11. ROTATIONS (II)

I Main Topics
- A Concepts behind rotations
- B Rotations using a stereonet
- C Successive rotations (drill core problem)

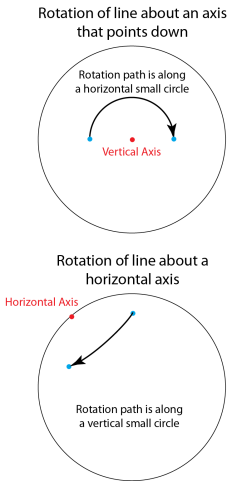
11. ROTATIONS (II)

II Concepts behind rotations
- A Determine approach
  1. Matrix of direction cosines
  2. Sequential rotation about multiple axes
  3. Rotation about a single axis
- B Need to consider whether object is rotated and coordinate axes are fixed or whether the object is fixed and coordinate axes are rotated. This affects the sign(s) and sequence of the angle(s) of rotation.

11. ROTATIONS (II)

III Rotations using a stereonet

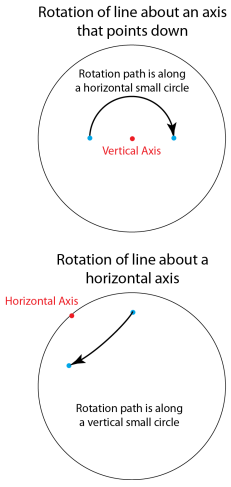
- A Best uses
  - 1 Rotation axis is vertical (but this case is trivial)
  - 2 Rotation axis is horizontal (e.g., to restore tilted beds)
  - 3 Rotations can be shown about axes of other orientation, but the techniques are cumbersome



11. ROTATIONS (II)

III Rotations using a stereonet (cont.)

- B **Construction technique**
  - 1 Find orientation of rotation axis
  - 2 Find angle of rotation and rotate **pole** to plane (or a linear feature) along a **small circle** perpendicular to the rotation axis.
    - a For a vertical rotation axis, the small circle is horizontal
    - b For a horizontal rotation axis, the small circle is vertical



11. ROTATIONS (II)

III Rotations using a stereonet (cont.)

C **WARNING**: **rotate planes by their poles, not their dip vectors**

1 Example: Rotation of an originally horizontal plane by 90° about a horizontal axis that trends north

2 Plane strikes north and dips to the east at 0°.

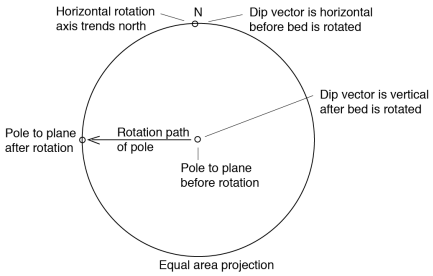
3 Pole: trends west (270°) and plunges 90°.

4 Dip vector: trends north (0°) and plunges 0°.

5 Rotate plane by +90° about a horizontal axis that trends north.

6 We can visualize that after the rotation the plane will still strike to the north but will dip 90°. How do the pole to the plane and the dip vector rotate?

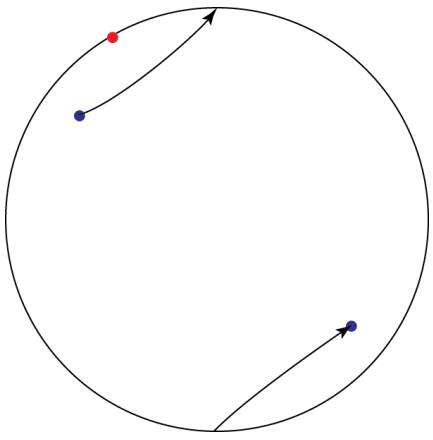
7 Bottom line: rotate planes by their poles, not their dip vectors



11. ROTATIONS (II)

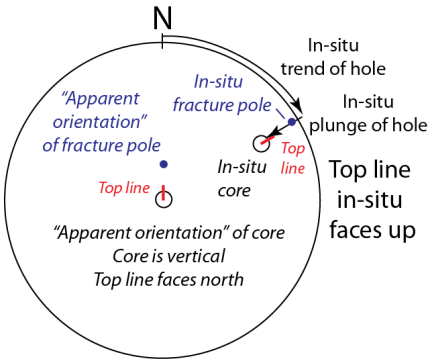
III Rotations using a stereonet (cont.)

D Rotations of line past horizontal



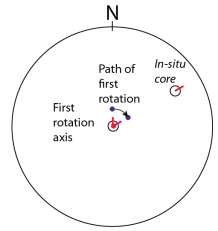
11. ROTATIONS (II)

IV Successive rotations (drill core problem)
- A Description of problem
  - 1 Drill core (and included features) are in one orientation in-situ and another after extraction
  - 2 Find in-situ orientations from apparent orientations and hole orientation

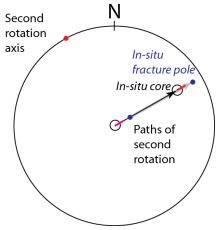


11. ROTATIONS (II)

IV Successive rotations (drill core problem)
- B First Method
  - 1 First Rotation
    - a Rotation of vertical drill core about vertical axis that points down
    - b Rotation angle equals borehole trend
    - c Reference frame stays fixed.
    - d Top line of core (red) rotates clockwise from facing north to facing the in-situ borehole trend.
    - d Structures in core rotate along a horizontal small circle.



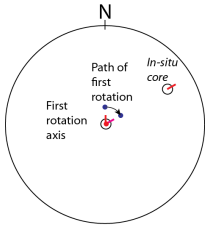
First rotation



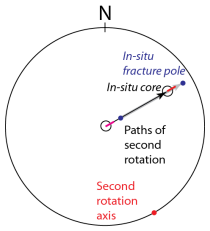
Second rotation

11. ROTATIONS (II)

IV Successive rotations (drill core problem)
- B First Method (continued)
  - 2 Second Rotation
    - A Rotation axis: horizontal; trend = (90°+ borehole trend)
    - b Reference frame stays fixed
    - c Rotation angle = 90° - borehole plunge. Core rotates from vertical up to the plunge of the in-situ borehole.
    - d Trend of core is maintained.
    - e Rotation of core and structures are along vertical small circles



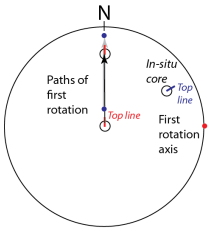
First rotation



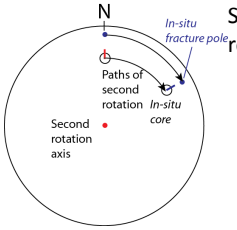
Second rotation

11. ROTATIONS (II)

IV Successive rotations (drill core problem)
- B Second Method
  - 1 First Rotation
    - a Rotation axis: horizontal, trends east
    - b Rotation angle equals 90° minus borehole plunge
    - c Reference frame stays fixed
    - d Top line of core (red) faces north throughout rotation
    - d Structures in core rotate along a vertical small circles



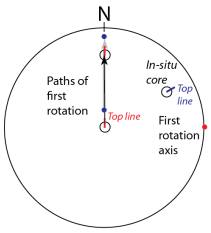
First rotation



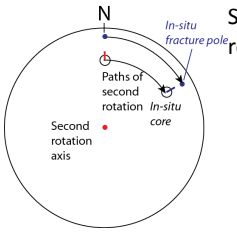
Second rotation

11. ROTATIONS (II)

IV Successive rotations (drill core problem)
- B Second Method (continued)
  - 2 Second Rotation
    - A Rotation axis: vertical
    - b Reference frame stays fixed
    - c Rotation angle equals borehole trend
    - d Plunge of core is maintained.
    - e Rotation paths of core and structures are along horizontal small circles



First rotation



Second rotation