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Fracture corridors and fault interaction in a context of polyphase deformation - Example from the Chalks of the Isle of Thanet Anticline, Kent, England

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Fractures are difficult to predict in the subsurface as they are below mapping resolution such as seismic. However, in a reservoir with a low matrix permeability, like chalk reservoirs, connected fractures provide the permeable pathways. Zones of intense fracturing or fracture clusters are common. Among clusters are fracture corridors, which correspond to elongate zones of sub-parallel narrowly spaced through-going fractures, where the fractures are (sub)parallel to the orientation of the long axis of the zone. The fracture spacing within a fracture corridor is very small compared to the mechanical unit formed of one or several beds controlling the fracture corridor height. Individual fractures in the corridor may only be a few metres long, while the zone can extend for a few hundreds of metres. These highly connected corridors of fractures generate fluid flow pathways that may be responsible for an early water break-through during hydrocarbon production. Interpreting the corridors is therefore an important but difficult task in reservoir characterization. We present an outcrop study of fracture corridors that relate their distribution to the larger scale faulting and folding.
To understand the development of fracture corridors and to characterize their relationship to faulting and folding we consider an outcrop analogue of a fractured reservoir: the Isle of Thanet anticline (Kent, SE England). In this area, the Upper Cretaceous chalks have undergone a polyphase deformation generating a gentle E-W axis fold and several sets of faults and fractures. Numerous fracture corridors are observed in the high curvature area of the fold and only a few in the other parts of the fold.
We show, however, that despite the relationships to folding this fracturing is not directly linked to the folding. The fracture corridors, as well as the fold itself, are localised by a pre-existing basement fault that reactivates faults in the chalk cover. Fracture corridors are associated with strike-slip fault reactivation associated with polyphase deformation. The fracture corridors are generated in an oblique orientation to these pre-existing faults. They nucleate from slip patch tips at areas of stress concentrations. Stress concentrations also correspond to fault plane changes in orientations and steps between segments. Further deformation of both pre-existing faults and corridors may lead to block rotations and to the development of a fault gouge within the sheared corridors.
This work emphases the importance of the distribution of subseismic faults in the context of polyphase deformation. The distribution of small scale, low throw faults can have a critical impact on the distribution of latter fractures and on the emplacement of fracture corridors. Several examples of fracture corridors have been observed in other outcrop areas and are now under further investigation. All of these examples are associated with the reactivation of pre-existing surfaces appropriately oriented relative to a late stress event.