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Unraveling the deformational history of faults from AMS

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The faults chosen for this study belong to the Iberian Chain (Northeastern Iberian Plate) and include two kinematically different kinds of structures (thrusts and strike-slip), with well-developed fault gouges several tens or hundreds of meters thick (Datos Fault System and Daroca Fault) and thinner clayey layers linked to thrust surfaces (Cameros-Demanda Thrust). The Cameros-Demanda Thrust has a relatively simple history of Mesozoic extension and Tertiary inversion. Along the thrust several areas with fault rocks include weakly oriented breccias, deformed conglomerates and clayey fault gouge with S/C structures. The Datos and Daroca faults show a more complex history of movement and are of key importance in the Variscan and Alpine evolution of the Iberian microplate. They show fault rocks with thickness of up to hundreds of meters, consisting of fault gouges, microbreccias and fault breccias with large blocks of stratified Paleozoic and Mesozoic blocks.
Anisotropy of Magnetic Susceptibility (AMS) can be an useful tool in order to discriminate the tectonic evolution of such faults, remembering the different behaviors as part of different stages in northern Gondwana (Variscan cycle) and the Iberian microplate (Alpine cycle).
Samples for the AMS study were collected from 56 sites, 29 (434 specimens) belonging to three areas of the Cameros-Demanda Thrust, 17 (196 specimens) in the Datos Fault System, and 10 (114 specimens) at the Daroca Fault. AMS results at the Cameros-Demanda Thrust show a main NW-SE magnetic lineation (Matute and Prejano areas), a secondary NE-SW magnetic lineation (Matute area) and a girdle distribution from NE to SW in the Panzares area. These results suggest a main NW movement for the Cameros-Demanda Thrust, consistent with kinematic indicators, but also evidence a NE-directed minor contribution, especially in the easternmost outcrops. Daroca and Datos Faults show a grater variability, both in plunge and azimuth, and magnetic lineation can be related to vertical movements in some sites as well as horizontal movements in other, suggesting strain partitioning of the dextral, transpressional movement and compressional jogs in areas with strike changes along the fault.
Temperature versus susceptibility curves (from 40 to 700ºC) were carried out to determine the magnetic carriers of the bulk susceptibility and to ensure the reliability of the AMS results. In the Daroca Fault the paramagnetic behavior dominates and hematite is seldom evidenced as the main ferromagnetic carrier. In the Datos Fault the main magnetic carriers are hematite, magnetite and pyrrotite. In the Cameros-Demanda Thrust the main magnetic carrier is magnetite.Temperature dependent clay minerals and vitrinite reflectance data suggest that deformation for the Daroca Fault occurred at shallow crustal levels consistent with early diagenetic conditions in contrast to that observed for the Cameros-Demanda Thrust where deeper conditions are indicated by long-range ordered mixed layer I-S. Relatively shallow conditions for Daroca Fault are confirmed also by fluid inclusion petrography from syn-kinematic veins where immiscible liquid and vapor phases are entrapped. More complex is the interpretation of the Datos Fault where two populations of mixed layer I-S and widespread decrepitated fluid inclusions are present.