Methodology for simulating fractures in a fault zone: Analysis of the data from “cirque de Navacelles”

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The construction of reservoir models representative of fractured reservoirs is a key point to study their hydraulic, mechanic, and chemical behaviors in particular for the safety of CO2 storage.

In the literature different fault models are presented that depend on several characteristics of the environment such as the lithology, stratification, regional stress, fluid contents… Moreover in the faulted reservoir models for hydromechanic simulators, the fault zone is highly simplified. This zone is represented as a succession of three main compartments with different hydro mechanical properties: the fault core (usually with very low permeability and rigidity), surrounded symmetrically by a damage zone generally highly permeable and presenting a fracture network whose characteristics (fractures' lengths, orientations, number of sets, etc.) depend on the distance to the fault core, then by a less dense or non fractured area.

To verify the validity of the afore-described conceptual model (usually used to describe mature large faults) at reservoir-scale in a low-deformed carbonate setting, and then to reproduce (in a static reservoir model) the observed fractures' distributions, observations were collected on the site of « cirque de Navacelles » (southern France). This site is located outside major fault systems and can be considered as a good analogue of the low-fractured rock formations targeted for co2 storage. This area is composed of alternating limestones/shales, few deformed, with deca-metric faults. Moreover, thank to the incision by the Vis river several outcrops allow the observation in different directions.

Thus, on several outcrops of this site, a systematic survey of fractures has been conducted along a scan line. Several geometric characteristics have been identified (dip, dip direction, aperture, fracture height and vertical persistence …). The fractures are classified either in joints for simple discontinuities, either in veins if crystallization is present or in faults when the two walls are shifted. A statistical analysis of the measures is performed as a function of the distance from the main fault zone. These statistics take into account the bias due to stereological effects (1D observation of 3D objects), truncation, and censoring.

In the studied site, the fracture exhibit variations that depend not only on the distance from the main faults but also on the geology characteristics (type of formation, bed thickness …). Starting from these observations a specific geostatistical model has been developed to build such fault zones. The developed stochastic model should serve to better account for uncertainty related to the distribution of fractures of damage zones in reservoir flow simulations used for CO2 storage performance assessment.

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