A05

From Static to Dynamic Fault Retention Potential Evaluation - A New Approach

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SUMMARY

In exploration the classical analysis of the retention potential of a fault zone in hydrostatic domain integrates a geometrical analysis (relay zone/segmentation), a reservoir juxtaposition study, a fault rock properties description and a re-activation tendency. The evaluation of the maximum hydrocarbon column height retention is performed at the present time using the fault entry pressure. In overpressure domain the fault entry pressure can not be used. There is a necessity to use a more dynamic approach: the fault zone permeability. Furthermore a fault zone evolves through time: fault initiation, fault sliding, fault burial, fault reactivation. And during this "life" its impact on fluid flow varies. The characterization of the fault zone permeability through time is so necessary. As several parameters can modify the fault zone permeability (temperature, pressure, stress, diagenesis) a complete understanding of the fault zone permeability through time is needed. To evaluate these parameters evolution through time our current work integrates a combination of outcrops description, geomechanical experimentation and basin modelling.

Faults zone behaviour can severely impact on prospect evaluation (i.e. hydrocarbon column height) as well as development schemes (i.e. compartmentalization). Hence it is one of the key factors to understand in Exploration and Production.

Fault impact on fluid flow can vary from complete barriers without flow across or along the fault to a negligible impact on across flow and even an increasing flow along the fault zone for example.
This complexity is also enhanced by the fact that fault behaviour can be different:
- Spatially: a fault can be a lateral seal and a vertical conductive drain for example
- Temporally: during its life a fault can start as a conducting interface and then become a barrier.

To be predictive we have to identify and understand which key parameters will impact the fluid flows across and along the faults. To assess the retention potential of a fault zone a complete characterisation is needed. Such characterisation needs to take into account the geometrical aspects (i.e. fault segmentation/relay zones using the seismic data), the reservoir juxtaposition across the fault (using Allan diagram), the fault rock characterisation (using analogues, geomechanical modelling) as well as the fault stability during a potential re-activation (stress field modification).

For the present time most of this characterisation is mainly concentrated on siliciclastic contexts with normal faulting. In these contexts the conventional approach in exploration to assess the across-fault retention potential is quite “static” with the use of the fault entry pressure to evaluate a hydrocarbon column height at the present day. However its application is limited to the hydrostatic domain and doesn’t take into account water-water pressure differences, fault zone diagenesis and the fault evolution through time for example. In reservoirs, faults can be treated using multiplier tranmissivities which take into account the fault permeability.

In overpressured domains, besides hydrocarbon column height evaluation, the role of the faults in pressure cell generation and leakage is also important to understand. There is a necessity to think in a more “dynamic” way (i.e. evolution through time) by using fault permeability (Fig.1).

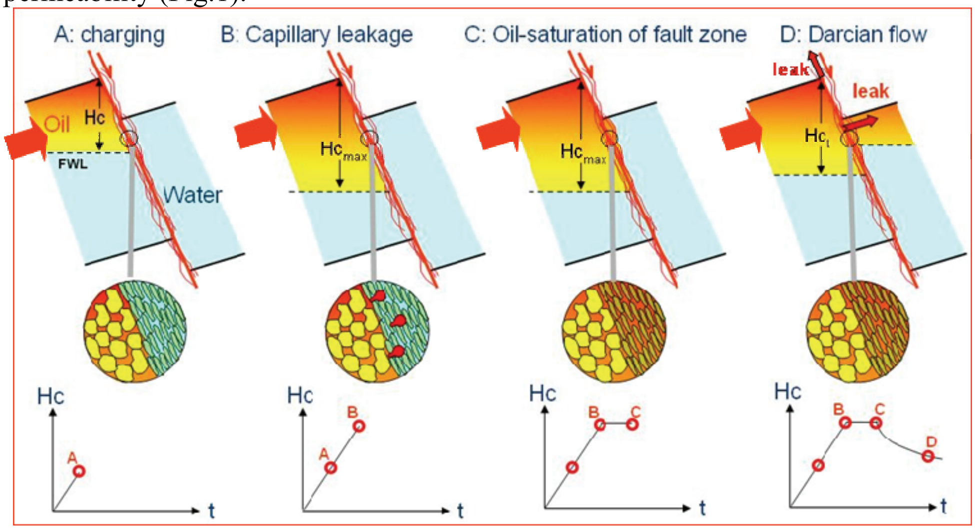

Figure 1 *In overpressured domains: from entry pressure to permeability.*

Moreover as the fault characteristics evolve through time (Fig.2) (geometry, fault zone architecture, diagenesis, stability...), so will the impact of the fault on fluid flow.

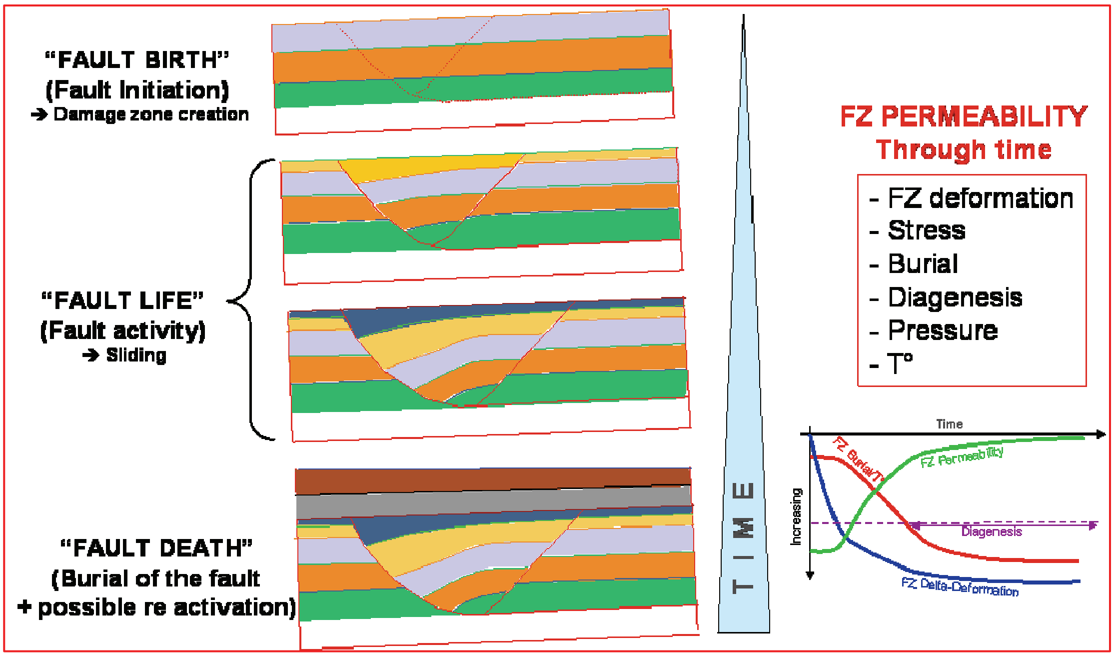

__Figure 2__ Schematic fault zone evolution through time.

To be able to perform a good fault behaviour retention evaluation, the understanding of the 4D evolution of the fault zone is needed. To try to capture this evolution, which is complex, modelling is essential. In exploration, basin modelling can be a way of integrating all these parameter changes through time: burial, stress field, temperature, hydrocarbon generation, diagenesis, timing of faulting…

This approach can also be generalised to the hydrostatic domain. This allows reconciling the exploration and the reservoir approaches, both using fault zone permeabilities.

Work presented here evaluates fault zone permeability through time using analogue outcrop descriptions, experimentation (analogical and numerical) and basin modelling (Fig.3).

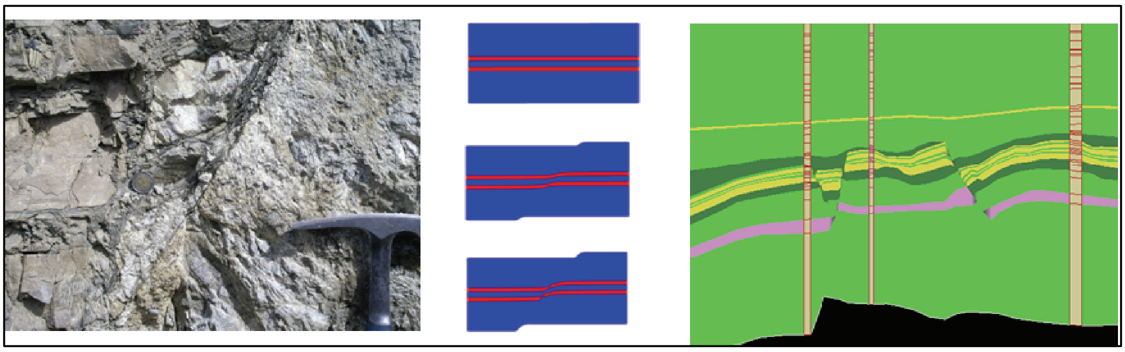

__Figure 3__ Fault zone characterisation through time using analogue outcrops, geomechanical and basin modelling.