FRACTURED RESERVOIRS

The study of the geology of a fractured reservoir requires the study of the relationship between the fracturing process and the geological events which took place during this phase. This includes the elaboration of a correct theory of fracturing and a valid diagnosis of the features of a fractured reservoir.

Rock fracturing will most commonly have

a tectonic origin, differential the fracturing depends on the pattern of mechanical stresses of the rock material and rock properties. Hence, the results of fracturing, such as fractureopenings, size, distribution, orientation, etc., will be related to stresses and type of rock (brittle or ductile), structural conditions, depth (overburden stress), lithology,

bed thickness, etc.rates of diagenesis and lithification.

Fractures which are generated as the result of stress which reduces rock cohesion

can be attributed to various geological events, such as:

a. diastrophism in the case of folding and faulting,

b. deep erosion of the overburden, which will cause a differentiated stress on the rock through the planes of weakness,

c. rock volume shrinkage as a result of loss of water when pertaining to shale or shaly sands.

d. rock volume shrinkage in the case of a variation of temperature in igneous rocks.

Classification based on descriptive criteria

Natural fracture vs. induced fracture

A natural fracture is any'break or crack,occurring in the rock,including those cracks which can be identified by the presence of slickensides and mineralization.

induced fractures are all those cracks which result during coring (such as breaks along the bedding plane) or from mishandling of cores.

- The classification of fractures based on their appearance and morphology has been elaborated by Steams' through the following categories:
- **a.** Unequivocal natural fractures; those which are partially filled or totally filled by vein material and also those which are opened and lie on a parallel trend to partially or totally filled fractures.
- **b.** Very probable natural fractures; fractures with slicken sided surfaces and also those parallel to them.
- **c.** Probable natural fractures; fractures with clean, fresh surfaces accompanied by small fractures which are parallel to the unequivocal fractures.
- **d.** Induced fractures; generally recognized as fresh, clean fractures parallel or normal to the core axis as a result of bending or twisting of the core during coring

Measurable and non-measurable fractures

Measurable fractures are visible fractures which may be defined by width, length, orientation (dip and strike angle), while non-measurable fractures are only traces across the core which end within the core. Any reference to fracture density or intensity, etc., should refer to the visible natural fracture which indicates a certain dip angle and direction.

In addition, there are broken cores with fractures which are not measurable either because they are too dense and irregular or because there is no criterion of evaluation. There are two types of such fractures and they are denominated breccia and rubble, Breccia is formed by acute angled pieces of similar sized pseudo-prismatic matrix blocks which fit together, often forming hundreds of mini blocks per foot. In general, breccia is considered to be any fractured rocks which have over 50 fractures/foot.

The other type of fractured rock denominated rubble represents an irregular broken core where the individual pieces do not fit together and no criteria exist to evaluate the fracture density

. Macrofractures and microfractures

The difference between these two categories mainly concerns the dimensions of the fractures.

In general, macro fracture corresponds to a fracture with a large width (over 100 microns) and considerable length, while micro fracture applies to a fracture of limited length and width (sometimes microfractures form a continuous network which is hydrodynamically very similar to a porous medium). In the literature it is often possible to come across terms such as, macrofractures = fractures while microfractures = fissures.

The division of the same categories of fractures may be interpreted differently when referriigg to a genetic criterion. In this case, macrofractures may refer to large or cavernous openings resulting from dissolution-erosion, whereas microfractures with dimensions below 100 microns will develop in response to structural and tectonic events.

Open and closed fractures

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Based on direct examination, there are two categories of fractures - open fractures and closed fractures;

these depend mainly on circulating water and precipitation, which is capable of plugging the fractures with anhydrite, minerals,

etc. On the other hand, fractures which are closed in surface conditions may often be open or partially open in reservoir conditions where pore pressure acts on fracture walls.

Classification of fractures based on geological criteria

- the geological history of a reservoir is directly related to the fracturing process. Since the major role in generating fractures is played by
- tectonic events and the geological environment (lithology), any classification of fractures has to take these criteria into consideration.

Fractures associated with folding

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In general, fractures are related to the folding 3axis and therefore are denominated:

a. longitudinal fractures - along the folding axis

b. transversal fractures - perpendicular to the folding axis

c. diagonal fractures - in relation with the folding axis

Fractures and the stress state

If fractures are associated to one or more states of stress they are divided into two groups:

a. conjugate fractures

b. non-conjugate (orthogonal) fractures

where conjugate fractures are those which have been developed from a unique state of stress

The totality of the fractures could be associated with their direction and therefore:

a. The fracture system is formed by all fractures having the same mutually

b. the fracture network is the result of various fracture systems.

Fractures associated with stratigraphy parallel direction.

The variations of dimensions and density of fractures depend on lithology and

thickness of the layer in which the fractures are developed. The results obtained will

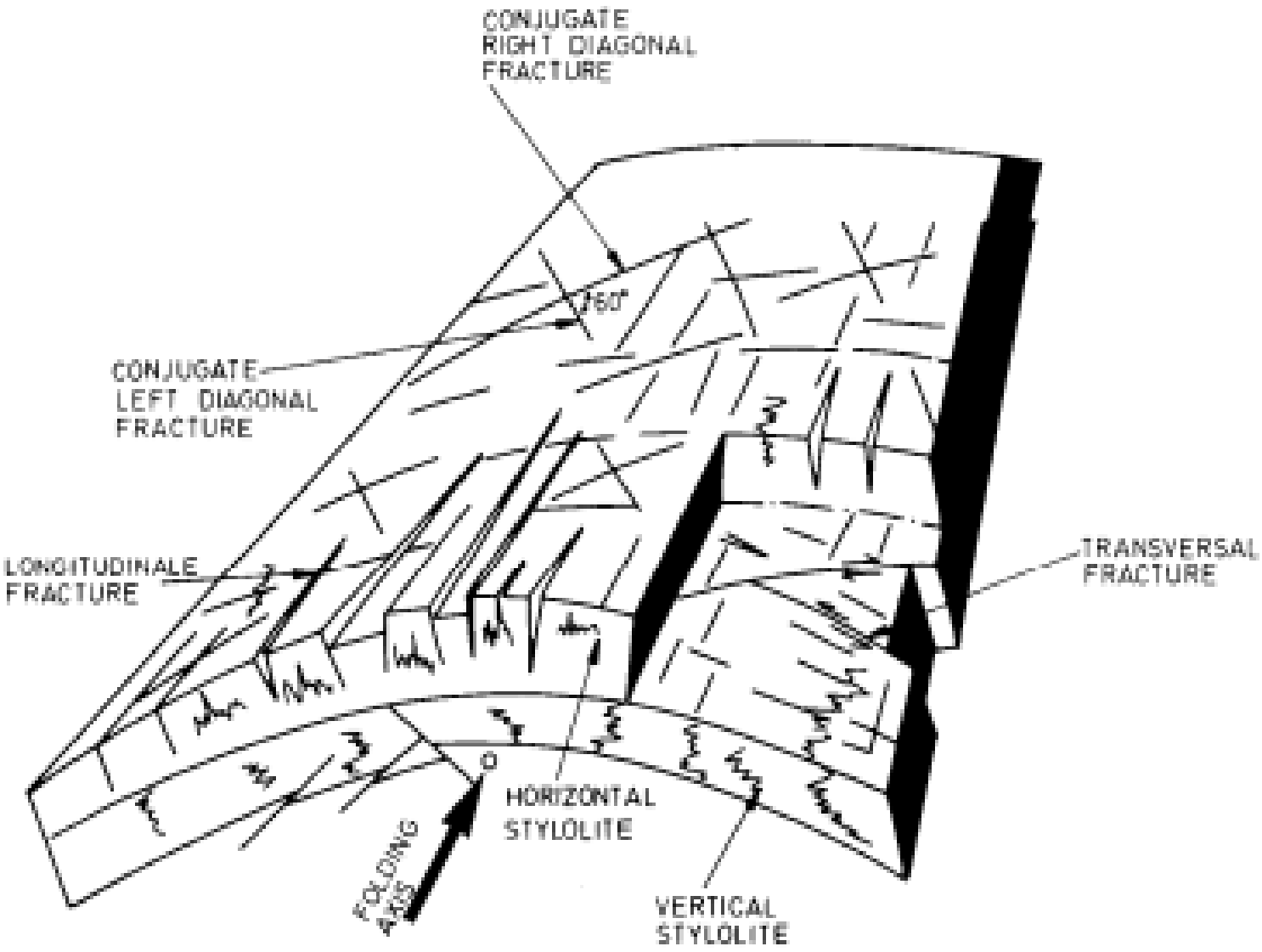
divide the fractures into two categories:

a. first-order fractures

b. second-order fractures

First-order fractures are those which cut through several layers of rock,

second-order fractures are limited to a single layer of rock.


CONJUGATE
RIGHT DIAGONAL
FRACTURE
60°
CONJUGATE
LEFT DIAGONAL
FRACTURE
LONGITUDINALE
FRACTURE
TRANSVERSAL
FRACTURE
HORIZONTAL
STYLOLITE
FOLDING
AXIS
VERTICAL
STYLOLITE