

Geochemistry Symbol Plotting and Analysis

The Geochemistry system provides a variety of symbol plotting and analysis tools including interactive colour symbol classification, multi-parameter symbol plotting (Bar, Rose and Pie Plots), symbol plotting using data from two channels and the principal component and factor analysis tool.

Geosoft provides sample data for you to use when working through these How-To Guides. These data files can be found in your ".../Geosoft/resourcefiles/data/geochemistry" folder.

This How-To Guide will show you how to the following:

1. [Set Geochemistry Preferences](#)
2. [Create a New Map and Basemap](#)
3. [Interactive Colour Symbol Classification](#)
4. [Multi-parameter Symbol Plotting](#)
5. [Symbol Plotting using Data from Two Channels](#)
6. [Principal Component and Factor Analysis](#)

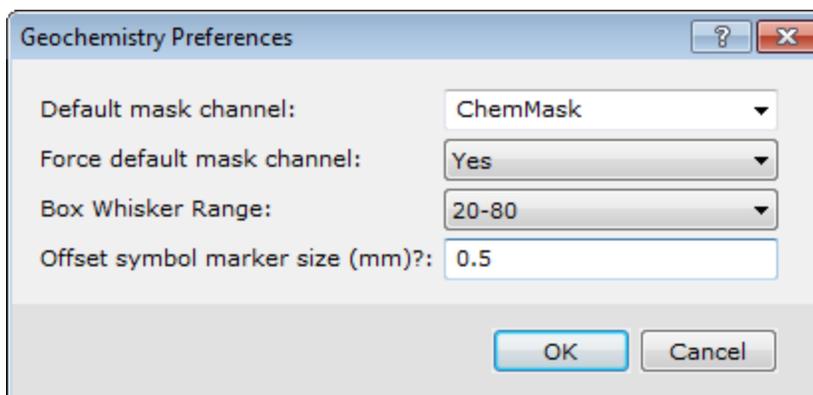
Setting Geochemistry Preferences

Preferences are global variables, and remain set for a given installation of Oasis montaj. The values are stored inside the user's Advanced Settings file (Edit|Settings|Advanced). This means they remain the same for different data sets and Oasis montaj projects.

Setting Geochemistry Preferences

Use the *Geochemistry Preferences* dialog to customize the global variables in the Geochemistry system.

1. On the *GeochemMap* menu, select **Preferences**.
The *Geochemistry Preferences* dialog appears.



2. From the dropdown lists select the *Default mask channel*, *Force default mask channel* and *Box Whisker Range*.
3. Specify the *Offset symbol marker size (mm)?*.

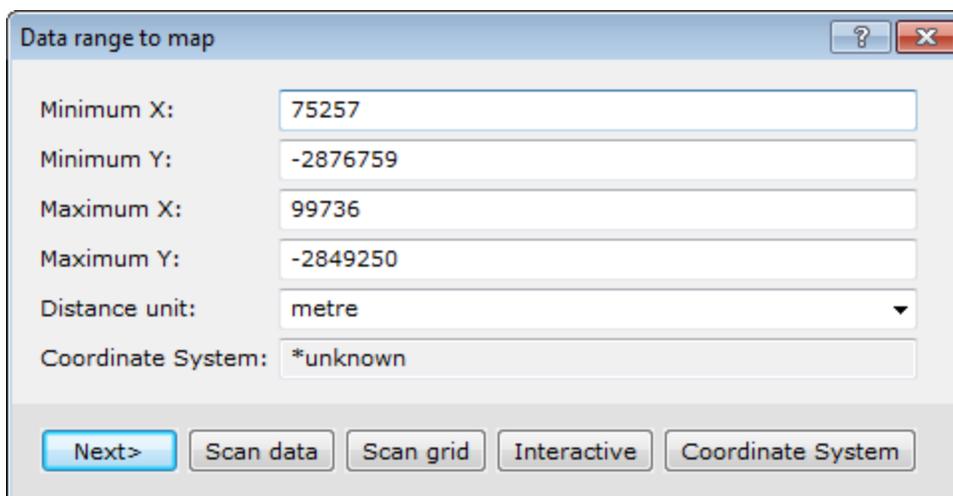
 The Default mask channel will become the default mask channel in any dialog where the selection of the mask channel has not been set. When setting the Force default mask channel to (Yes) the mask channel setting will always be initialized to this value (you may of course still select any value from the drop down list). The Box Whisker Ranges available are 20-80 or 25-75.

 For more information, click the **Help** button on the Geochemistry Preferences dialog.

Creating a New Map

You must create a new map before you can plot your classified symbols.

1. Select the database.
2. On the *GeochemMap* menu, select **New Map**. The Data range to map dialog is displayed. This dialog is used to specify the extent of the data you want to map.



The screenshot shows a dialog box titled "Data range to map". It has a title bar with a question mark icon and a close button (X). The dialog contains the following fields and controls:

- Minimum X: 75257
- Minimum Y: -2876759
- Maximum X: 99736
- Maximum Y: -2849250
- Distance unit: metre (dropdown menu)
- Coordinate System: *unknown

At the bottom of the dialog, there are five buttons: "Next>", "Scan data", "Scan grid", "Interactive", and "Coordinate System".

3. Click **Scan data** to automatically scan this information from the current open database. After scanning the database for the X and Y data range, the system updates the fields in the dialog with the new information.
4. Select the correct *Distance unit* from the dropdown list.
5. If you would like to define a Coordinate System for the map, click **Coordinate System**. The *Coordinate System* dialog will be displayed. Select your coordinate system and click the **OK** button to return to the *Data range to map* dialog and the Coordinate System will be displayed (as shown below).

6. If you would like to define the data range interactively on a current map, click **Interactive**. Select the data range by defining a rectangular area on the current map.
7. Click **Next>** to continue. The *Create a New Map* dialog appears.

8. Specify the *Map name*.
9. Use the dropdown list to select the *Map template*. Map templates define the orientation and layout of the map. To customize a template, click **Templates**.



For detailed instructions on map templates, see the Online Help.

10. Click **Scale** to scan the scale from the grid or database. The system picks the scale that will make the grid or data best fit the map. Optionally, adjust the scale to a workable number by entering it manually, e.g., "250000".
11. Click **Finish**. The system displays a new blank map on the screen.

Add a Base Map

The basic components of a base map include:

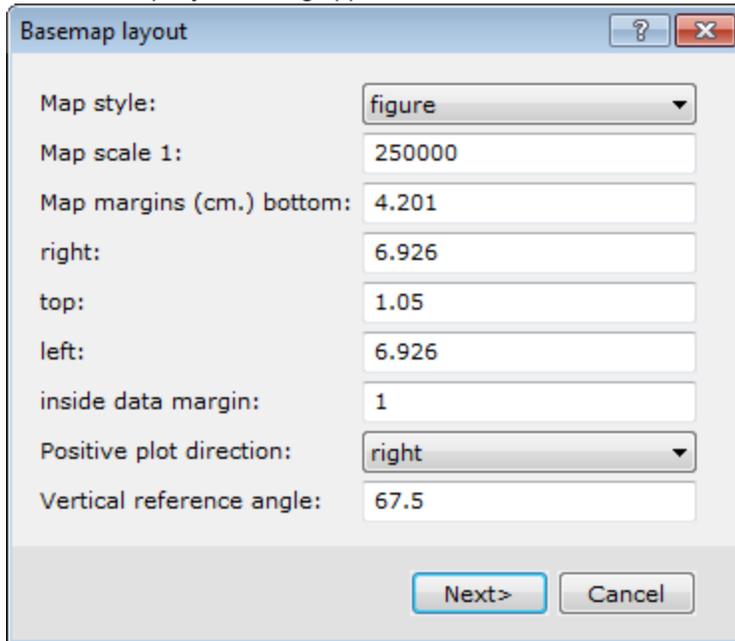
- > Surround (line around the map)
- > North arrow
- > Scale bar

- > Title block for large maps or title text for small figure maps
- > Map grid annotations

Creating and Plotting a Base Map

1. Select the map with which you want to work.
2. On the *GeochemMap* menu, select **Draw Base Map**.

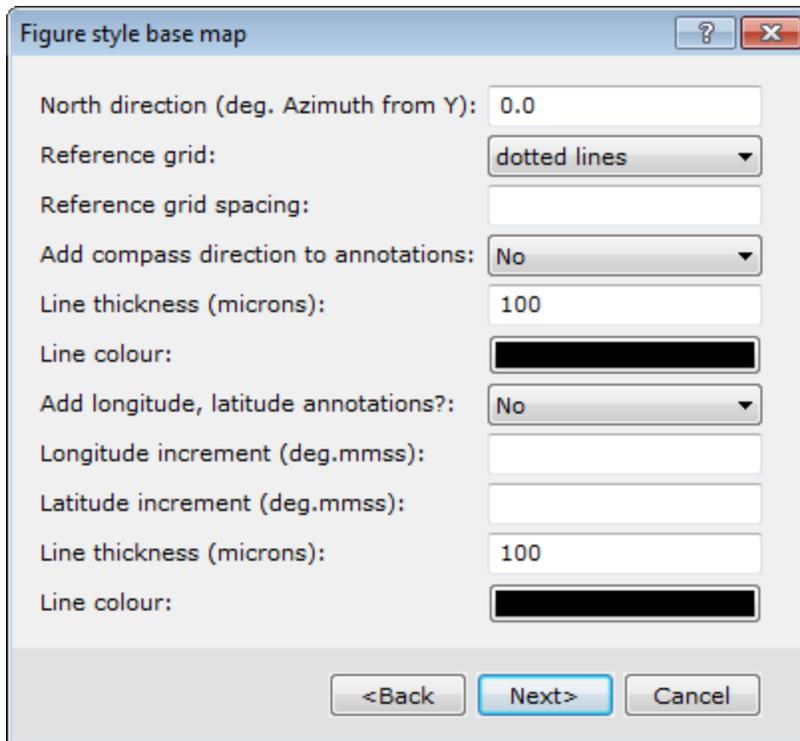
The Basemap layout dialog appears.



3. Use the *Map style* dropdown list to select the map style as, *map*, *figure*, or *custom control file*.
4. Specify the remaining parameters, or accept the intelligent default values.
5. Click **Next>**. The *Figure style base map* dialog appears.



Depending on the Map style selected, subsequent dialogs might differ.

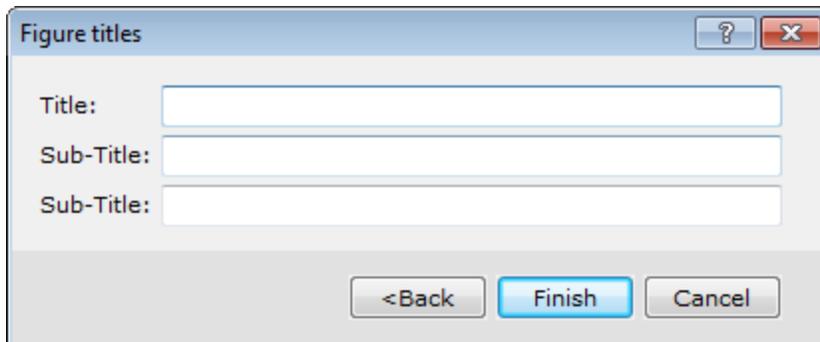


The 'Figure style base map' dialog box contains the following fields and controls:

- North direction (deg. Azimuth from Y):
- Reference grid:
- Reference grid spacing:
- Add compass direction to annotations:
- Line thickness (microns):
- Line colour:
- Add longitude, latitude annotations?:
- Longitude increment (deg.mmss):
- Latitude increment (deg.mmss):
- Line thickness (microns):
- Line colour:

Buttons: <Back, Next>, Cancel

- Set the parameters for your base map, including the reference grid and line details.
- Click **Next>**. The *Figure titles* dialog appears.

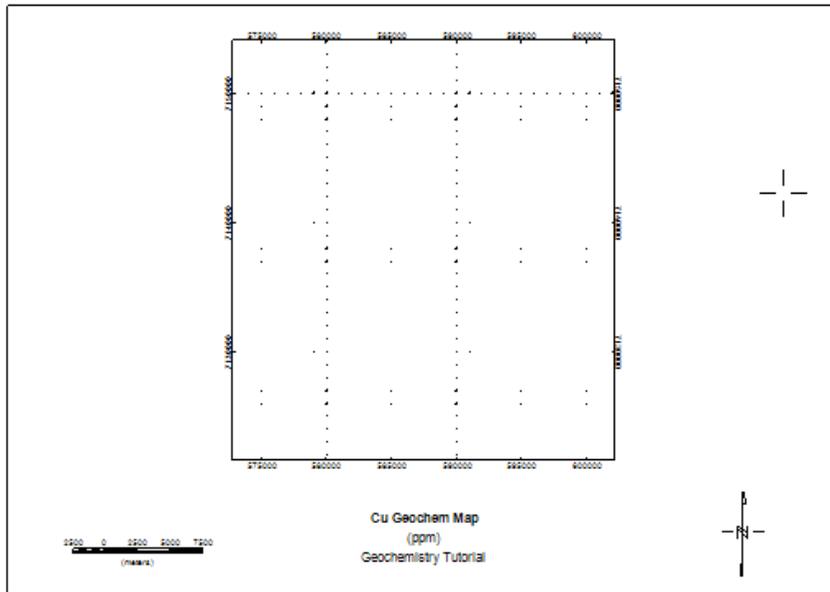


The 'Figure titles' dialog box contains the following fields and controls:

- Title:
- Sub-Title:
- Sub-Title:

Buttons: <Back, Finish, Cancel

- Enter the *Title* and *Sub-Title(s)* for your map.
- Click **Finish**. The map is displayed. An example is shown below.



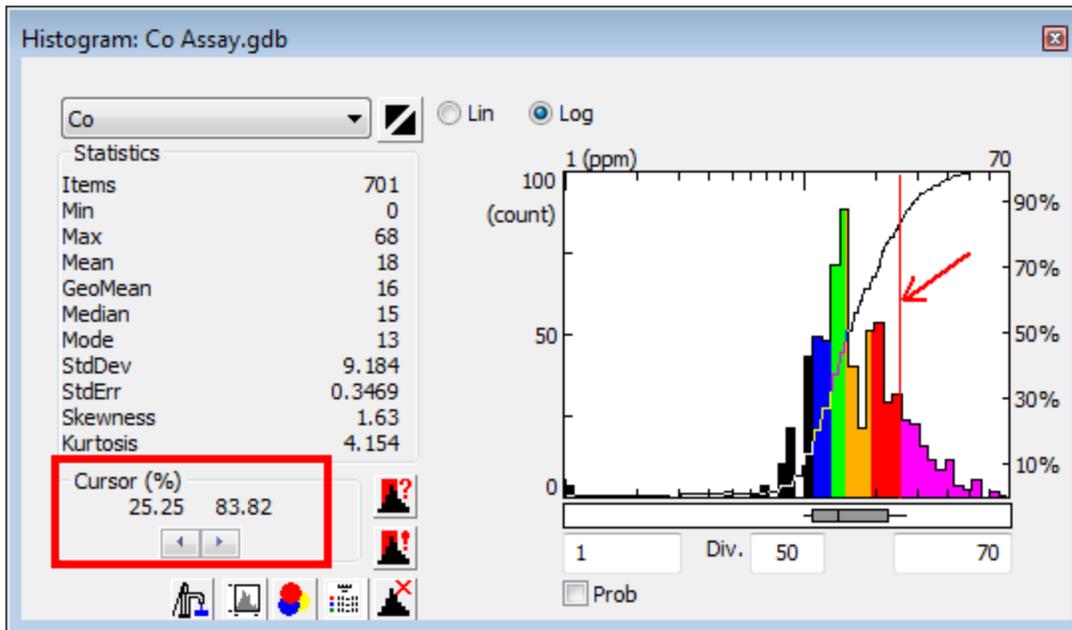
Interactive Colour Symbol Classification

Before you can create a classified symbol plot, you must obtain zones for plotting. An easy way to do this is via the *Histogram Tool*. The first step is to analyse your data to determine zones for classification. The second step is to plot your classified symbols on a map.

Identifying Zones for Plotting

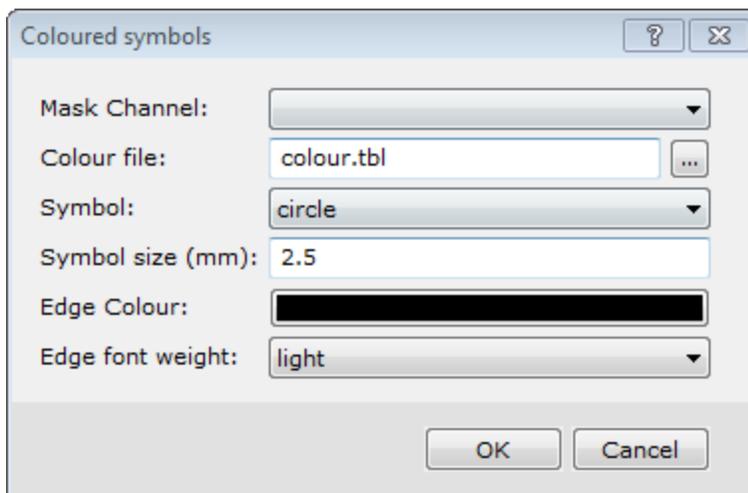
1. Open and select a Histogram tool, in the histogram window click the appropriate histogram box, or you can press the arrow buttons in the *Cursor %* box, to position the red line cursor.

2. Read data values directly from the cursor box on the screen.



Plotting Classified Symbols

1. Make sure a map is selected in your project and the *Histogram Analysis* Tool is opened.
2. In the *Histogram Analysis Tool*, click the **Plot classified colour symbols on the current map** () button. The *Colored symbols* dialog appears.



3. Select the *Mask Channel* if one is used.
4. Specify the *Colour file* used to colour the symbols.



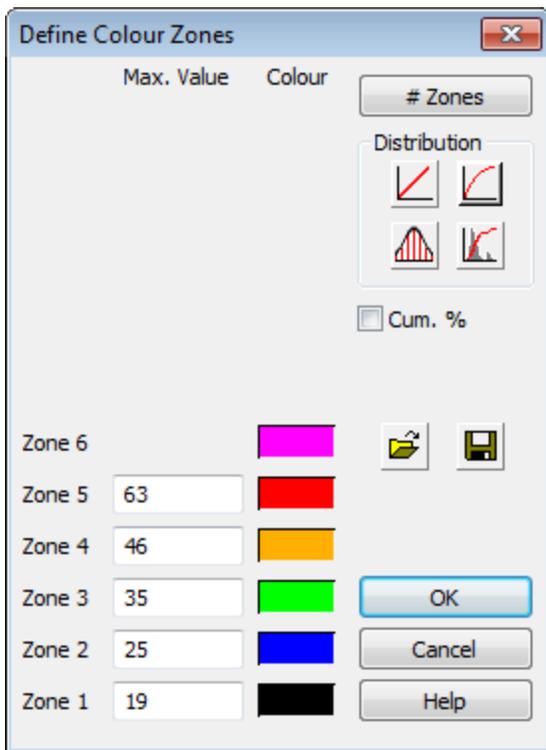
The system uses a default colour table called *colour.tbl*. This ASCII file initially defines 256 colours. Since the zoning in the Colour Symbol Tool only enables you to specify 8 zones, we recommend you change this file to *8.tbl*. If you want to make this change permanent, change the default colour table using the Global Settings|General menu option.

5. Specify the *Symbol*, *Symbol size*, and *Edge Colour* options.
6. Click **OK**. The system displays the colour symbols on the map in the background and displays the *Colour Symbol Tool* in the foreground.



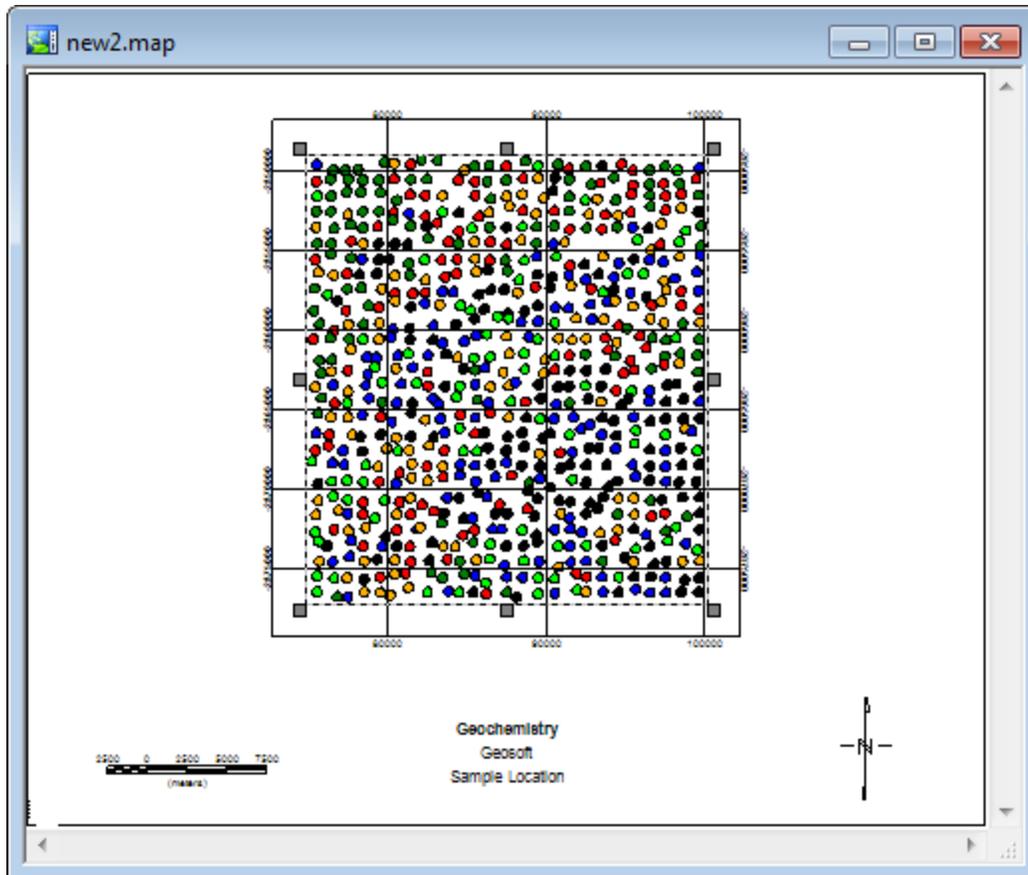
Note that the palette bar on the left has only six colours as defined by the colour table.

8. Click the **Define Divisions Manually** button () . The *Define Colour Zones* tool appears.



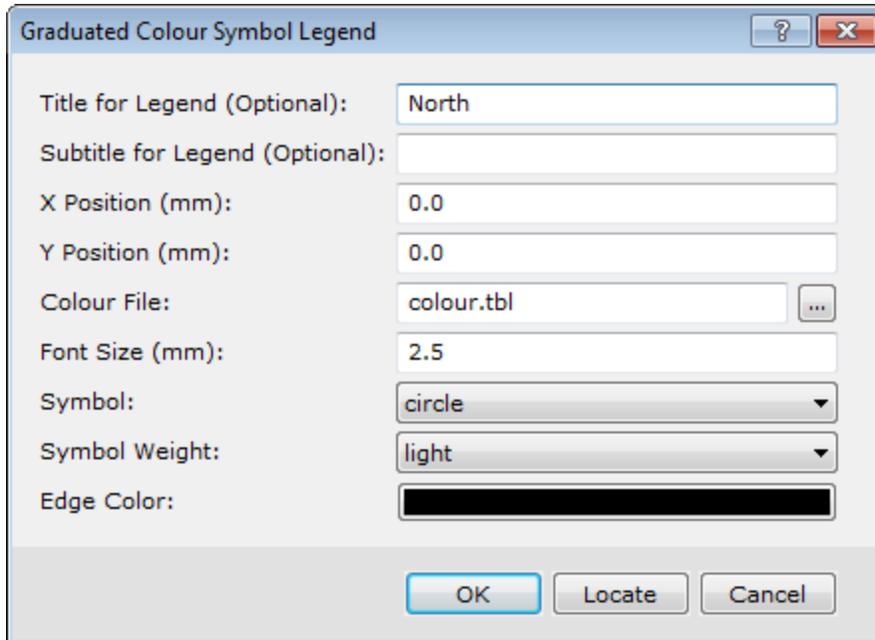
9. Click the **#Zones** button. The system displays the *Select Number of Zones* dialog box.
10. Enter the # of zones you want to use and click **OK**. The system returns to the *Define Colour Zones* tool.
11. Select the **Cum. %** check box and enter the maximum percentage for each zone.
12. Choose a colour from the palette and click **OK**. Repeat this process until you are satisfied with the colours for each zone.
13. Click **OK**. The *Histogram Analysis* tool is again displayed.

14. To save the colour zone, click the Save button (). Enter a name and navigate to your project folder to save your custom colour zone file with your project data.
15. Click **OK** to close the *Colour Symbol Tool*.
16. To close the *Histogram Analysis Tool* click the () button. The coloured symbols are plotted to the current map.

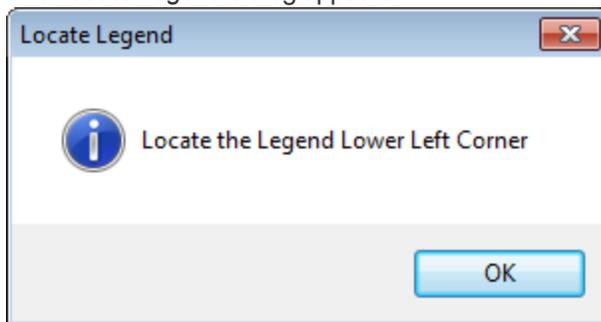


Adding a Symbol Legend Interactively

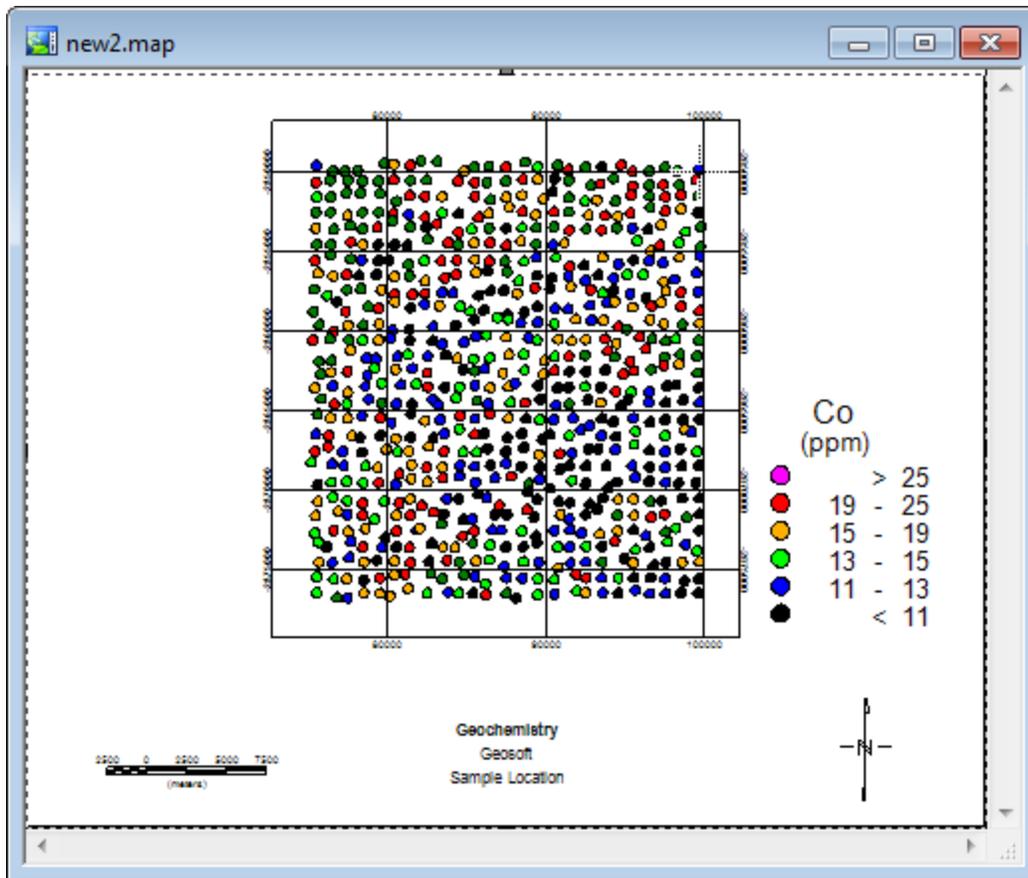
1. Open and select the map to add a Symbol Legend.
2. Open the *Histogram Analysis Tool* and click the **Plot symbol legend on the current map** button (). The *Graduated Colour Symbol Legend* dialog appears.



3. Specify the *Title for Legend (Optional)*, *Subtitle for Legend (Optional)*, and *Colour file* (created in the previous *Plotting Classified Symbols* section) and you can leave the remaining parameters to the intelligent defaults.
4. Click the **Locate** button.
The *Locate Legend* dialog appears.



5. Click **OK**.
6. The system displays the cursor as a cross hair on the map. Position your cursor on the map where you want the lower left-hand corner of the legend to appear and left-click. You will be returned to the previous dialog.
7. Click **OK**. The system plots the legend on the map and redisplay the *Histogram Analysis Tool*.



8. To close the *Histogram Analysis Tool*, click the (✖) button.

Multi-parameter symbol plotting

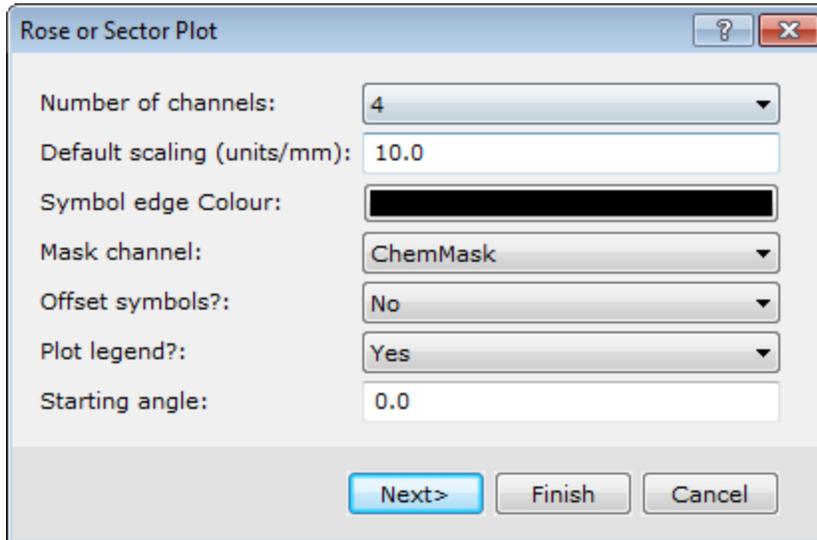
The Geochemistry system includes three additional point plots, *Pie Plots*, *Rose (or Sector) Plots*, and *Bar Plots*, as well as their associated legends. Each can plot up to 8 channels simultaneously on a single map. Scaling of the individual channels may be specified, and defaults are taken from the symbol-scaling attribute for each channel. All three plots use a common interface, and share parameters, enabling ease of use. These plots make use of the *Outlier Limit* attribute to clip too-large values.

- > **Pie Plots:** The scaled data occupy relative arc percentages of the pie.
- > **Rose or Sector Plots:** Are similar to the pie plots, but each sector has the same angular span. The radius of each sector scales with the data value.
- > **Bar plot:** The height of each bar scales with the data values.
- > **Legends:** Each new plot has it's own legend, that can also be run on its own.

Displaying Rose or Sector Plots

This feature creates Rose (or Sector) plots, which are similar to Pie plots, as each section has an equal angle, but the radius of individual segments scales with the data value.

1. Open and select a map in your project workspace.
2. On the *GeochemMap* menu, select *Point Plots* and then select **Rose (Sector) Plot**.
The *Rose or Sector Plot* dialog appears.

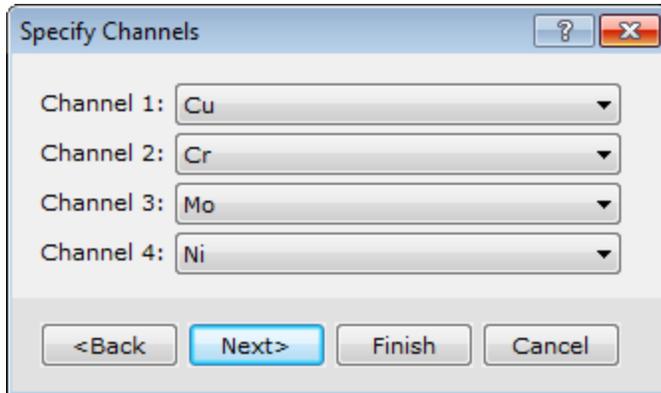


3. Use the *Number of channels* dropdown list to select the number of assay channels to plot from the current database.
4. Specify the *Default scaling (units/mm)*.
5. Using the dropdown lists, select the *Symbol edge Colour*, *Mask channel*, *Offset symbols?* and *Plot legend?*.
6. Specify a *Starting angle* or accept the default (0.0).

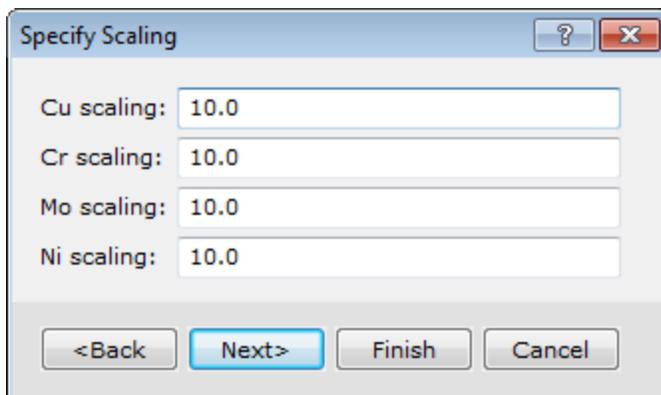


A new feature of the Geochemistry system is the ability to Offset Symbols. To view this new feature, select **Yes** in the *Offset symbols* box.

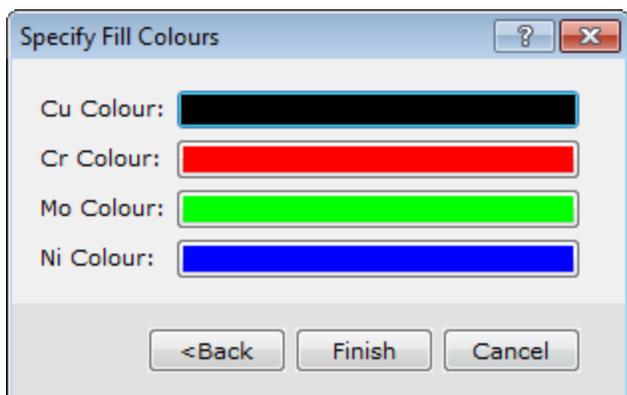
8. Click **Next>**.
The *Specify Channels* dialog appears.



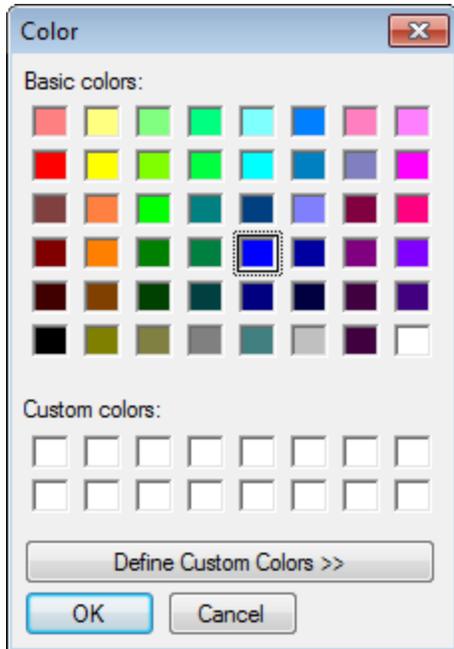
9. Select the assay *Channels* to plot, and click **Next>**.
The *Specify Scaling* dialog appears.



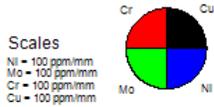
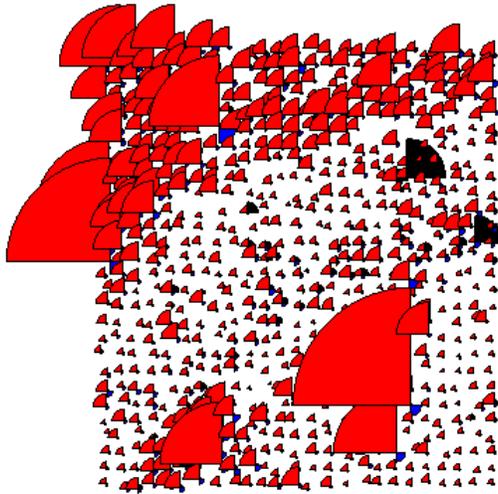
10. Based on the assay values, specify the scaling for each element. Click **Next>** to display the *Specify Fill Colours* dialog.



11. Click inside the *Colour* boxes to display the *Color* tool.



12. You can select a new colour from the *Basic colors* palette or click the **Define Custom Colors** button to select a custom colour.
13. Click **OK** to return to the *Specify Fill Colours* dialog.
14. Click **Finish** to process the Rose or Sector Plot parameters. The *Rose or Sector Plot Legend* dialog is displayed.
15. Click **Finish** to plot the Rose (Sector) Plot and Legend on the current map.

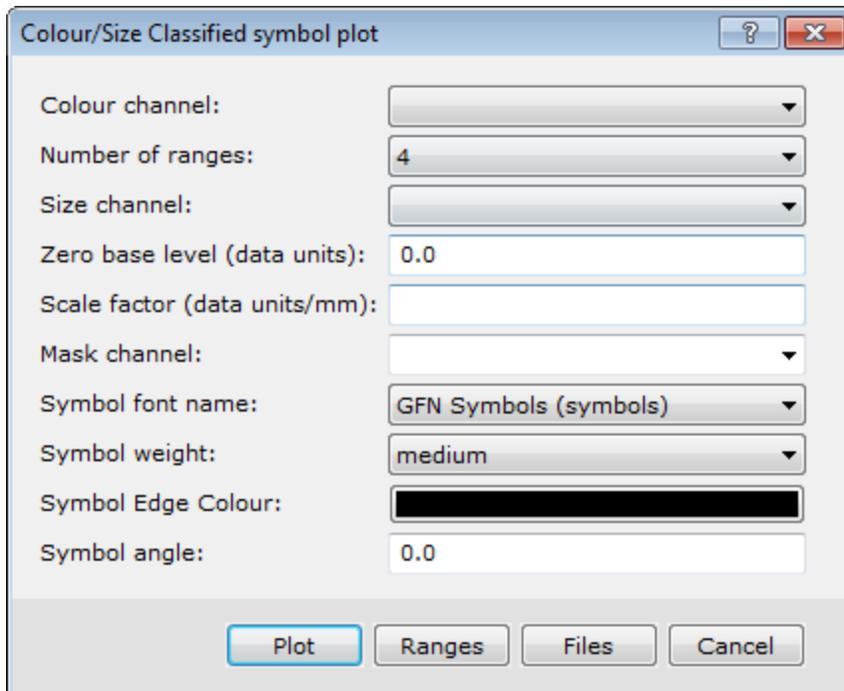


Symbol Plotting using Data from Two Channels

You can plot classified symbols, using one channel to determine the colour of the symbols, and another channel to provide the symbol sizes.

Creating Two Channel Symbol Plots

1. On the *GeochemMap* menu, click *Point Plots* and then select **Colour Range and Proportional Size**. The *Colour/Size Classified symbol plot* dialog appears.

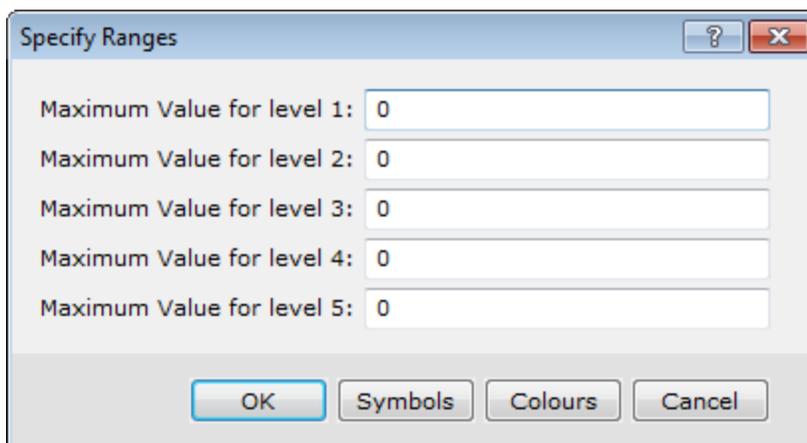


2. Use the dropdown list to select the *Colour channel*, *Number of ranges* and the *Size channel*.
3. Specify the *Zero base level (data units)* and *Scale factor (data units/mm)*.
4. Select the *Mask channel* from the dropdown list.
5. Select the *Symbol font name*, *Symbol weight* and *Symbol Edge Colour*.
6. Specify the *Symbol angle*.



For detailed information about the above parameters, click the **Help** button on the *Colour/Size Classified symbol plot dialog*.

8. To specify the data ranges, click the **Ranges** button and the *Specify Ranges* dialog will appear.



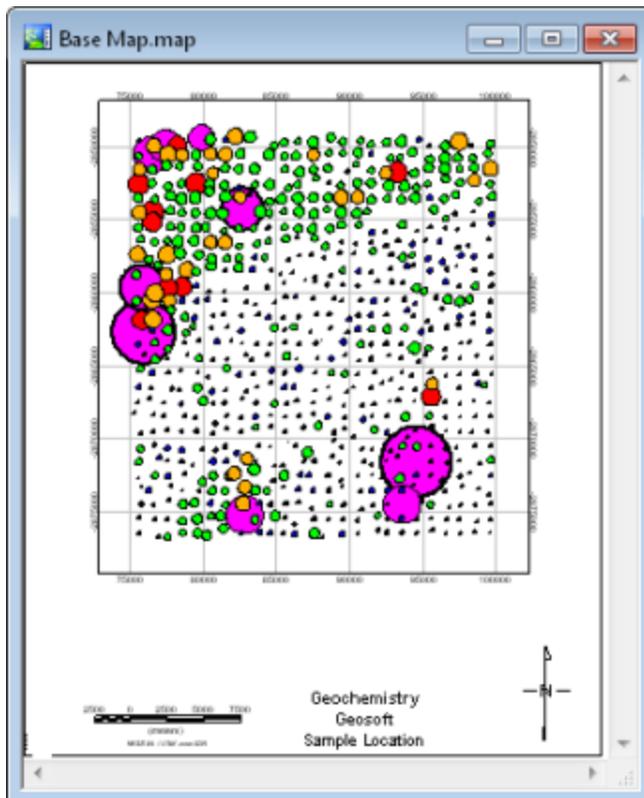
- Specify the ranges for each of your levels. On this dialog you can also select the **Symbols** button to select the symbols for each level and the **Colours** button to select the colour for each level and when you are satisfied with your selections, click **OK**.

The *Colour/Size Classified symbol plot* dialog is again displayed.



You can click the **Files** button to save your settings to an ITR file

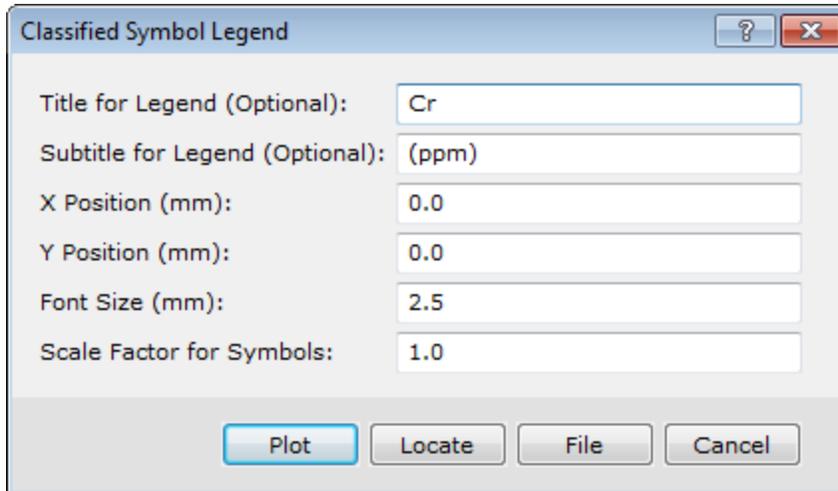
- Click the **Plot** button to plot the symbol plot on the current map.



Plotting a Symbol Legend

- On the *GeochemMap* menu, click *Point Plots* and then select **Colour Range Symbol Legend**.

The *Classified Symbol Legend* dialog appears.

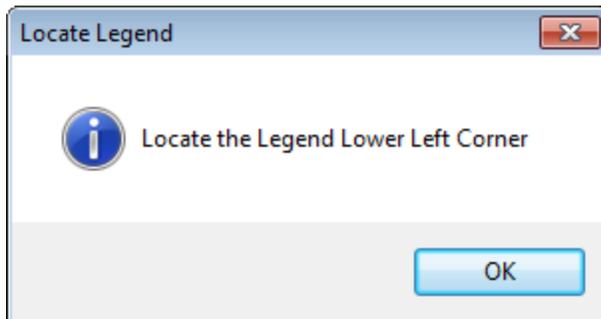


- Specify the *Title for Legend (Optional)*, *Subtitle for Legend (Optional)*, *X Position (mm)*, *Y Position (mm)*, *Font Size (mm)* and *Scale Factor for Symbols*.

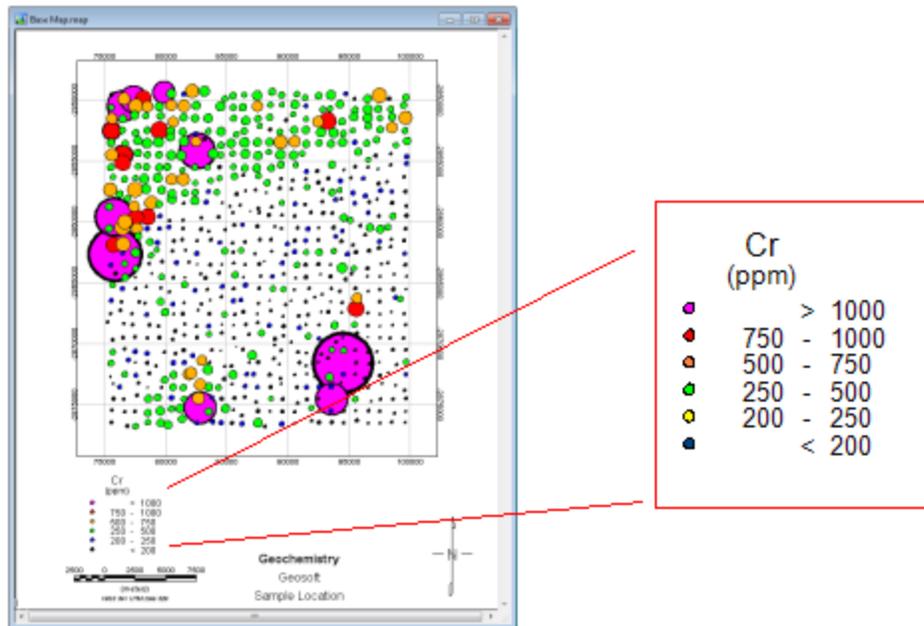


You can leave the *X Position (mm)*, *Y Position (mm)* to the default values and use the interactive **Locate** button to locate the legend on the map.

- Click the **Locate** button. The *Locate Legend* dialog is displayed.



- Right-click on the map where you want the *Symbol Legend* displayed. The *Classified Symbol Legend* dialog is again displayed.
- Click **Plot**. The Legend is displayed on the current map.



Principal Component and Factor Analysis

Principal Component Analysis (PCA) and Factor Analysis are two methods that can help reveal simpler patterns within a complex set of variables. In particular, these methods seek to discover if the observed variables can be explained largely or entirely in terms of a much smaller number of variables called factors.

In mineral exploration, the most common application of these multivariate analysis methods is to characterize and map inter-relationships within high volume surface geochemistry data sets. Data volumes are a growing problem as geochemists seek to extract more information and knowledge from data sets with up to 50 or more variables.

Quick Review of PCA and Factor Analysis

PCA and Factor Analysis are often misunderstood due to their abstract mathematical nature. Concepts such as eigenvalues, basis vectors (eigenvectors), loadings, and scores are difficult to map into the framework of real-world geological problems.

Without examining the mathematics in detail, the basic starting point is to compute a correlation matrix using all variables and samples in a verified and properly subsetted geochemical database. This matrix is used to compute a new set of "artificial" variables, called eigenvectors, each with its own distinct eigenvalue. The numerical value of the eigenvalue indicates the contribution of the "artificial" variable or factor to the total variation in the data set.

Two other entities that play a role in this mathematical setup are:

- > Loadings – Express the influence of each original variable, such as, e.g., Au, within a factor
- > Scores – Numbers that express the influence of an eigenvector on a specific sample; enable spatial mapping of factors on individual samples

Comparison of PCA and Factor Analysis

The main commonality between PCA and Factor Analysis is that they both use eigenvectors, eigenvalues, loadings, and scores. The differences are:

- › PCA is often used as a simple starting point in multivariate analysis
- › PCA eigenvectors cumulatively account for all the variability in a dataset, whereas Factor Analysis results include an unresolved component
- › For the above reason, Factor Analysis is often considered to be “statistical” in nature, rather than purely mathematical as PCA
- › Factor Analysis results are often transformed through Varimax and other methods to optimize eigenvectors for interpretation

Before Starting

This section provides a general overview of the Principal Component and Factor analyses in Oasis montaj. The interpretation results are for demonstration purposes only, and may not reflect the true geology of the region. This section describes one possible interpretation of the data. Interpretation of results typically depends on the project requirements and the user specifications.

Before applying the discussed analytical methods, you must have a solid understanding of the problem you are trying to solve. You must have strategies for determining how the analytical techniques will answer the following questions:

- › Has the data been verified adequately to obtain meaningful results?
- › How many different factors are required to explain the pattern of relationships between variables?
- › What is the geologic significance of the factors?
- › What proportion of the elements is explained by the most important principal components?
- › What is the spatial relationship of factors (i.e., how do they map)?

 *To be processed using the analytical methods in the Geochemistry system, your assay channels must be classified as ASSAY channels. When importing your data using GeochemImport, the attribute Class for assay channels is defaulted as ASSAY. To classify channels not imported through GeochemImport as ASSAY, right-click the channel header, and select Attributes from the pop-up menu. The Assay Information dialog is displayed. In the Class field, enter “ASSAY” ASSAY and click **OK** to continue.*

Step 1 - Verifying Data

Data verification is absolutely critical in multivariate analysis. Historically, lack of care in preparing data and poor overall results have led to a negative perception of these methods.

Geosoft tools such as the Histogram and the Scatter Analysis can help you quickly identify data with detection limit problems or outliers. Outliers can be defined as data values outside a statistical range (for example, the 95th percentile, or the mean \pm 2 standard deviations). After these data or variables are identified, the Geosoft sub-setting tools and math expressions can assist you in eliminating problematic data or outliers before proceeding with PCA and Factor Analysis.

Histogram Tool

The Histogram tool can be used to determine the data distribution and population range. The Histogram tool can also be used to identify outliers by means of the cumulative % option. For details, see the Performing Histogram Analysis section.

Scatter Plot Tool

The Scatter Plot tool can be used to determine the distribution and population ranges of the data. The Scatter Plot tool also enables you to specify a masking channel to record any classification operations performed via other functions in the Scatter Plot tool. For details, see the Using the Scatter Plot Tool section.

Math Expressions

Math expressions enable you to define a range for the data. Following are two math expressions you can use to define a data range:

`Window (exp, Minvalue, Maxvalue)`

This function, when applied to a channel, returns a DUMMY value if the specified expression is NOT in the Minimum – Maximum range. Otherwise, it returns the expression value. For example, WINDOW (As, 5,700) will dummy out all the values below (less than) 5 and above (greater than) 700 in the As channel.

`CLIP (exp, Minvalue, Maxvalue)`

This function, when applied to a channel, returns the expression value if the expression is in the Min-Max range. Otherwise, it returns the clipped Min or Max value. This function is a little different from Window (above). Values not in the range are not dummied but held as the min or max value. For example, CLIP(As,5,700) keeps all the values in the range 5 – 700 as normal values, and assigns any value not in the range to the nearest min or max value. I.e., any number less than 5 becomes 5, and any number greater than 700 becomes 700.

For details, see the Applying Math Expressions section.

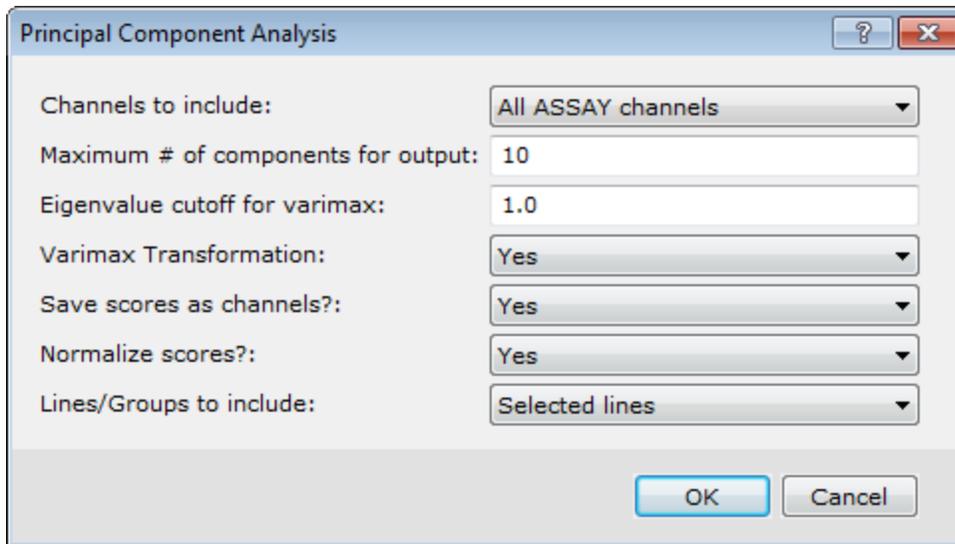
Step 2 - Performing PCA and Factor Analysis

The Principal Component analysis is a mathematical method designed to reveal the relationships between two or more (often many) variables. Measurements, which include many variables, are commonly encountered in mineral exploration and geochemistry. PCA and Factor Analysis determine the significance of the correlation between the variables.

The basic problem in PCA and Factor Analysis is determining the number of starting factors. The typical approach is to select an arbitrary, yet standard number, i.e., 5 or 10. In Oasis montaj, the default is a maximum of 10 components.

Performing the Principal Component Analysis

1. Select a database, e.g., assay.gdb.
2. On the *GeochemAnalysis* menu, select **Principal Component Analysis**.
The *Principal Component Analysis* dialog appears.



3. On the *Channels to include* dropdown list, select *All ASSAY channels* or *Displayed ASSAY channels*.
4. Specify the *Maximum # of components for output*. The specified number determines the number of principal components created. The principal component results are displayed in the database and in the log file princomp.log. Prior to the calculation of the principal components, the data are transformed to the form suitable for analysis. Depending on whether the assay channel's Logarithmic Distribution attribute is set to "Yes", the logarithms of the data are taken. The mean is then removed, and finally the data are normalized through division by the variance (standard deviation).

 *When importing data using GeochemImport, the Logarithmic Distribution attribute for assay channels defaults to Yes. To set the logarithmic distribution for assay channels not imported through GeochemImport, right-click the assay channel header and Attributes from the pop-up menu. The Assay Information dialog box is displayed. On the Logarithmic Distribution dropdown list, select "Yes", then click **OK** to continue.*
5. In the *Eigenvalue cutoff for varimax* field, type the correct amount. Note that the correlation matrix is produced from the transformed data. Eigenvector decomposition is performed to determine the eigenvectors (which are directionally equivalent to the principal components) and eigenvalues. The relative significance of each component is indicated by its eigenvalue. The first principal component has the largest eigenvalue, and succeeding components have smaller eigenvalues, as their significance in the data decreases. The cut-offs determine the number of Varimax factors derived from the Factor Analysis. All components with eigenvalues less than this value are rejected, and the principal component loadings are re-computed using Kaiser's Varimax scheme.
6. Select *Yes* to perform a *Varimax Transformation/rotation* on the principal component data.
7. On the *Save scores as channels?* dropdown list, select *Yes* or *No*. Scores describe the contribution of each principal component to each data point. A score channel is created for each principal component specified. The score channels are displayed in the database as SC1, SC2, etc. Score values are commonly presented spatially on a map using colour-coded symbols.
8. Select whether to *Normalize scores?*. The values are transformed so that they lie between 0 and 100. If the range of score values is A to B, then a value X is transformed using the formula: $X' = (X-A) * 100 / (B-A)$.

9. On the *Lines/Groups to include* dropdown list, select *Selected lines*, *Displayed line* or *All lines*. Statistics are calculated on the collected data.
10. Click **OK** to perform the Principal Component analysis on the ASSAY data.

The results are displayed in the spreadsheet window. The princomp.log file is also displayed. It contains the computed results. The following is a partial example of the log file. For more information on the log file parameters, click the **Help** button on the *Principal Component Analysis* dialog.

Principal Component analysis: d:\geodemo\Master.gdbSection (1)

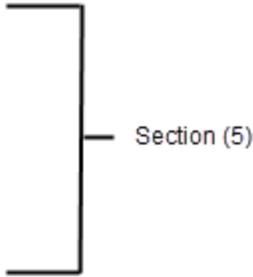
Number of channels included: 11 — Section (2)

Number of principal components displayed: 9 — Section (3)

Number of rows of data: 691 — Section (4)

Data Transformations

```
-----
Cr      : Logarithmic Normal Distribution
Co      : Logarithmic Normal Distribution
Ni      : Logarithmic Normal Distribution
Cu      : Logarithmic Normal Distribution
Zn      : Logarithmic Normal Distribution
As      : Logarithmic Normal Distribution
Zr      : Logarithmic Normal Distribution
Mo      : Logarithmic Normal Distribution
Sn      : Logarithmic Normal Distribution
Pb      : Logarithmic Normal Distribution
Cu_edit : Logarithmic Normal Distribution
```



Correlations of Standardized Data Section (6)

```
-----
          Cr    Co    Ni    Cu    Zn    As    Zr    Mo    Sn    Pb    Cu_edit
Cr      1.000  0.339  0.775  0.411  0.273  0.073  -0.082  -0.189  -0.246  0.078  0.415
Co      0.339  1.000  0.443  0.260  -0.015  0.102  -0.139  -0.122  -0.167  -0.115  0.273
Ni      0.775  0.443  1.000  0.668  0.316  0.048  -0.426  -0.338  -0.370  -0.144  0.676
Cu      0.411  0.260  0.668  1.000  0.573  -0.137  -0.339  -0.421  -0.363  0.016  0.998
Zn      0.273  -0.015  0.316  0.573  1.000  -0.288  -0.007  -0.363  -0.199  0.494  0.566
As      0.073  0.102  0.048  -0.137  -0.288  1.000  -0.252  -0.113  -0.007  -0.285  -0.131
Zr     -0.082  -0.139  -0.426  -0.339  -0.007  -0.252  1.000  0.625  0.166  0.445  -0.340
Mo     -0.189  -0.122  -0.338  -0.421  -0.363  -0.113  0.625  1.000  0.147  0.008  -0.418
Sn     -0.246  -0.167  -0.370  -0.363  -0.199  -0.007  0.166  0.147  1.000  0.013  -0.375
Pb      0.078  -0.115  -0.144  0.016  0.494  -0.285  0.445  0.008  0.013  1.000  0.008
Cu_edit 0.415  0.273  0.676  0.998  0.566  -0.131  -0.340  -0.418  -0.375  0.008  1.000
```

Eigenvalues of correlation matrix Section (7)

```
-----
Factor Eigenvalue cum. %
```

Following are descriptions of the princomp.log file sections.

Section (1)

The first comment line in the log file identifies the type of analysis and the name of the current database.

In our sample log file, the type of analysis is Principal Component Analysis, and the current database is identified as D:\GeoDemo\master.gdb.

Section (2)

The second comment line in the log file indicates the number of ASSAY channels included in the analysis.

In our sample file, the number of assay channels included is 11.

Section (3)

The third comment line in the log file displays the number of principal components displayed. Determining how many different factors are required to explain the pattern of relationships between the variables is a key task. Strategies include evaluation of the amount of variability reflected in each eigenvector, and the acceptable total variance accounted for by a set number of eigenvectors.

In our sample file, the number of principal components is 9.

Section (4)

The fourth comment line displays the number of rows of data selected in the database.

In our sample file, the number of rows is 691.

Section (5)

This section identifies the transformation performed on each ASSAY channel to make the data suitable for analysis.

In our sample file, each assay channel has been transformed to Logarithmic Normal Distribution.

Section (6)

This section contains the correlation matrix of the standardized data. To standardize the data, they are first transformed (see above), then the statistical mean value is removed, and finally the data are divided by the variance (standard deviation). The maximum positive correlation possible is 1.0, and the maximum negative (or inverse) correlation possible is -1.0.

In our sample file, the maximum positive correlation is Cr, Ni with a value of (0.775). The maximum inverse correlation is Zr, Ni with a value of (-0.426).

Section (7)

This section contains a list of factors, their eigenvalues from the correlation matrix, and the cumulative % of each factor. The eigenvalues represent the relative significance of each component.

In our sample file, the 1st factor has an eigenvalue of 4.087 and represents 37.2% of the total factors. The first 3 factors have eigenvalues above 1.0 and represent 67.4% of the total factors.

Section (8)

This section contains the eigenvectors derived from the correlation matrix. Eigenvectors are directionally equivalent to the principal components and their eigenvalues.

In our sample file, for Principal Component 1 (PC1) the variable with the greatest eigenvector is Cu_edit, followed by Cu, Ni, Cr, Zn, Co, etc.

Section (9)

This section contains Principal Component Loadings. Loadings are the eigenvectors ordered in terms of the eigenvalues size and scaled by the square root of the eigenvalues.

In our sample file, for PC1, the largest loading is Cu_edit, followed by Cu, Ni, Cr, Zn, Co, etc.

Section (10)

This section displays the proportion of the variables explained by the factors.

In the sample log, Ni for Factor 1 has a cumulative component value of (0.740), whereas Zn only has a cumulative component value of (0.330). Note that Zn and As have no component value in Factor 9.

Section (11)

This section contains Varimax Principal Component Loadings (VPCL). Loadings are eigenvectors ordered in terms of the eigenvalues size and scaled by the square root of the eigenvalues.

In the sample log, there are only 3 VPCL displayed. The VPCL calculation considers the Eigenvalue cutoff for Varimax specified in the Principal Component Analysis dialog. In our example, the eigenvalue cut-off was specified as 1.0, therefore components with eigenvalues less than 1.0 have not been considered in this calculation. For the VPCL, the greatest loading is Ni, followed by Cr, Co, and Cu_edit, Cu, etc.

Section (12)

This section contains the proportion of variables explained by the Varimax factors. This list displays the cumulative factors of each component for each element.

In the sample log file, Ni for Factor 1 has a cumulative component value of (0.732), whereas Zn only has a cumulative component value of (0.055). Because only 3 Varimax Principal Components are displayed, the cumulative components do not total 1.0.

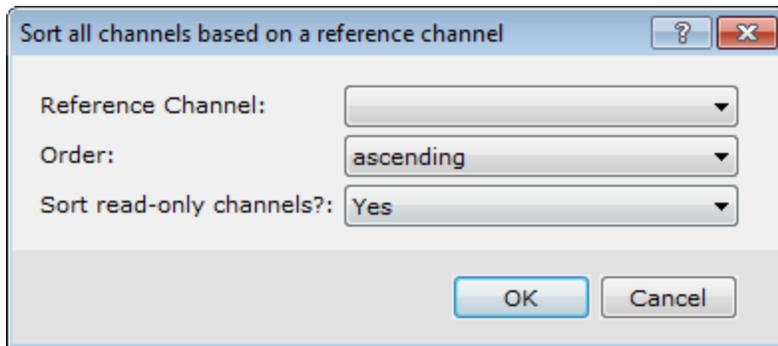
Step 3 - Determining Geologic Significance

Determining geologic significance of the factors requires an understanding of the target, litho-geochemistry, and alteration patterns in the area under investigation. Typically, geochemical expertise and the knowledge of the exploration project are pooled to interpret results.

An absolutely critical step is to compare the hypothetical factors with the observed results. One simple method to do this is to plot the profiles of the variables that weight most strongly (positively or negatively) in eigenvectors, and to sort them using the Varimax (VSC) fields that have been added to the original geochemical database. This type of presentation can also help determine how much purely random or unique variance each observed variable includes.

Sorting By One Channel

1. On the *GeochemAnalysis* menu, click *GeochemUtilities* and then select **Sort All by 1 Channel**. The *Sort all channels based on a reference channel* dialog is displayed.



2. Use the *Reference Channel* dropdown list to select the VSC field.
3. From the *Order* dropdown list, select "ascending" or "descending" and then from the *Sort read-only channels?* dropdown list, select "Yes" or "No".
4. Click **OK**. The database is sorted by the VSC channel.

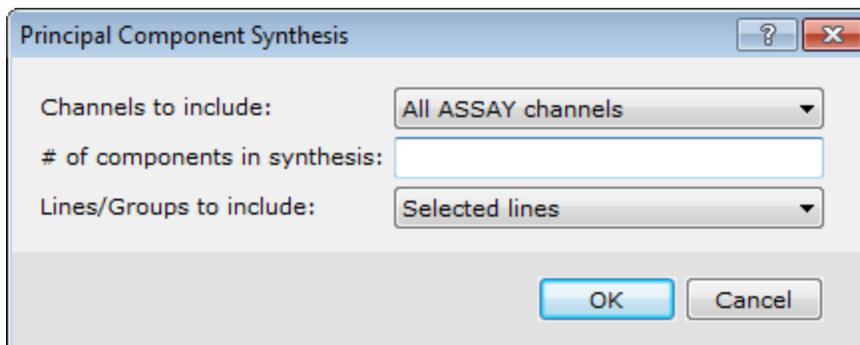
Step 4 - Performing the Principal Component Synthesis

The ability to synthesise Principal Components back to the original data units may help you verifying your results. By synthesising the data using only the most important components, you can determine what proportion of the variables (elements) are explained by the most important principal components. One way to evaluate the contribution of the principal components is to remove the influence of the less important components in order to emphasize the more important components. The Geochemistry system enables you to synthesise a specified number of principal components.

You specify the number of components to re-synthesise as less than your original starting components. The system calculates the data and displays the results in the database. The resultant channels have the same name as the original Assay channels with “_#” appended. The “#” reflects the number of components used to re-synthesis the data).

Performing the Principal Component Synthesis

1. On the *GeochemAnalysis* menu, select **Principal Component Synthesis**. The *Principal Component Synthesis* dialog appears.



2. On the *Channels to include* dropdown list, select "All ASSAY Channels", "Displayed ASSAY Channels", or "Select ASSAY channels from a list". The channels to include must be members of the ASSAY class.
3. Enter the *# of components in synthesis* to use when re-synthesizing the data. This number must be less than the

number of original components.

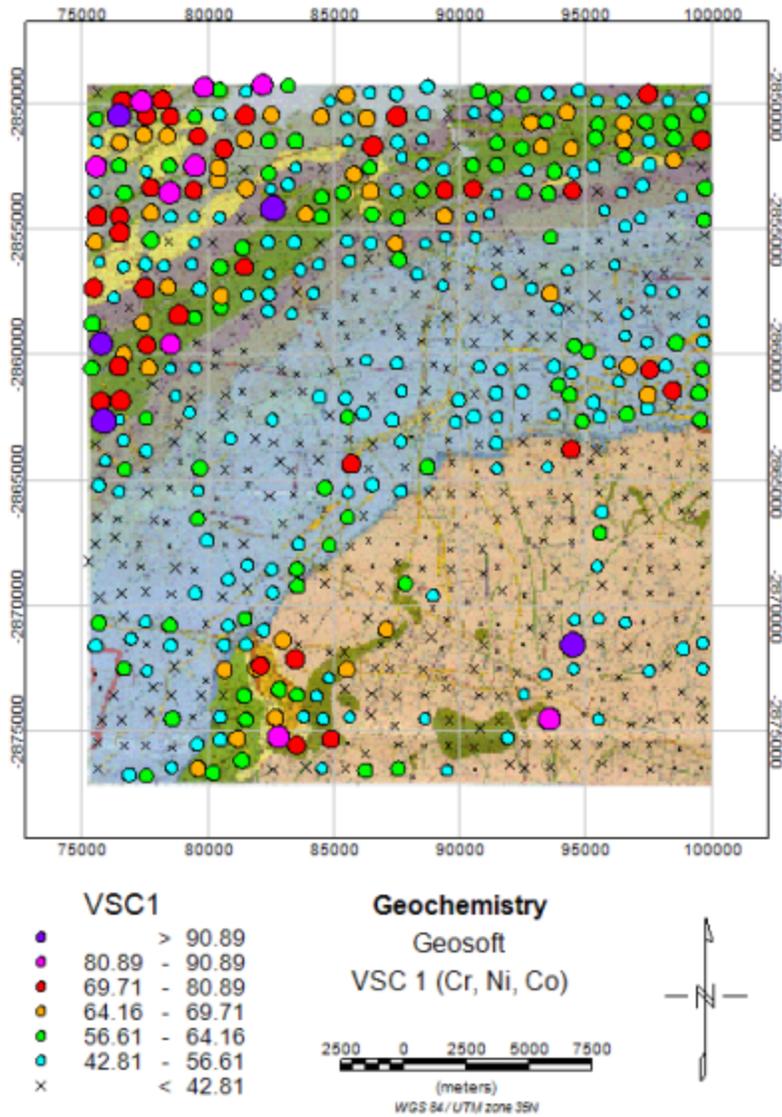
4. From the *Lines/Groups to include* dropdown list, select "Selected lines", "Displayed line/group only" or "All lines". Statistics will be calculated on the data collected from the selected lines.
5. Click **OK**. The synthesis results are displayed in the database.

The following sample table compares the values of the Cr, Ni, and Co variables from the original dataset with the results derived from synthesising the data using 7 components and 5 components.

Element	Original Data	7 Components in Synthesis	5 Components in Synthesis
Cr	52	51	66
Ni	11	11	14
Co	8	8	4

Step 5 - Mapping the Factor Analysis Results

After results are verified, a common method of presenting the data spatially is to display the results on a map using proportional, colour-coded symbols. The VSC results present the most clearly differentiated geologically interpretable picture. Mapping these values along with a geology grid of the area may assist in showing the trends in your data.



In the above example, Factor 1 (Cr, Ni, Co) mapped the chromium boundary as identified on the geological map. Other factor scores could also be mapped to confirm their relationship to the geology.

Publication Date: December-16-15

Copyright 2015 Geosoft Inc. All rights reserved.