Mapping strain in the footwall of a thrust: Preliminary results from 3D bulk fabric of illite.

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The Sigues fold (Aragon, Spain) presents an exceptional outcrop where 1) the footwall is largely exposed, 2) it is constituted of homogenous shales, 3) the strain varies at distance from the emergent thrust, with all steps of cleavage development. The best model to explain the strain distribution is the trishear propagation of a thrust with a P/S ratio of 1. However, from East to West, the thrust geometry is changing progressively from blind thrust to flat ramp. The topographic surface as well as the position of the emerging part of the thrust determine the geometry of the structure. This is, therefore, a place with variable geometries, which allow us to describe the different geometric stages of the ramp-and-flat model that we are used to find in major orogenic thrusts.

To map the strain, we measured the magnetic fabric of hundreds of shale fragments (weighting a few grams) in dozens of localities. The magnetic fabric is governed primarily by illite. Hence, the magnetic fabric represents a 3D view of illite organization, i.e. the matrix of those shales (see Gracia-Puzo et al., EGU, EMRP3.8). The measurement of 3D fabric of illite takes about a minute per fragment and is non-destructive.

Magnetic fabric of shale fragments provides three useful parameters, the degree of anisotropy, the shape parameter from oblate to prolate, and the length of the confidence angle of the minimum axis of tensor. We show that all these three parameters are highly sensitive to strain. While each locality provides homogenous results from ~15 fragments (covering few square meters each), it is statistically different from one site to the other, with trends consistent with distance to the main thrust. Assuming rigid rotation of illite particles, we calculate the strain using Eigen values of magnetic fabric tensor.

Our preliminary maps shows: 1) that the strain increases considerably (from units to tens in %) when approaching the main thrust, 2) at a distance of more than 1 km, several strain gradients are detected, suggesting that blind thrusts propagate in the footwall. Serial N-S cross-sections are expected to describe the lateral variability on the structure, the deformation accumulated on the footwall and also establishing the portion of the hanging wall which is being affected and the décollement of the thrust. Our approach is thus promising to map strain in shales from deformed
regions, both from natural outcrops, or from boreholes.