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Fault growth in high porosity sandstones: A field study in the "Bassin du Sud-Est", Provence, France

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Faulting in porous sandstone produces zones of deformation bands rather than planar fracture surfaces. Cataclastic deformation bands (CDBs) are brittle shear zones that form through the combined effects of compaction and cataclasis. Porosity and grain size reduction associated with CDBs formation cause strain hardening, and the result is the initiation of a new band, adjacent to the first. Beyond a poorly understood scale limit, continued deformation may result in the development of localised slip surfaces and/or ultracataclastic fault zones at the edge of clusters of deformation band zones. However, the mechanical causes and consequences of this localisation are not clear.

Deformation structures in Cretaceous high-porosity sands and sandstones from the "Bassin du Sud-Est" (France) are cataclastic deformation bands (CDBs) and a lower number of larger-displacement ultracataclastic faults. Different study areas within the Bassin du Sud-Est were subjected to different tectonic histories, allowing us to examine: (i) the role of tectonic loading path on CDB network development, and (ii) the development of larger ultracataclastic faults.
(1) For a study area which had been subjected mainly to Pyrenean-Provençal shortening, a 250 m long outcrop recorded a persistent high density of sets of reverse-sense conjugate deformation bands which did not appear to cluster around any mapped faults. In this case, a high density of one of the conjugate sets of CDBs inhibits generation of the other conjugate set. This high density is confined to a >10m thick high-porosity sandstone bed.
(2) For two study areas which had experienced significant Oligocene-Miocene extension, a moderate, undulating background density of normal-sense CDBs was recorded, which became focussed into clusters in places. Later, larger ultracataclastic faults and discrete slip planes are found localised within or at the edges of some of the CDB clusters, but other clusters are present without larger faults within them, suggesting that these clusters may be prior expressions of deformation localisation before generation of the larger faults.

These field data from the Bassin du Sud-Est suggest the influence of previous structural heritage on further fault network growth. Other factors can also influence CDB growth, such as host grain size, with coarse sandstones having thicker CDBs. Along with bed thickness; host grain size could therefore also be an important contributor to the scale limit in CDB growth.