Mechanics of Polygonal Fault Systems

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Polygonal systems of normal faults are found in layer-bound sequences of very fine-grained sediments that have undergone passive subsidence and burial. The conventional wisdom is that the mechanism which promotes faulting is syneresis, a term embracing any process of spontaneous shrinkage without increase in external stress. This belief is now influencing interpretations of polygonal fault system development: for example, a polygonal fault system in Pliocene sediments of the Lower Congo Basin with furrows above the fault tips at the seabed has been interpreted as the result of shrinkage which started at the seabed, evolved to radial contraction with burial and then initiated faulting. That mechanism is not consistent with furrows located vertically above the upper tips of faults. I suggest the furrows are simply fault-tip folds, which readily explains the geometry of the polygonal faults—furrows system.

There is no evidence from triaxial tests that fine-grained sediments do exhibit syneresis, whereas laboratory data show that normal faults can grow in fine-grained clays undergoing vertical compaction because the friction coefficients on fault surfaces are exceptionally low. Fine-grained Cenozoic sediments which host polygonal fault systems are commonly overpressured due to undercompaction. Fortunately, where the sediments are still dewatering, faults are presumably still active, and low friction coefficients imply that horizontal stresses are close to lithostatic. This deduction has recently been confirmed for a North Sea polygonal fault system. It is common practice to drill wells underbalanced through fine-grained sequences, and the high horizontal stresses give a safety margin for controlling a kick.