GRAPHICAL PRESENTATION AND STATISTICAL ORIENTATION OF STRUCTURAL DATA PRESENTED WITH STEREOGRAPHIC PROJECTIONS FOR 3-D ANALYSES. COMMONLY USED PLOTTING AND CONTOURING TOOLS CAN BE DOWNLOADED FOR VARIOUS OPERATING SYSTEMS FROM THE WEB.

Commonly used in structural geology

Commonly used in min/crystal

Equal Area

Equal Angle
GRAPHICAL PRESENTATION AND STATISTICAL ORIENTATION OF STRUCTURAL DATA PRESENTED WITH STEREOGRAPHIC PROJECTIONS FOR 3-D ANALYSES. COMMONLY USED PLOTTING AND CONTOURING TOOLS CAN BE DOWNLOADED FOR VARIOUS OPERATING SYSTEMS FROM THE WEB.

Commonly used in structural geology

Equal Area

Commonly used in min/crystal

Equal Angle
ROSE DIAGRAM, only 2-d

<table>
<thead>
<tr>
<th>Våganecracks</th>
<th>Statistics</th>
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</thead>
<tbody>
<tr>
<td>N = 30</td>
<td>Vector Mean = 353.3</td>
</tr>
<tr>
<td>Class Interval = 5 degrees</td>
<td>Conf. Angle = 31.23</td>
</tr>
<tr>
<td>Maximum Percentage = 16.7</td>
<td>R Magnitude = 0.439</td>
</tr>
<tr>
<td>Mean Percentage = 5.88</td>
<td>Rayleigh = 0.0031</td>
</tr>
<tr>
<td>Standard Deviation = 4.11</td>
<td></td>
</tr>
</tbody>
</table>
From 3 dimensions to stereogram

From great circle to pole

Equal area projections
Great circles and poles

PLOT PLANE 143/56 (data recorded as right-hand-rule)
Great circles and poles

PLOT PLANE 143/56 (data recorded as right-hand-rule)
Equal Area

PLOT PLANE 143/56 (data recorded as right-hand-rule)

Great circles and poles

POLE
Equal Area

Great circles and poles

PLOT PLANE 143/56 (data recorded as right-hand-rule)
TYPICAL STRUCTURAL DATA PLOT FROM A LOCALITY/AREA. Crowded plots may be clearer with contouring of the data.
There are various forms of contouring, NB! notice what method you choose in the plotting program.

Common method, \( \% = \frac{n(100)}{N} \) (\( N \)-total number of points)
Kamb contouring statistical significance of point concentration on equal area stereograms: binominal distribution with mean - \( \mu = (NA) \) and standard deviation - \( \sigma = NA[(1-A)/NA]^{1/2} \) or \( \sigma/NA = [(1-A)/NA]^{1/2} \)

A is chosen so that if the population has no preferred orientation, the number of points (NA) expected to fall within the counting circle is 3\( \sigma \) of the number of points (n) that actually fall within the counting circle under random sampling of the population.

\[ N - \text{number of points, } A \text{ area of counting circle, if uniform distribution (NA) - expected number of points inside counting circle and } [N \times (1-A)] \text{ points outside the circle} \]
Poles to bedding S-domain, Kvamshestenen basin.

NB! the contouring is different with different methods!

Scatter Plot:
- N = 70
- Symbol = *
- 1% Area Contour:
  - N = 70
  - Contour Interval = 2.0%/1% area

Kamb Contour:
- N = 70
- First line = 1
- Last line = 70
- Contour Int. = 2.0 sigma
- Counting Area = 11.4%
- Expected Num. = 7.97
- Signif. Level = 3.0 sigma
Poles to bedding S-domain, Kvamshesten basin.

NB! the contouring is different with different methods!
STEREOGRAM, STRUCTURAL NORDFJORD.
A) Eclogite facies pyroxene lineation
B) Contoured amphibolite facies foliations (Kamb contour, n=380)
C) Amphibolite facies lineations
We often want to find the orientation of pre-deformation structures.

1) Determine the rotations axis
2) Make the axis horizontal, (remember that all points must undergo the same rotation as the axis along small circles)
3) Rotate the desired angle (all points follow the same rotation along small circles)
4) Opposite order back to present-day
Rotation of data.
We often want to find the orientation of pre deformation structures

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4) Opposite order back to present-day
Plunging fold:
1) Determine pre-fold sedimentary lineation
2) Determine post fold lineation on western limb.

Tilt fold axis horizontal
(and all other points follow small-circles)

Rotate around the fold axis until pole to limb P1 is horizontal.
All poles rotate along small circles
The original sedimentary lineation 072/00 must have been horizontal since it was formed on a horizontal bed.

The original sedimentary lineation 072/00 or 252/00
Rotate P2 back to folded position around F and the lineation follows on small circle
Rotate F back to EW and restore it to original Plunge, all poles follow on small circles.
Restore to original orientation of axis.
Lineation on western limb is found 231/09
Plunging fold:
1) Determine pre-fold sedimentary lineation
2) Determine post fold lineation on western limb.

Tilt fold axis horizontal (and all other points follow small-circles)

Rotate around the fold axis until pole to limb P1 is horizontal. All poles rotate along small circles. The original sedimentary lineation 072/00 must have been horizontal since it was formed on a horizontal bed.

The original sedimentary lineation 072/00 or 252/00. Rotate P2 back to folded position around F and the lineation follows on small circle. Rotate F back to EW and restore it to original Plunge, all poles follow on small circles. Restore to original orientation of axis. Lineation on western limb is found 231/09.

Figure 6-16. Procedure for unfolding and folding a plunging fold and determining the orientation of a pre-folding lineation.
Fold geometries and the stereographic projections of the folded surface
Figure 8-18. Determining attitude of fold-axial surface from a π-diagram.

a. Horizontal normal fold
b. Plunging normal fold
c. Plunging inclined fold
d. Plunging overturned fold
e. Reclined fold
f. Recumbent fold

Equal Area

N = 353
C.I. = 2.0 sigma
Folded lineations may be useful here to determine fold mechanisms.

Figure 8-26. Intersection lineation produced by a later planar foliation \( (S_3) \) cutting an earlier folded foliation \( (S_1) \). (Adapted from Turner and Weiss, 1963.)

Figure 8-27. Flexural-slip folding of a preexisting lineation. Lineation points lie on a small circle centered on the fold axis. Lineation that was perpendicular to the fold axis (open circles on equal-area plot) lies on a great circle after folding. (Adapted from Ramsay, 1967.)
Figure 8-28. Effect of buckling of individual layers during flexural-slip folding. The small-circle arc pattern of lineations is modified in the outer and inner arcs of the fold. (Adapted from Ramsay, 1967.)

Figure 8-29. Passive folding of a lineation. Lineation points lie on a great circle oblique to the fold axis. (Adapted from Ramsay, 1967.)
“Andersonian faulting”, Mohr-Colomb fracture “law”
Fig. 11. Stereographic (Schmidt-net) representations of synsedimentary intrabasinal faults in the study area. (a) Present orientations of oblique faults that cut the basal unconformity. \( n = 10 \). (b) Present orientation of main faults of the Selsvatn fault system. (c) Faults in (a) unfolded and back-rotated with bedding. \( n = 10 \). (d) Data in (b) unfolded and back-rotated. The synsedimentary orientations of the four main faults reveal that the Selsvatn fault system originated as an orthorhombic fault system characterized by positive elongation in east–west and north–south directions. See discussion in text.
STRESS AXES LOCATED WITH THE ASSUMPTION OF PERFECT MOHR-COLOMB FRACTURING

Figure 12-17. Equal-area plot showing estimation of principal stresses from a single set of slip lineations.

Figure 12-16. Equal-area plot showing estimation of principal stresses from data on two faults of a conjugate system. \( L_a \) and \( L_b \) are slip-lineation attitudes.
STRESS AXES LOCATED WITH THE ASSUMPTION OF PERFECT MOHR-COLOMB FRACTURING

Angle between fault & $\sigma_1$ is 30’
Fault contains $\sigma_2$ at 90’ to L

$\sigma_1$ bisects acute angle between fault 1 and 2
Fault 1 and 2 intersect at $\sigma_2$

Figure 12-16. Equal-area plot showing estimation of principal stresses from data on two faults of a conjugate system. $L_a$ and $L_b$ are slip-lineation attitudes.

Figure 12-17. Equal-area plot showing estimation of principal stresses from a single set of slip lineations.
SLIP-LINEAR PLOT are particularly useful for analyses of large fault-slip lineation data sets. Slip-lines points away from $\sigma_1$ towards $\sigma_3$ and with low concentration around $\sigma_2$. 

**Figure 12-14.** Construction of a slip linear plot. (a) Block diagram illustrating the position of the M-plane with respect to fiber slip lineations; (b) equal-area plot showing the slip linear and the great-circle traces of the fault plane and M-plane; (c) slip linears representing an array of faults in the southern Pyrenees of Spain. (From Anastasio, 1987.)
Figure 12-18. M-plane method of calculating principal stresses from a complex fault array. (a) M-plane great-circle traces for members of a complex array. Circles show the common intersection points (from Aleksandrowski, 1985); (b) block diagram showing how the common intersection of three M-planes may be related to a principal stress; (c) slip linear plot for the faults of plot 'a'. Note that the slip linear points toward $\sigma_3$ and away from $\sigma_1$ (from Aleksandrowski, 1985).
VARIOUS WAYS TO RECORD THE MEASUREMENTS IN DIFFERENT PROGRAMS
FAULTS WITH SLICKENSIDE AND RECORDED RELATIVE MOVEMENT FROM ONE STATION
SAME DATA AS BEFORE, STRESS-AXES INVERSION, RIGHT HAND SIDE ROTATED
Field exercises Tuesday 04/09

Departure from IF w/IF car at 09.00 am

Station 1 at Nærsnes
(large-scale fault between gneisses and sediments)
(ca 2-3 hours)
Station 2 a and b at Fornebo
(small-scale fractures, veins and faults with lineations)
(ca 2-3 hours)

Bring food/clothes/notebook/compass/etc.

Return to Blindern ca 4 pm.

10/09 Report in (presentation of measurements, interpretation and descriptions)