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Characterizing the strain field around co-seismic faults using magnetic fabrics

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Characterizing the deformation within and around fault zones is an important factor in the understanding of earthquake kinematics and energy dissipation, and also of the rock mechanics associated with faulting. In massive geological units, that lack visible strain markers, it is difficult to identify the fault zone and determine the strain field that is associated with the faulting.

Aiming to overcome these difficulties, we analyzed the anisotropy of magnetic susceptibility (AMS) of soft rocks next to co-seismic normal faults in the Dead Sea Basin (Masada Plain). In many deformed environments, the principal AMS axes are coaxial with the directions of the principal strain axes. Hence, the AMS fabrics might be helpful in resolving the strain field around the studied faults. The faults are exposed within outcrops of Pleistocene Lake Lisan sediments – which are composed of very fine alternating laminae of aragonite and detritus material. The laminae allow us to determine accurately the structural characteristics of the faults and correlate them with the magnetic fabric.

Specimens from normal faults, up to two meters away from the fault plane, were analyzed for AMS, LT-AMS (low temperature AMS) and AARM (Anisotropy of Magnetic Remanence) in order to determine the strain field and to isolate the different magnetic phases (diamagnetic, paramagnetic and ferromagnetic) that might contribute anisotropy to the total magnetic fabrics.

Structural measurements from 20 faults in Masada Plain show synthetic and antithetic normal faults striking parallel to the major Dead Sea Fault, dipping between 30° and 60°. The displacement along these faults is up to several meters. Correlation was found between the dip direction of the faults and the orientation of the maximum magnetic susceptibility (K1), especially closer to the fault. The AARM and the LT-AMS measurements also show similar correlation, suggesting that the different magnetic phases in the rock record the deformation in a similar way.