Chapter 2: What is a fracture

Notes for Slides:

Slide 1: The study of fractures began as a study directed towards quarries and hazards and as such tended to be an engineering problem.

Slide 2: The Obelisk Quarry at the Aswan Dam in Egypt is an early example of using the natural fracture system to quarry

Slide 3: Fractures in petroleum geology became important in the late 20th century (1990's) as large hydrocarbon deposits were found in tight rock. The success of these plays was dependent on encountering fracture systems generally associated with the bending moment of the beam (rock)

Slide 4: A large vocabulary has developed around fractures. Most of the vocabulary is no longer used by the practitioner although it is still pervasive in the literature

Slide 5: The major types of fractures

Slide 6: Typical stress conditions associated with fracture genesis. It should be noted that the material for this model is homogeneous and isotropic, two conditions that are exceptionally rare in the natural world.

Slide 7: Earlier fracture studies consistently tried to name fractures and generally used either the structural components of the fold as a frame of reference or the stress field as a frame of reference. Eventually the stress field became defined by the fracture distribution creating a circular argument and ignoring the importance of the strain pathways.

Slide 8: Surface geology of a part of the southern Canadian Rocky Mountains west of Calgary.

Slide 9: Fold in the Palliser Fm. (Devonian) in the hanging wall of the McConnell Thrust Sheet.

Slide 10: Sketch of tight folds in the core of the main fold.

Slide 11: Right section of fold

Slide 12: Distribution of poles to bedding (left) on the streonet describing the fold axis. Right stereonet show poles to fractures which fit the model that the bulk of the fractures are related to the fold.

Slide 13: Basin Centred gas is dependent of fracture systems to move the fluids through the rock column. The fractures challenge the conventional reservoir model. The emplacement of the hydrocarbons suggest that conventional migration systems based on buoyancy does not work.

Slide 14: Judith River Section along the Judith River north of Billings, MT.

Slide 15: Exploitation of the reservoir by a conventional approach

Slide 16: Exploitation of the reservoir using a horizontal well. The access to the fracture system in both the sandstone and the tight fine-grained reservoir

Slide 17: Thin sandstone within the Cretaceous Bow Island Formation of southern Alberta. The conventional producing zone is 1.5 metres thick and has produced 10.2 BCF.

Slide 18: Production from the zone with pressure measurements overlaid. The zone shows flat production with very minor pressure decline meaning that the reservoir must be much larger than conventional petrophysical analysis. Late gas decline appears associated with increased water production.

Slide 19: Schematic of distribution of water and gas within the Bow Island Fm. The under-pressure is achieved through the interplay of fresh water encroachment, capillary forces and relative permeabilities. The fracture system is the dominant delivery system to the well ensuring a large drainage volume and sustained rates.

Slide 20-25: Description of how faults form.

Slide 26: For faults to form there also has to be some sort of arresting system such that the fault does not carry on indefinitely. If the Fault needs elevated pressure to initiate failure then it needs to lose pressure to arrest failure. However faults are episodic and must re-establish elevated pressure to have subsequent failures. This means that there must exist a process of alternating sealing (to build up pressure) and opening (to bleed off pressure). The interplay of gouge and normal stresses are the likely tolls to establish this episodic nature.

Slide 27: Gouge along a fault in the Tertiary Wind River Formation (Wyoming)

Slide 28-32: Some drilling problems associated with fractured reservoirs.