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The petrofabric of Vesta and Mars crusts as revealed by the anisotropy of magnetic susceptibility of achondrites

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We investigate the petrofabric of the crusts of Mars and Vesta through the measurement of the anisotropy of the magnetic susceptibility (AMS) of achondrites. Previous data are integrated with new measurements to obtain a dataset that provide macroscopic information about the magnetic fabric of 41 meteorites of the howardite-eucrite-diogenite clan (HED, falls only) and 16 Martian meteorites. The interpretation takes into account the large contribution of paramagnetism to the magnetic susceptibility of these meteorites. We use a model that allows the computation of the anisotropy degree of the population of ferromagnetic grains and provides a quantitative proxy for the degree of shape preferential orientation of these grains in HED and Martian meteorites. The results also provide quantitative information about the shape of the magnetic fabric (prolate, oblate). If we admit that, like for chondrites, the preferential orientation of ferromagnetic grains is indicative of the overall petrofabric of the meteorites, our data provide the first quantitative estimates of the intensity and shape of the petrofabric of Vesta and Mars crusts.

Most HED achondrites are breccias but display a strong and spatially coherent magnetic anisotropy, indicating that intense deformation of FeNi grains took place after brecciation. The average fabric of eucrites, howardites is oblate (i.e. the texture is foliated) whereas the fabric of diogenites is more neutral. The howardite results suggest the existence of an isotropic fraction of magnetic minerals that can be ascribed to the presence of carbonaceous chondrite clasts that have preserved their original magnetic fabric. In this hypothesis, howardites have an intensity of petrofabric very similar to

eucrites and diogenites. Thermal metamorphism (itself possibly impact-related) plus lithostatic compaction occurring after brecciation appears as the best candidate to explain the observed petrofabric in eucrites and diogenites, whereas compaction by hypervelocity impacts may be reponsible for the fabric of howardites.

Among Martian meteorites, basaltic shergottites and nakhlites display an oblate fabric (foliated texture) with only limited variations among each group. Olivine-phyric shergottites have a neutral fabric that may be attributed to a deeper origin. Nakhlites have a weaker fabric intensity than shergottites. The fabric intensity is comparable to what is classically observed in terrestrial volcanic and plutonic rocks.