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Anisotropy of Magnetic Susceptibility (AMS) of Carbonate Rocks as a Proxy for the Strain Field near the Dead Sea Transform in Northern Israel

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To exploit the potential of anisotropy of magnetic susceptibility (AMS) axes (k1, k2, k3) and magnitudes as a tool to estimate the strain field around major faults, the AMS of calcite-bearing diamagnetic rocks that crop out next to the Dead Sea Transform (DST) were measured. The low-field bulk-susceptibility of Bar-Kokhba limestone formation is -10.67$\pm$1.69 [μSI], very close to the value of a single calcite crystal. Thermomagnetic curves show temperature independent and reversible behavior. Chemical composition analysis indicates minor amounts of Fe contents <300 ppm. Results of XRD diffraction and petrofabric study of thin-sections and SEM images indicate that the Bar-Kokhba rocks are calcite mono-mineralic rocks. The magnetic fabrics are solely controlled by the alignment of c-axes of almost pure calcite crystals and help to assess the direction of the maximum shortening prevailing post-deposition and during the tectonic evolution of the DST.

In one studied site, high Fe contents <6000 ppm were found, which are associated with young morphological processes of chemical alteration. In this site, thermomagnetic curves indicate temperature dependency and irreversibility. IRM curves show saturation around 200 mT, evidence of ferro/ferimagnetic minerals. AARM measurements reveal isotropic fabric which suggesting that the ferro/ferimagnetic minerals are contributing no anisotropy to the AMS. The AMS of the diamagnetic fabric is masked by a paramagnetic fabric of Fe-bearing minerals. Using liner correlation between Fe content and bulk susceptibility we applied a novel tensor subtraction method and successfully isolated the diamagnetic fabric from the total AMS. The paramagnetic fabric has characteristics of sedimentary fabrics, while that of the diamagnetic fabric has tectonic characteristics. The isolation process indicates that the AMS of carbonate rocks is mostly controlled by the diamagnetic phase, where the Fe content is below 500 ppm.

Differences in the degree of anisotropy parameters of the Bar-Kohkba rocks are probably related to differences in strain magnitudes accumulated in the rocks. Based on the AMS measurements one major group of AMS k3 axes are defined, showing maximum horizontal shortening parallel to the N-S striking DST. The present study demonstrates the useful application of AMS measurements in “Fe-free” limestones, which serve as recorders of the strain field next to plate-bounding faults. This opens a new frontier in using AMS as a proxy for strain.