How does a rock matrix accommodate strain in marls? Looking for answers using AMS, X-ray diffraction and X-ray microtomography

H. Saur,T. Boiron, P. Sénéchal, C. Aubourg, , H. Derluyn, P. Moonen, R. Wenk.

Our study aims to shed a light on the relationship between the fabric of a bulk material and the morphology of its constituents, and this in a context of increasing deformation. With this objective in mind, we focus on Hecho marls found near Sigues, from the Pyrenean Jaca Basin (Spain). At this exceptional site, the gradually increasing deformation of a deposit can be closely monitored over a distance of several kilometres (see Aubourg et al., RST 2018). Three stages of deformation are distinguished in the Hecho Marls: cleavage-free, pencil-cleavage and slaty cleavage. We analysed the bulk 3D fabric of different marl samples by means of Anisotropic Magnetic susceptibility (AMS) and X-ray diffraction (XRD) measurements. The same samples were subsequently analyzed by means of X-ray microtomography (XCT) to characterize the pore system as well as the fine fabric composed of thousands of individual quartz and calcite grains. Our analysis shows that illites reorganized their fabric in response to the development of the cleavage. The AMS shape parameter appears to be an excellent gauge to trace the strain magnitude imposed by tri-shear fault propagation. Calcite and quartz fabrics exhibit remarkably similar behavior in cleavage-free and pencil-cleavage marls, with a foliation parallel to the bedding plane, and subtle lineation. By contrast, in slaty cleavage marls, both orientation and shape of ellipsoids of calcite fabric contrast with quartz fabric. This is likely explained by pressure solution process. As a whole, the pore fabric mimics calcite fabric. This study opens new approach to assess the physical properties of deformed unconventional reservoirs.