Question 1: The depths of fractures

>>a. Which of the following depth intervals contains the highest number of fractures?<<
   (x) Less than 5400 ft
   ( ) 5400–5600 ft
   ( ) 5600–5800 ft
   ( ) 5800–6000 ft
   ( ) Greater than 6000 ft

[explanation]
Less than 5400 ft. Twelve out of the total 28 fractures are contained within the depth range less than 5400 ft. A second, smaller cluster is present within the interval of 6100–6200 ft.
[explanation]

Question 2: The dominant orientation of fractures

a. Which of the following strike intervals contains the highest number of fractures?

   ( ) 0° to 90°
   ( ) 90° to 180°
   (x) 180° to 270°
   ( ) 270° to 360°

[explanation]
180° to 270°. There are two sets of dominant fracture strike directions, with the most averaging around ~210° and a few at ~000°.
[explanation]

>>b. Which of the following dip intervals contains the highest number of fractures?<<
   ( ) 0° to 15°
   ( ) 15° to 30°
   ( ) 30° to 45°
   ( ) 45° to 60°
   ( ) 60° to 75°
   (x) 75° to 90°

[explanation]
75° to 90°. The majority of the fractures dip steeply between ~75-90°.
[explanation]

>>c. Which of the following dip direction intervals contains the highest number of fractures?<<
   ( ) 0° to 90°

( ) 90° to 180°
( ) 180° to 270°
(x) 270° to 360°

[explanation]
270° to 360°, Most dip directions, are at ~310°.
 [explanation]

Question 3: The dominant aperture of fractures

a. Which of the following aperture intervals contains the highest number of fractures?
   (x) 0 mm to 4 mm
        ( ) 4 mm to 8 mm
   ( ) Greater than 8 mm

[explanation]
0 mm to 4 mm. Eleven of the 28 picked fractures have apertures between 0 and 4 mm. Eight more have apertures between 4 mm and 8 mm. The remaining 9 have apertures greater than 8 mm. [explanation]

b. Which of the following aperture intervals contains the highest number of gently dipping fractures of which the dip is less than 45°?
   ( ) 0 mm to 4 mm
   ( ) 4 mm to 8 mm
   (x) Greater than 8 mm

[explanation]
Greater than 8 mm. At shallow dip angles, approximately less than 40°, relatively large aperture fractures predominate. The smaller-aperture fractures generally dip steeply.
[explanation]

c. Which of the following aperture intervals contains the highest number of nearly north-south striking fractures of which the strike is either between 0° and 15°, or between 75° and 105°, or between 345° and 360°?
   ( ) 0 mm to 4 mm
   ( ) 4 mm and 8 mm
   (x) Greater than 8 mm

[explanation]
Greater than 8 mm. The larger aperture fractures generally strike north-south.
[explanation]

Question 4: Hydraulic fracturing fundamentals

a. From the discussion on mini-frac or extended leak-off tests, choose the correct statement:

( ) Fracture Breakdown Pressure (FBP) is the best estimate of the least principal stress (S3) magnitude, even if Instantaneous Shut In Pressure (ISIP) measurement is available.
(x) Correctly interpreted Instantaneous Shut In Pressure (ISIP) is a reasonable estimate of the least principal stress (S3) magnitude.

[explanation]
FBP represents the pressure at which unstable fracture propagation away from the well bore happens (fluid flows into the fracture faster from the wellbore than the pump supplies; hence the pressure drops). Therefore, it tends to overestimate the least principal stress. As discussed in the lectures, a correctly interpreted and well defined ISIP is probably the most reasonable estimate of the least principal stress (s3) magnitude.
[explanation]

b. Why is the leak-off pressure a reasonable approximation of the magnitude of the least principal stress?

( ) The slight decrease in the rate of wellbore pressurization is caused by a decrease in the system volume as a result of the onset of hydraulic fracturing.
( ) The pressure-volume curve has reached its summit where the pressure is high enough to propagate a hydraulic fracture.
(x) The noticeable change in the rate of wellbore pressurization is caused by propagation of a hydraulic fracture, which increases the system volume.

[explanation]
The first option is incorrect because the system volume must <i>increase</i> when a hydraulic fracture develops.
The second option is incorrect because the summit of the pressure-volume curve is the formation breakdown pressure, which is usually significantly greater than the least principal stress.
The final option is correct. The least principal stress is <i>best</i> approximated by the instantaneous shut-in pressure (ISIP). However, the leak-off pressure is a reasonable approximation of the least principal stress because the change in pressure it records represents an increase in system volume, which means that a hydraulic fracture must have formed.
[explanation]

N
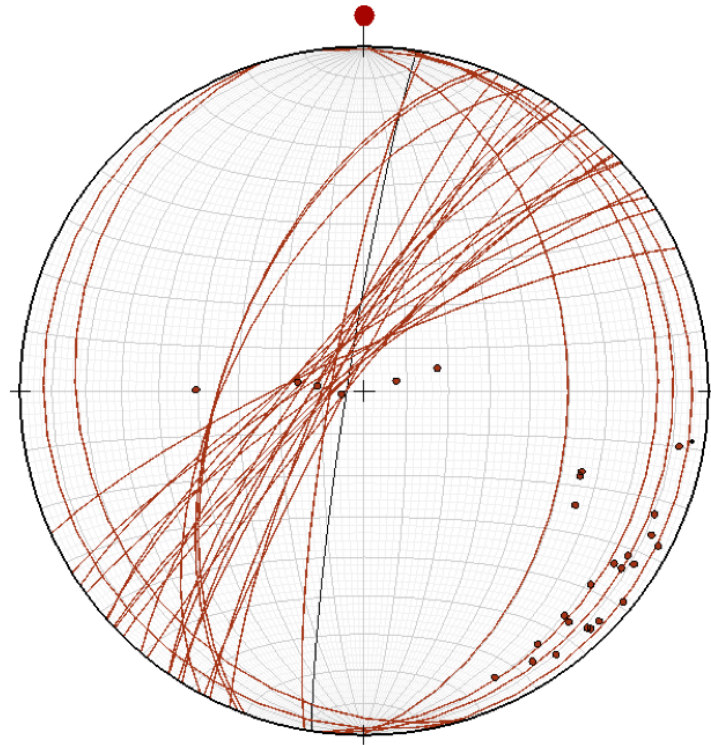
Mean Direction: 310.3°
95% Confidence: ±18.8°
n = 28