EPSC 240: GEOLOGY IN THE FIELD

FOLDS & STEREONETS

GEOLOGY OF QUEBEC: TOPICS

1. Modern Saint Lawrence Estuary (present-day depositional environment)
2. Hudson Bay Lowlands (glacial-modern)
3. Glacial geology of Quebec, e.g., Champlain Sea (Neogene)
4. Monteregian Hills (Cretaceous)
5. Saint Lawrence lowlands (Paleozoic)
6. Appalachian foreland - Ophiolites (Paleozoic)
7. Appalachian foreland - Dunnage and Humber Zones (Paleozoic)
8. Grenville Orogen (Proterozoic)
9. Labrador Trough (Archean-Proterozoic)
10. Abitibi region gold (Archean)
11. Superior Province (Archean)

GEOLOGY OF QUEBEC

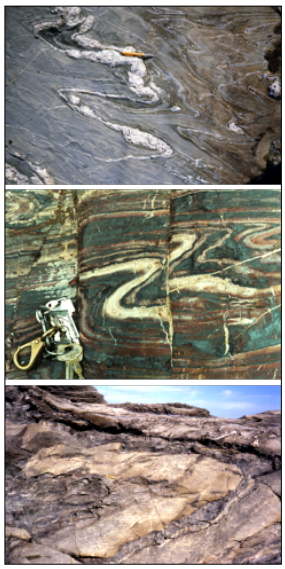
- Presentations: Nov 28
- Reports due: Dec 4
- Decide on individual/groups for presentations
- Email me your topics by next Monday, Nov 5

LABS – DUE DATES

- Lab 7 – Grenville report – this Wednesday Oct 31
- Lab 8 – Magog report – Monday Nov 5
- Lab 9 – Cross sections – Wednesday Nov 7
- Notebooks for marking

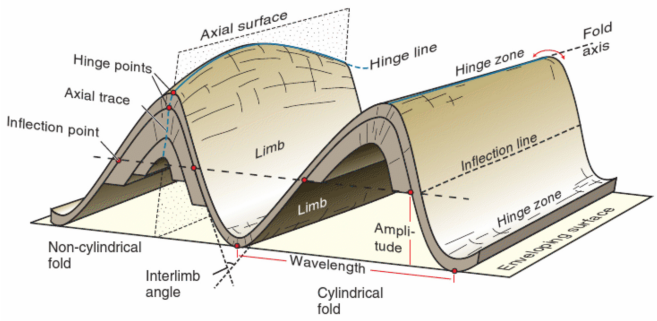
WHAT DEFINES A FOLD?

- In order for a fold to be visible, we need a surface that is folded! The FORM SURFACE
  - *Bedding*
  - *Dyke*
  - *Compositional banding*
  - *Foliations*
  - *Erosion surface*
- Normally assume the FS was planar before folding



FOLDS

- Defined by a curve or bend in an originally straight surface - approximate a sine wave
- Form when rocks are compressed ➔ can use folds to tell the direction rocks were compressed in the past



AXIAL PLANE

- 2D surface with 3D orientation
- Passes through all of the hinge lines on the contacts between layers

FOLD AXIS / HINGE LINE

- 1D line with 3D orientation
- Parallel to the axial plane

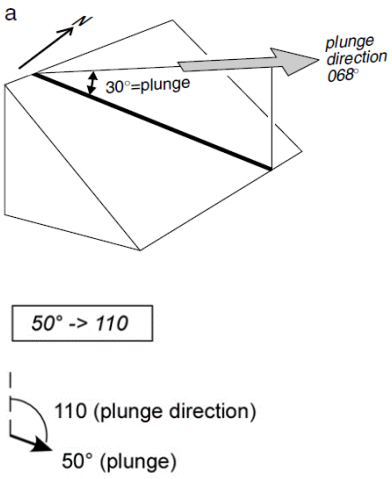
TREND & PLUNGE

Plunge

- Angle measured from horizontal to slope of line, measured through the vertical
- 0 to 90°

Trend (aka plunge direction)

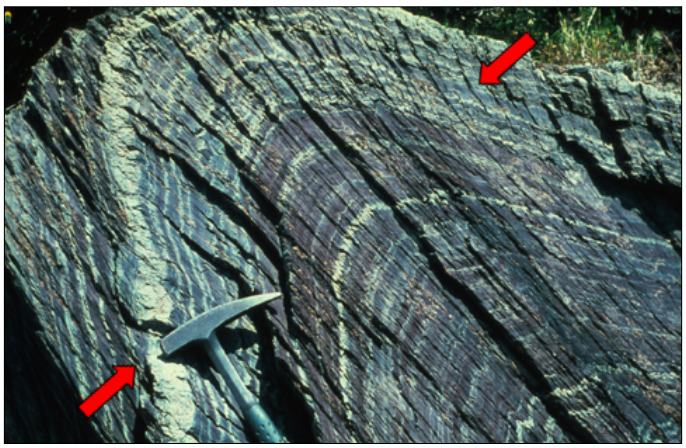
- Azimuth of trend of the line when projected in the horizontal
- 0 to 359°



Lisle and Leyshon, 2004

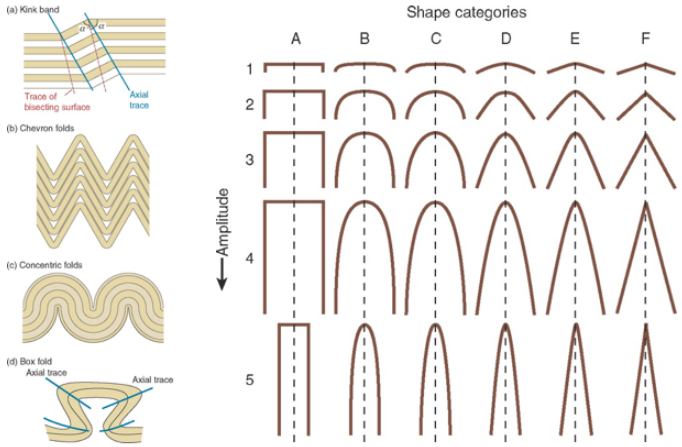
AXIAL PLANAR CLEAVAGE

- Parallel to the axial plane!



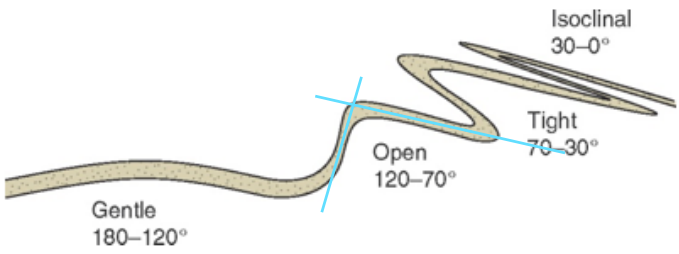
FOLD SHAPE

- How rounded or pointy is the hinge zone?



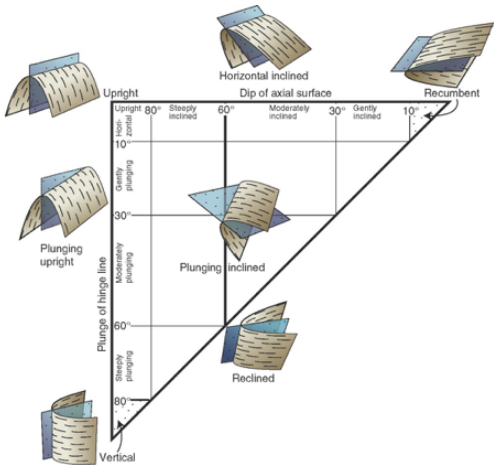
FOLD SHAPE

- Interlimb angle: the angle between the limbs!



FOLD ORIENTATION

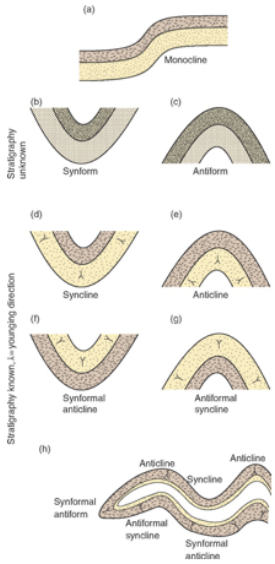
- Two pieces of information required to define fold attitude:
- **Fold axis**
  trend and plunge
- **Fold axial plane**
  strike and dip



FOLD CLASSIFICATION

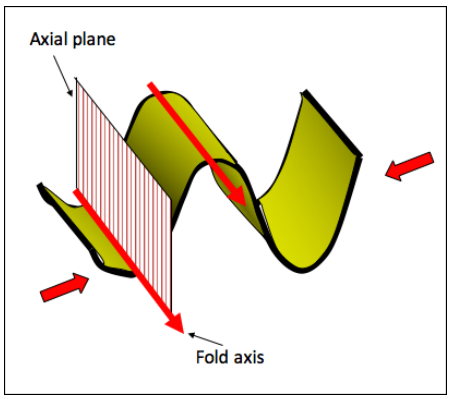
Younging direction, aka up-direction:

- Original top or upper side of a sedimentary or volcanic bed
- Can be determined using some kinds of primary sedimentary structures, such as graded bedding and cross bedding



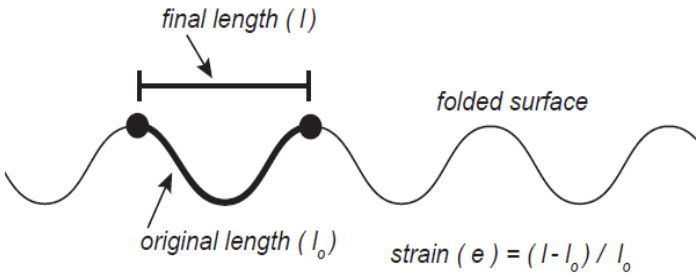
WHY DO FOLDS FORM?

- Compression. A good assumption: the compression direction was perpendicular to the axial plane



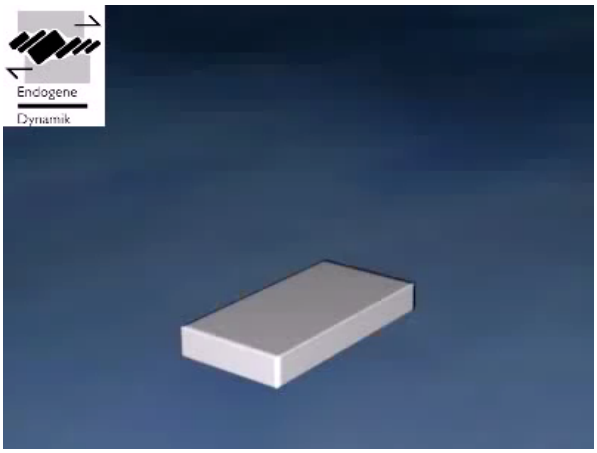
STRAIN

- *Quantitative* measure of the change in shape, size, volume, orientation, or position of any deformed feature in a rock



GEOLOGY CAN GET COMPLICATED

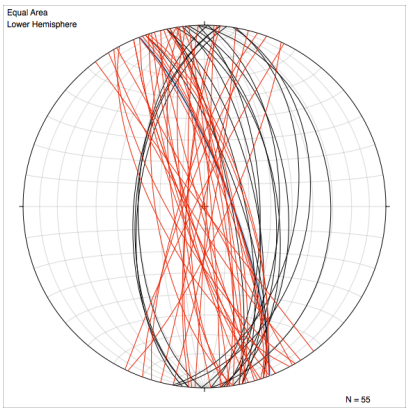
- Folds are sometimes folded again

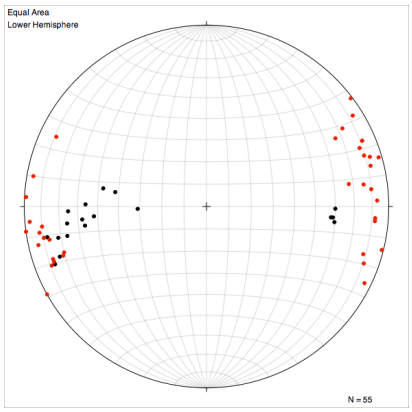


video link: http://www.ged.rwth-aachen.de/index.php?cat=Media&subcat=Videos&page=Videos

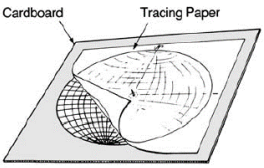
STEREONETS

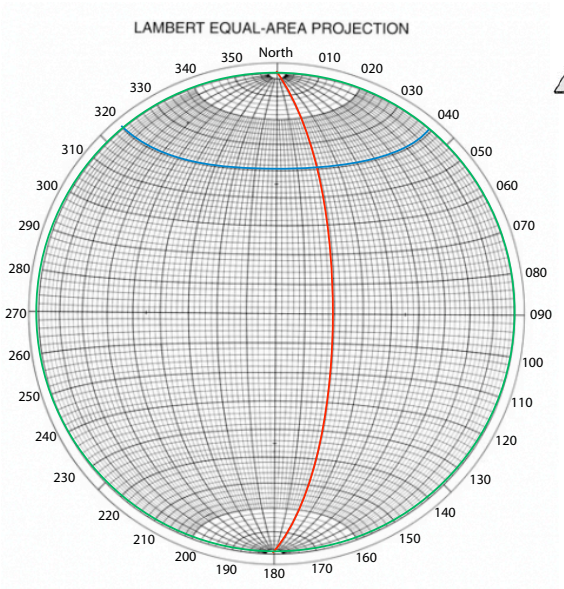
- Used to represent 3D orientation of planes and lines
- Graphical calculator for analyzing 3D data





STEREONETS



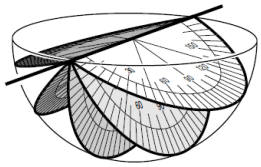


- Great circles from N to S – intersect at poles
- Small circles from E to W – don't intersect
- Primitive circle – circumference

Davis et al., 2012

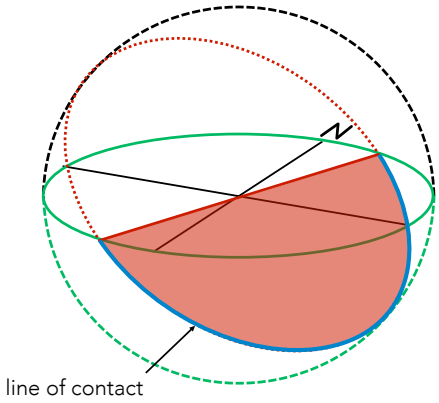
STEREOGRAPH PROJECTION

- In structural geology, we always project from the lower half of the sphere
- "Lower hemisphere projection"



STEREOGRAPH PROJECTION: PLANES

- The plane passes through the centre of the sphere
- The plane intersects the surface of the sphere

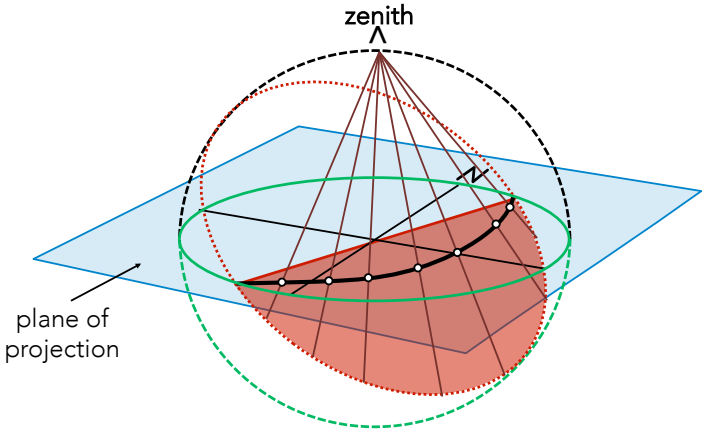


- Line of contact at surface of sphere: circle with a radius the same as that of the sphere
- Line is projected up onto planar surface (stereonet)

After Lisle & Leyshorn, 2004

STEREOGRAPH PROJECTION: PLANES

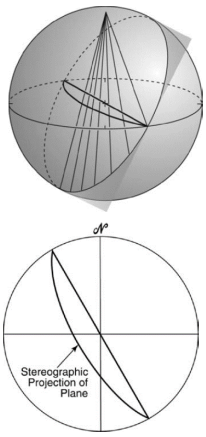
- Consider curved line on the hemisphere as a series of points
- Project a line through each point to the zenith, intersecting the plane of projection



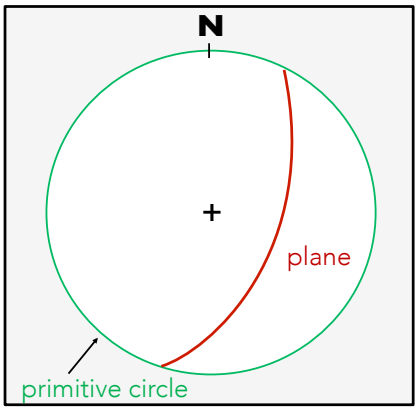
After Lisle & Leyshorn, 2004

STEREOGRAPH PROJECTION: PLANES

- This intersection is the *stereographic projection* of the plane
- The result: an arc on a horizontal plane (stereonet)



Davis et al., 2012

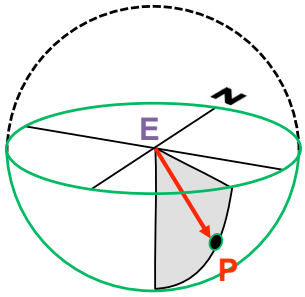


Planes (2D) plot as curves (1D) on a stereonet...

After Lisle & Leyshorn, 2004

STEREOGRAPH PROJECTION: LINES

- The line passes through the centre of the sphere (E)
- The line intersects the surface of the sphere at point (P)

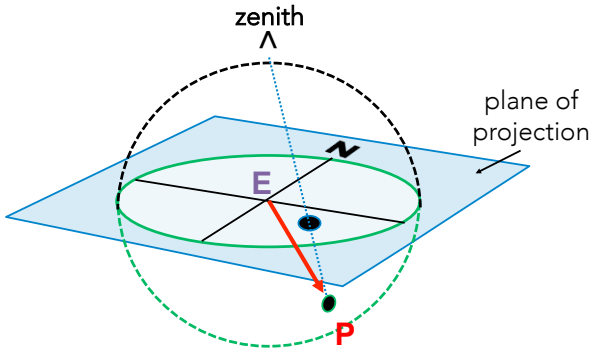


- Point is projected up onto planar surface (stereonet)

After Lisle & Leyshorn, 2004

STEREOGRAPH PROJECTION: LINES

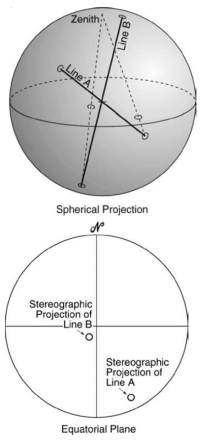
- Project a line from P to the zenith of the sphere
- Plot the point where it intersects the plane of projection

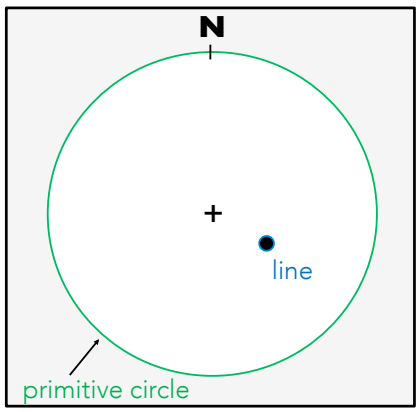


After Lisle & Leyshorn, 2004

STEREOGRAPH PROJECTION: LINES

- This intersection is the *stereographic projection* of the line
- The result: a point on a horizontal plane (stereonet)





Lines (1D) plot as points (0D) on a stereonet...

Davis et al., 2012

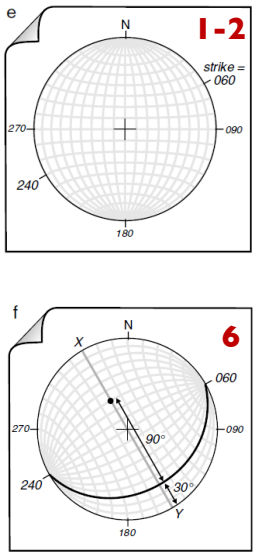
After Lisle & Leyshorn, 2004

PROCEDURE FOR PLOTTING PLANES

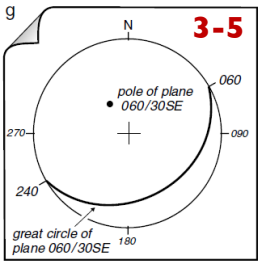
1) Sketch the primitive circle
2) Plot on **N, E, S, W** and the **strike direction**
3) Rotate the tracing paper until the marked strike direction falls at either the **N** or **S pole**
4) Starting at the end of the E-W small circle (090 or 270), **count in** towards the centre to the *angle of dip*

** Start at 090 or 270 depending on dip direction. e.g., if dip is to the SW, count from the direction closest to the S & W directions you marked*

5) Trace the **great circle** corresponding to this dip – *this is the plane*



Example: 060/30 SE

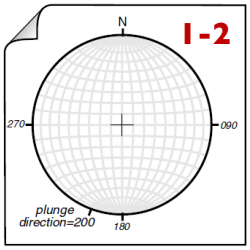


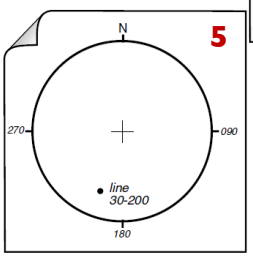
Check your answer:
If your dip direction is correct, the curve of the great circle that you traced will point in the specified dip direction

Lisle & Leyshorn, 2004

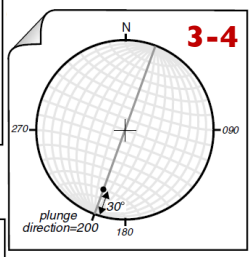
PROCEDURE FOR PLOTTING LINES

1) Sketch the primitive circle
2) Plot on **N, E, S, W** and the **plunge direction**
3) Rotate the tracing paper until the **N-S great circle or E-W small circle** intersects the plunge direction
4) Starting at the primitive circle, **count** in along the N-S or E-W circle *(whichever you've lined up your plunge direction with)* towards the centre to the angle of plunge
5) Plot your point!





Example: 30 ➔ 200



Check your answer:
Your point should fall in the quadrant corresponding to the plunge direction of the line

Lisle & Leyshorn, 2004