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48. Evolution of brittle deformation and fault growth in a high porosity sandstone analogue from the Cretaceous of 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 (Aydin, 1978; Aydin and Johnson, 1978, 1983; Antonellini *et al.*, 1994; Du Bernard, 2002; Torabi *et al.*, 2007). 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 (Aydin, 1978; Aydin and Johnson, 1978, 1983). Continued deformation may possibly result in the development of localised slip surfaces at the edge of deformation band zones (Aydin and Johnson, 1983; Antonellini and Aydin, 1995; Shipton and Cowie, 2001). However, the mechanical causes and consequences of this localisation are not clear. Understanding the evolution of fault geometrical and hydromechanical properties during fault growth and network development is of major importance in fluid flow prediction in the crust. This contribution is based on field and laboratory data of CDBs, obtained in the Upper Cretaceous high-porosity sands and sandstones of the Southeast France in the “Bassin du Sud-Est”. This complete field and multi-scale study is based on three main research axes: (i) A complete and systematic field study based on scan lines totalling 717 meters long; (ii) A microstructural and a statistic porosity and granulometry analysis based on samples extracted from the outcrops previously mapped in detail. (iii) A permeability study based on the same samples. Based on our different methods of analysis, the main results can be summarized as follows: (1) For each outcrop, the position of all visible CSBs was recorded along one meter wide scan-lines perpendicular to the main structures and through their damage zones. This systematic field study of CDBs shows: (i) The overall CDB density is low to moderate, with the predominance of thin CDBs; (ii) A few zones present an anomalous CDB density increase, where CDBs are organized in clusters patterns, with sometimes a localized main slip plane. (2) The CDBs characterisation based on field data show us the predominance of thin CDBs, with small thickness and displacement, suggested to correspond to strain hardening processes by addition of individual deformed strands. Larger faults are also present with different spatial distribution characteristics. (3) Microstructural studies show a drastic reduction of pores and grains size with fault displacement and thickness increase. (4) The grain and pores size reduction is quantified with the computer programme NIH Image, and shows a two order scale reduction between the host rock and a mature fault. (5) There is an important permeability reduction between the host sands, the thin CDBs and the larger faults. This study based on multi-scale field data suggests two main ideas: (i) Clusters of thin CDBs can evolve into larger faults; (ii) Thin CDBs and CDBs cluster increase by a strain hardening process whereas larger faults grow by strain softening processes. Those different analysis methods exhibit the evidence of a transition in growth mechanism from thin CDBs to larger ultracataclastic fault zones. These larger fault zones form preferentially in contexts where a previous generation of CDBs

already exists, suggesting the influence of previous structural heritage on further fault network growth.

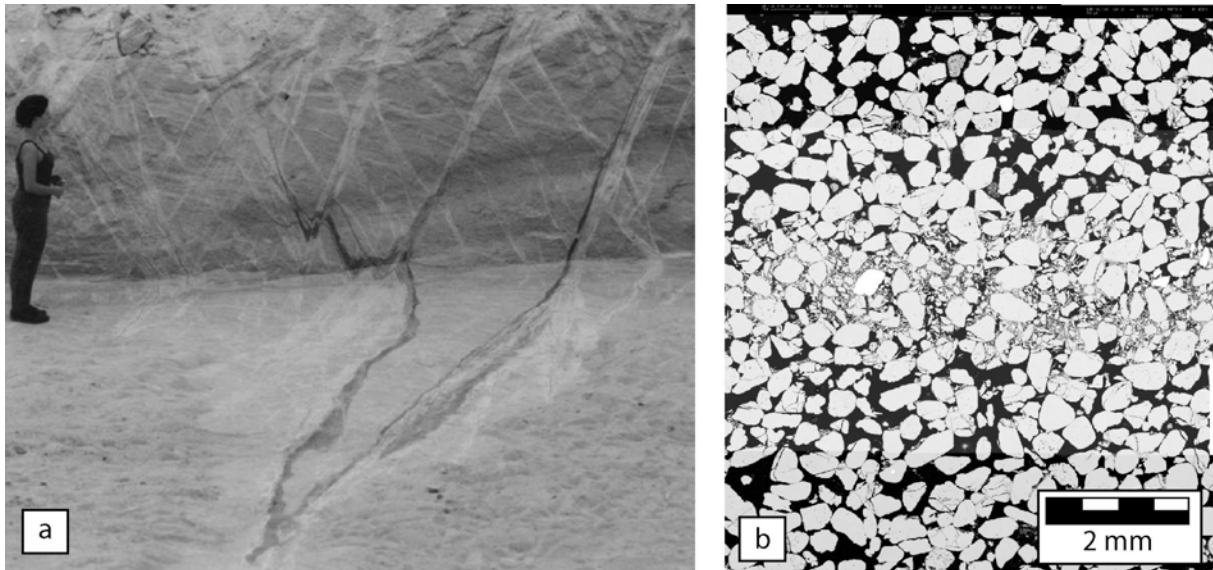


Figure 1. (a) Field view of red iron-deposits in the sands adjacent to the CDBs in the Massif d'Uchaux areas, corresponding to recent fluid flow. (b) Scanning electron micrograph showing the details of the grain fracturation and reduction for a single strand CDB in the sands of Bédoin area.

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