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Role of polygonal faults on sedimentary fabric of unconsolidated sediments: implications for compaction and fluid migration

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Since the 1990's polygonal faults have been widely reported from hydrocarbon exploration and scientific surveys. This kind of fracturing is attributed to volumetrical contraction of sediments commencing during compaction at shallow burial depth. This faulting is characterized by small extensional faults displaying a polygonal pattern in plan view. The development of polygonal faults seems to be controlled by the fine-grained nature of sediments and their mineralogy; in particular high smectite content is considered to play an important role in the initiation of such faulting.

In the Congo and Norway Basins, using high-resolution 3D seismic data, we have visualized the progressive deformation of polygonal faults during burial, leading to the conclusion that it is an ongoing process starting at the water-sediment interface. Polygonal faulting can temporarily stop, due to a regional change in environmental conditions from smectite-rich sedimentation to coarser input during glacial period, and the interval is progressively buried. Polygonal faults can be reactivated due, for example, to the instantaneous loading of debris-flow deposits. Finally, these faults act as high permeable pathways and fluids can reach shallower depths forming well-expressed pipes and pockmarks on seafloor.

Studying deformation of unconsolidated shallow sediments is highly relevant for predictive models of seepage occurrence, for the sealing capacity of the sedimentary cover over reservoirs and, in a more general sense, for the tectonic behavior of the sedimentary column.