

Using GEOrient: an example

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1. The synthetic dataset

Consider the following set of dummy data. It is shown here in an Excel spreadsheet format, but could equally be in a textfile (.TXT; .CSV, etc) or in any other data table in almost any type of application (e.g. ArcGIS; MapInfo; Microsoft Access; Micromine; Oracle;....). Only the first 10 rows of data are shown.

In this dataset, there are some primary orientation data in columns 2 & 3 and some associated data in columns 5 & 6. All other columns contain data we are not interested in.

The primary orientation data might represent planes, or lines, or we might just be interested in plotting the directions as rose diagrams.

In this instance, the Conventions I have used are dip and dip direction for planes (or plunge and plunge direction for lines). Your data conventions might be different and can be set in the Conventions Tab after you open the data.

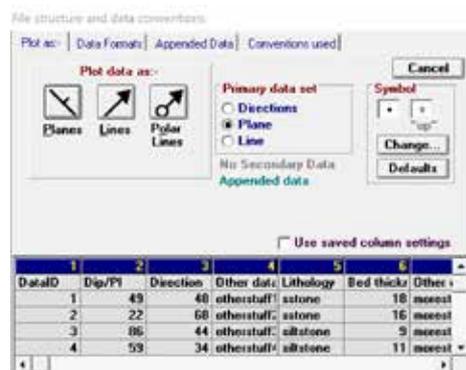
1	2	3	4	5	6	7
Dip			Bed			
DataID	/Pl	Direction	Other data	Lithology	thickness	Other data
1	49	48	otherstuff1	sstone	18	morestuff1
2	22	68	otherstuff2	sstone	16	morestuff2
3	86	44	otherstuff3	siltstone	9	morestuff3
4	59	34	otherstuff4	siltstone	11	morestuff4
5	35	206	otherstuff5	coal	3	morestuff5
6	75	42	otherstuff6	coal	11	morestuff6
7	48	213	otherstuff7	marl	9	morestuff7
8	16	190	otherstuff8	marl	3	morestuff8
9	51	66	otherstuff9	sstone	8	morestuff9
10	7	41	otherstuff10	sstone	13	morestuff10

2. Open the data for plotting

If the data already exist in a text file, then open it using the File.. Open menu, or the Open file button. This action will open the File Formatting dialog.

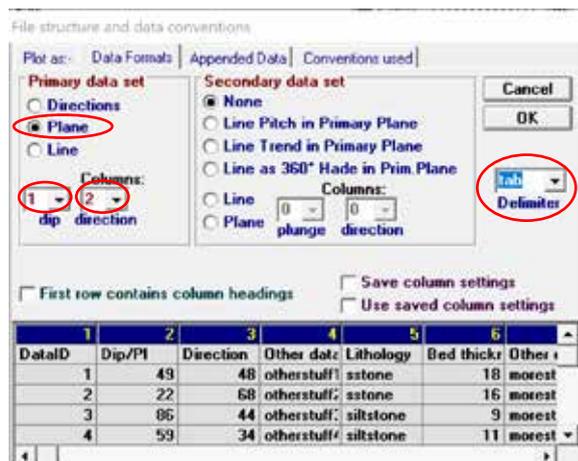
More commonly, it is easier to just copy the data block from the source table and paste it into GEOrient. To do this:

- 1) Select and copy the data block in the spreadsheet
- 2) Open GEOrient and select Blank Plot (either from the icon button or from the File menu). The plot will open initially as a blank stereonet circle, even if you only want to plot the directions as a rose diagram.
- 3) Select Paste External Data, either from the Edit menu or by hovering over the blank plot and pressing the right mouse button.



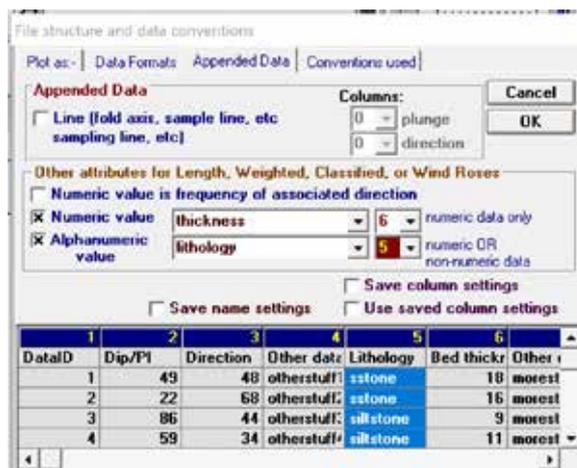
Initially the File Formatting dialog will open on the first tab as in the figure above, but to ensure that we indicate the correct structure of our data, open the DataFormats tab.

1. Check that the data columns are displayed separately. If they aren't in separately numbered columns, then you may need to change the Delimiter character. Since I have copied these data from an Excel spreadsheet they are in Tab-delimited form. But if your data is from a CSV file, for example, you would need to indicate the delimiter as a comma.
2. Check the type of Primary data. Initially here, I will treat the data as Planes in the first example.
3. Now indicate which columns the different parts of your data are in. The default will be to show columns 1 and 2 as the dip and direction columns, but here I need to set the dip in column 2 and the direction in column 3. [These column numbers can be set manually but can also be quickly set by first clicking on the Column dropdown combo and then by clicking on the column heading in the data table below].
4. Check the box indicating that the first column contains the column headings. It doesn't matter whether or not you do this. As that headings row is non-data, GEOrient will not plot it anyway.

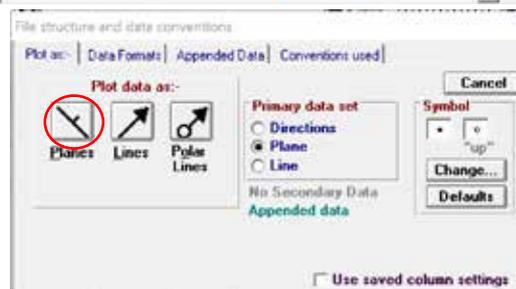


If we are going to use the alphanumeric data in the Bed lith column or the numeric data in the Bed thickness column then we need to indicate these columns as Appended Data. Open the Appended Data tab.

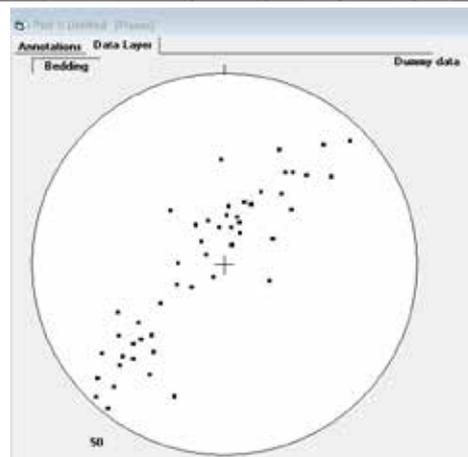
1. Check the numeric value checkbox and give a name to the numeric value if you wish and indicate which column it is in (here it is 6).
2. Do the same for the Lith column. Here that data is in column 5



We now have fully described the structure of our data so return to the first 'Plot as:' tab. In this instance we have indicated that our data are planes, so we will plot them as planes using the button with the strike/dip symbol. [Note that it is quite possible to choose to plot the data as lines. In this instance the dip and dip direction will be plotted as lines].



The data will now display in the stereo circle as points. These will be poles if you have chosen to plot the data as planes or will be lines if you have chosen either the Line button or the Polar Line button. Lines are for axial data, where the sense of direction of the line is immaterial (for example, fold axes). Polar Lines are where the sense of the line is important (such as current directions, or sense of slip vectors in fault data).

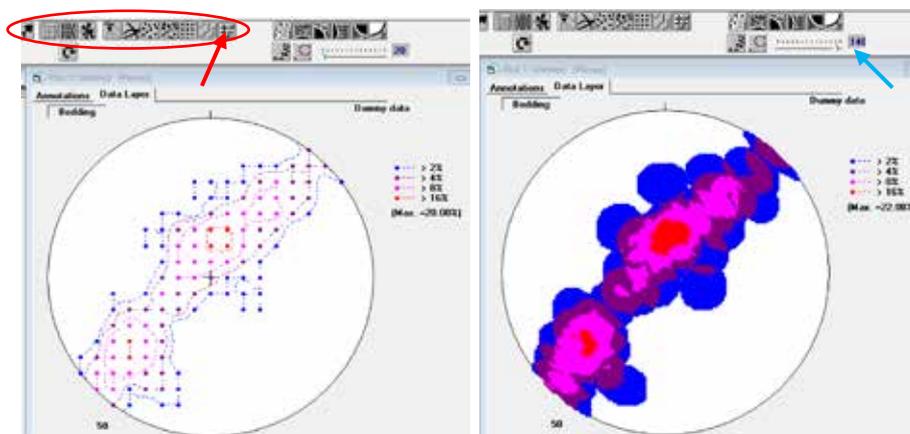


3. Changing the type of plot

We can choose to display these plane data as different types of plot display using the buttons in the toolbar. It is at this point that I would select the Rose Diagram button to plot circular histograms of the direction data. I will describe that in another section.

4. Stereonet plots

I most commonly choose to show plots as contoured gridded density plots (using the button with the red arrow). When you first plot the data with this button it will show a sparse density grid. To get the type of display shown here I increase the grid density to a high number using the textbox with the blue arrow and its associated slider bar.



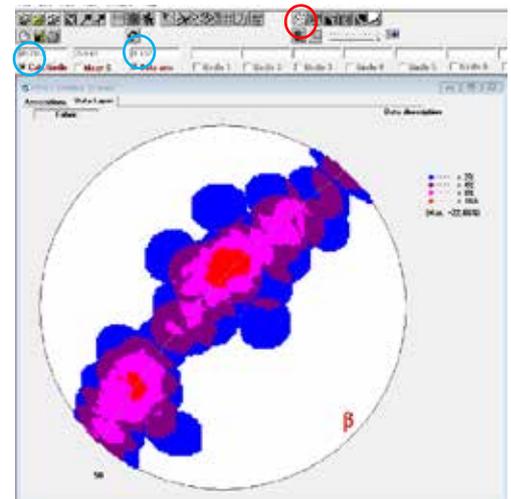
5. Analysing the stereonet data

The bedding data here show a great circle spread of poles, which would indicate a cylindrical fold. To quantify that we can overlay a calculated great circle, a calculated beta axis, or our own manual great circle overlays.

- 1) Use the girdle button (red circle) to open the girdles panel.
- 2) Check the Calc.Girdle and Beta axis checkboxes to add the calculated features.

The beta axis is the calculated orientation of the fold axis, which here plunges shallowly to the southeast (9-132). The girdle contains two distinct point maxima of unequal size. These maxima would be the orientation of the fold limbs, with the larger maxima being a longer limb. Thus, we have an inclined asymmetric fold plunging shallowly southeast. The longer limb dips shallowly to the southwest and the shorter limb steeply to the northeast. That is, these folds verge to the northeast.

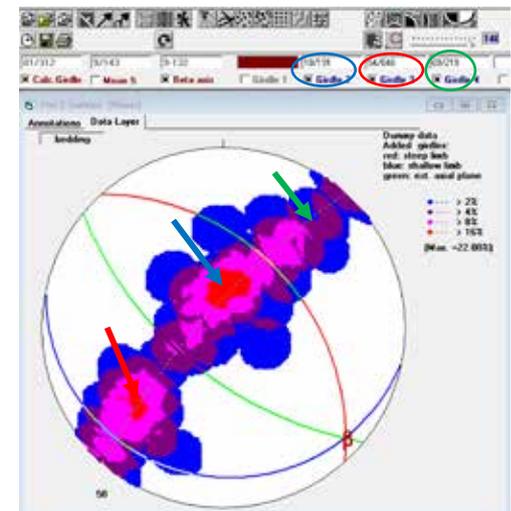
I'd like to add manual great circles to represent the orientation of the fold limbs and an estimate of the orientation of the axial plane, which will pass through the fold axis (the beta) and lie a little closer to the longer limb than the shorter limb. I'd like these manual great circles to have a different style to the default dashed lines, so I change these in the Preferences dialog (see section below).



6. Manually inserting great circles

User-defined great circle girdles can be plotted either by manually filling in the orientation text boxes or by pointing and clicking. It is generally easier to point and click.

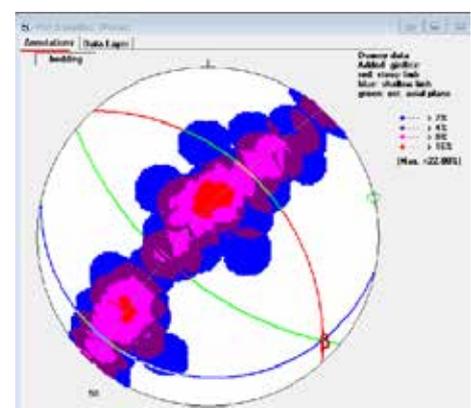
- 1) Double-click in one of the Girdle textboxes (e.g Girdle 2 - blue circle); hold down the shift key and using the right mouse button click in the centre of the larger central point maximum (blue arrow). This will insert a great circle whose pole is the point you just clicked on. [Read the help file for the various point and click options, or just experiment].
- 2) Do the same for the smaller southern maximum (red arrow). Double click on the Girdle 3 textbox, and Shift-Right-click on the centre of the maximum (red arrow).
- 3) We can only estimate the orientation of the axial plane, but we add a third great circle by Shift-Right-clicking at an appropriate point on the calculated best-fit girdle (green arrow) such that it adds a great circle that lies somewhat closer in orientation to the shallow limb than to the steep limb (green).



7. Annotations: adding user-defined symbols or beta axes

If you wish to ignore the calculated girdles and the beta axis, then uncheck those checkboxes and add them manually. To use your own beta axis, you need to add it as an annotation. Annotations are point symbols that are added in their own layer.

- Open the annotation tab on the plot itself. New points are added by using the Alt key with either the left or right mouse button. Be careful to make sure that you have the Annotation tab selected as else you will be adding points to the dataset itself. When selected, the annotation tab has a red line beneath the word 'Annotation'. Here I have added a cross, perhaps to represent the orientation of a horizontal trench from which the data were derived.



8. Changing symbols, line styles or colours: Preferences dialog

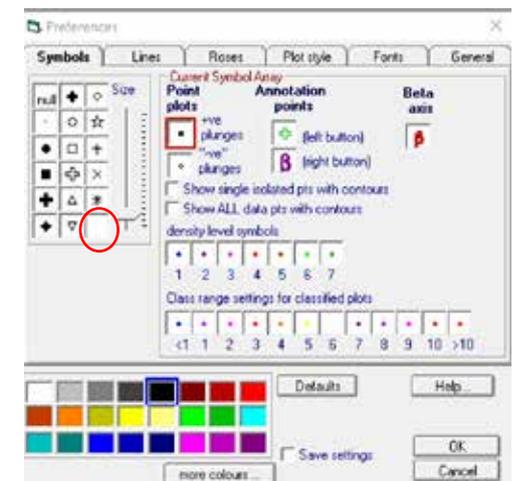
In the figures above, I have changed the weight and colour of lines and symbols. To do this I have changed their values in the Preferences dialog. To access this dialog, hover over the plot, right click the mouse button and select Preferences... from the drop-down menu. The Preferences option is also available from the Edit menu.

To change lines on the plot:

- Open the Lines tab in the preferences dialog and change the style, colour, and weight of the girdles you wish to modify. Here I will set girdle 2, 3, and 4 to blue, red, green solid lines with a thickness of 2 pixels. Click inside each of the textboxes in turn, then select the solid line style, then adjust the Width slider to the second tickmark, then click on the desired colour. Then repeat for any other lines you wish to change. Press OK when done.

To change symbols on the plot:

- On the first Symbols tab, follow a similar procedure to change the symbols you want to use. Note that the symbol labelled Beta axis refers to the calculated beta axis. Here I have added a second, differently coloured beta axis as a Right-click annotation symbol so that I can use it as a manually-added beta if I don't agree with the location of the calculated axis. [Note that the beta symbol character does not display on many computers. It is the symbol in the lower right cell of the set of available symbols (circled in red).
- In this same Symbols tab, I have reset the colours of some of the point symbols that I want to use. Other tabs in this Preferences dialog allow a large amount of flexibility in how your plots look.

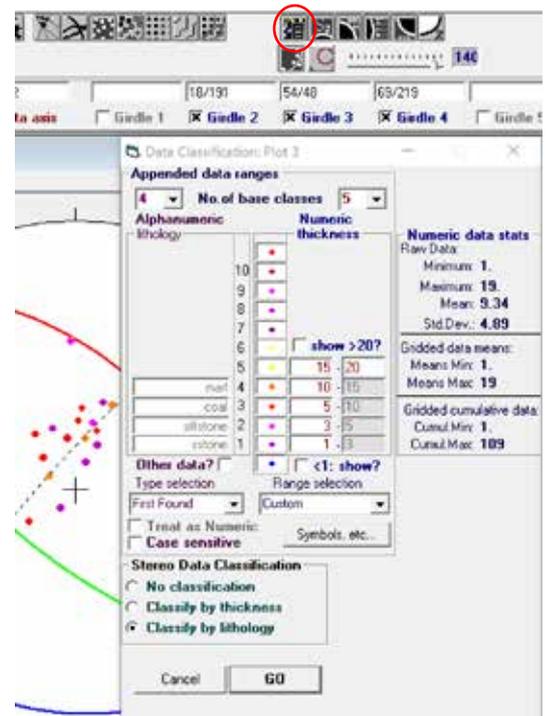


In most instances the stereonet at this point is all you want. But we have Appended data that we can use to delve deeper plotting either simple **classified stereonets**, or **numeric stereonets**. The use of these options is described more fully in the Help dialog.

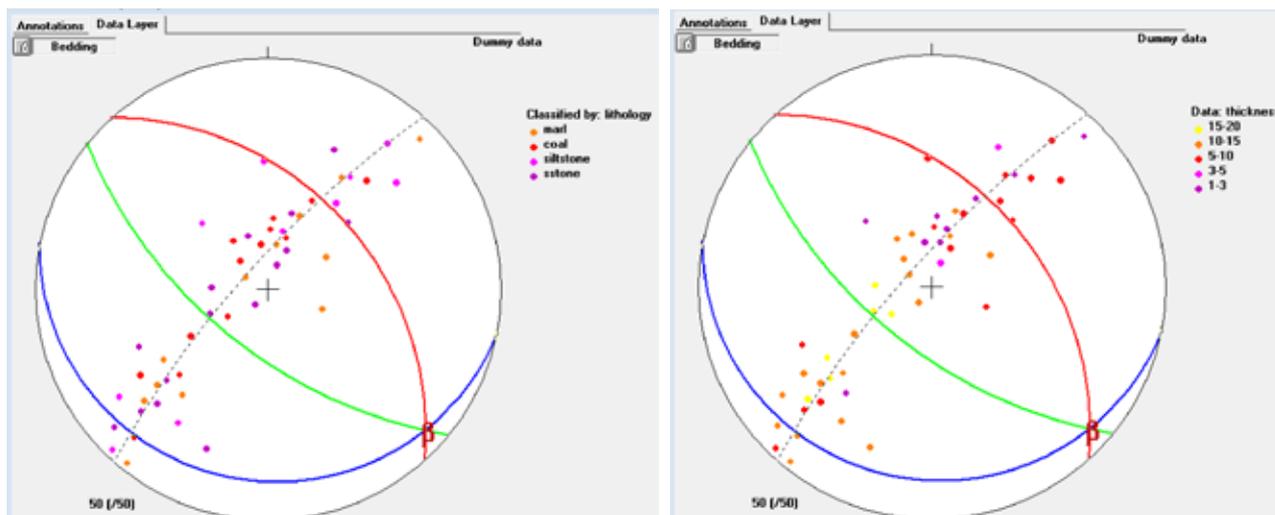
9. Classified Stereonet Plots

Classified stereonet plots allow you to modify the plots by including the Appended data. In its simplest form we will simply colour the plotted poles by the Lithology column, or even by ranges in the numeric data.

- Select the Data Classification button in the toolbar (or the *Show Data Classification dialog* item under the View menu).
- Set the number of base classes you want to use. GEorient will attempt to prepopulate the textboxes. Here I have set 4 base classes for the Appended alphanumeric data in the Lith column. I have set 5 base classes for the numeric data and manually reset the data ranges for each.
- Click the Classification that you want. Here I have selected 'Classify by lithology'. Press **GO**.



If I selected 'Classify by thickness' I would be presented with a dialog extension that allows me to select 'Classified data points'. This option will treat the numeric ranges as coloured points in the same way as the lithology above.

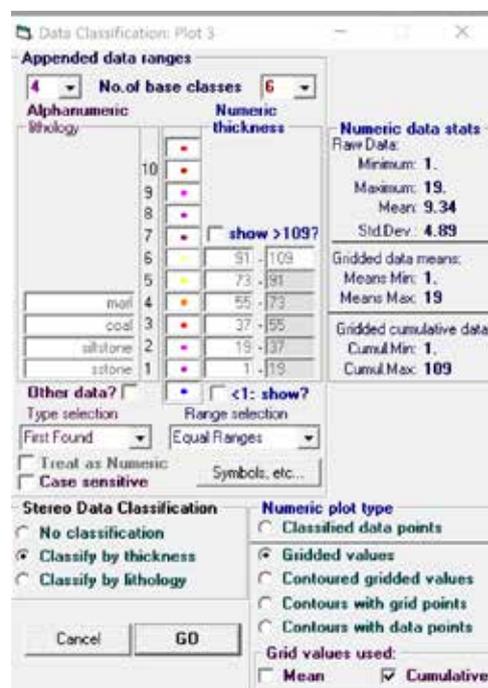


10. Numeric Stereonet Plots

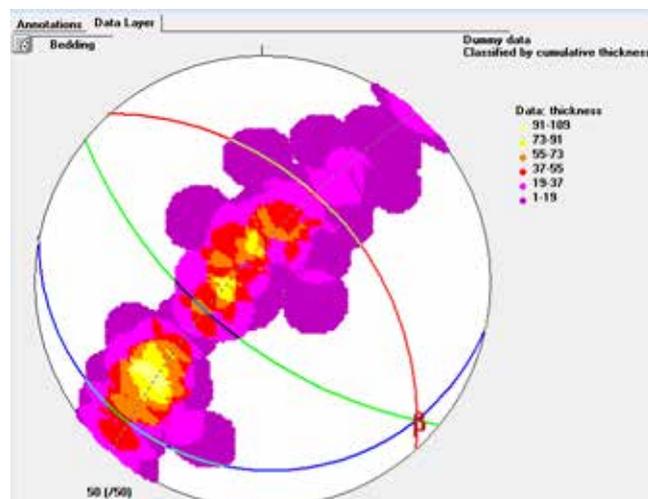
When I choose 'Classify by thickness', which is a numeric value, I am presented with an expanded Classification dialog that provides me with options to plot or contour the actual numeric data. In some situations, this provides a powerful tool, such as when the orientation of veins also includes their thickness and assay values.

Numeric Stereonet plots are a variant of Gridded Density plots. At each grid point, the values associated with any vectors (lines or normals) that lie within the counting cone are plotted.

- 1) Choose whether the grid values are to be the 'Cumulative' sum of all vectors lying within the counting cone, or the 'Mean' value of those vectors
- 2) Reset the Numeric ranges as these will be different for Means or Cumulative totals. In this instance, the Cumulative values are chosen, and the range of values is 1-109.
- 3) Select how to display the data. In the first plot (right) I have chosen 'Gridded values'. The density of the grid is still set from the previous stereonet plot.

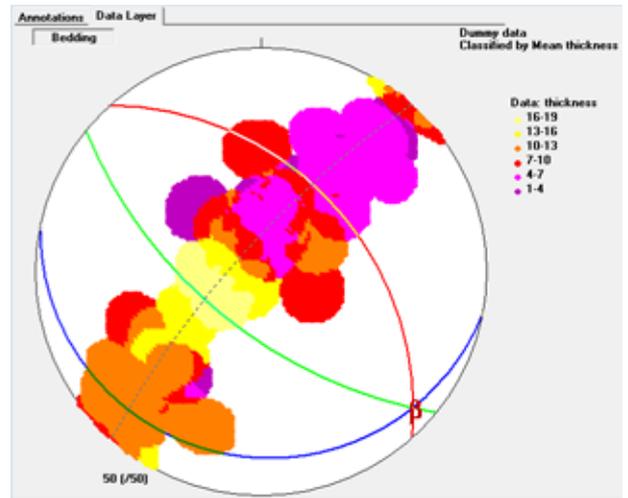


In this instance, the cumulative thickness of the beds at each grid point is not particularly surprising. The point maxima in the plot coincide with the point maxima in the frequency plot, so the maximum cumulative thickness simply corresponds to the maximum frequency.



- 4) But it is a little more meaningful, in this instance, to look at the mean thickness by orientation. In this plot I have chosen 'Mean thickness', and have reset the ranges from 0-19 accordingly.

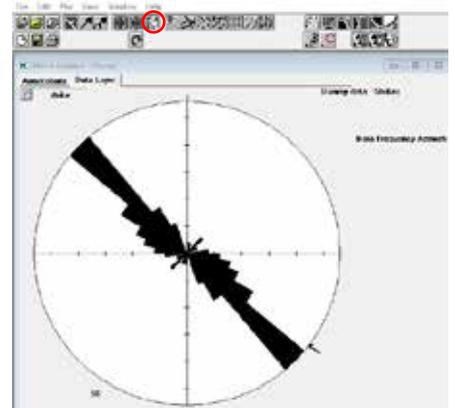
In this instance, there is a clear relationship between the Mean thickness of the beds and the position in the fold. The yellow maximum corresponds to the hinge area of the folds. [This would be a clear indication of non-parallel folds and a component of flattening].



11. Rose Plots

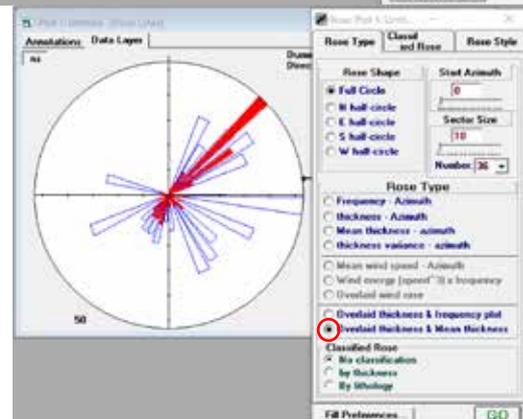
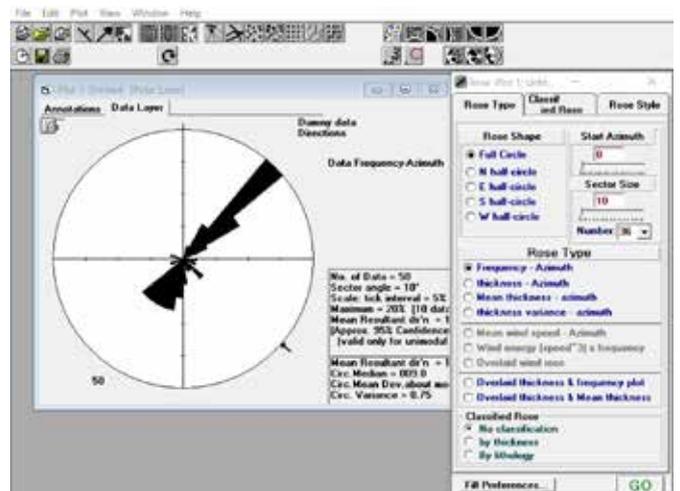
Any stereonet can be shown as a Rose Plot of the directions by selecting the Rose button in the toolbar (red circle). Here we have indicated that our data were planes when we loaded them, so the Rose plot shows a histogram of the strikes, not a terribly useful way to look at this 3D data.

In order to demonstrate rose plots, I will reload the same data, but this time I will indicate that they are directions only, and will plot them as Polar Lines (i.e as vectors). The Appended data will remain the same.



The first time you plot these data they will be displayed around the edges of a stereonet circle. Select the Rose plot button to display them as a rose diagram. The initial Rose plot will be a simple Frequency-Azimuth plot. An additional Rose Diagram dialog will be displayed that allows you to reset the rose parameters and style, and to select other plotting options.

Because we have additional appended numeric data (the bedding thickness), this dialog will display additional options for plotting various thickness parameters. Below I have chosen (red circle) to overlay the Mean thickness plot over the Frequency azimuth plot.



12. Classified Rose Plots

Any data that has either appended associated numeric or alphanumeric (text) data can be shown as classified rose plots. That is, a plot in which the rose sectors are equivalent to stacked histograms.

- At the bottom of the Rose Plot dialog is a section labelled Classified Rose. It will initially be set at No Classification. But by selecting either the numeric data button (thickness in this example) or the alphanumeric data button (lithology in this example) and pressing the GO button, the data will display as a Classified Rose. Here, I have a Frequency-azimuth plot classified first by thickness, then by lithology. In this instance of synthetic bedding data, this type of plot does not tell you much. But, for example, if the directions were strikes of veins, and the alphanumeric data were vein types, then Classified Rose plots are very useful.

