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3-D printed analog rocks: A new approach to examine inclination flattening

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The importance of inclination flattening in deflecting primary magnetization in sediments has been debated since the seminal work of King (1955, Roy. Astron. Soc. Geophys. Suppl. 7, 115- 134). Several methods have been proposed to correct inclination for the effect of compaction, and most of these assume that the paleomagnetic vector behaves as a passive line, i.e. March model, under deformation. Our knowledge of how ferromagnetic particles behave under compaction, however, is poor. In this study we revisit this problem using a novel approach that deforms rock analogs that have been produced by a 3D printer. Particles of single domain magnetite/maghemite have been mixed in the polymer with a concentration of 0.15 wt %. Five series of cylindrical analog rocks with porosities varying between 0% to 20 % were printed. Two samples were printed of the polymer material alone. Mechanical properties were investigated under uniaxial deformation with Zwick/Roell universal testing machine with a 20 kN load cell; samples are shown to behave elastically under deformation. To investigate the effect of compression on remanence, samples were given an anhysteretic remanent magnetization (ARM) at 45° to the cylinder axis. The polymer material alone is diamagnetic, isotropic and does not acquire an ARM. ARM intensity, magnetic susceptibility and magnetic fabric are similar for all samples with magnetite before compaction. First order reversal curve analysis indicates little to no agglomeration of the magnetic particles. Samples were incrementally compressed, and magnetic anisotropy and remanence was measured with the sample under compaction for each increment. The degree of anisotropy of all samples , except the nonmagnetic cylinders increases with degree of compaction. Inclination is deflected with increasing compaction, but the amount is not as pronounced as expected for the March model. Our results suggest that the magnetic grains behave more like rigid particles in a viscous matrix.