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Micro-structural analysis to identify micro-scale deformation mechanisms and their effects on fault sealing capacity: an example from the Lenghu5 thrust-fold belt, Qaidam Basin, NE Tibetan Plateau

Pei, Y.[1], Knipe, R.J.[2], Paton, D.A.[2], Li, A.[3], and Wu, K.[1]

[1]School of Geosciences, China University of Petroleum, Qingdao, 266580, China. Email: peiyangwen@163.com
[2]School of Earth and Environment, University of Leeds, Leeds, LS2 9JT, UK
[3] Rock Deformation Research, Pinnacle, Leeds, West Yorkshire, LS1 5AA, UK

As faults can be barriers or conduits for fluid flow, it is critical to understand fault seal processes and their effects on sealing capacity of a fault zone. Apart from stratigraphic juxtaposition between hanging wall and footwall, the development of fault rocks is of great importance in changing sealing capacity of a fault zone. Micro-structural analysis, utilizing high performance Scanning Electron Microscope (SEM), is an effective method to identify the detailed micro-deformation mechanism and its effects on modifying porosity and permeability of a fault rock. In this research, the Lenghu5 thrust-fold belt, with well exposed outcrops, is selected as an example for detailed outcrop mapping and SEM micro-structural analysis. Detailed outcrop mapping is employed in situ to describe and interpret the geometry of well-exposed outcrops, particularly the detailed fault zone architecture. The rock samples, collected in both the fault zones and the undeformed hanging walls/footwalls, are studied by SEM micro-structural analysis to identify the deformation mechanisms at micro-scale and evaluate their influences on the fluid flow properties of the fault rocks. The micro-scale deformation mechanisms accounting for porosity and permeability reduction of fault rocks have been identified, e.g., clay smears, phyllosilicate-framework fault rocks (PFFRs), cataclasites, cemented fractures, etc. The degree of sealing capacity of different fault processes is highly decided by the clay/phyllosilicate content and burial depth. At micro-scale, high concentration of clay/phyllosilicate minerals in host rocks are likely to form continuous clay smears or micro- clay smear between framework silicates, which can significantly decrease porosity and permeability of a fault rock. The burial depth is also of importance in controlling sealing capacity of a fault rock as it decides the level of compaction and lithification of host rocks.

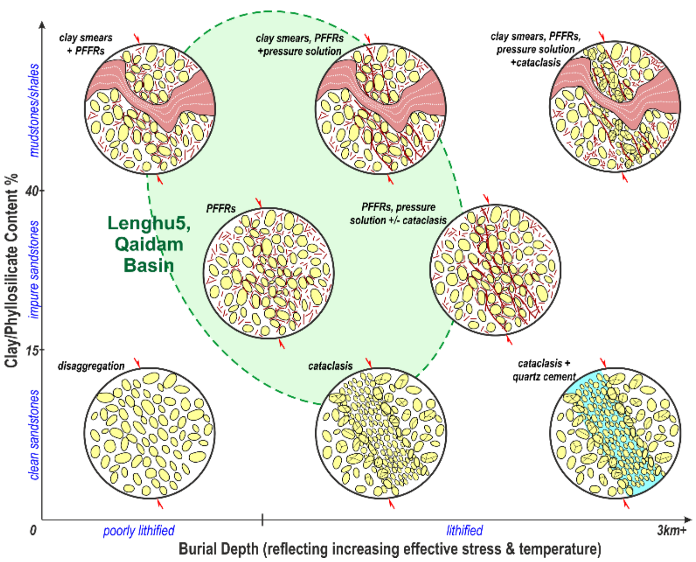

Figure 1: Schematic cartoons of micro-structural deformation mechanisms with various fault rocks generated in different geological settings, e.g., clay content of the host rocks and burial depth (reflecting increasing effective stress and temperature) (modified from Jolley et al., 2007).

References:

[1] Jolley S et al. (2007) Petroleum Geoscience 13: 321-340.