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Deformation bands in porous carbonate grainstones: field and laboratory observations

A. Cilona (a), P. Baud (b), E. Tondi (a), F. Agosta (c), S. Vinciguerra (d), A. Rustichelli (a), and C.J. Spiers (e)

(a) Geology Division, School of Science and Technology, University of Camerino, 62032, Camerino, MC, Italy, (b) EOST Strasbourg, Université de Strasbourg/CNRS, UMR 7516, France, (c) Department of Geological Sciences, University of Basilicata, Italy, (d) Dipartimento di Scienze della terra, Università degli studi di Torino, Via Valperga Caluso, 35, 10125 Torino, Italia, (e) Utrecht University, Faculty of Geosciences, HPT Laboratory, Utrecht, The Netherlands

Recent field-based studies documented deformation bands in porous carbonates, these structures accommodate volumetric and/or shear strain by mean of pore collapse and grain rotation and sliding. Microstructural observations of deformation bands samples showed that, at more advanced stage of deformation, pressure solution helps to reduce the grain size enhancing the particulate flow and forming narrow cataclastic zones within the bands. In contrast, laboratory studies on the mechanics of deformation bands identified grain crushing, pore collapse and mechanical twinning as the micromechanisms leading to strain localization.

In this paper, we present a multidisciplinary study integrating field and laboratory analyses performed on a Cretaceous carbonate grainstone aiming at investigating the microprocesses responsible for the development of deformation bands in this rock. A quantitative microstructural analysis of natural deformation bands was carried out by mean of a stereological technique to define the spatial distribution of pressure solution seams within the deformation bands. Two sets of triaxial experiments were performed under wet conditions. The deformed samples often displayed a shear-enhanced compaction behavior and strain hardening, associated with various patterns of strain localization.

We constrained the pressure conditions at which natural deformation bands formed and we reproduced in laboratory low and high angle-to the major principal stress deformation bands. Moreover, by comparing natural and laboratory structures, we gained new insights on the mechanisms occurring in nature and in the laboratory.