile EEZ limits are also shown.

In the above image, three boundary data sets have been loaded. They are listed in the left pane. The 

box turns the layer on and off. In the example, two are displayed. The shape file that is currently active is highlighted in blue (here, 

).

The shapefile components are listed in the right pane. Click one of these components (here, 

) to illuminate that feature on the map.

The Layer Manager tool (rightmost icon,  , in tool bar) contains a tick box that turns the layer on and off (

), discards the layer (

), and allows the layer transparency to be altered via the slider bar  .

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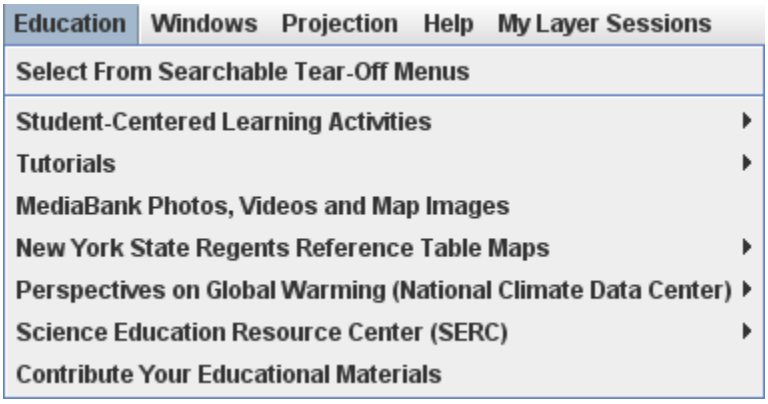
5.6) Education

This menu provides links to various education web resources related to GeoMapApp:



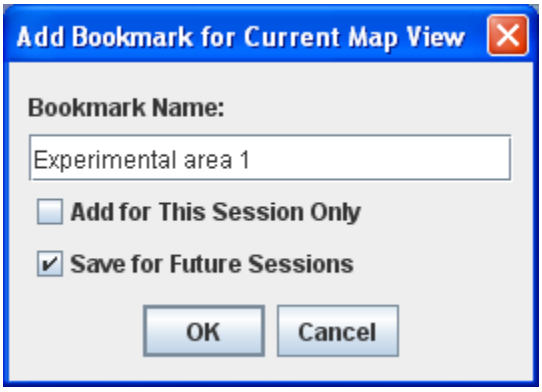
For example, under **Student-Centered Learning Activities** are listed classroom-ready, freely-available, teacher-tested learning modules centred around GeoMapApp, including MARGINS mini-lessons. These education modules range in scope from middle school concepts to graduate student level.

5.7) Bookmarks

The Bookmarks function allows users to specify the boundaries of predetermined geographical regions. Bookmarked places can be opened in future GeoMapApp sessions. If you wish to share the boundaries – for example so that every student in your class can open GeoMapApp at exactly the same view – use the Save Session function.

5.7.1) Create a bookmark for the displayed map region

Use **Add Bookmark for Current Map View** to create a bookmark the map region currently on display. The name for the bookmark is typed in the text box.

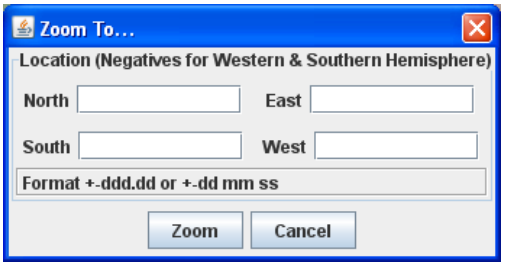


By default the bookmark will be temporary. Select **Save for Future Sessions** to make the bookmark available for future GeoMapApp sessions.

Bookmarked places are accessed in two ways. Click on **Browse/Organize Bookmarks** to bring up a navigation window listing the bookmarks. When a bookmark is selected, the map automatically zooms to that geographical region. The second way is to click on the **Show Bookmarked Places** menu item. All bookmarked places are shown as rectangles on the map. Click in one of the rectangles to automatically zoom to that area.

5.7.2) Zoom to a specific geographical region

When Zoom to a Specific Region... is selected, the N, E, S, W boundaries are specified in the window that pops up. Note that the format is either decimal degrees or degrees minutes seconds. In either format, use negative for south or west values. For areas straddling the International Date Line, use longitude values in the 0-360 degree range.



When the map has zoomed to the new place, note that the map area on display may not correspond exactly to the specified boundaries – the map is fitted into the aspect ratio of the GeoMapApp window.

The new area on display can be bookmarked using the steps given above. Many bookmarks can be added to the GeoMapApp menu by repeating these steps.

To delete a bookmark, use the Browse/Organize Bookmarks menu, select the bookrmark for deletion, and hit Delete Bookmark(s).

For those interested, bookmarks are stored in a text file called *My Saved Places.loc* in a folder called *places* which is stored in the hidden *.GMA* folder.

5.7.3) Zoom to the world map

Return to the world map view using the menu item called Zoom to Global Scale .

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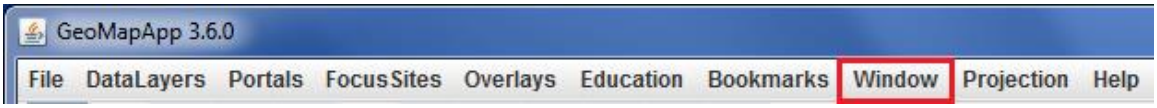
5.8) Window



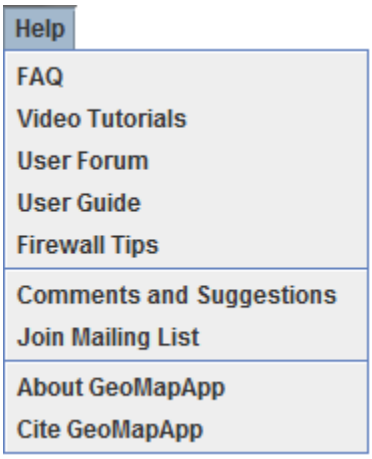
The **Window** menu lists all GeoMapApp function windows that are currently open and offers a quick way to bring them to the front. When one of the windows is selected from the list, it is automatically brought forwards.

5.9) Projection

Three map projections are currently offered in GeoMapApp: Mercator, south polar, north polar. The **Projection** menu offers a one-click way to switch from the current displayed projection to another without needing to close and re-open the program.

5.10) Help

Provides links to various help documents, video tutorials on YouTube, an FAQ page, a user forum, and this User Guide. There's also a link for comments and feedback, and to sign up for the GeoMapApp announcements e-mail list.



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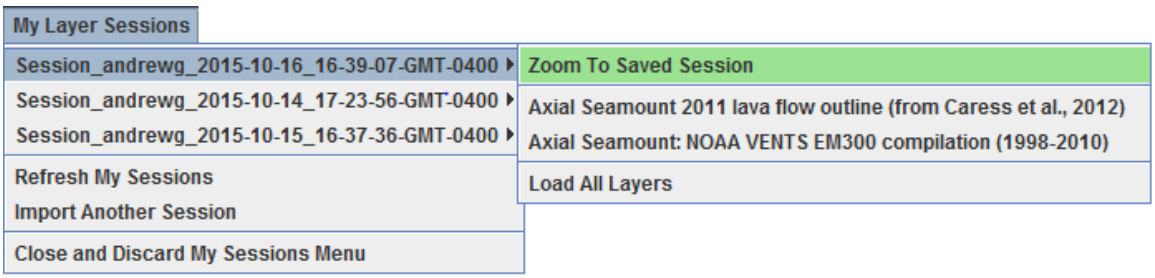
5.11) My Layer Sessions

This menu exists only when the **Sessions Manager** is active. It provides access to the imported saved sessions. Use **Import Another Layered Session** to import additional sessions. The **Refresh My Sessions** button refreshes the list of locally-saved sessions. Here's an example of the *My Layer Sessions* menu:

In this example, three saved sessions have been imported. Moving the cursor over a saved session reveals its component layers. To help keep track of saved layers, each saved layer is associated with a color. In the following example, the session and its saved data sets are tagged with a green color.



The **Close and Discard the Sessions Menu** item removes the **My Layer Sessions** menu from the top of the GeoMapApp window.

For more information on saving a session, see also the Sessions Manager section and the How to Save a Session section.

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6) Guide to the Toolbar

See video tutorial on YouTube

6.1) Arrow Cursor 

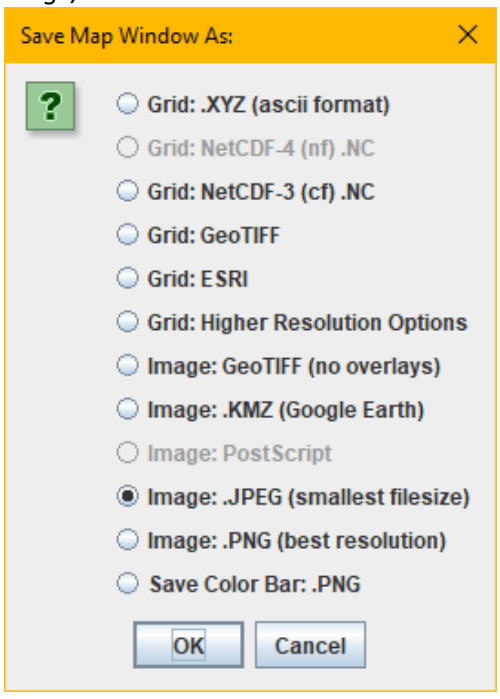
Use the arrow cursor to select items on the map or items from loaded data tables.

6.2) Pan 

When selected, click on the map and drag. This pan function offers an alternative to scrolling the map.

6.3) Save 

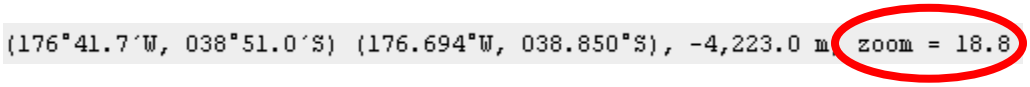
The map window image may be saved in a number of image formats. When a grid has been loaded, additional options for saving the grid are presented. If the GMRT bathymetry/elevation synthesis base map grid is loaded, the menu item called Grid: Higher Resolution Options allows higher-resolution versions of the GMRT grid to be downloaded. The color scale bar for the base map or loaded grid may be saved using this Save function. This toolbar icon is equivalent to clicking *File > Save Map Window as Image/Grid File*.



6.4) Zoom 

When zooming in  either click on the map or click-and-drag the cursor to define a rectangle on the map. When zooming out, click once the map for each zoom out operation.

Note: when the cursor is in the map window, the 'zoom factor' is shown at the end of the tool bar display values.



For many base maps and grids in GeoMapApp, the maximum native resolution is achieved at a zoom factor of 512. That was chosen to be equivalent to a pixel size of about 100m which is a typical value for the cell size for gridded multibeam swath bathymetry data. Going beyond that value merely stretches the image making the pixels bigger.

However, a number of built-in grids and images have higher native resolutions and so can withstand further zooming. For example, in the continental United States, land elevations in the base map are derived from the 10m USGS NED data set and zoom factors of around 4,000 can be used to see stunning detail in the topography.

Additionally, some grids derived from scanning sonar devices attached to dive vehicles have resolutions on the order of a few meters or better. In those cases, the zoom factor can be very large (around 12,000) before pixilation becomes noticeable.

6.5) Undo Zoom 

The 4 most recent zoom actions are stored in GeoMapApp. Click  up to 4 times to undo each zoom action in sequence.

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6.6) Profile/Distance tool

Generate profiles across grids and find the distance between points using this function.

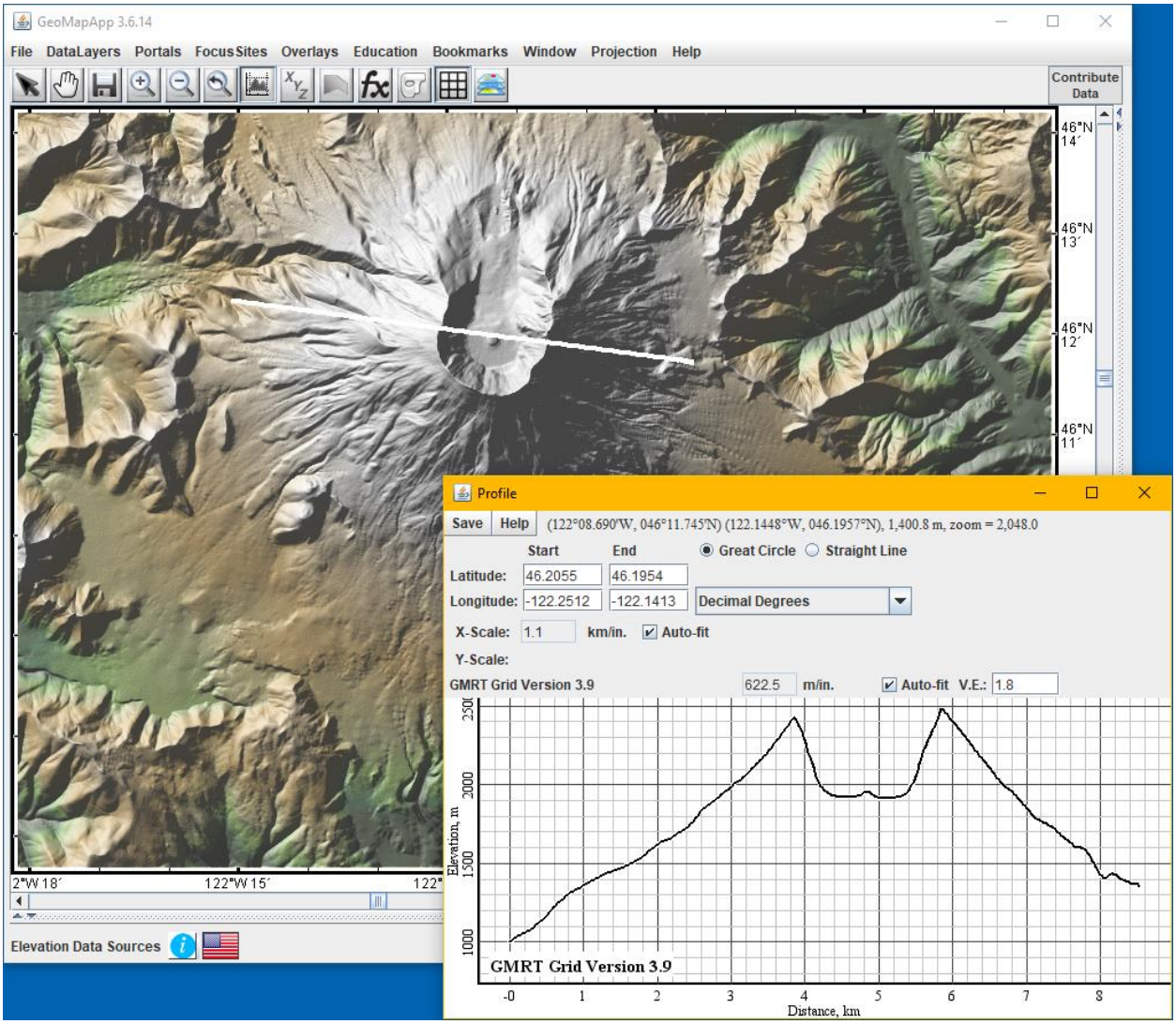
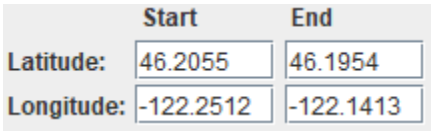


Figure: Topographic profile across Mt St. Helens. As the cursor is moved in the profile window, the cursor location is displayed on the profile track as a small red. Save options for the profile are listed under the Save menu.

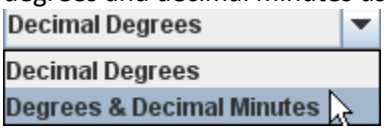
6.6.1) Basic profile tool functionality

Selecting the profile tool from the toolbar automatically loads the underlying GMRT global digital elevation base map comprising ocean depths and land topography. The profile line is defined by two points. Click once in the map window to specify the start point. Keep the cursor depressed and drag the cursor to the desired end point. Release the cursor to draw the profile line. A profile window immediately opens.

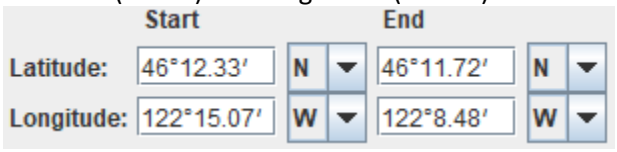
Alternatively, start and end points can be specified in the profile tool window using the start and end field:



The default format of the start and end coordinates is decimal degrees but that can be changed to degrees and decimal minutes using the format drop-down menu:



When in degrees and decimal minutes format, the hemispheres (N,S,E,W) for the start and end point latitudes (N or S) and longitudes (E or W) must be defined as shown here:



Geographic position (in formats of degrees-decimal minutes and decimal degrees) and elevation are listed at the top of the profile window, along with the zoom factor.

To change the axes scaling, untick the Auto-fit box, and type a scale into the window. Hit enter for the scaling to take effect. In the following example, auto-fitting on the y-axis has been disabled and a manually-defined y-axis scale of 4000m/inch is specified.

By default, the profile is taken along a great circle line. Choose between great circle and straight line by selecting the radio button: 

6.6.2) Generate profiles across other grids

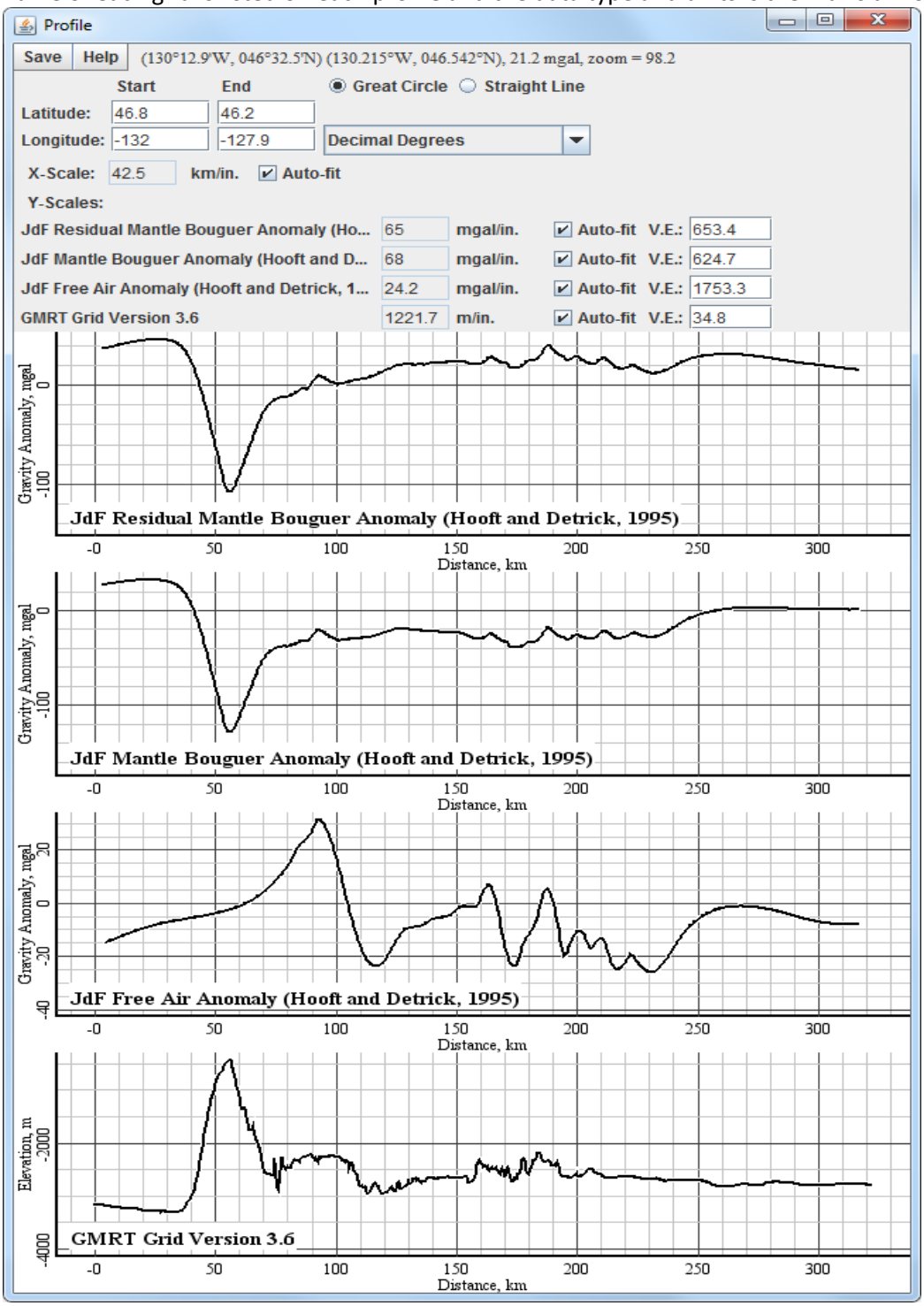
The default setting for the profile tool is to generate a profile across the GMRT digital elevation base map. Profiles can be taken across *any* other built-in or imported grid regardless of what type of data is represented by the grid. See such an example here.

6.6.3) Generate profiles through multiple grids

The default setting for the profile tool is to generate a profile across the GMRT digital elevation base map. A vertical stack of co-located profiles can be generated when multiple grids are loaded. Up to four loaded grids can be profiled as a stack in this way, and the grids can be built-in grids, imported grids, or a

mixture. To exclude specific grids from being displayed in the stack, untick the Plot Profile tick box ☐ plot profile in the Layer Manager window.

In the following screenshot for the Juan de Fuca region, four grids have been loaded – the underlying GMRT global elevation model for seafloor bathymetry, and three gravity anomaly-related grids. The name of each grid is listed on each profile and the data type and units is the Y-axis annotation.



6.6.4) Vertical Exaggeration

The profile is automatically exaggerated to fill the profile window. Defined as the x-axis scale divided by the y-axis scale, the vertical exaggeration (VE) is changed in one of three ways:

- Type a new VE value into the text box and hit enter: Vertical Exaggeration: 1.8
- Untick the y-axis scale auto-fit box Auto-fit , enter a new scale in the box Y-Scale: 609.1 m/in. and hit enter.
- Untick the x-axis scale auto-fit box Auto-fit , enter a new scale in the box X-Scale: 1.1 km/in. and hit enter.

6.6.5) Distance tool

When the Profile Tool is active, click the cursor and drag it around the map. The distance from the original location to the cursor's current location is instantaneously displayed in the upper bar of the main map window (to the right of the zoom factor):

(074°41.2′E, 008°58.0′N) (074.687°E, 008.966°N), -2,724.0 m, zoom = 33.4, distance = 418.45 km

When the cursor is released, the end point of the profile line is defined and the profile window pops up.

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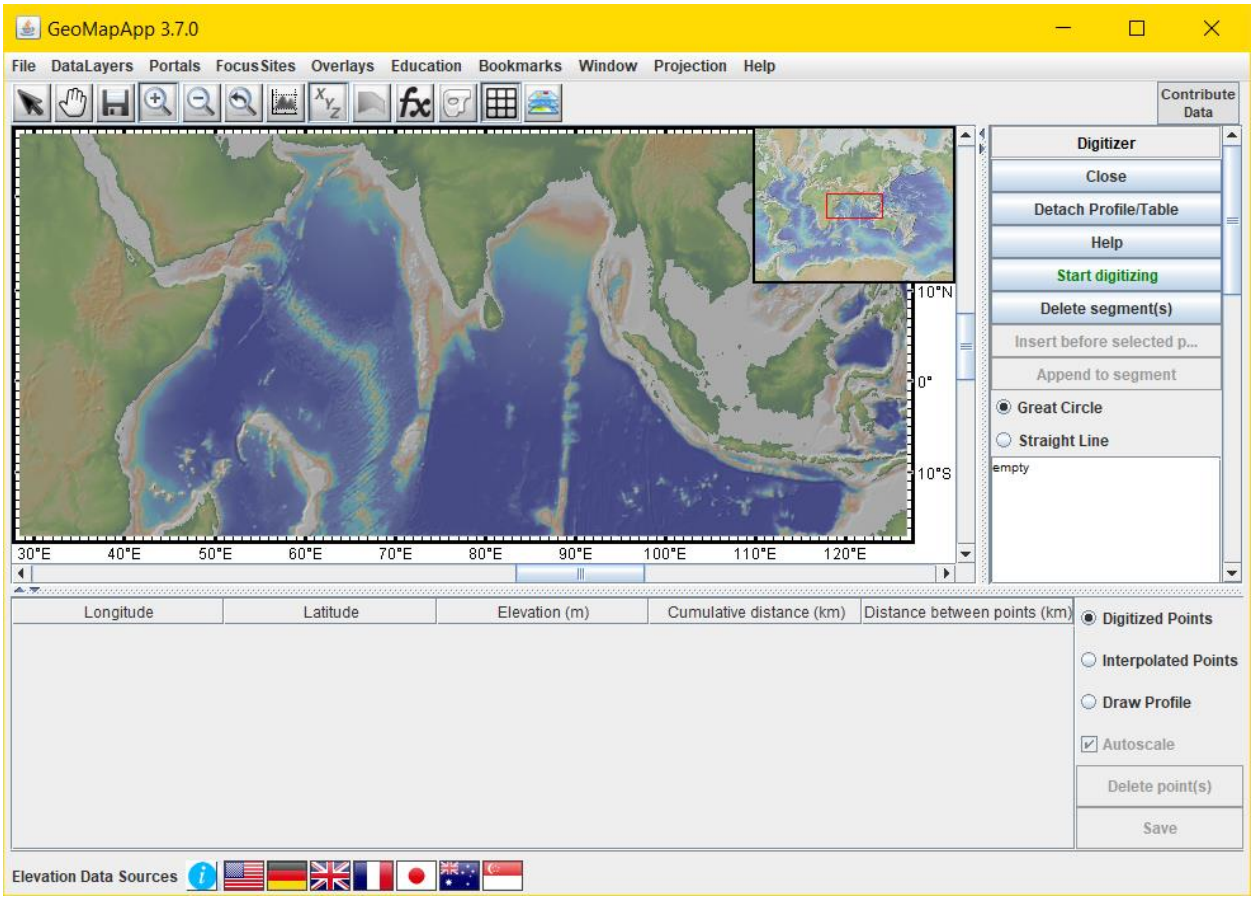
6.7) Digitizer 

The digitizing function allows any loaded grid to be digitized. Digitized points may be moved around on the map dynamically and a profile may be generated. The points and profile can be saved.

If a grid has not yet been loaded when the digitizer button is  clicked, the default underlying GMRT base map grid is loaded. If, however, a grid has already been loaded, that grid will be digitized instead.

See video tutorial on YouTube

When the digitizer tool is activated two things happen: Various panels appear in the GeoMapApp window, and the base map GMRT grid is loaded (unless another grid is already loaded).

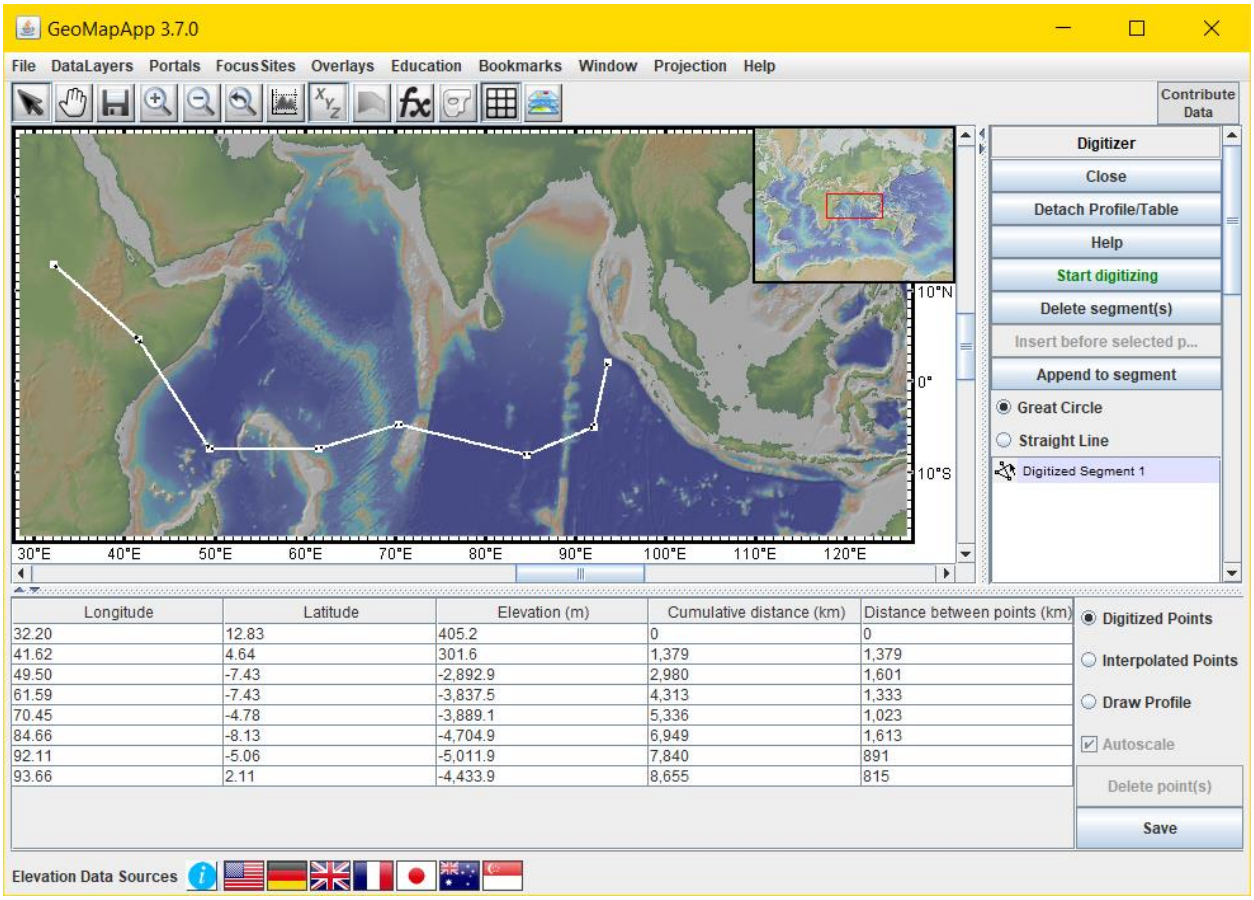


To begin digitizing, click on the 

button. The cursor becomes a cross-hairs (+). Click points on the map. To finish digitizing, either double-click the last point or click the Red Stop digitizing button 

.

The line segments on the map turn white, with small squares at each digitized point. The digitized points are listed in the table beneath the map, along with the sampled grid values and distance columns.



Longitude	Latitude	Elevation (m)	Cumulative distance (km)	Distance between points (km)
32.20	12.83	405.2	0	0
41.62	4.64	301.6	1,379	1,379
49.50	-7.43	-2,892.9	2,980	1,601
61.59	-7.43	-3,837.5	4,313	1,333
70.45	-4.78	-3,889.1	5,336	1,023
84.66	-8.13	-4,704.9	6,949	1,613
92.11	-5.06	-5,011.9	7,840	891
93.66	2.11	-4,433.9	8,655	815

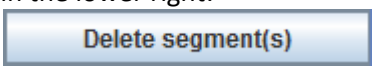
Figure: By default, the GMRT base map grid is loaded and digitized. If any other grid is loaded, its Z values will be displayed in the middle column.

There are two ways to continue adding points to the ones that have already been generated, as follows.

To add new points **to the end** of an existing digitized segment, click the Append to Segment button: Append to segment. Doing so will re-activate the digitizing function.

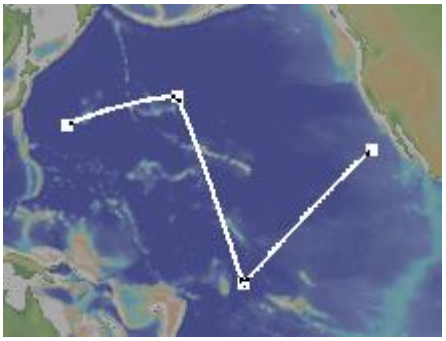
To add new points **within** an existing digitized segment, first activate one of the digitized points: Do this either by clicking on the point on the map or selecting a row from the table beneath the map. Once an existing point has been activated, it will turn red and the Insert Before Selected Point button is now available in the right pane: Insert before selected point. Click that button and a message pops up to notify the user that the digitized points will temporarily disappear from the table whilst the new points are added. Click on the map to add new intermediate points. To finish adding new intermediate points, either double-click the point just added or click the red Stop Digitizing button.

To delete specific points click on the point on the map or select a row from the table beneath the map and then click the Delete Points button in the lower right: 

Delete an entire digitized segment with 

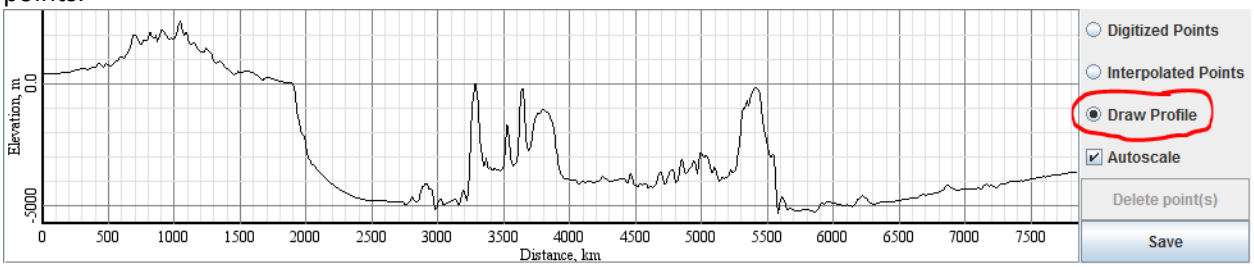
Save the digitized table with 

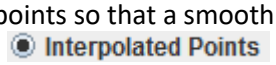
The digitized points are interactive - drag the points on the map or manually edit the Lat/Lon values in the table to move points (double-click the table cell to edit a value). In the example below, one of the points is dragged to the SSW. The table and profile are updated instantly to reflect the new positions.



The ability to move the points either by dragging them on the map or manually editing the Lat/Lon values in the table allows the positions to be defined precisely.

In the lower right, use the Draw Profile button to generate an interpolated profile between the digitized points.



The elevation values are extracted from the loaded grid by interpolating 100 intermediate points between each pair of digitized points so that a smooth profile is generated. The interpolated points are displayed in the table when the 

button is clicked. The profile can be saved as an image using the Save button in the lower right. Note that the Draw Profile option 

must be active in order to save the profile as an image.

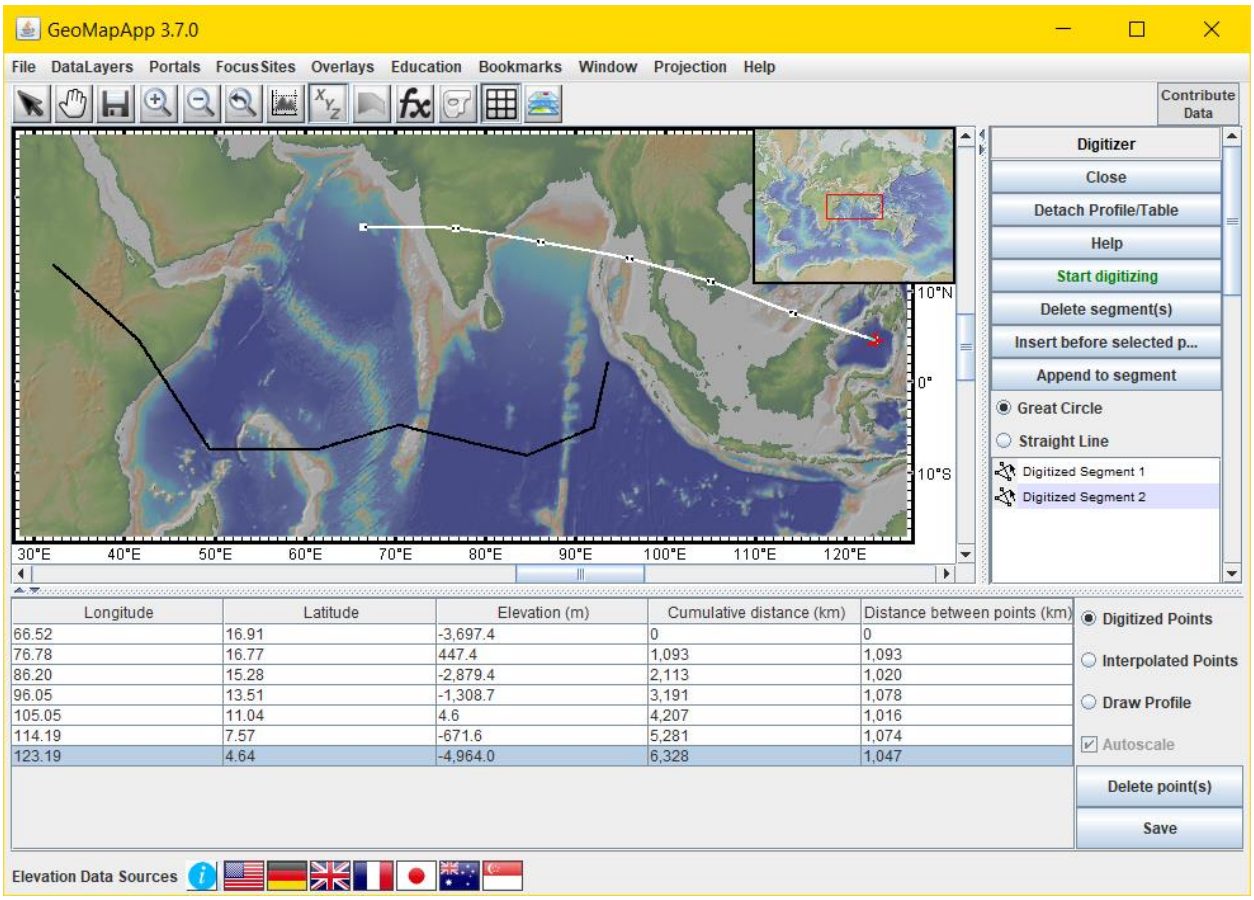
Moving any of the points on the map will instantly change the profile.

Save the table or profile using the Save button in the lower right. Any interpolated points will also be written to the saved file when the save table option is chosen. Example:

```
#NOT TO BE USED FOR NAVIGATION PURPOSES
Longitude       Latitude        Elevation (m)   Cu
Digitized points
32.203  13.514  393.0   0       0
41.484  3.513   418.1   1508    1508
48.797  -5.476  -4652.8 2796    1288
57.938  -6.315  -1174.1 3812    1015
66.516  -5.756  -3580.7 4762    951
75.938  -5.616  -5218.3 5805    1043
83.109  0.703   -4212.6 6867    1062
86.766  8.824   -3636.3 7856    990
Interpolated points
32.203  13.514  393.0   0       0
32.300  13.414  391.6   15      15.237
32.396  13.314  390.2   30      15.237
32.493  13.214  388.4   46      15.237
```

To digitize a new segment, click on the 

button again. The previous segments turn black. The new segment is white. The digitized segments are listed in the panel on the right. Switch between the digitized segments by clicking the relevant segment name.



Digitizing any loaded grid

By default, the Digitizer function extracts values from the GMRT base map digital elevation model. It can also be used to extract values from any grid that is loaded – whether the grid is one of the many built-in grids or is an imported grid.

To digitize a grid, load it so that it is displayed in the map window, then begin digitizing.

The example below shows the table beneath the map when a magnetic anomaly grid is loaded and digitized. Note that the magnetic anomaly value is listed in the middle column:

Longitude	Latitude	Magnetic Anomaly (nT)	Cumulative distance (km)	Distance between points (km)
37.97	17.98	12.6	0	0
42.75	11.73	-46.4	864	864
53.44	9.38	25.1	2,061	1,197
59.77	9.80	-8.4	2,756	695
61.59	3.37	25.6	3,499	742
69.47	2.11	-23.9	4,384	886
78.19	2.39	8.6	5,354	969

All digitized points are lost when GeoMapApp is closed. Save them with 

if they are needed for future use.

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6.8) Shapefile Manager

When a shapefile is loaded, the shapefile manager can be used to toggle the shapefile on and off, and, for multi-shape shapefiles, to select individual shapefile components.

In the image example, below, two multi-shape shapefiles are loaded. Select one by clicking its name in the left pane, then select in the right pane which individual shapefile component to view.

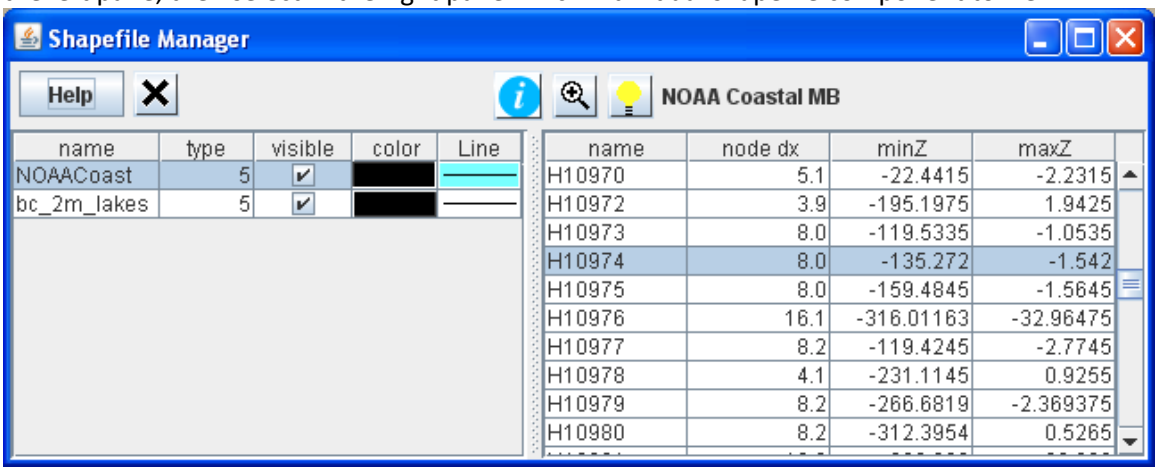
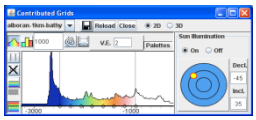
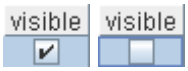


Figure: The multi-shape NOAA coastal grids shapefile is selected. Clicking the light bulb loads the grid for shapefile H10974. The multi-shape lakes shapefile, bc_2m_lakes, is also loaded. Click in the left pane to display its component shapefiles. Other examples of multi-shape shapefiles include built-in geographical boundaries data sets.

For grid shapefiles, click the light bulb to open the grid dialog  and click the zoom button to zoom on the area covered by the shapefile. The information button provides additional on-line information on the data set. The shapefile can be toggled on and off using the visibility buttons 

. Discard the shapefile using .

6.9) Focus

In rare instances when the map view does not come into focus after zooming, click the focus button to refresh the image.

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6.10) Mask function

See video tutorial on YouTube

GeoMapApp's GMRT base map includes higher-resolution bathymetry and land elevation data from a number of sources including a large number of multibeam swath bathymetry data sets and regional grids, 10m USGS NED land elevations, coastal grids, and under-ice data. Clicking the mask function applies a transparent mask to reveal the location of this higher-resolution data. Semi-opaque grey areas indicate no higher-resolution data was used in the GMRT tiles. Click the mask function button again to discard the mask.

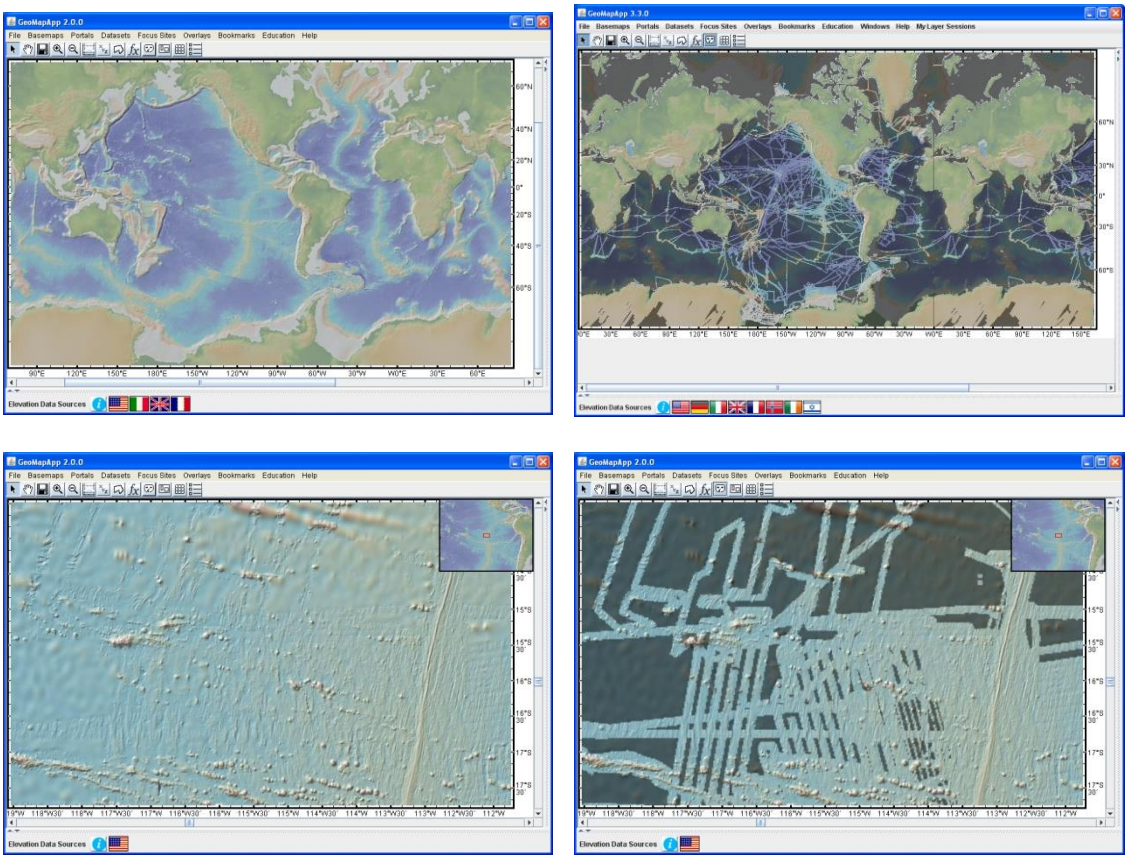

Figure: (Top row) The GMRT base map (left) and the location of higher resolution data used in its creation (right). (Bottom row) When zooming, some areas look 'fuzzy' or lacking in detail (left, an example on the East Pacific Rise). The mask function (right) reveals areas of multibeam data (transparent mask); the grey areas were not refined using multibeam data.

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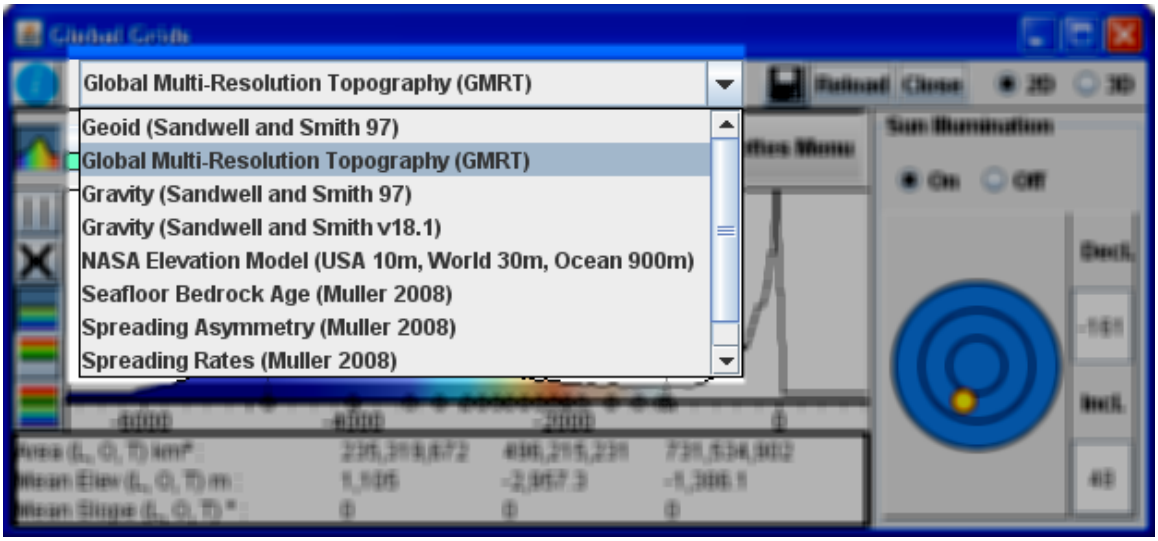
6.11) Loaded Grids window

This shortcut loads the GMRT base map grid. When a grid is loaded, the *Loaded Grids* window allows other global grids to be quickly selected from the drop-down menu.



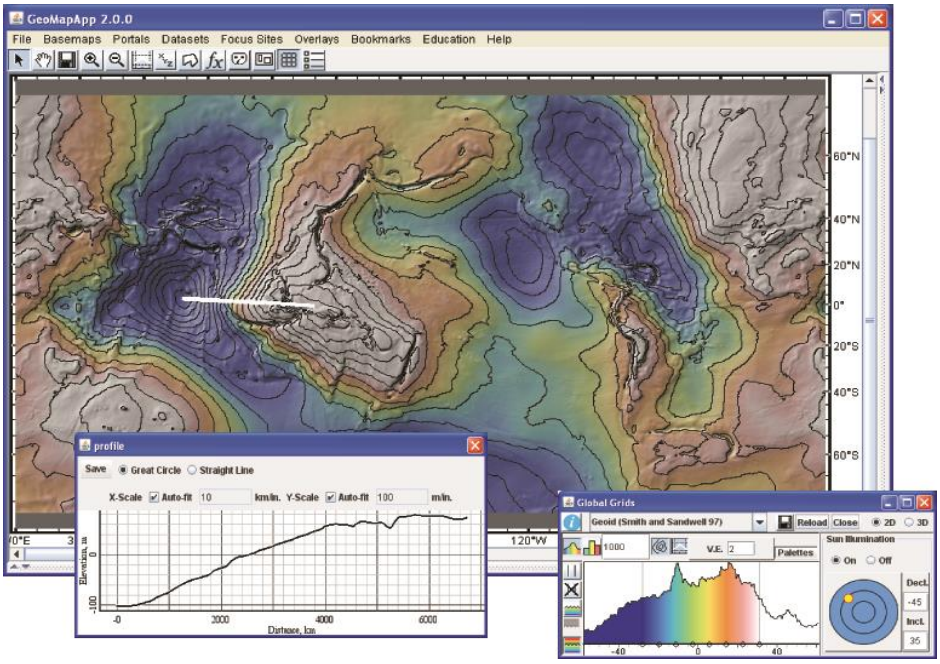


Figure: Global grid of geoid height anomaly (Sandwell and Smith, 1997), with ten-meter contours, and a profile showing the remarkable 180m geoid height anomaly between the Indian Ocean and Indonesia.

See the grid manipulation section for more information on grid functionality.

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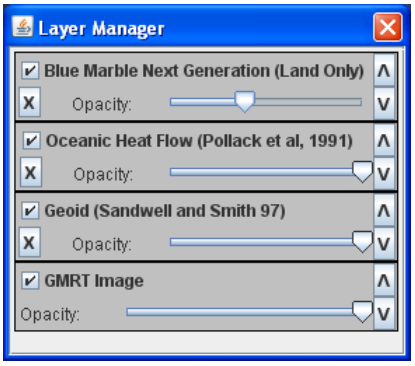
6.12) Layer Manager

Use the functions in the Layer Manager window to turn layers on and off, change layer transparency (opacity) and layer ordering, and discard layers.



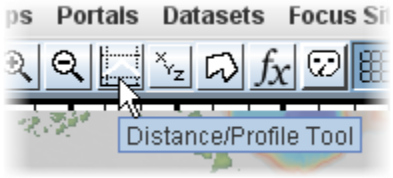
Turn the layers off/on by ticking or unticking the display box (☑, ☐). Bring layers to the front by changing their order with the vertical arrows ^ v. Layer transparency is controlled with the transparency function – see below. Click the X box to discard the layer.

6.12.1) Layer transparency

Slide the Opacity slider bar ( ) to the left and right to alter the layer transparency. That allows convenient comparison with features on other layers. When the slider bar is all the way to the right the layer is opaque and so is fully visible. As the slider bar moves to the left, the layer becomes more transparent thus allowing other layers to become visible.

7) Tool tips

Many icons and table column headings contain active tooltips. Allow the cursor to linger over the item for a second or two to see the associated tooltip.



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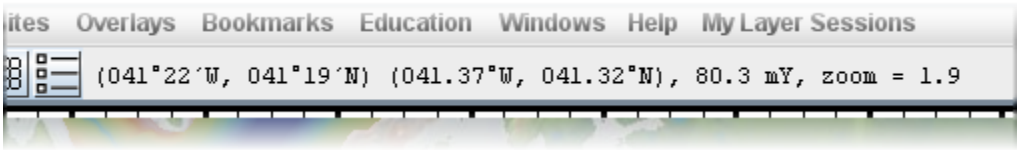
8) Toolbar Text Display



The displayed text varies with three cases.

Case 1: No grid loaded (default view, or when images are loaded)

```
(073°56.3′E, 012°35.4′N) (073.939°E, 012.589°N), zoom = 33.4
```

From left to right, the text in this example shows:

Longitude in whole degrees and decimal minutes, East or West (range is 0-180).
Latitude in whole degrees and decimal minutes, North or South (range is 0-90).
Longitude in decimal degrees, East or West (range is 0-180).
Latitude in decimal degrees, North or South (range is 0-90).
Zoom factor. This number indicates how far in we have zoomed. A zoom factor of 1 corresponds to the global view. For those interested, a zoom factor of 512 is the zoom level at which a 100m gridded data set can be viewed without obvious detrimental image pixelation. The USGS NED land elevation data set used in the GMRT base map has a resolution of 10m in the conterminous US and zoom factors of 2048 or 4096 still offer good detail. Ultra-high-resolution grids at hydrothermal vent sites (some with grid cell size of just 25 cm!) can withstand even higher zoom factors, up to tens of thousands.

Case 2: Grid loaded

```
(074°19.0′E, 009°04.9′N) (074.316°E, 009.082°N), -2,733.0 m, zoom = 33.4
```

Same as case 1, but now shown to the right of the geographic location is the z value of the grid at the cursor location (-2733m in this example, 80.3 mY in the snapshot example shown at start of section).

For many grids, the native grid resolution may support large zoom factors.

Case 3: Profile tool activated (grid is loaded)

```
(074°41.2′E, 008°58.0′N) (074.687°E, 008.966°N), -2,724.0 m, zoom = 33.4, distance = 418.45 km
```

Same as case 2, but now shown to the right of the zoom factor is the distance from the start of the profile to the current position of the cursor (418.45 km in this example). The Profile Tool thus provides a convenient distance-measuring function.

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9) GeoMapApp Tutorials on YouTube

A range of short video tutorials is available on the GeoMapApp channel on YouTube

The tutorials can be viewed in any web browser.

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10) Cookbook

10.1) How to Import Data – Tables and Spreadsheets

See video tutorial on YouTube

ASCII data tables and spreadsheets in Excel .xls and .xlsx format may be imported to GeoMapApp.

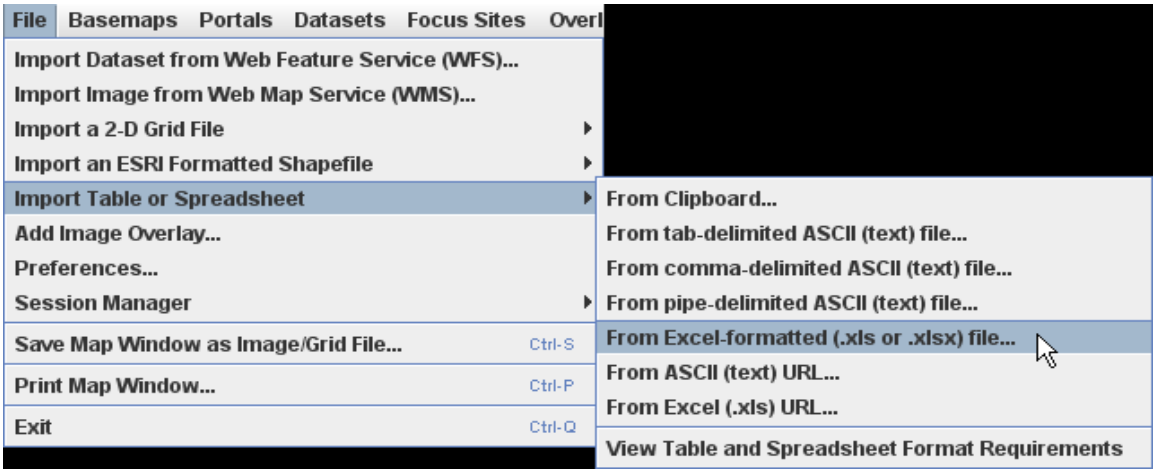
	A	B	C	D	E
1	Station/pen	Pen_Lon	Pen_Lat	# therm used	Heatflow W/m^2
2	t2h01p01	-86.761	9.574	11	0.036
3	t2h01p02	-86.772	9.587	11	0.032
4	t2h01p03	-86.785	9.599	11	0.034
5	t2h01p04	-86.797	9.611	11	0.035
6	t2h01p05	-86.803	9.618	11	0.038
7	t2h01p06	-86.809	9.624	11	0.040
8	t2h01p07	-86.813	9.628	11	0.049

Figure: Example spreadsheet called TicoFlux2_Processed_Heatflow.xls contains NSF MARGINS-funded heat flow data collected by Andy Fisher in central America.

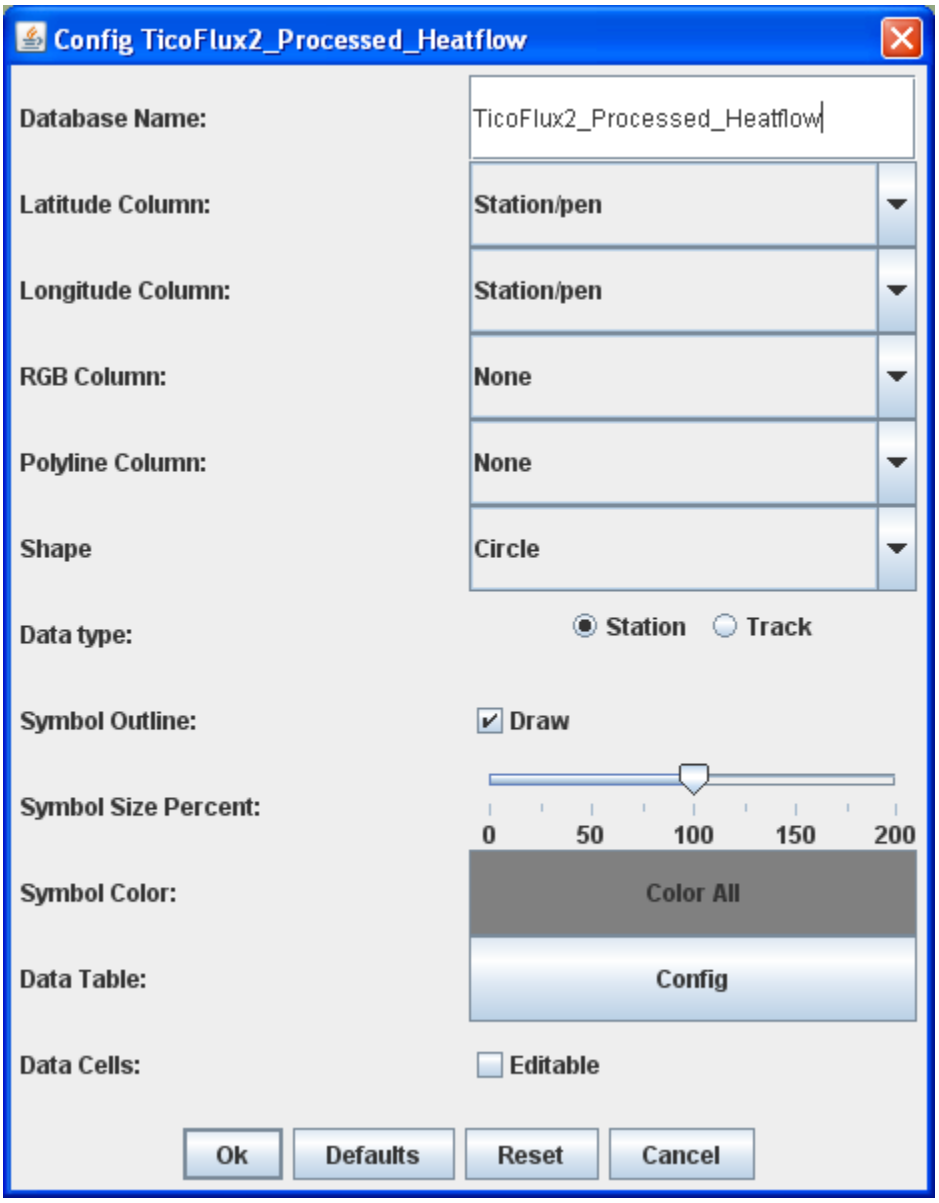
The spreadsheet must contain a column for longitude (in decimal degrees between +/- 180) and a column for latitude (in decimal degrees between +/- 90). The first row of the spreadsheet is expected to be column headings.

Spreadsheets containing dozens of columns can be imported successfully. Also, those containing simple formulae generally can be imported. If a spreadsheet fails to import, try converting it to a tab-, comma- or pipe-separated ASCII file and then use the appropriate ASCII table import option in the same menu. Note also that the old Excel 5.0/95 (BIFF5) format is no longer supported.

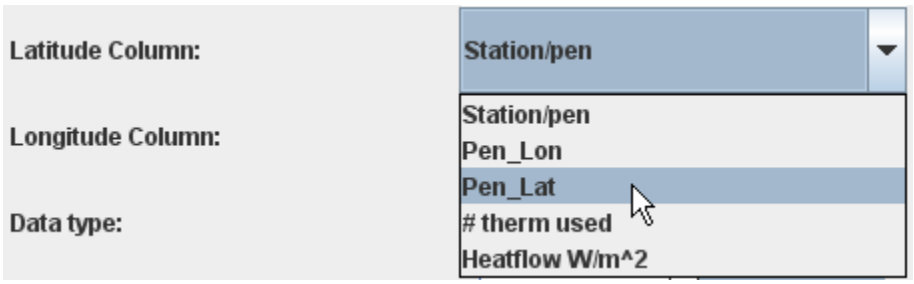
Select the import function:



Locate the file and Open it. After GeoMapApp reads the contents of the file, a *Config* window appears.



GeoMapApp searches for a latitude and longitude column heading (it can recognise “Latitude”, “latitude”, “lat”, for example). If no match is found, the latitude and longitude columns must be specified in the *Config* window. Open the drop-down menu for Latitude Column and select the latitude column from the list. In this example, it is “Pen_Latitude”.

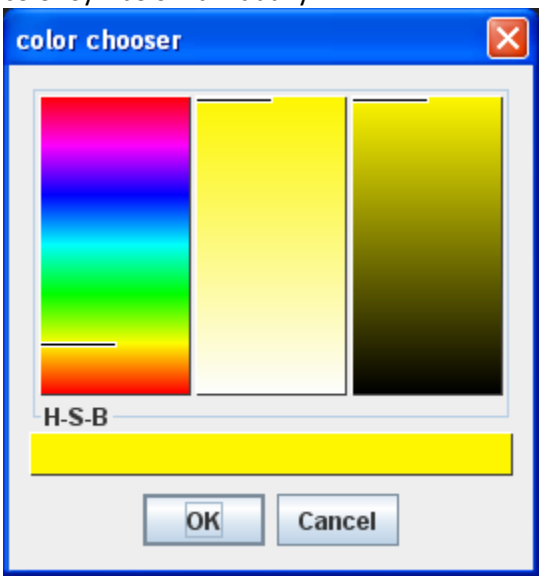


Similarly, select the longitude column. Click 

.

When loading a tabular data set, the symbol color can be defined. Click the Color All button:

In the Color Chooser window, drag the horizontal bars up and down to select a color. Hit OK to apply the color. Note that the color applies to *all* symbols. See lower down in this section for details on how to color symbols individually.



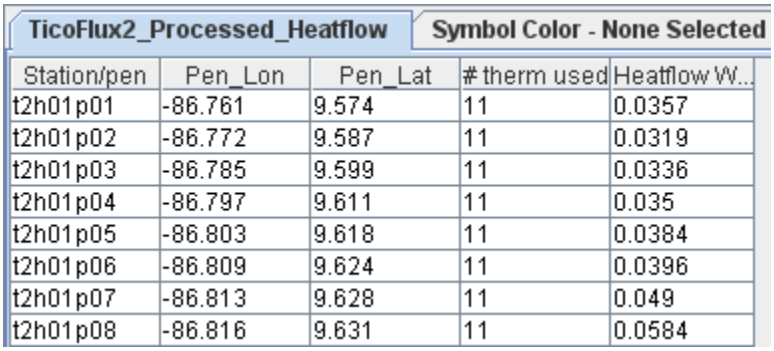
The shape of symbols is chosen under the 

menu. Like the symbol color, it applies to all symbols.

Once the parameters have been set, hit the OK button to import the tabular data set. Two things happen. First, the symbols are plotted on the map and second, a table appears beneath the map.

If there are no symbols on the map and no records beneath the map, it is likely that the geographical area displayed in the map window does not include the area covered by the imported data set. So, zoom out until the symbols and table are shown.

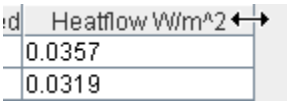
The table displays the contents of the imported data records for all locations that fall within the boundary of the map window.



TicoFlux2_Processed_Heatflow | Symbol Color - None Selected

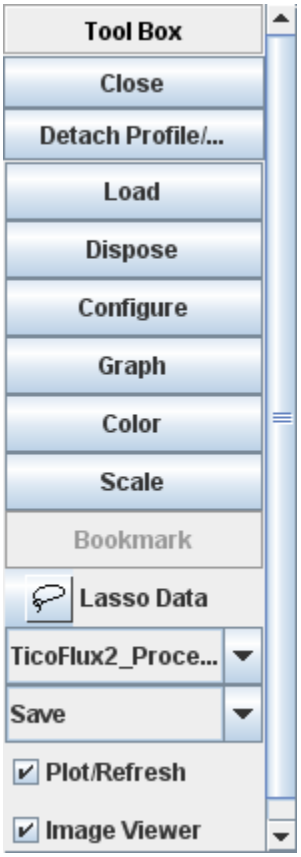
Station/pen	Pen_Lon	Pen_Lat	# therm used	Heatflow W...
t2h01p01	-86.761	9.574	11	0.0357
t2h01p02	-86.772	9.587	11	0.0319
t2h01p03	-86.785	9.599	11	0.0336
t2h01p04	-86.797	9.611	11	0.035
t2h01p05	-86.803	9.618	11	0.0384
t2h01p06	-86.809	9.624	11	0.0396
t2h01p07	-86.813	9.628	11	0.049
t2h01p08	-86.816	9.631	11	0.0584

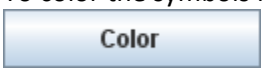
Widen the columns by clicking on the column border and dragging the double-headed arrow cursor.



Heatflow W/m^2
0.0357
0.0319

A panel containing function buttons appears on the right side of the map.

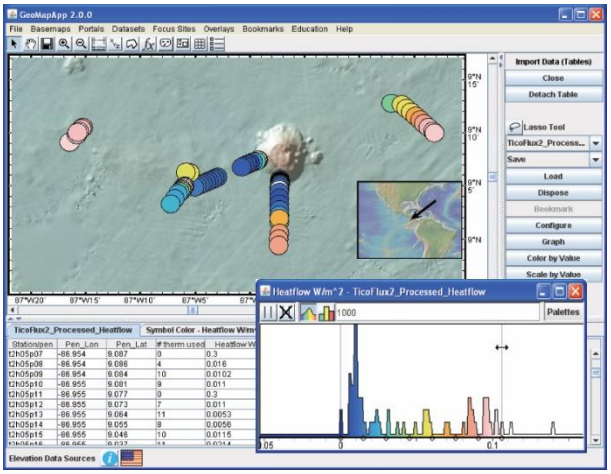


To color the symbols individually, there are two ways to proceed: interactively using the 

button or manually be including a column of Red,Green,Blue values in the imported file.

For the first way, click 

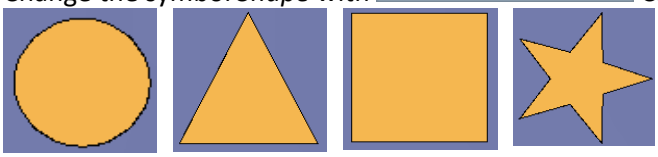
and choose a parameter on which to color (e.g. by heat flow value). The color histogram window shows the selected value along the x-axis and the number of values on the y-axis. Drag the vertical grey lines sideways with the cursor (double-headed arrow) to change the color range.



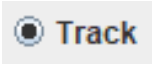
For the second way, a specific color can be defined within the imported file by creating one column that contains Red,Green,Blue comma-separated values. For example, to define a record's symbol as yellow, the RGB value for it would be 255,255,0.

Change the symbol *Shape* with 

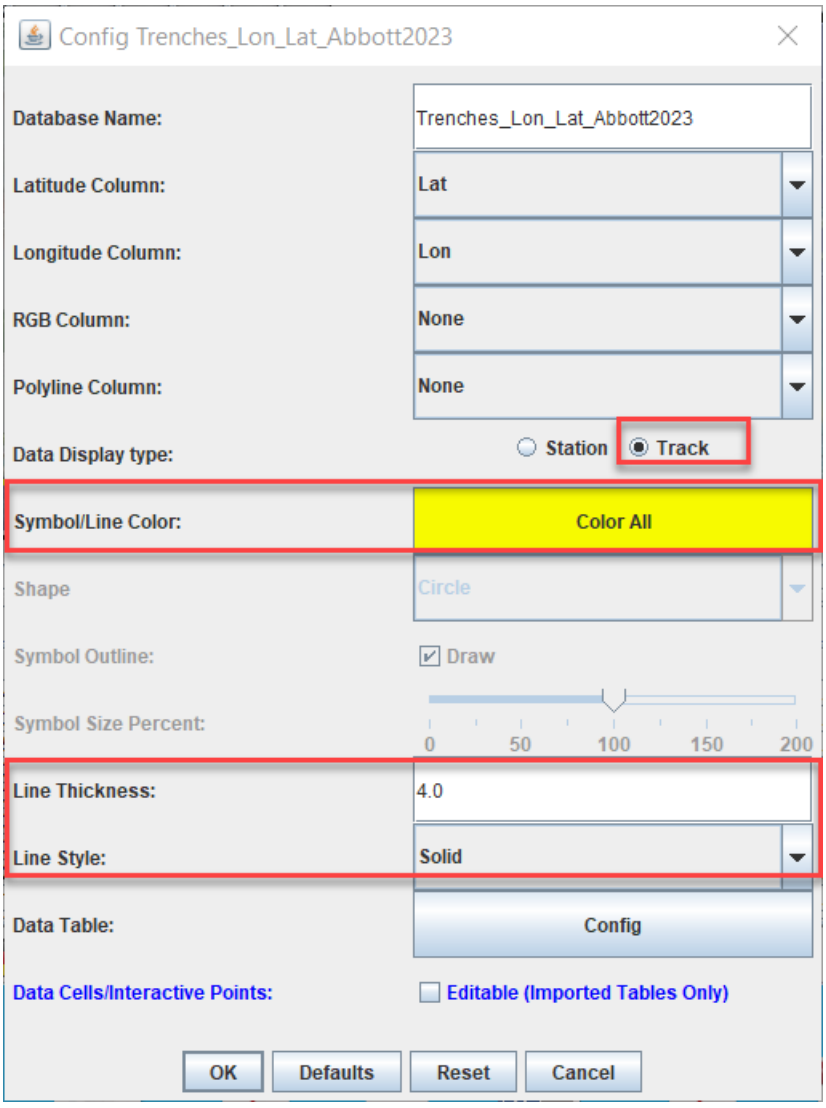
Choices are: Circle, square, star, triangle.



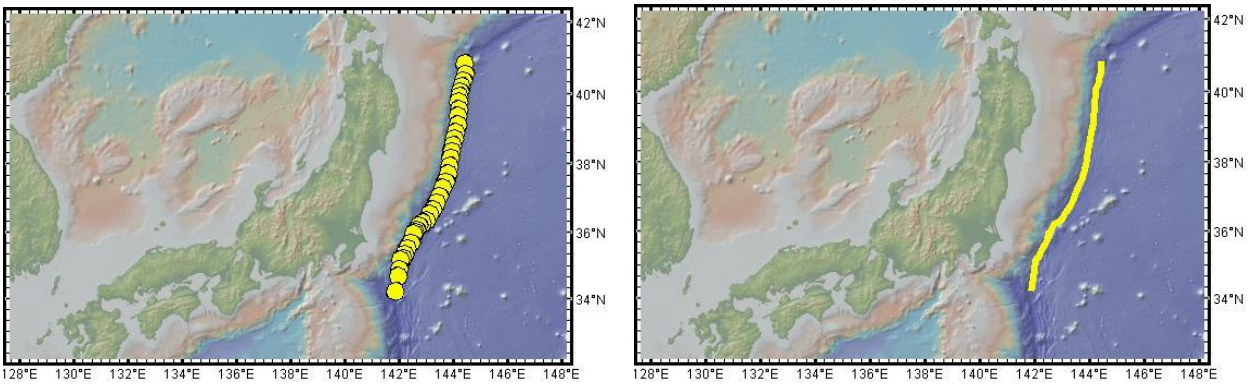
Lines Versus Points

By default, tabular data sets are displayed as points on the map. A continuous line may be used to join the points and is activated in the Configure window by selecting the "Track" radio button: 

The default color for the track line is grey. Use the Line Thickness and Line Style parameters to control the appearance of the line, and use the Symbol/Line Color function to change color:



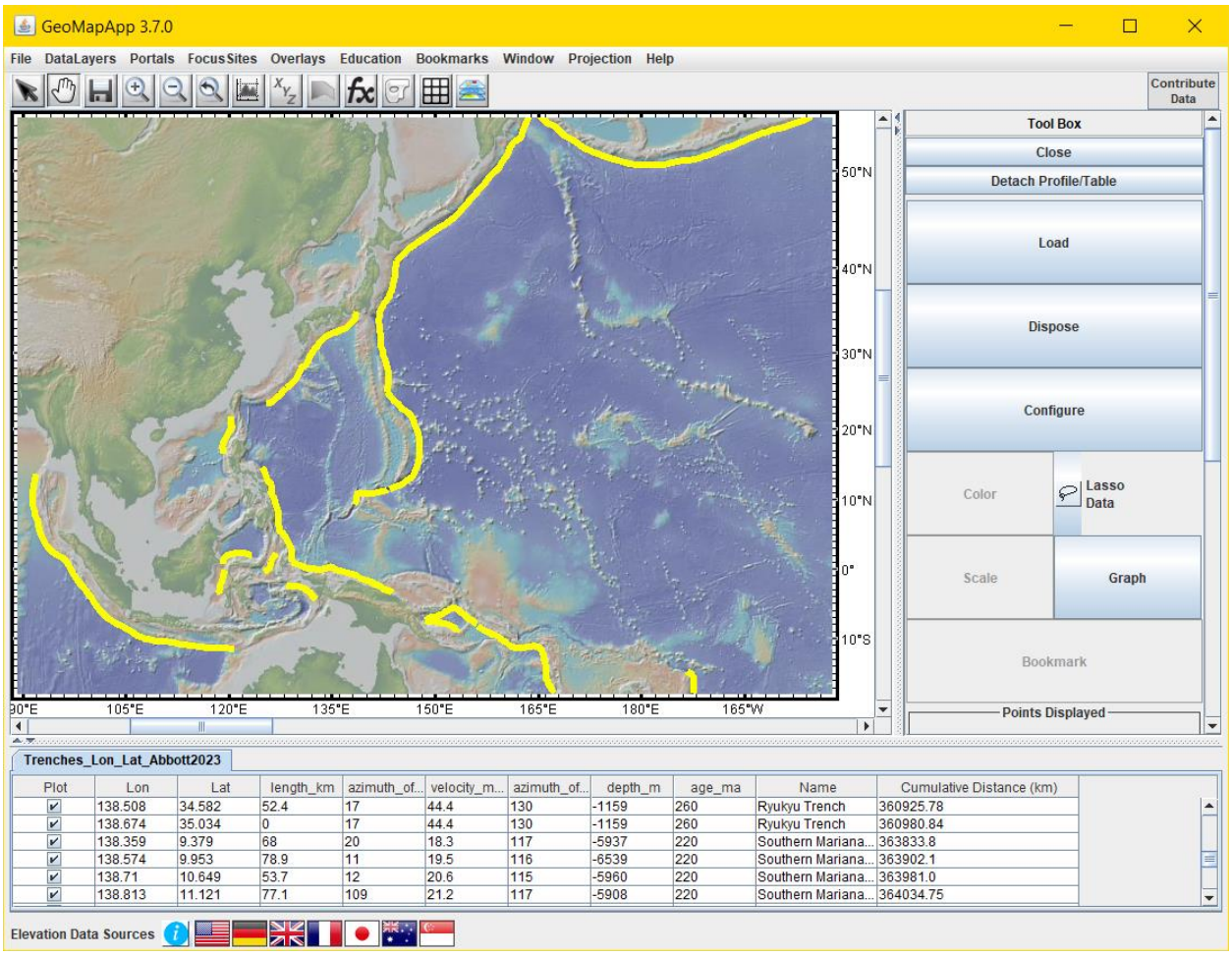
The example below shows an imported ASCII data table that contains the location of the Japan Trench (data courtesy of Dallas Abbott, LDEO, 2023). On the left, the imported points are plotted as points, here colored yellow. On the right, the same points are plotted as a continuous, thick yellow line.



When drawing a line between the points, the “greater than” segment separator symbol (“>”) may be used to distinguish separate segments within an imported ASCII file. Any row in the ASCII table in which the first character is “>” will be treated as a segment separator. The line is broken at the segment separator so that lines are drawn only between points within each segment.

Example of imported, tab-delineated ASCII table with segment separators:

Lon	Lat	length_km	az_of_line	velocity_mm/a	az_of_velocity	depth_m	age_ma	Name
153.108	-8.684	12.9	148	13	230	-3853	220	Trobriand Trench
153.237	-8.89	33	177	13	230	-3122	220	Trobriand Trench
153.255	-9.186	0	177	13	230	-3122	220	Trobriand Trench
>								
156.296	-8.174	29.8	141	98.1	255	-3210	220	D'Entrecasteaux Arc
156.467	-8.382	33.1	127	97.8	255	-2051	220	D'Entrecasteaux Arc
156.706	-8.563	9.4	117	97.6	255	-2963	220	D'Entrecasteaux Arc



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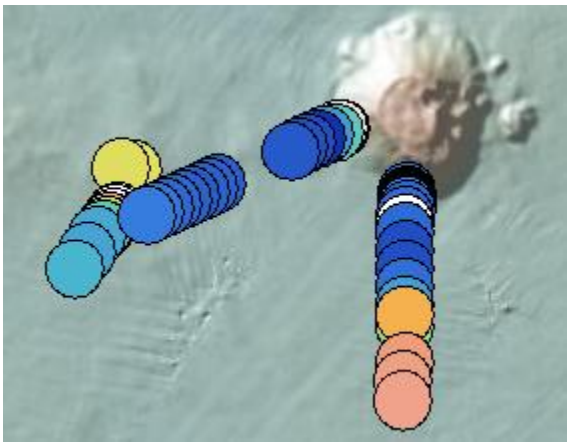
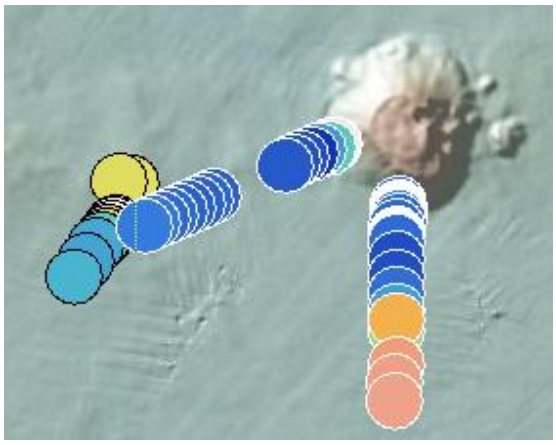
10.2) How to Lasso Data Points

When tabular data is loaded, click the lasso tool 

to activate the selection function. Move the cursor to the map window, click and hold the cursor button, and draw around the points of interest.



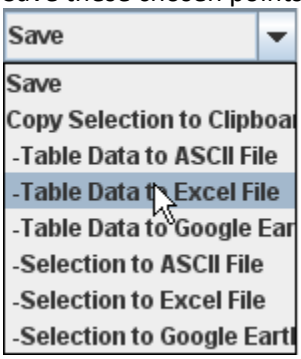


The selected points are highlighted in white on the map, and in blue in the data table below the map window.

TicoFlux2_Processed_Heatflow | Symbol Color - Heatflow W/m^2 | Sy

Station/pen	Pen_Lon	Pen_Lat	# therm used	Heatflow W/m^2
t2h07p06	-87.071	9.087	9	0.0104
t2h07p07	-87.075	9.085	9	0.0107
t2h07p08	-87.08	9.083	11	0.0132
t2h07p09	-87.084	9.081	11	0.0141
t2h07p10	-87.091	9.104	11	0.0565
t2h07p11	-87.097	9.105	11	0.0547

Save these chosen points in a range of formats using the right-pane Save function.



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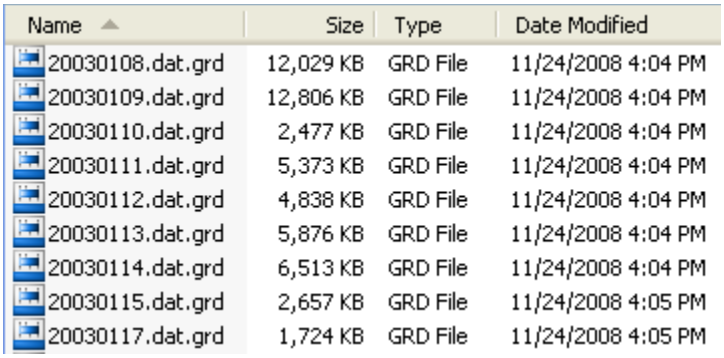
10.3) How to Import Data – Grids

See video tutorial on YouTube

Gridded data sets can be imported in GeoMapApp in various formats: GMT netCDF , ESRI ASCII or ESRI binary , Geodas GRD98 or ASCII Polar (.asc). Grids may be in Geographic or UTM projection.

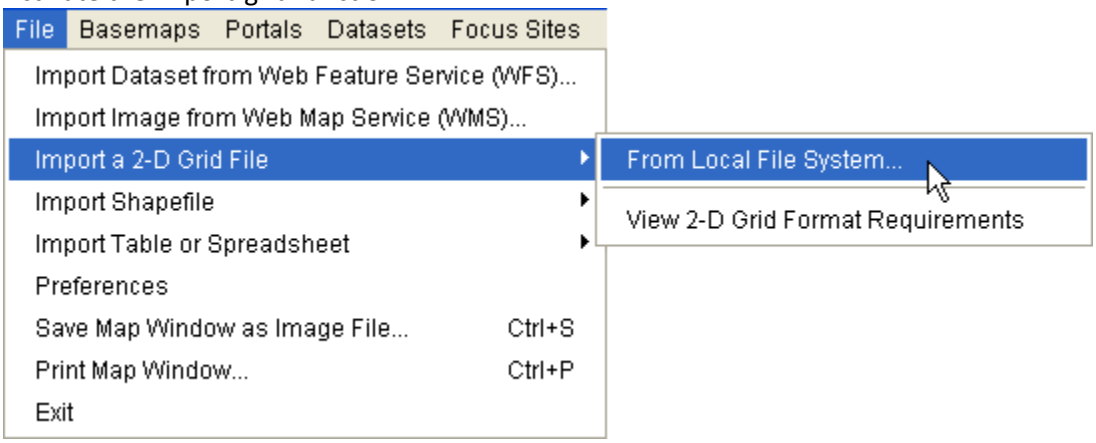
Grids can be imported either separately one at a time or as a one group. The example below shows how to import multiple grids at once. The multiple grids must reside in the same folder.



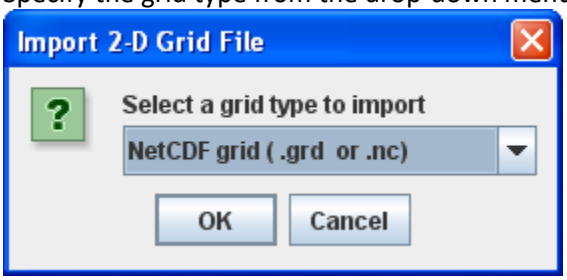
Name	Size	Type	Date Modified
20030108.dat.grd	12,029 KB	GRD File	11/24/2008 4:04 PM
20030109.dat.grd	12,806 KB	GRD File	11/24/2008 4:04 PM
20030110.dat.grd	2,477 KB	GRD File	11/24/2008 4:04 PM
20030111.dat.grd	5,373 KB	GRD File	11/24/2008 4:04 PM
20030112.dat.grd	4,838 KB	GRD File	11/24/2008 4:04 PM
20030113.dat.grd	5,876 KB	GRD File	11/24/2008 4:04 PM
20030114.dat.grd	6,513 KB	GRD File	11/24/2008 4:04 PM
20030115.dat.grd	2,657 KB	GRD File	11/24/2008 4:05 PM
20030117.dat.grd	1,724 KB	GRD File	11/24/2008 4:05 PM

Figure: List of netCDF grids constructed from JAMSTEC research vessel Kairei processed multibeam swath bathymetry data collected in 2003.

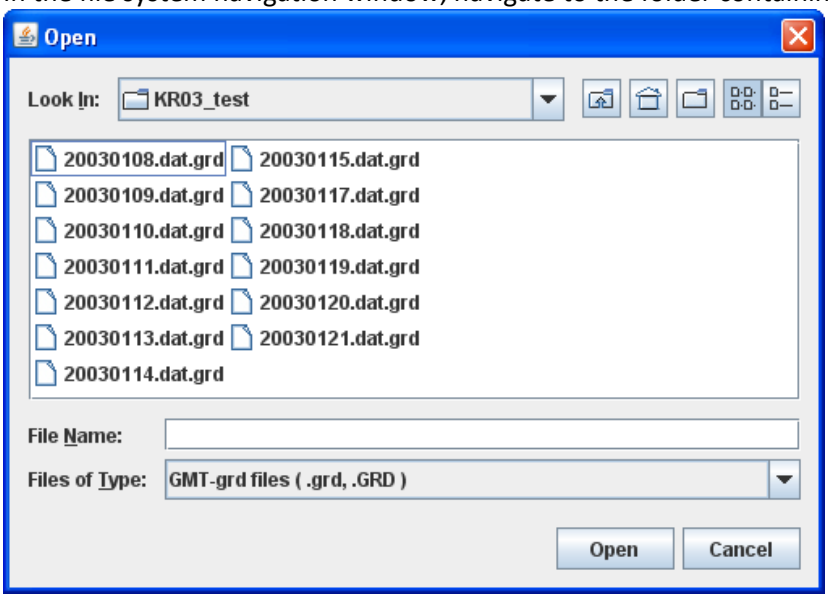
Activate the import-grid function:



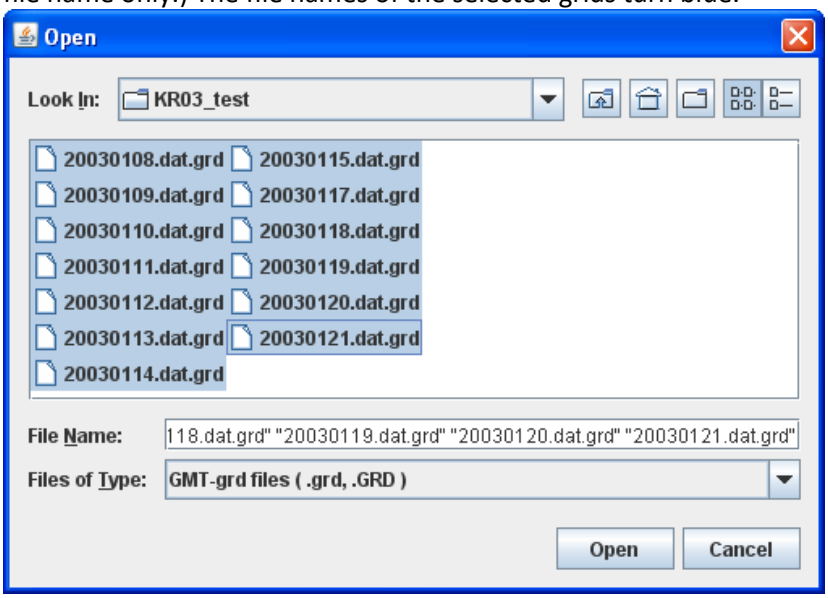
Specify the grid type from the drop-down menu and click OK:



In the file system navigation window, navigate to the folder containing the grids



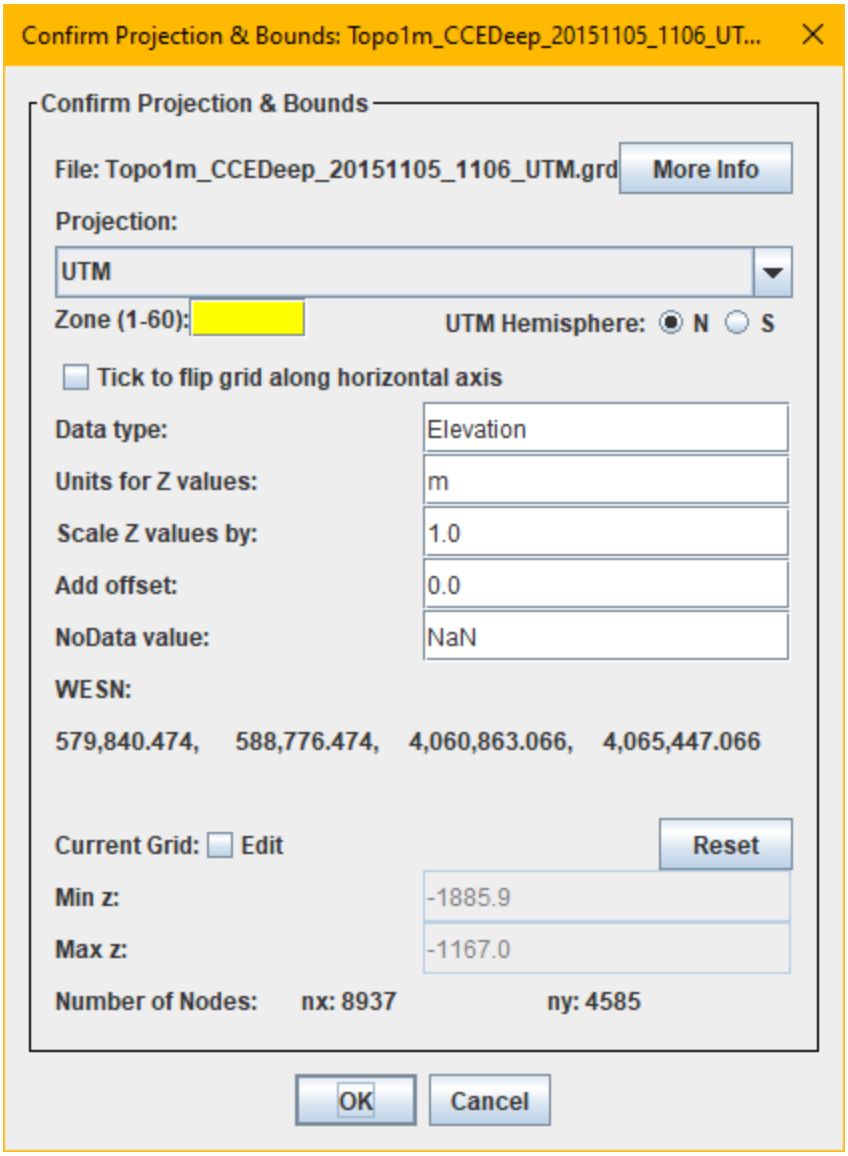
Use the cursor (shift-click) to select one or more of the grid files. (To import just one grid, select that grid file name only.) The file names of the selected grids turn blue.



Click 

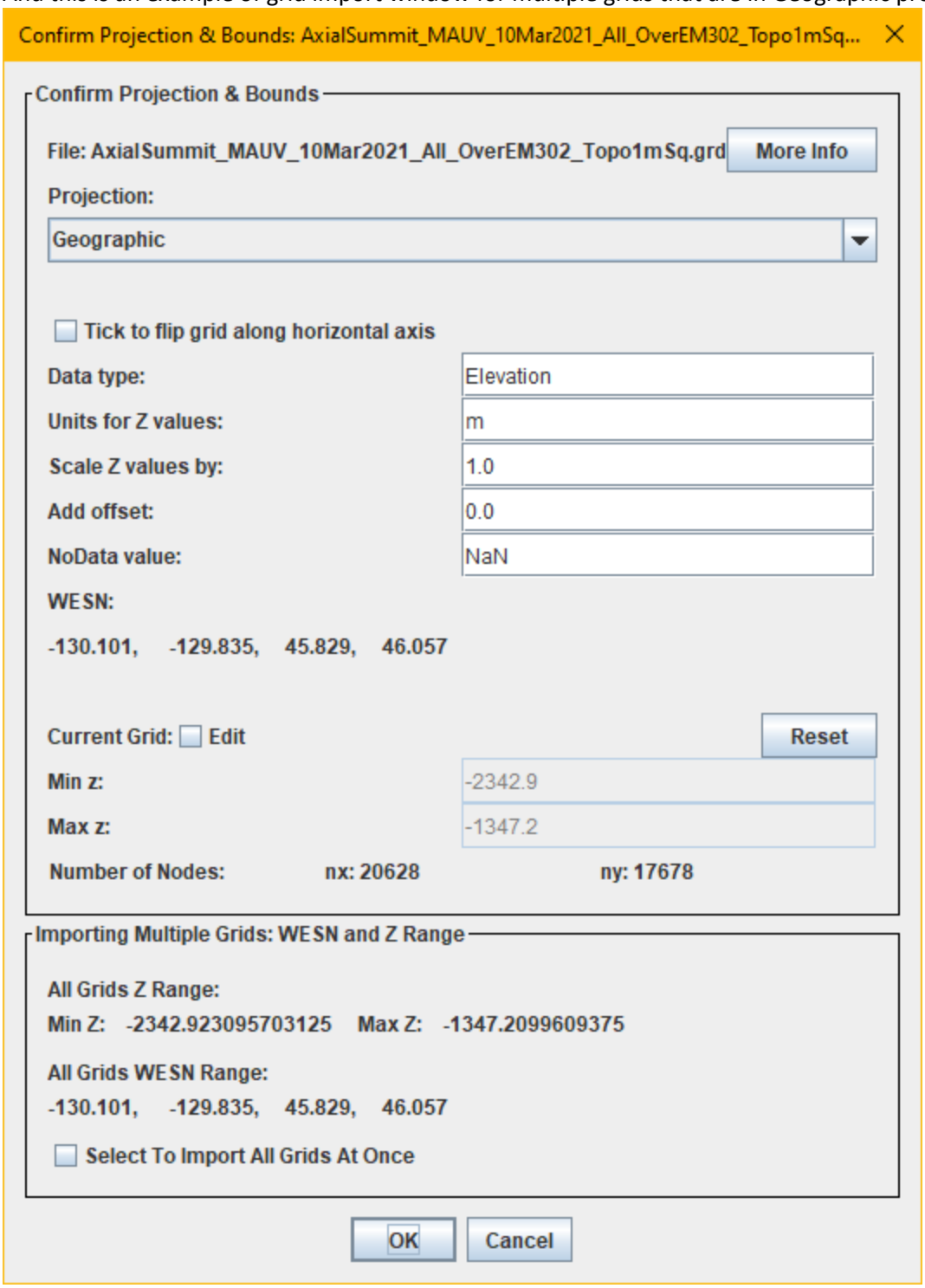
When importing grids, a *Confirm Projection and Bounds* window like one of those shown below appears. It displays header information for the grid/grids to be imported and requires some user input. The information extracted from the header includes the grid projection (UTM or geographic), the number of grid nodes (nx, ny), the west/east/south/north bounds, and min/max Z values.

Here is an example of grid import window for UTM grid. GeoMapApp recognises that the grid is in UTM projection but the user must specify the UTM zone as an integer in the yellow text box. The hemisphere is specified by selecting the N or S radio button. For example, for UTM zone 10N, type 10 in the yellow zone box and click the N radio button:



The other options presented in this import window are described below.

And this is an example of grid import window for multiple grids that are in Geographic projection.



For both UTM and Geographic grids, a range of import options are available.

Flipped grids
Grid arrays are typically loaded from the southwest corner to the northeast corner. For grids that are loaded the other way, they will be displayed upside down and in the wrong geographical location. To correctly import the grid, click the "*Tick to flip grid along horizontal axis*" box:

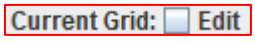
If an upside down grid was imported it is necessary to remove some local files before importing it correctly. First, you will need to delete the local tiles that were created when the grid was imported. That is because the local tiles are appended and not overwritten when subsequent grids are imported. To delete the local tiles, go to the folder in which the grid resides. You will see some "z_nnn" folders with names like z_1024 and z_512. Delete all of those "z_nnn" folders. You will also see some shapefile components (.shx, .shp, .dbf, etc). Delete those shapefile components, too. Only the original grid/grids should remain in that folder. Second, now that the incorrect local tiles have been deleted, the grid may be imported once more. This time, though, in the *Confirm Projection and Bounds* pop-up window, click the box labelled "*Tick to flip grid along horizontal axis*". The imported grid should now be displayed in the correct geographical location in the map window.

Data type, units, scale factor, offset
The data type and units for an imported grid may be specified in the Data type and Units for Z values boxes. The units are then displayed in the top bar of the GeoMapApp window. And both the units and data type are displayed if a profile is generated from the grid.

The gridded Z values can be scaled by any factor using the 

option. This is useful for switching depths from positive downwards to negative downwards, for example (by scaling by -1.0). A DC shift may be added to the Z values using the Add Offset box.

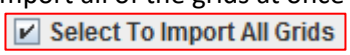
NoData values
Typically, grids are coded so that any cells with NoData will have a value of “NaN” (Not a Number). For grids in which the NoData value is not NaN, use the NoData Value box to type in the value. For example, for a grid in which a value of 128 is used for NoData, type 128 in the box.

Edit grid
The 

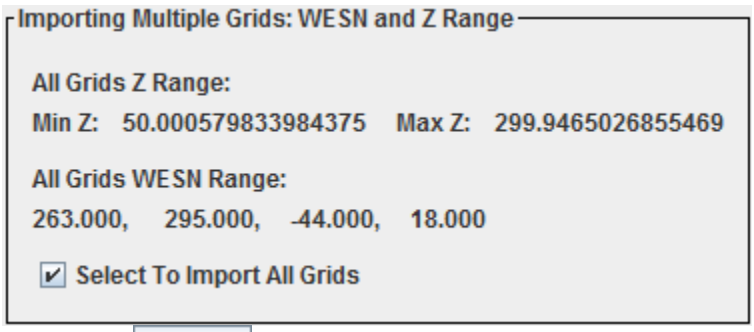
box allows the min/max Z values of the current grid to be manually edited.

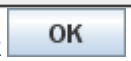
To manually edit or scale individual grids within the group of grids to be imported grids, click 

- the *Confirm Projection and Bounds* window will display the grids information one grid at a time.

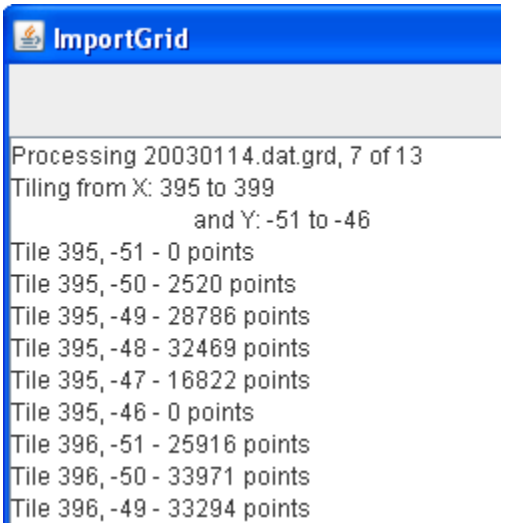
Import multiple grids
To import all of the grids at once (and to apply the same scaling factor to all of the selected grids), tick the 

box. Check that the bounds listed in the lower part of the window are sensible. For example:



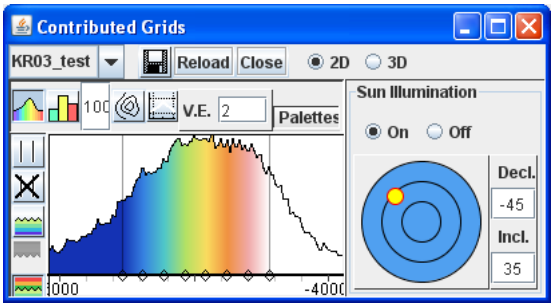
Then, click 

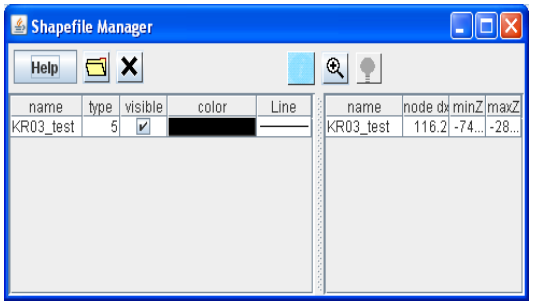
As each grid is processed, its status is shown in the *Import Grid* window.

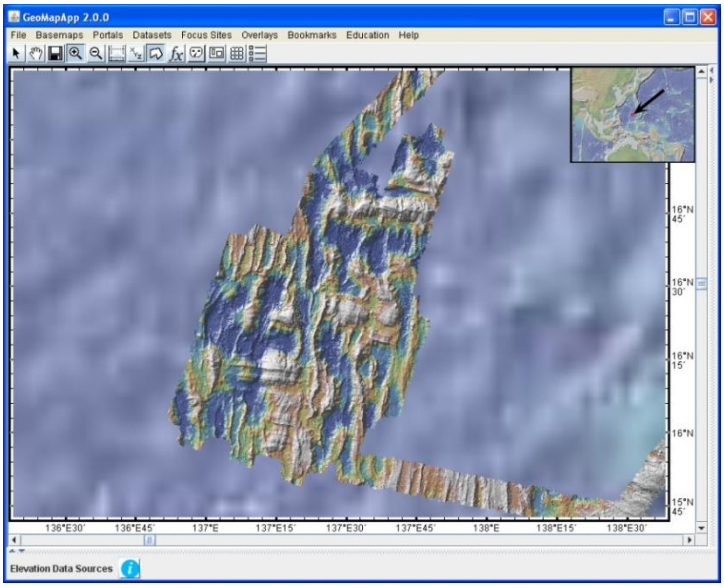


When all of the grids have been processed the folder containing the grids now includes a set of *z*-folders and a suite of shapefile components. These new files and folders should not be discarded at this stage - the shapefile allows the imported grids to be accessed instantly at a later date, and the *z*-folders allow zoom capability.

Two new GeoMapApp windows appear – a grid dialog and a shapefile manager – and the map window zooms automatically to the gridded area.







The wide range of GeoMapApp grid manipulation functions can now be applied to these imported grids – changing the color palette, sun illumination, vertical exaggeration, adding contours, taking profiles, overlaying imported data points, saving images, and so on.

If you would like your grid to be built into the GeoMapApp base map or the GeoMapApp menus, please contact us.

Note that imported grids are loaded for the current GeoMapApp session only. But, there is a quick way to re-load them – simply import the shapefile and the grid will instantly be displayed. The shapefile may be imported under File > Import an ESRI Formatted Shapefile, as described in this section.

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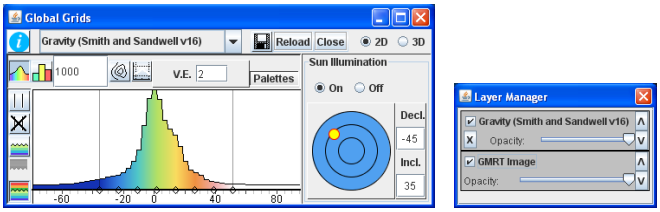
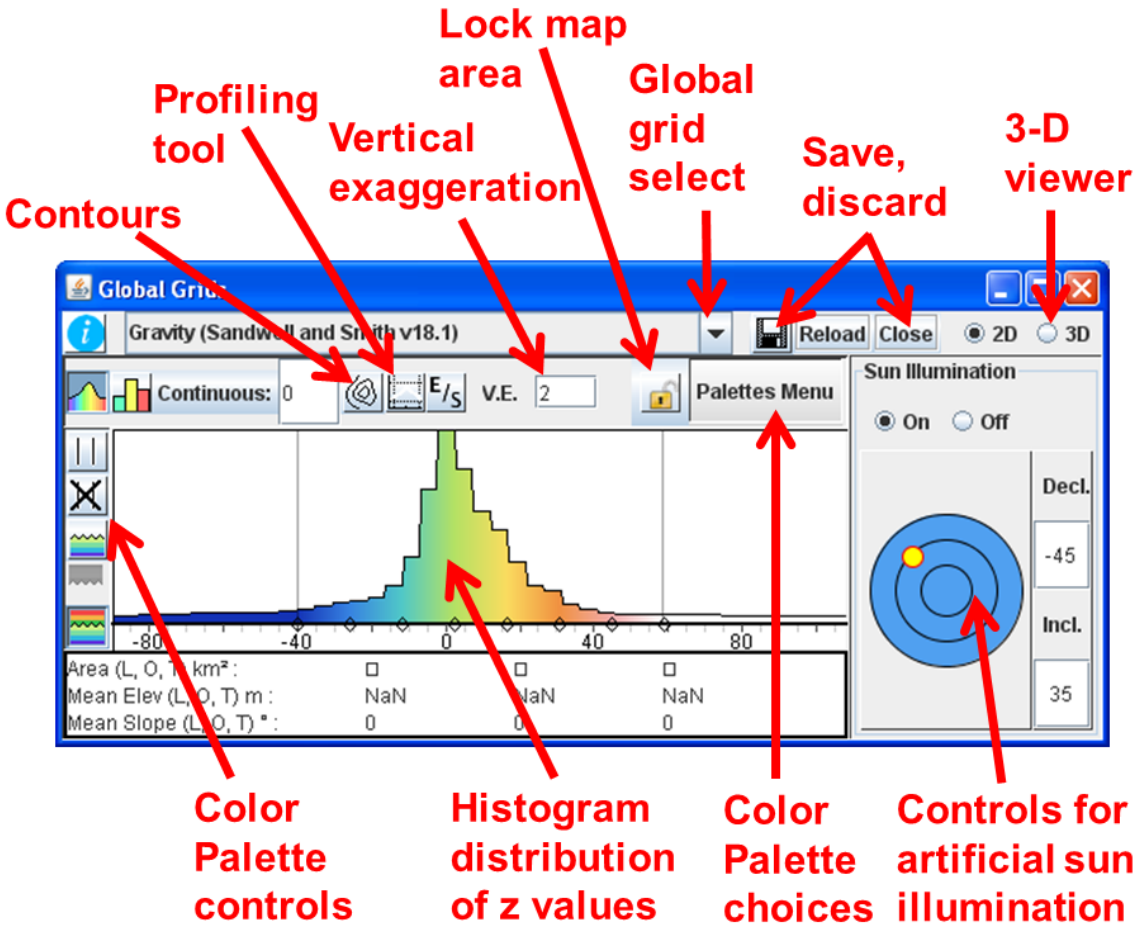
10.4) How to manipulate grids

See video tutorial on YouTube

When any grid is loaded, two windows pop up: the grid dialog window (shown at left, below) and the Layer Manager (shown at right, below).





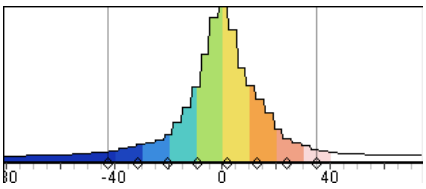
In the grid dialog window, the histogram shows the relative distribution of gridded z-values for the map area displayed in the map window. For example, for a relatively flat area, the color histogram will show a narrow distribution of gridded z-values. In contrast, a map area that includes a wide range of z-values will yield a histogram that is broad.

The color scale is automatically adjusted so that the palette spans the full range of gridded z-values displayed in the map. To change the span of the colors, drag the two thin, grey vertical lines to the left

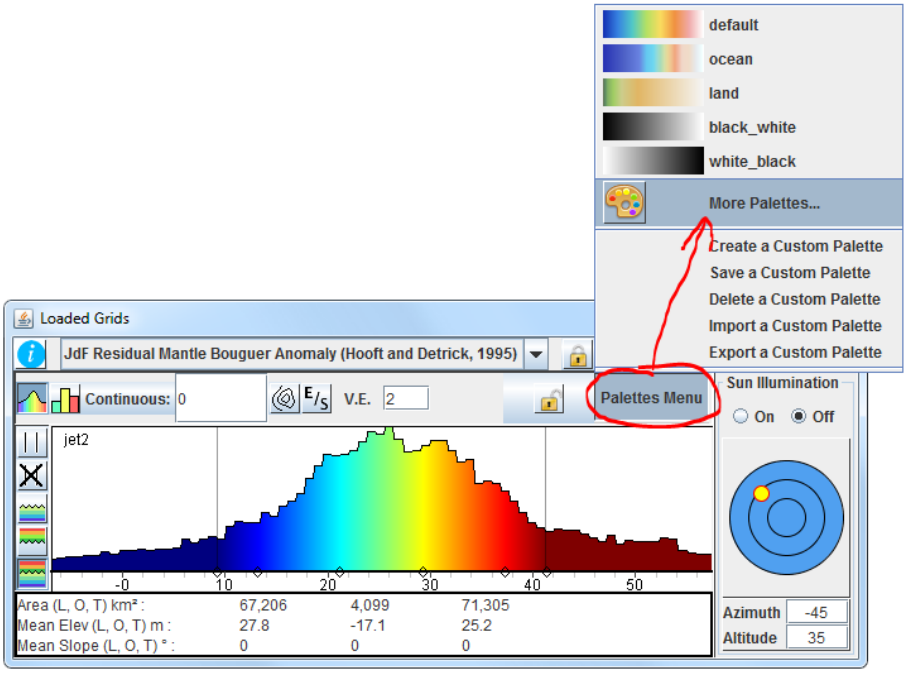
or right – the cursor will become a double-headed arrow that can be dragged. The map will refresh instantly with the new range of colors. Reset the color range to the default by clicking the normalizing button  . The chosen limits can be locked with the  button. This preserves the limits when the map window is zoomed or panned.

The “ocean palette” button  is a shortcut to a color palette suitable for z-values between 0 to about -8000 (typical ocean depth ranges). The “land palette” button  is a shortcut to a color palette suitable for z-values between 0 to about +6000 (typical land elevations). The  button switches to the default palette that spans both positive and negative ranges. The continuous rainbow button  spreads the color scheme uniformly across the z-range of the grid. Discrete color changes are specified with the bar chart button – specify the increment for the color change boundaries by typing in the associated text box: 

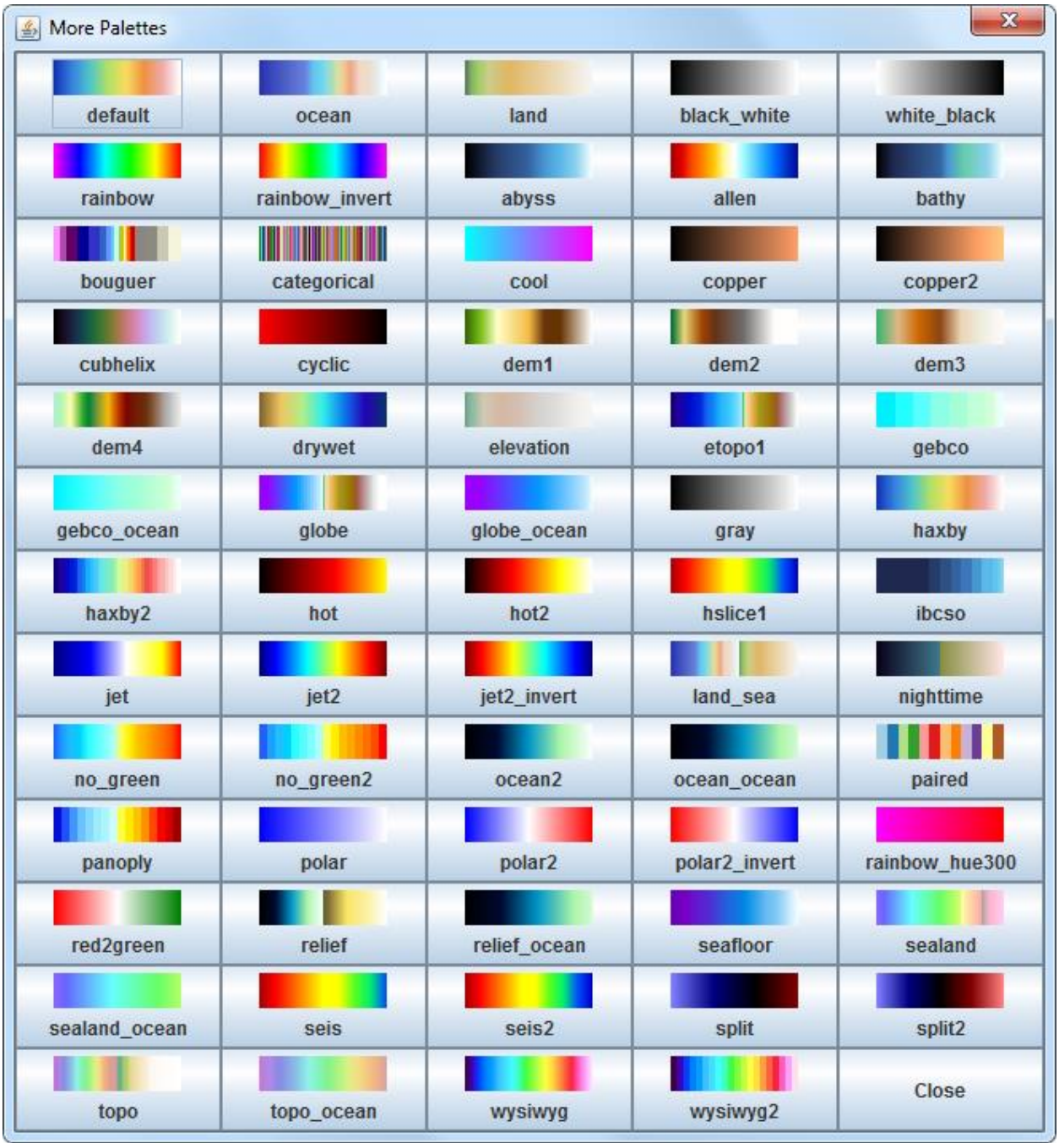
.



Click the **Palettes Menu** button to choose from amongst 65 built-in palettes or to create or save a custom palette. The full suite of available built-in palettes is displayed by clicking Palettes Menu > More Palettes, as shown here:

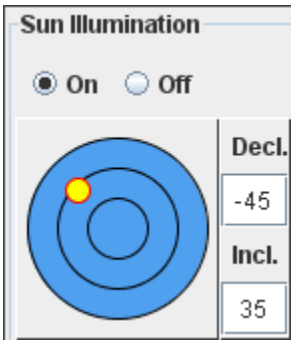


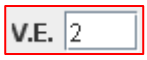
Available built-in color palettes:



In all palette-related functions, two thin grey vertical lines displayed in the histogram window can be dragged left or right to change the color range.

The right-side of the grid dialog window controls the artificial sun illumination of the grid display. Change the illumination angle and brightness by dragging the yellow sun symbol. Precise illumination angles can be specified by typing degree values into the text boxes.



The intensity of shading is determined by the vertical exaggeration which is specified in the 

box.

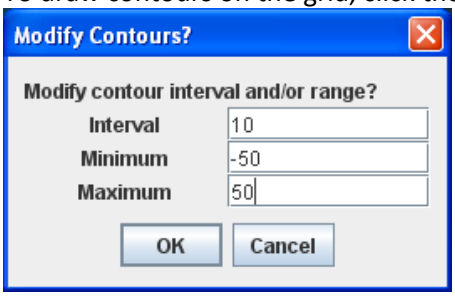
To lock the area displayed on the map, click the padlock symbol  . That is useful if additional data sets with different bounds are loaded.

Switching between the 'below zero'  , 'above zero'  and 'continuous'  color palette buttons allows different z-ranges of the grid to be colored and shaded independently. For example, that can be useful for applying different coloring/shading settings to a map display that includes ocean floor depths and land elevations.

The 

button switches the histogram between the distribution of elevations (or whichever z value is represented in the grid) and the distribution of gradients.

To draw contours on the grid, click the contour  button to open a contour parameters box.



Specify the contour interval and the maximum/minimum values to be contoured. When the 

button is clicked, the contours are processed on the local CPU and displayed on the map. The contours can be turned off by clicking the contour button again.

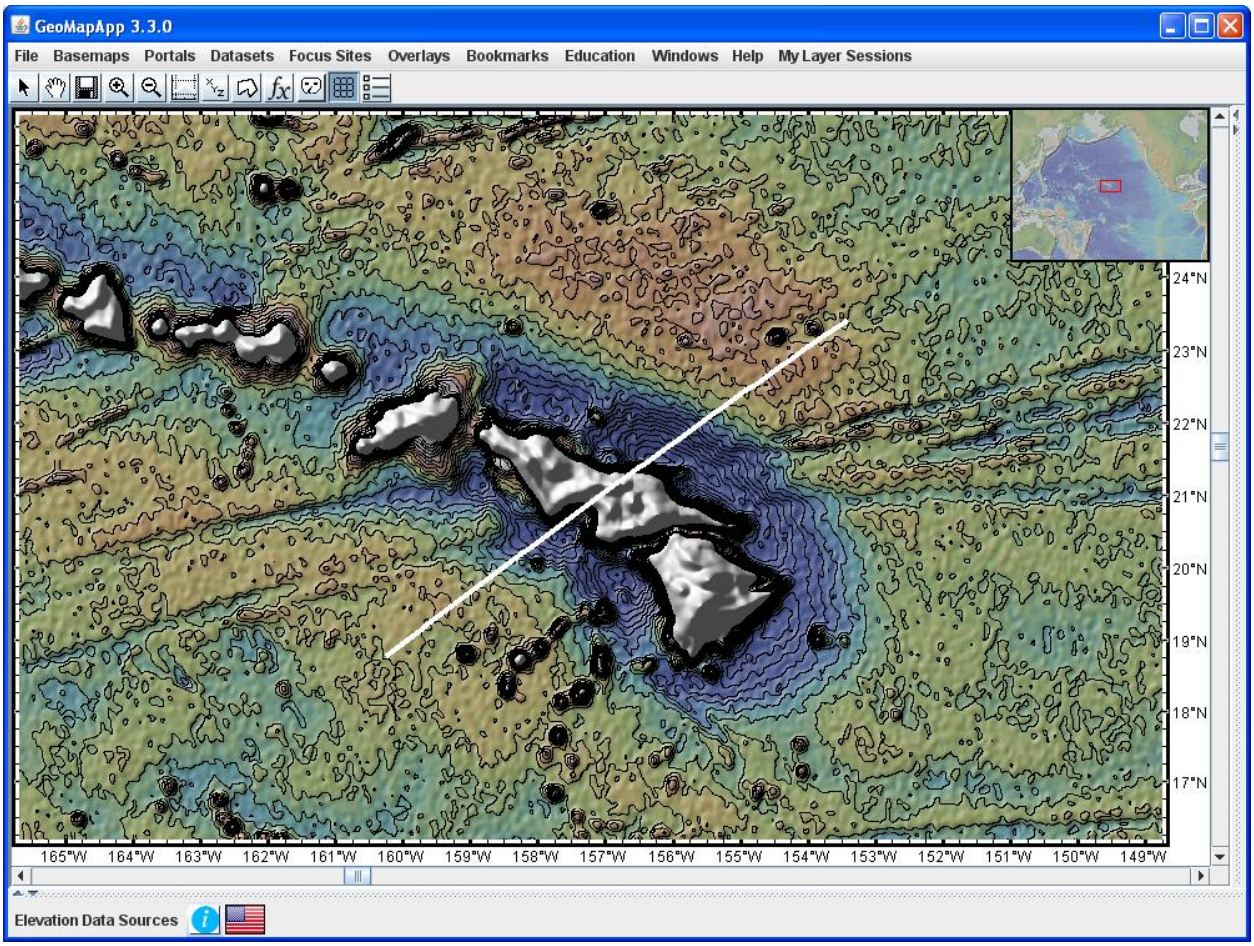


Figure: Hawaiian islands free-air gravity anomaly grid with contours displayed at 10mGal intervals. An upper contour limit of 100mGal was imposed. The white line is the location of the profile, shown below.

With any grid loaded, profiles are generated using the profile function  . Once clicked, the cursor becomes active as a profiling tool. Drag the cursor across the map window to draw a profile line.

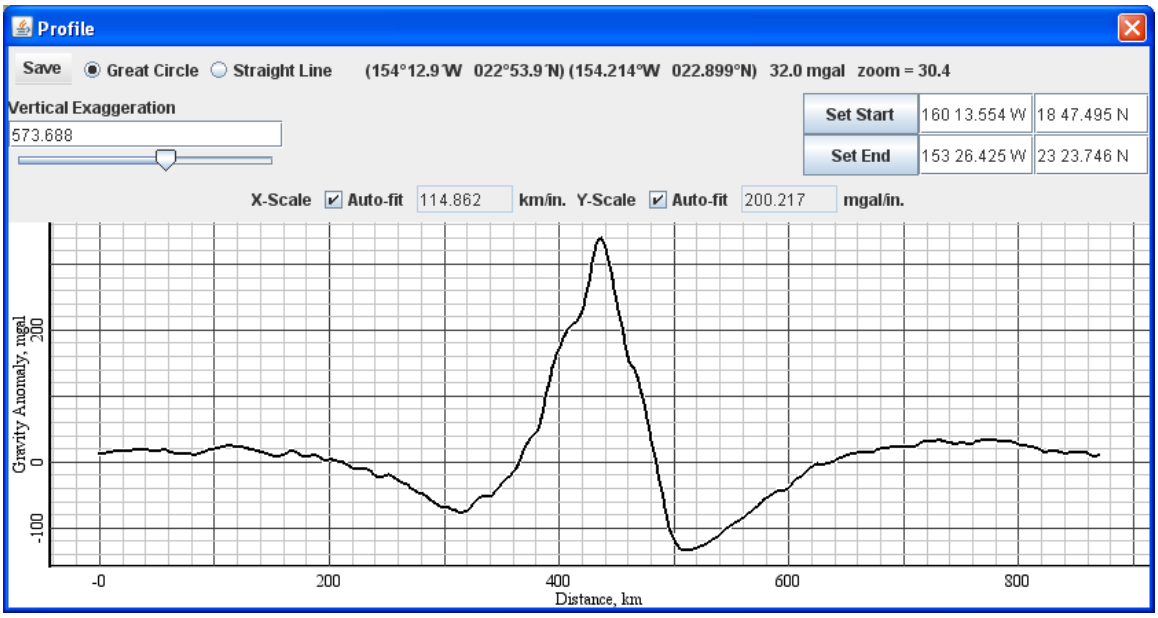


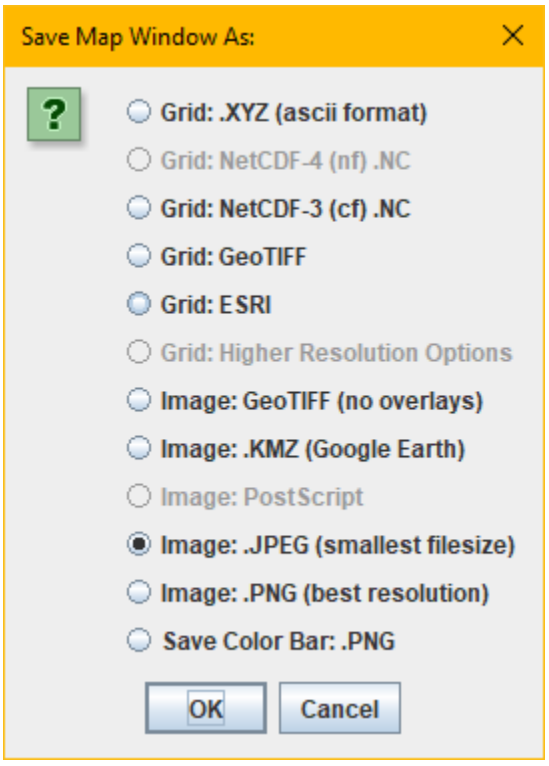
Figure: Flexural moats around the Hawaiian islands shown in this profile of the Sandwell-Smith satellite-derived free-air gravity anomaly.

In the grid dialog window, click the information button (in the upper left) to open a web page with more information about the loaded grid.

To reload or discard the grid, click the Reload Close buttons.

The grid that is visible in the map can be saved in many different formats using the save button . The map can also be saved as an image.

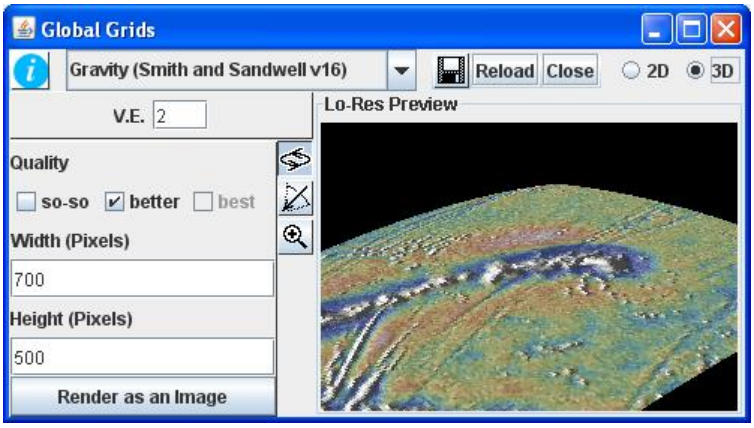
Most of the grid-save options will save the grid at the resolution of the map window. However, when the GMRT base map grid is loaded, a range of grid resolution options is available by selection the Grid: Higher Resolution Options: Grid: Higher Resolution Options

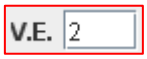


The grid can be viewed in 2-D or 3-D, controlled with the 

selection. When 

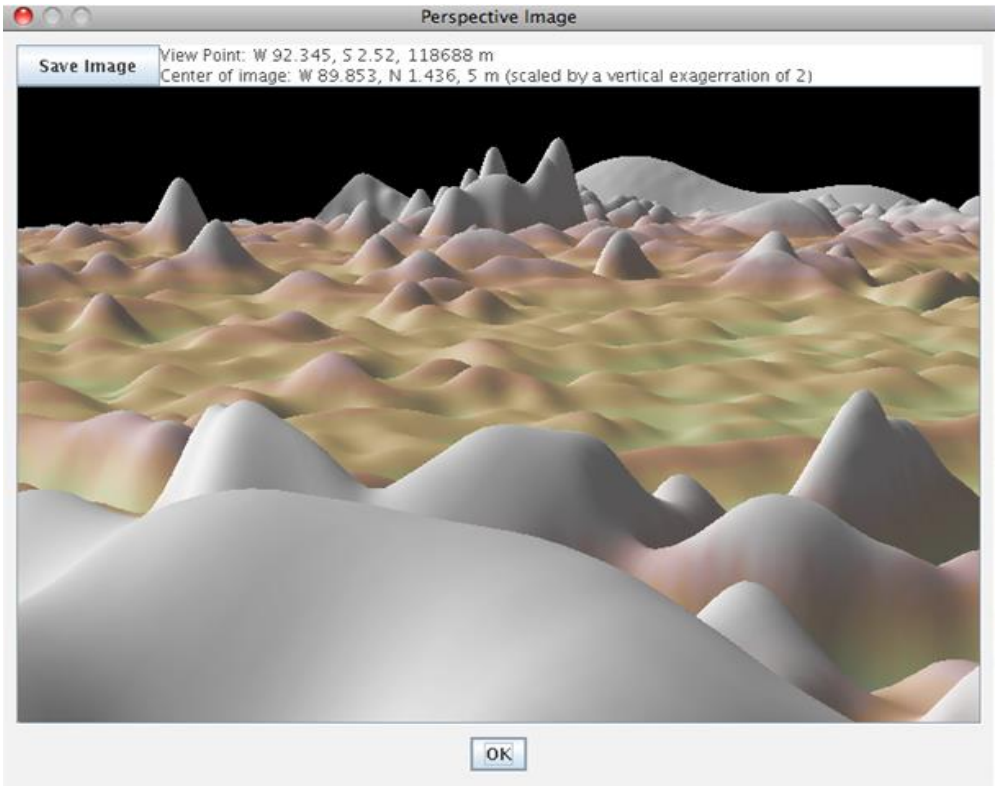
is selected, a 3-D perspective viewing window is opened. It shows a low-resolution version of the grid and allows various parameters to be altered.



Rotate the grid using the  button (drag cursor left or right in the preview image). Tilt the surface with  (drag cursor up or down in the preview image). Zoom in or out with the zoom  button (in preview image, drag cursor to the right to zoom out, and to the left to zoom in). Change the vertical exaggeration by typing the factor into the 

box. Specify the pixel size of the fully-rendered

image – the default 700 x 500 pixels works well with most laptop screens). Click Render as an Image to produce the full-resolution 3-D perspective plot.



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10.5) How to generate multiple profiles

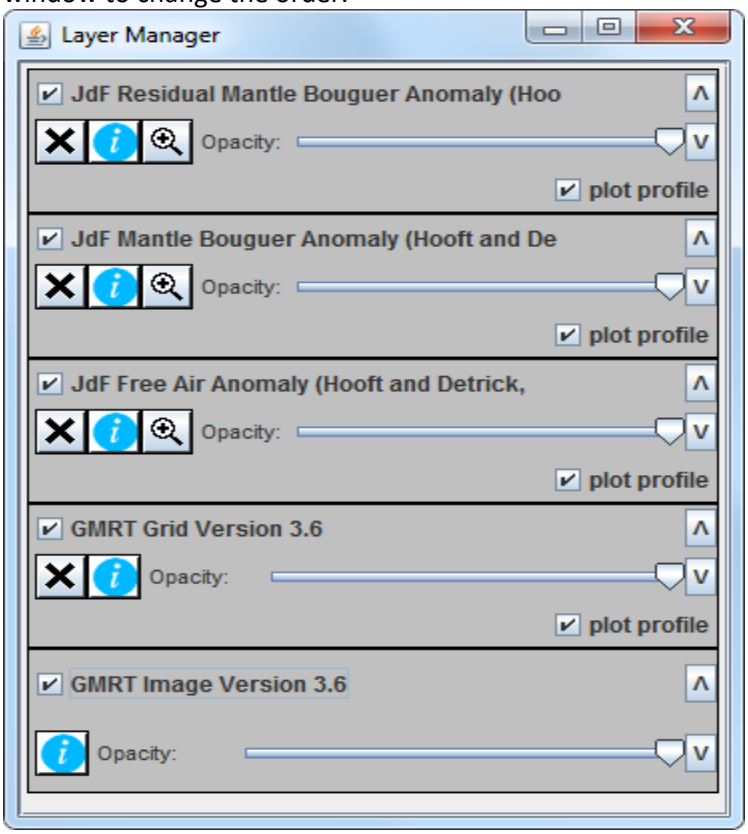
The ability in GeoMapApp to layer multiple data sets can be used to generate a stack of co-located profiles through multiple grids. Up to four loaded grids can be profiled as a stack in this way, and the grids can be built-in grids, imported grids, or a mixture.

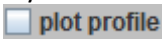
In the following example for the Juan de Fuca region, four grids have been loaded:

- The underlying GMRT global elevation model for seafloor bathymetry. Click the grid load shortcut in the toolbar to quickly load this: 
- Gravity free-air anomaly (FAA) grid from Hooft and Detrick (1995)
- Gravity mantle Bouguer anomaly (MBA) grid from Hooft and Detrick (1995)
- Gravity residual mantle Bouguer anomaly (RMBA) grid from Hooft and Detrick (1995)

The three gravity-related grids are built-in data sets. Find them under DataLayers > Geophysics > Gravity Anomalies and Geoid heights > Gravity Anomalies > By Region.

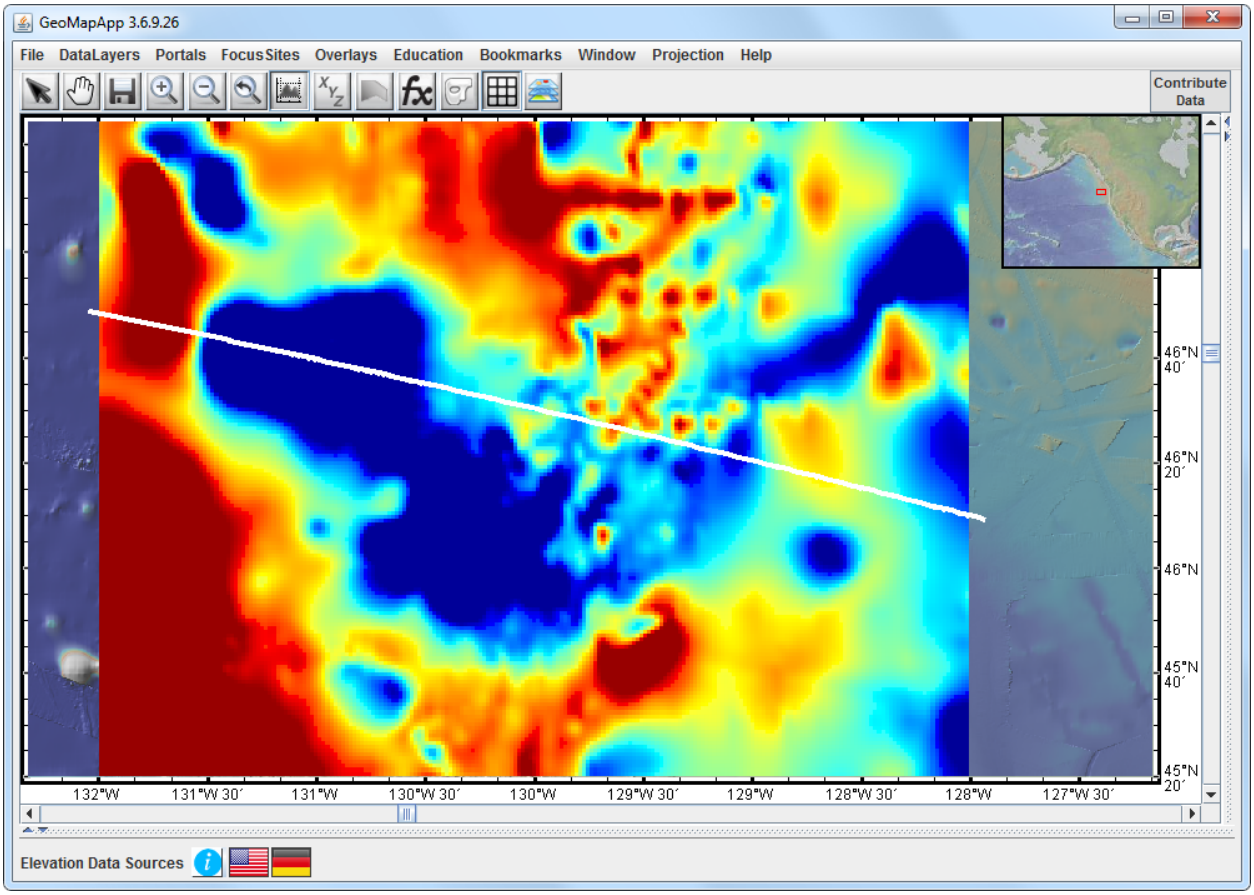
The grids can be loaded in any order – use the up/down arrows on the right side of the Layer Manager window to change the order.



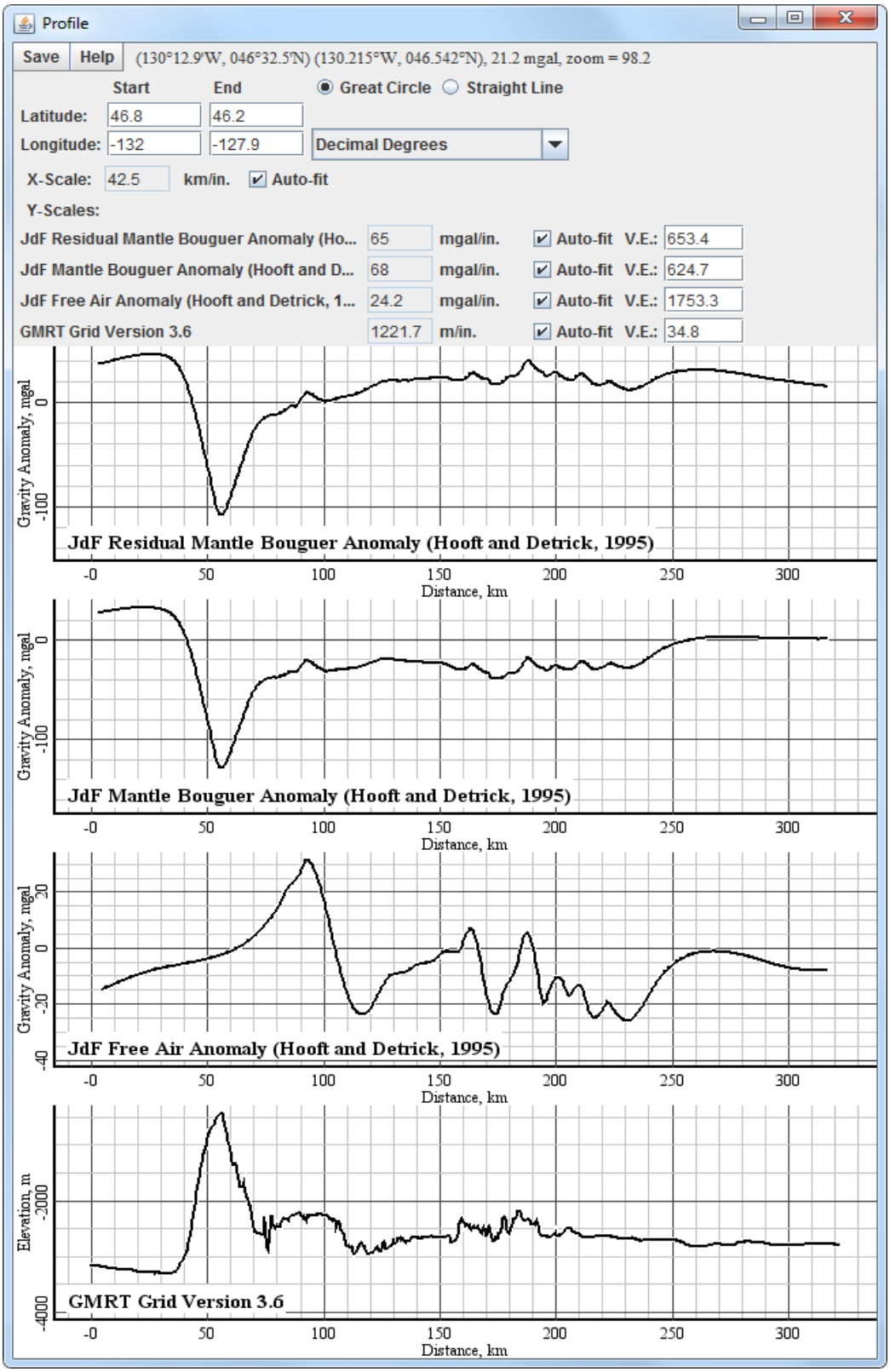
To exclude specific grids from being displayed in the stack of profiles, untick the Plot Profile box in the Layer Manager window, as shown here:  Only those profiles with ticked boxes will be displayed. By default, profiles for all grid layers are displayed, up to the maximum of four profiles.

The screenshot below shows the grids loaded in the map display. As shown in the Layer Manager, the RMBA grid is the top-most grid. The color palette was changed from the default to the “jet2” palette.

In the toolbar, click the  button to activate the Distance/Profiling tool. Then draw a profile line – it will be displayed in white on the map.



The vertical stack of co-registered profiles will be displayed in a new window, and the grid name is listed beneath each profile, like this:



Use the Save button in the upper left to save the profiles as an image file or as an ASCII data table.

10.6) How to sample a grid at user-specified points

Any 2-D loaded grid, whether built-in or imported, can be sampled at specific points using either the digitizer function or the *Waypoints and Survey Lines* portal.

To sample a grid at a small number of points or where only approximate values are required, the digitizer function may be the simplest approach. By default, the digitizer function will sample the GMRT global elevation model. If any other grid has been loaded, that other grid will be sampled instead. See the Digitizer section for more information.

To sample a grid at a large number of points or where precision is required, the *Waypoints and Survey Lines* portal allows a file of user-specified points to be imported. In the portal, the points are referred to as waypoints. In this manner, the GeoMapApp waypoints portal provides a grid sampling capability similar to the 2-D grid sampling function offered by the GMT grdtrack program. By default, the waypoints portal will sample the GMRT global elevation model. If any other grid has been loaded, that other grid will be sampled instead. See the Waypoints and Survey Lines portal section for more information.

In either approach, the digitized or imported points are interactive - drag the points on the map or manually edit the Lat/Lon values in the table to move points (double-click the table cell to edit a value).

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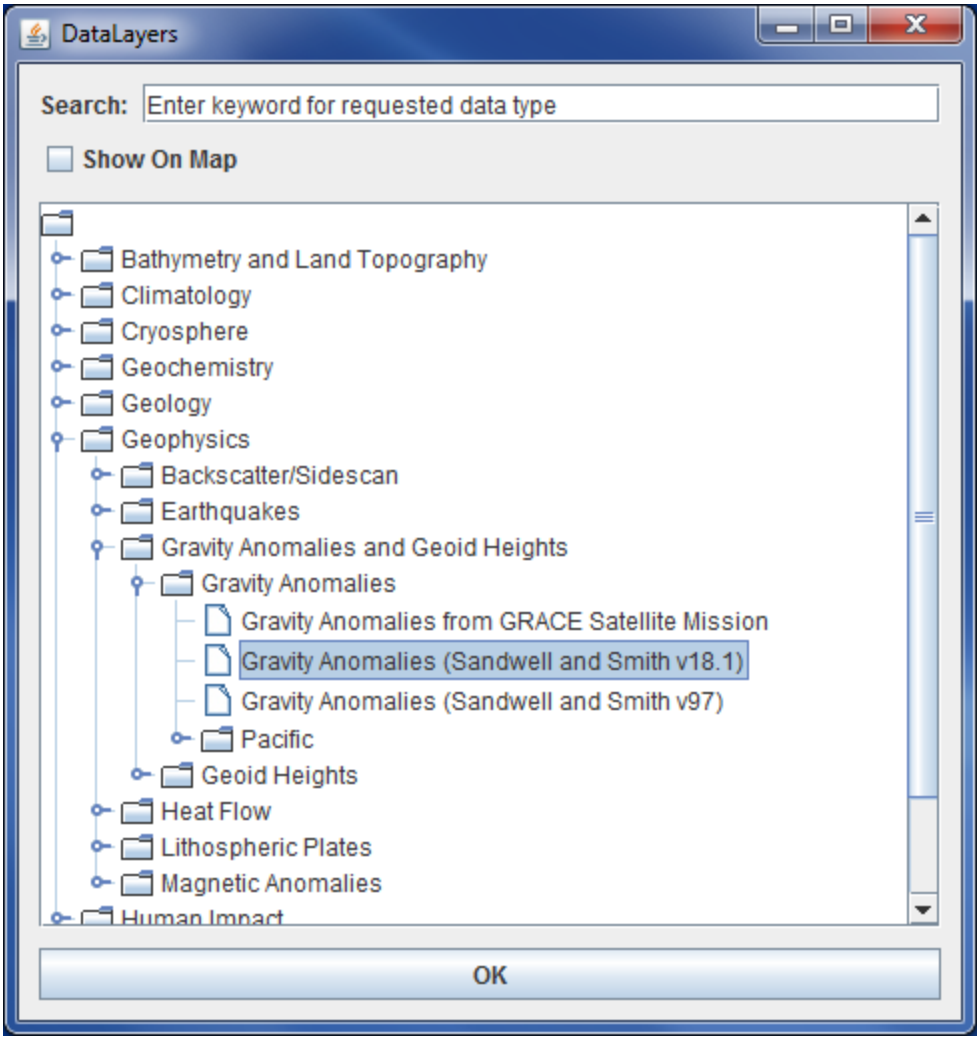
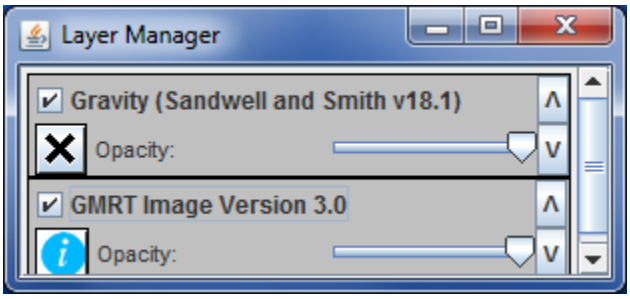
10.7) How to use the Layer Transparency

Layer transparency can be changed to allow other layers to become visible. This is useful for comparing data sets in different layers. In the following example, we compare satellite-derived free-air gravity anomalies for the Hawaiian islands with the regional bathymetry – we might want to do this when studying lithospheric flexure.

Zoom to the Hawaii region and load a gravity FAA data set (here, we use the tear-off menu option to simplify the menu navigation).



In the Layer Manager window, toggle the gravity data set off and on by unticking/ticking the ☑, ☐ box.



Slide the Opacity slider bar () to alter the transparency of the layer. When the bar is all the way to the right the layer is opaque. As the slider bar is moved to the left, the layer becomes increasingly transparent allowing the other layers to become visible. When the slider bar is all the way to the left (equivalent to unticking the ☑ box), the layer is completely transparent (invisible) and the underlying layer is fully visible. Click the discard box ☒ to discard the layer.

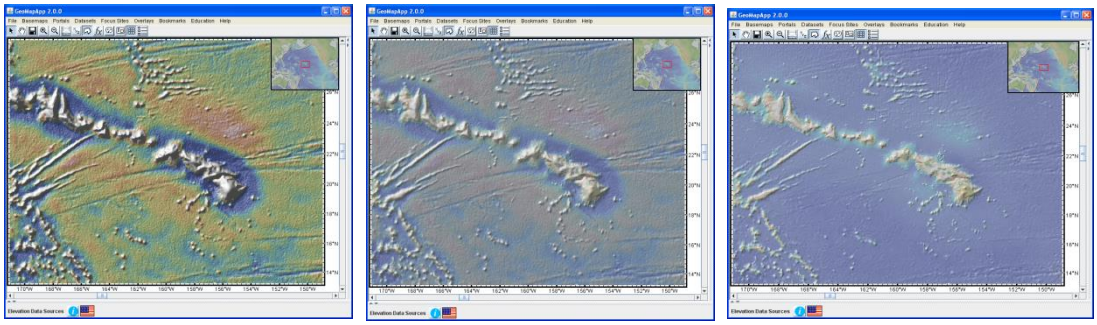


Figure: (Left) Layer is opaque and fully visible. (Middle) As opacity decreases, the underlying GMRT bathymetry becomes visible. (Right) When fully transparent, the original layer is no longer visible, allowing the GMRT layer to be displayed fully.

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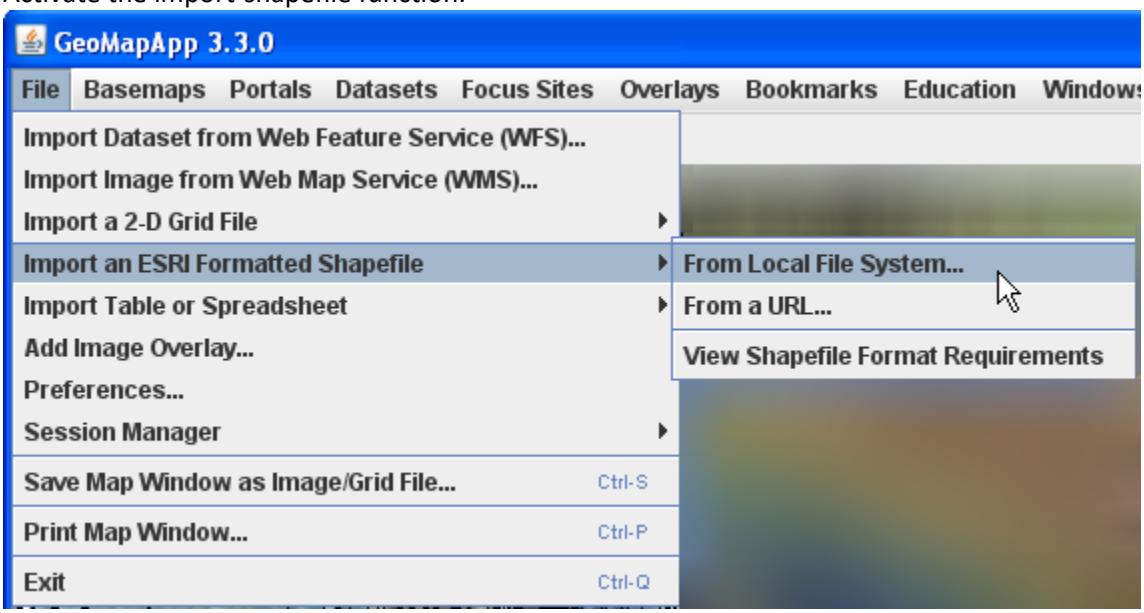
10.8) How to Import Data – Shapefiles

See video tutorial on YouTube

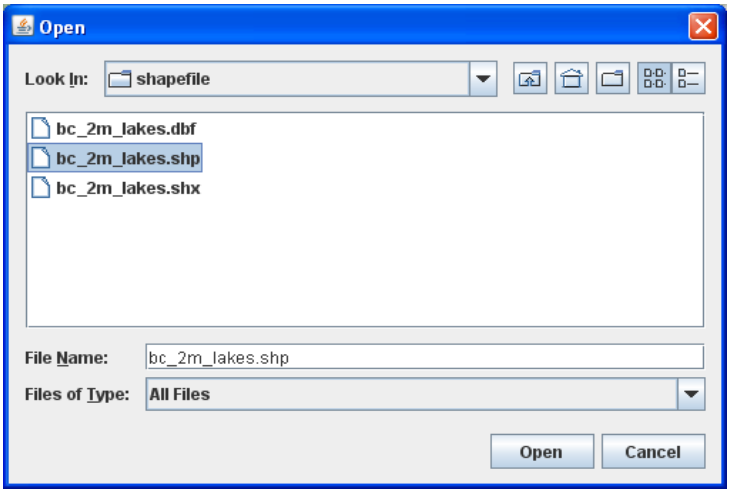
Shapefiles usually comprise a number of component files. To import a shapefile to GeoMapApp, the following component files must be present: .shp, .shx, .dbf.

Activate the import-shapefile function:

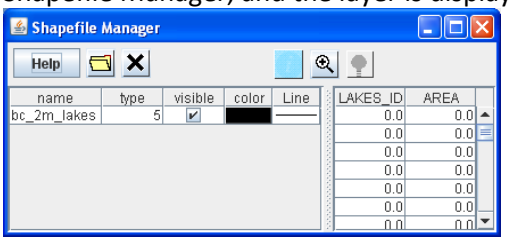


Navigate to the folder containing the shapefile component files and check that the .shp, .shx, .dbf are present. In this example, a shapefile contains the outlines of lakes at 2m resolution for British Columbia.

Select the .shp file (bc_2m_lakes.shp) and click Open



A Shapefile Manager window appears. The shapefile contents are listed in the right panel of the Shapefile Manager, and the layer is displayed on the map.



In the right panel, click on an item in the list to highlight that feature – on the map, the feature turns white.

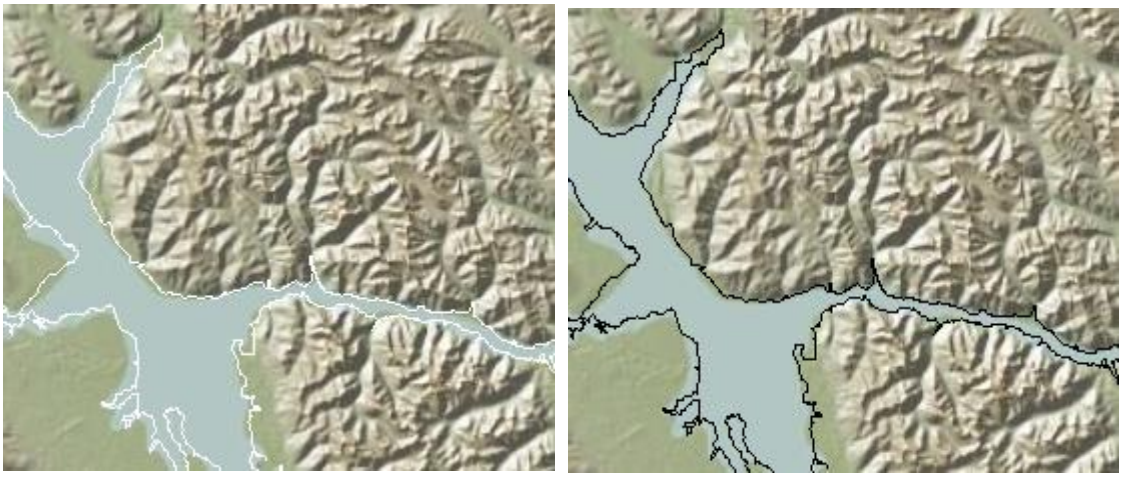


Figure: Close-up of British Columbia lake outlines. (Left) Shapefile component is selected (highlighted in white). (Right) Item is de-selected (outlined in black).

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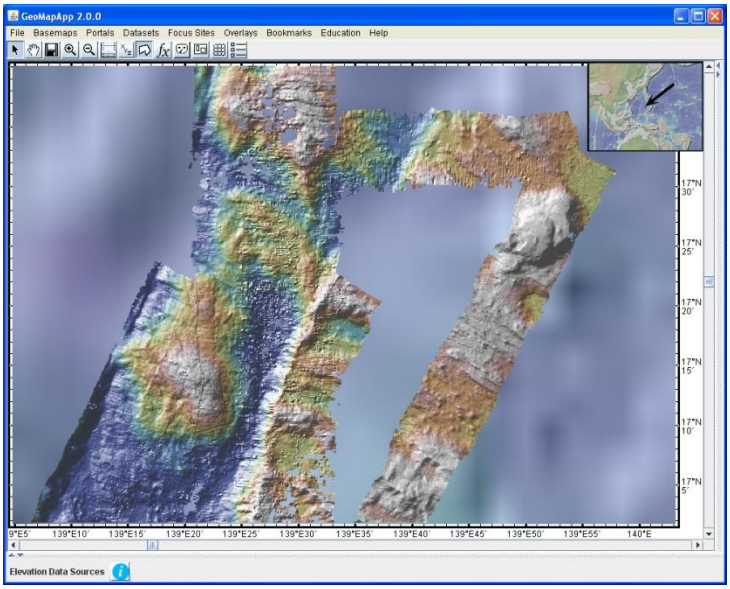
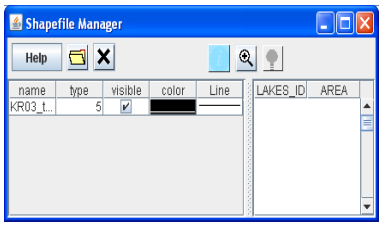
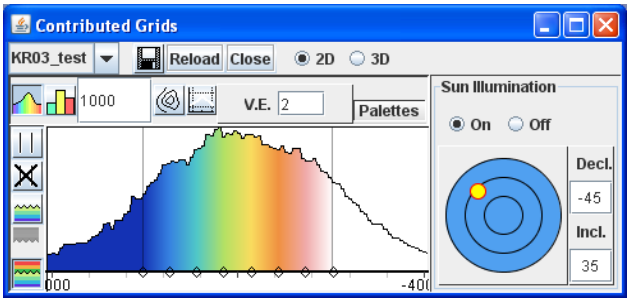
10.9) How to Import Data – Shapefiles of grids

When grids are imported to GeoMapApp, the import procedure automatically generates a shapefile of the grid. This shapefile can be imported at a later date without having to re-import or re-process the original grid.

Follow the steps above for importing shapefiles. Since the shapefile content is a grid, the grid dialog window also appears.







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10.10) How to Save a Session

GeoMapApp offers a Session Manager capability to save, share, and re-use a pre-loaded state of GeoMapApp. That can be useful and efficient when teaching, collaborating or simply as a convenient means to pick up where you left off.

The **Session Manager** function captures the loaded data layers and data portals, the map location, and zoom, any color palette, contouring and shading parameters, any layer transparency settings, and, for tabular data sets, any symbol color and scale choices. The information is stored as a small XML file that can be shared with colleagues and students. When a saved session file is imported, GeoMapApp automatically zooms to the geographical area and displays all of the previously-loaded data layers in the same way that they had been saved, including any coloring, contouring, scaling choices.

In teaching, a saved session could be shared with a class allowing every student to open GeoMapApp at exactly the same starting point from which to begin their data explorations.

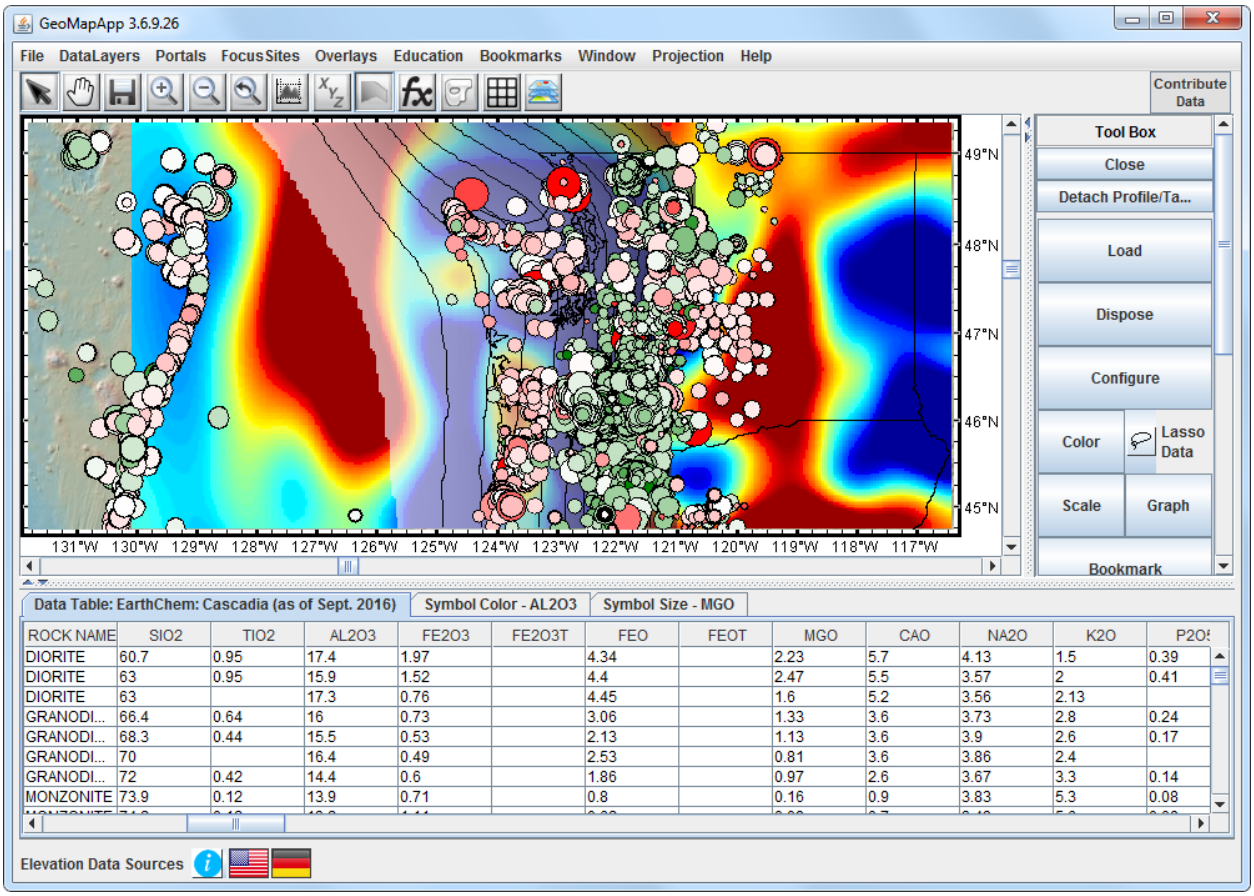
The Session Manager menu is under the File menu (File > Session Manager). It offers the following options:

Save the current display using the *Save Current Session* option. The saved information is stored in a simple, small XML file on the local machine. The name of the saved session file is, by default, constructed from the user name and a date and time stamp. Example: “Session_andrewg_2019-04-23_16-56-56-GMT-0400.xml”. The files can be manually renamed if desired.

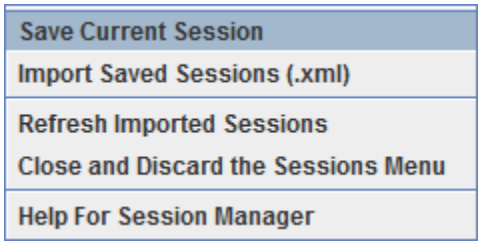
The contents of the saved session XML file tell GeoMapApp which data sets and display options are being used. For teaching or collaborating, that XML file is the one to share.

Most built-in data sets can be captured in the save session file. Note that any *imported* data sets such as any imported tables, spreadsheets, grids or shapefiles are excluded because there is no way to capture their content in the simple save session XML file.

In the Cascadia region example below, four built-in data sets have been loaded. (a) In the background, the bright reds and blues display a grid of shear wave seismic velocity data from a tomographic depth slice. (b) Overlain on that is a grey-shaded grid giving depth to the top of the subducting slab, with contours. (c) The outlines of state boundaries. (d) Geochemical data plotted as circular symbols that are colored on one analytical parameter and scaled in size on another parameter.



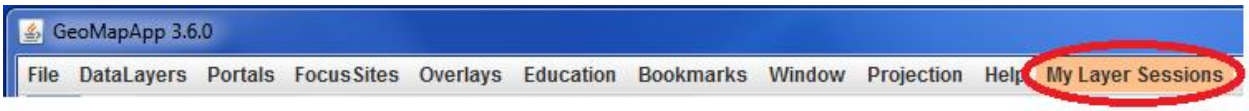
This snapshot state of GeoMapApp can be preserved by saving the session using *File > Session Manager > Save Current Session*. This action will save a small XML file on the local computer:



To import a saved session at a later time, go to *File > Session Manager > Import Saved Session* and navigate to and import the saved session file.

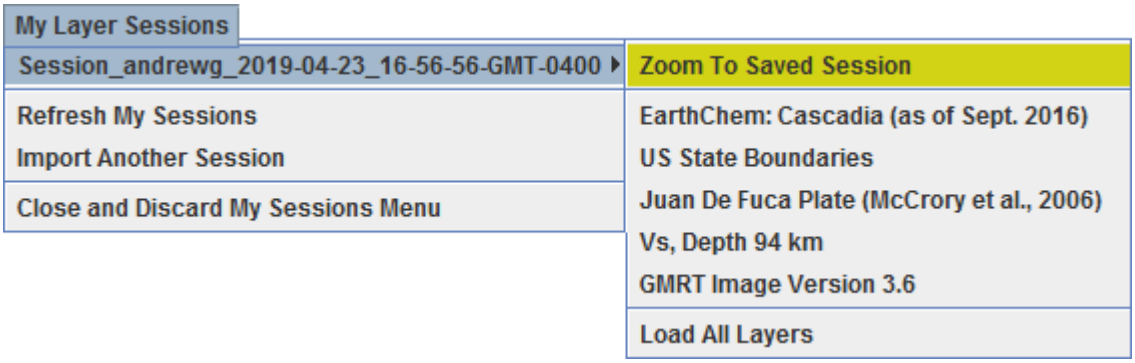
When the session file is read, the map will automatically zoom to the area and all of the associated data sets and data portals will be loaded. Any saved contour, transparency, color and symbol size scale options will be applied automatically. (Depending upon the speed of your internet connection and the data sets and portals being accessed, that may take a minute.)

When all of the components of the imported session have been loaded and displayed, a new menu called *My Layer Sessions* appears in the menu bar at the top of the GeoMapApp window.



Initially, the *My Layer Sessions* menu name is shown in orange to highlight its presence. Once the menu has been accessed, the orange color is removed.

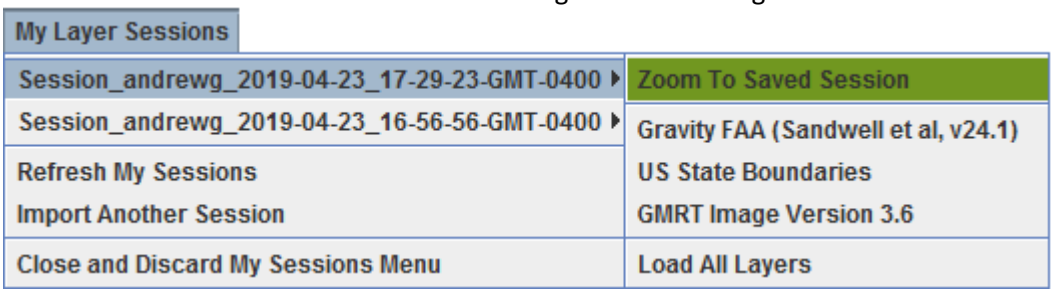
The *My Layer Sessions* menu lists the imported session and, when the cursor hovers over the session name, its component data sets are listed in a cascading menu on the right, like this:



On the right, the individual components in the saved session are listed in the same data layering order as in the original session. Individual layers may be loaded by clicking them. Or, all data sets can be loaded by selecting *Load All Layers*.

Additional sessions may be imported, either using File > Session Manager > Import Saved Session or via the *My Layer Sessions* menu (*My Layer Sessions* > Import Another Session).

When more two or more sessions have been imported, the sessions are displayed in a list. The most recently-imported session is listed at the top. This list allows users to switch from one saved session to another. In the example below, two sessions are listed on the left. The data layer components for the most recent session are shown in the cascading menu on the right:



Each imported session is tagged in the *My Layer Sessions* menu with a specific color in the component list to help distinguish one imported set of layers from another.

When multiple sessions have been imported, it is occasionally necessary to use the up-down arrows in the Layer Manager window to move the layers to the desired layering order.

The *Close and Discard My Sessions Menu* option removes the *My Layer Sessions* menu from the menu bar (the saved session files remain stored on the local machine). When the *My Layer Sessions* menu is discarded, the loaded data layers and zoom remain – they can be separately discarded using the Layer Manager window.

See also the My Layer Sessions section.

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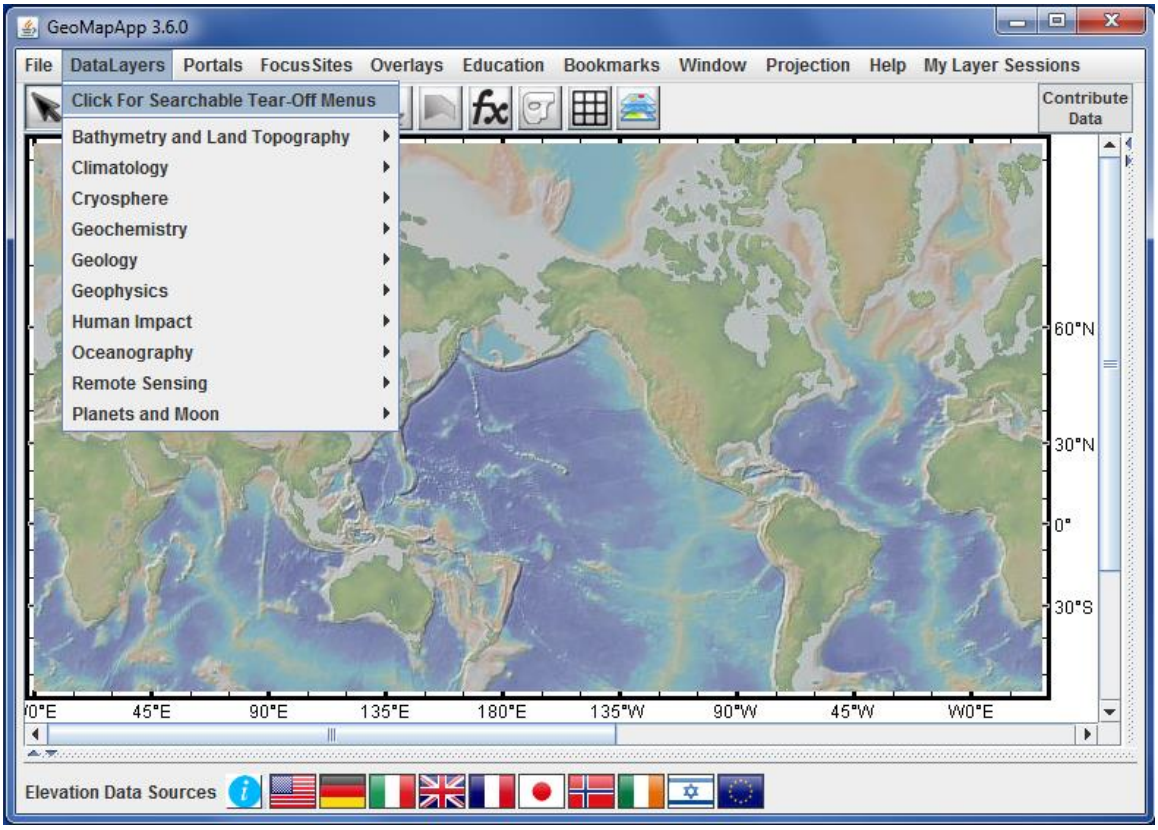
10.11) How to use the Tear-Off Menus, and search

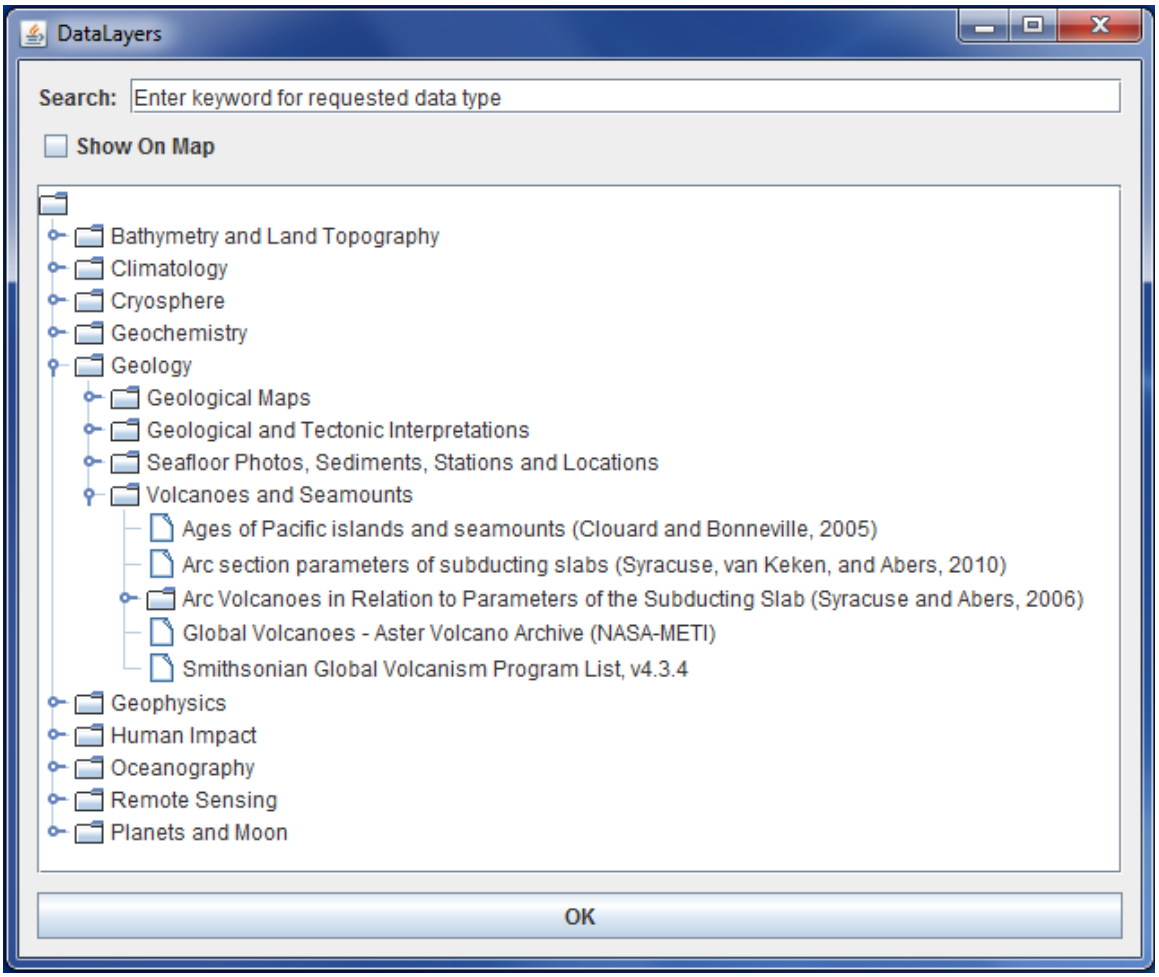
Sometimes, navigating the GeoMapApp cascading menus can be frustrating if the item of interest is embedded deep within the menu structure. Tear-off menu functionality can help. It generates a simple menu navigation window that remains open and active throughout a GeoMapApp session. It also offers a basic search capability.

Tear-off menus are available for the DataLayers, Portals, Focus Sites, Overlays, and Education menus.

To activate the tear-off menu function, click Click For Searchable Tear-Off Menus which turns blue when moused over.



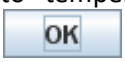
The corresponding menu navigation window opens, as shown below. In the menu navigation window, open a folder by either double-clicking the folder symbol ( ) or clicking the turn-down widget ( ).



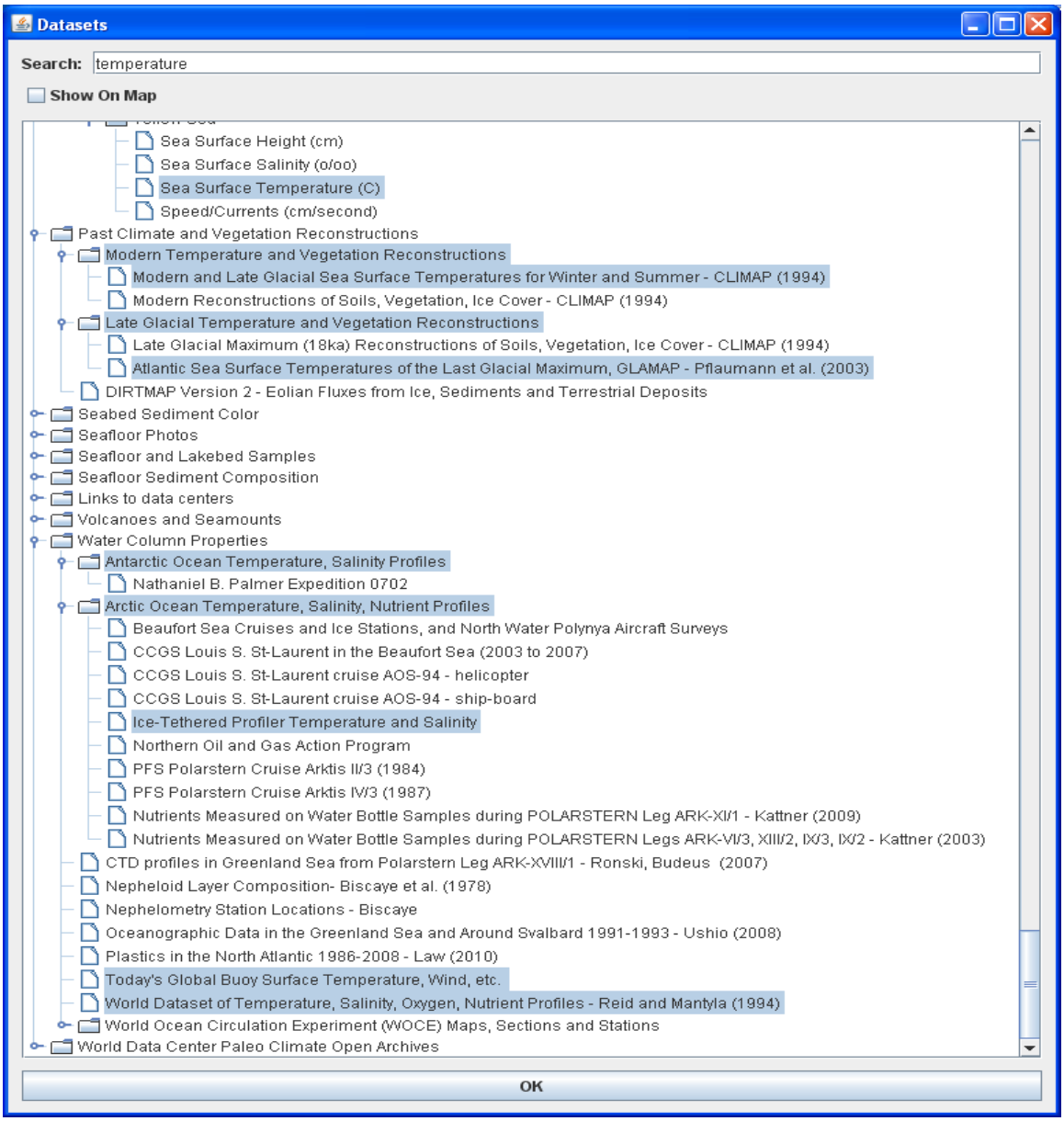
To load an item, select it from the menu listing and click the 

button.

Tear-off menus also allow folders to be opened in separate navigation windows. Drag the folder out of the navigation window. The folder instantly opens as a menu in a new, active window. Sub-folders are again active.

To search for a particular data type within each main GeoMapApp menu category, enter a key word in the tear-off menu textbox and hit the Enter key. In the example shown below, the DataLayers tear-off menu is open and a search for data types related to “temperature” will highlight all of the relevant menu items. Click one of the menu items and the 

button to load it in the map window.



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10.12) How to move and sort tabular columns

With any tabular data set loaded, the rows within a column can be sorted in ascending or descending order by clicking on the column header. The order of columns can be changed by clicking on the column header and dragging the column left or right.

Earthquakes Magnitude above 4.0 (1973-2006) Int'l Seismological Centre

Year	Month	Day	Time(hhmmss.mm)UTC	Latitude	Longitude	Magnitude	Depth
1973	1	25	222559.5	13.7	-89.32	4.4	100
1973	2	21	144557.3	34.06	-119.04	5.9	8
1973	6	7	183242.9	14.28	-92.01	6.2	78
1973	6	30	80857.6	13.76	-90.93	5.1	78
1973	7	27	194247.9	12.81	-86.67	5.3	199
1973	8	6	232916.6	33.97	-119.48	4.7	13
1973	8	19	221749.4	12.65	-88.51	5.1	68
1973	10	11	84006.5	13.26	-89.77	4.5	68

Earthquakes Magnitude above 4.0 (1973-2006) Int'l Seismological Centre

Longitude	Latitude	Magnitude	Depth	Year	Month	Day	Time(hhmmss.mm)UTC
-117.03	34.05	4	8	1974	1	31	60528.8
-93.03	33.96	4	1	1974	2	15	224901.8
-118.97	34.05	4	8	1974	10	8	5605.1
-118.08	34.08	4	8	1974	12	19	123616.9
-116.42	33.05	4	8	1975	10	14	111118.7
-90.12	13.65	4	96	1977	10	30	222839.5
-119.17	33.9	4	5	1978	5	23	91650.8
-117.45	34.15	4	4	1978	8	11	4730.1

Figure: For this ISC data set, the original configuration of the tabular data is shown in the upper panel. Beneath it, the latitude, longitude, magnitude and depth columns have been moved to the left, and the magnitude column has been sorted in ascending order.

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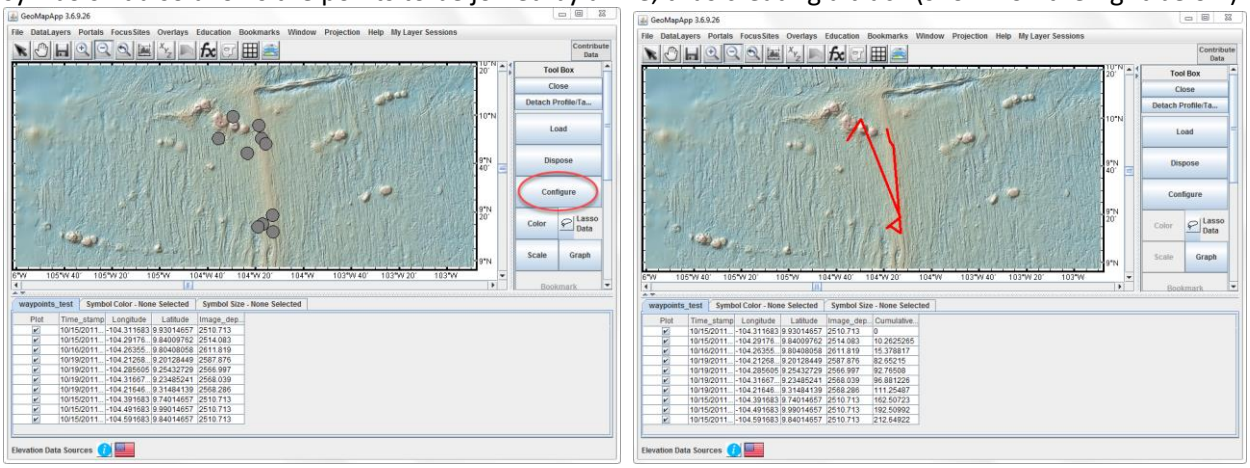
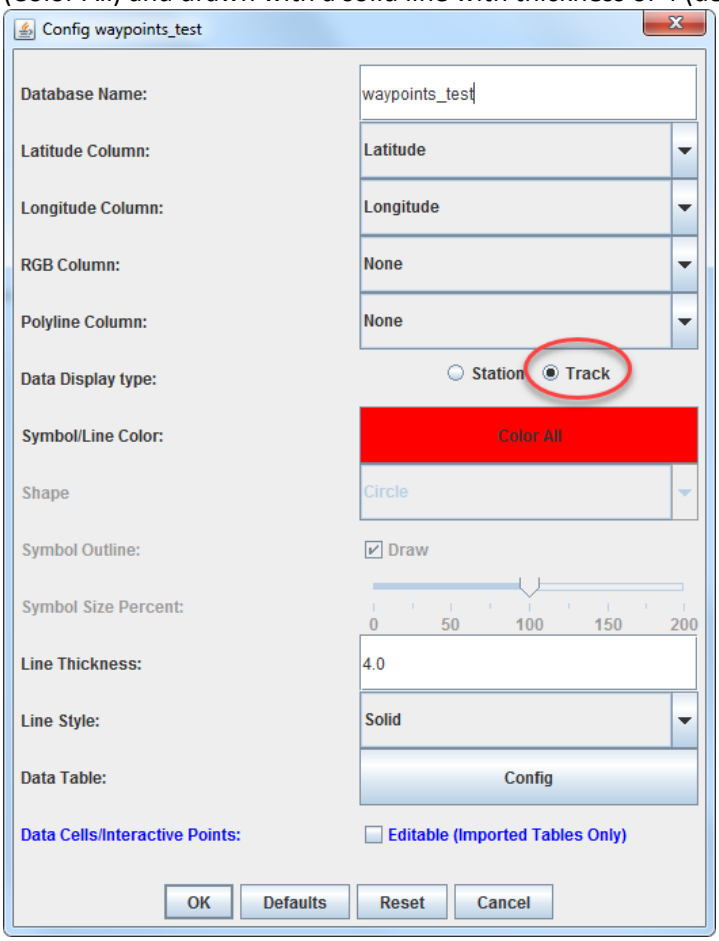
10.13) How to plot tabular data as a track instead of points

By default, tabular data, whether built-in or imported, is plotted as grey circles on the map (shown on the left below). The Configure button (circled in red) provides control over the size, type and color of the symbols. It also allows the points to be joined by a line, thus creating a track (shown on the right below).



To switch to a line, open the Configure window and select Track. In this example, the track is colored red (Color All) and drawn with a solid line with thickness of 4 (default is a grey line, thickness 1).

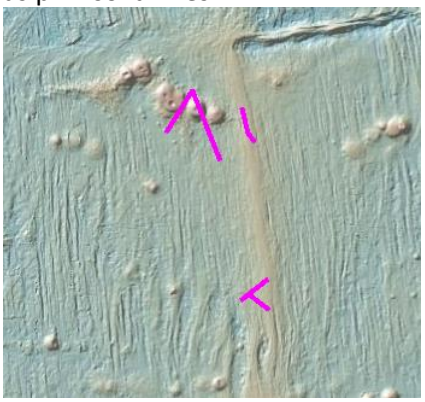


When plotting tabular data in track mode, the default is to join the points sequentially with one continuous line that runs from point to point.

Segment separators may be used to split the line into separate segments. The “>” character is used in the file to indicate the start of a new segment (it tells GeoMapApp to lift the pen). In the tab-delimited ASCII data table below, a comment line (starting with the “#” character) is used for naming three segments: Segment 1, Segment 2, Segment 3. The segments are defined with the “>” character. The “>” character must be on its own line and must be followed by a data line. For this reason, it is necessary to put any comments such as the segment names on the line before the segment separator. Note that it is unnecessary to have a segment separator at the top of the file.

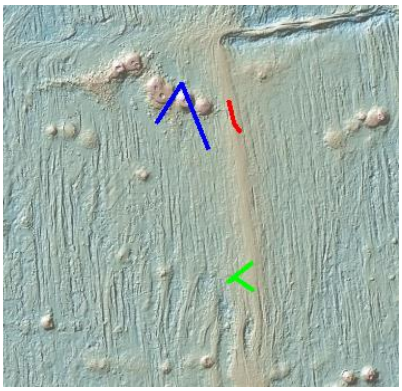
```
Time_stamp      Longitude       Latitude        Image_depth (m)
# Segment 1
10/15/2011 20:00        -104.311683     9.93014657      2510.713
10/15/2011 22:27        -104.2917611    9.84009762      2514.083
10/16/2011 22:44        -104.2635537    9.80408058      2611.819
# Segment 2
>
10/19/2011 03:16        -104.2126845    9.20128449      2587.876
10/19/2011 07:26        -104.285605     9.25432729      2566.997
10/19/2011 07:42        -104.3166719    9.23485241      2568.039
10/19/2011 07:52        -104.2164668    9.31484139      2568.286
# Segment 3
>
10/15/2011 20:00        -104.391683     9.74014657      2510.713
10/15/2011 20:00        -104.491683     9.99014657      2510.713
10/15/2011 20:00        -104.591683     9.84014657      2510.713
```

When plotted in Track mode, the segment separators split the track into three segments, here plotted as pink solid lines:

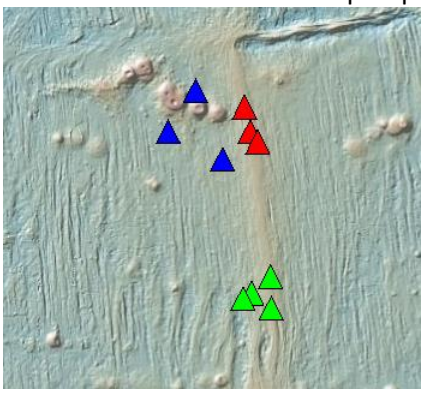


It may be preferential instead to plot the line segments in different colors. For that, an RGB column must be added to the table. The RGB column gives the comma-separated Red,Green,Blue values (in the range 0-255). In the example below, an RGB column was added to color the first segment red, the second segment green, and the third segment blue.

```
Time_stamp      Longitude       Latitude        Image_depth (m) RGB
# Segment 1
10/15/2011 20:00        -104.311683     9.93014657      2510.713        255,0,0
10/15/2011 22:27        -104.2917611    9.84009762      2514.083        255,0,0
10/16/2011 22:44        -104.2635537    9.80408058      2611.819        255,0,0
# Segment 2
>
10/19/2011 03:16        -104.2126845    9.20128449      2587.876        0,255,0
10/19/2011 07:26        -104.285605     9.25432729      2566.997        0,255,0
10/19/2011 07:42        -104.3166719    9.23485241      2568.039        0,255,0
10/19/2011 07:52        -104.2164668    9.31484139      2568.286        0,255,0
# Segment 3
>
10/15/2011 20:00        -104.391683     9.74014657      2510.713        0,0,255
10/15/2011 20:00        -104.491683     9.99014657      2510.713        0,0,255
10/15/2011 20:00        -104.591683     9.84014657      2510.713        0,0,255
```



The RGB column coloring also works when plotting the data table as points (in the Configure window, switch back to Station to plot points). Here the symbols are changed from default circles to triangles:



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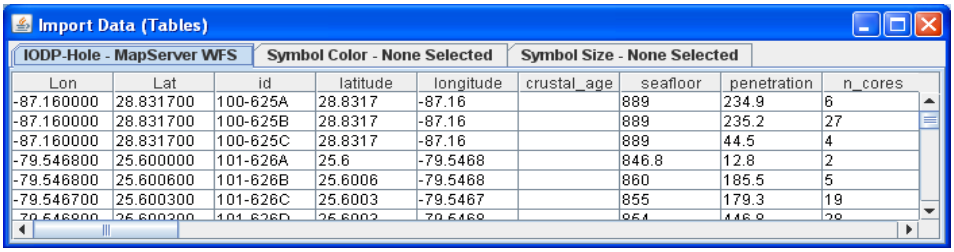
10.14) How to Detach or Re-Attach Tables

When any tabular data set is loaded, click Detach Table in the upper right. This detaches the table, allowing the map window to become larger and the self-contained table to be moved around the screen.



Lon	Lat	id	latitude	longitude	crustal_age	seafloor	penetration	n_cores
-87.160000	28.831700	100-625A	28.8317	-87.16		889	234.9	6
-87.160000	28.831700	100-625B	28.8317	-87.16		889	235.2	27
-87.160000	28.831700	100-625C	28.8317	-87.16		889	44.5	4
-79.546800	25.600000	101-626A	25.6	-79.5468		846.8	12.8	2
-79.546800	25.600600	101-626B	25.6006	-79.5468		860	185.5	5
-79.546700	25.600300	101-626C	25.6003	-79.5467		855	179.3	19

Example of free-floating, detached table, in this case for the IODP web feature service.

Click Attach Table to re-connect the table to the map window.

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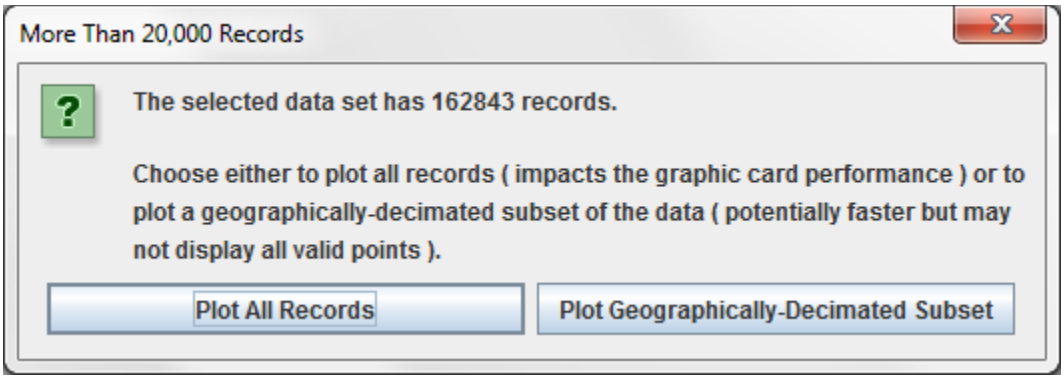
10.15) How to load data sets with many points

For large data sets, GeoMapApp displays a notice if there are more than 20,000 points asking if all points should be plotted or just a decimated set. In this example, the data set contains 162,843 records:



If *Plot All Records* is chosen, all of the points will be plotted on the map. For very large data sets, more memory may need to be allocated to GeoMapApp may have to be started – see the details in the Download and start GeoMapApp section.

If *Plot Geographically-Decimated Subset* is chosen, all of the records will be read into operating memory but no more than 20,000 points will be plotted in the map window. The displayed decimated points are chosen to be representative of the geographical distribution of the entire data set although some quirks are known to occur. Do not worry – the hidden points have not been lost. Upon zooming in, more of the points become visible.

Although modern computers tend to contain high-performance graphics cards compared to older computers, the decimation option is still provided for users who may be using older machines.

GeoMapApp now allows the display parameters for multiple tabular data sets to be visible at the same time. So, the display parameters for one tabular data set will be preserved and will remain visible when a second tabular data set is loaded. To help distinguish one tabular data set from another, we recommend that you use a different symbol for each data set. To select a symbol click the Configure button in the right pane and choose from circle, square, triangle and star.

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11) Miscellaneous

11.1) GeoMapApp Built-In Data Sets

GeoMapApp offers a wide range of research-grade built-in data sets covering a broad array of geoscience fields. The built-in data sets are presented through the DataLayers menu.

The data sets may be explored by navigation through the cascading menus or by searching the menus using key words, as described in this section.

A web page lists recently-added data sets: http://www.geomapapp.org/data_set_news.html

In addition, some remote data sets that are served via web feature or web mapping services such as those served by federal agencies or data repositories are available through the following two menus:

File > Import Data Set from Web Feature Service (WFS)
File > Import Image from Web Map Service (WMS)

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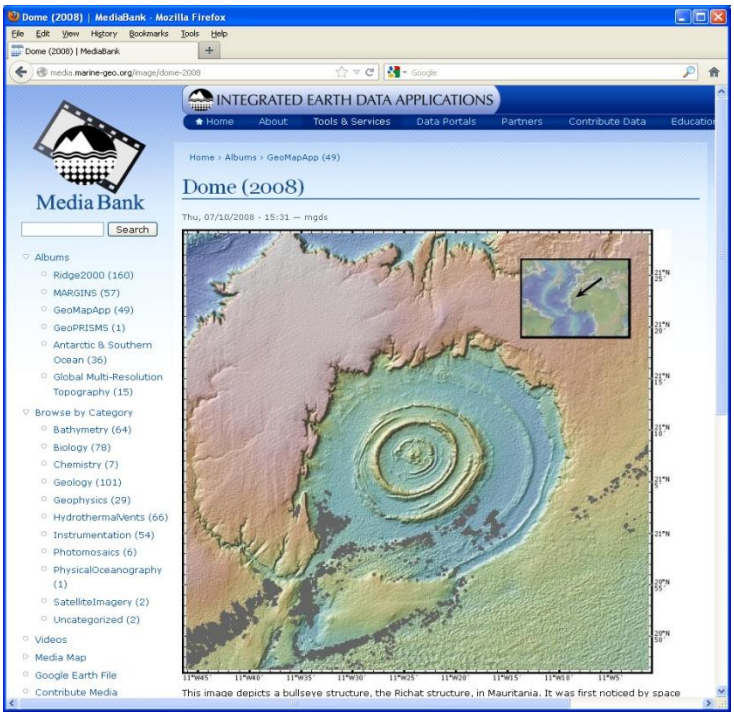
11.2) GeoMapApp Image Gallery

A number of compelling GeoMapApp images are available via MGDS MediaBank which can be accessed via the *Image Gallery* link on the GeoMapApp web page.



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11.3) Citing GeoMapApp

When citing cite GeoMapApp, please reference its use and include the URL **http://www.geomapapp.org/** in text and figure captions.

If you generate a map or image using the default base map, the Global Multi-Resolution Topography (GMRT) Synthesis, please also cite ***Ryan et al., 2009*** in your paper's reference list.

Ryan, W.B.F., S.M. Carbotte, J.O. Coplan, S. O'Hara, A. Melkonian, R. Arko, R.A. Weissel, V. Ferrini, A. Goodwillie, F. Nitsche, J. Bonczkowski, and R. Zemsky (2009), Global Multi-Resolution Topography synthesis, Geochem. Geophys. Geosyst., 10, Q03014, doi:10.1029/2008GC002332.

Additionally, you may wish to cite the GMRT web page:
https://www.gmrt.org/

11.4) Frequently-Asked Questions

A regularly updated FAQ page is available, here: http://www.geomapapp.org/FAQ.html

11.5) User Forum

A user forum is available for users to post questions and comments: http://forum.geomapapp.org/
The forum currently hosts more than 60 topics and has more than 200 posts.

11.6) Contact us, and the GeoMapApp listserv

Questions about GeoMapApp, as well as suggestions for improvements and notification of any bug, should be sent to info@marine-geo.org

To join the GeoMapApp mailing list, go to the Mailing List link under the Help menu.

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