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Paleomagnetic and rock magnetic investigation of an exceptionally pristine sample from Mars

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Unaltered samples from Mars are available as meteorites recovered right after their fall. Only 4 of them were available (the last one fell 50 yrs ago) until the recovery of a Martian meteorite fallen in Morocco in July 2010. We obtained a 1.8 g sample away from the fusion crust of this fall (named Tissint), to study its magnetic properties. Petrographic examination indicates the meteorite is an olivine-phyric shergottite, with pyrrhotite and chromite as the only identified potentially magnetic minerals. Rock magnetism is fully consistent with pyrrhotite-bearing shergottites [1], with a high coercivity of remanence (Mrs/Ms $\approx$0.4, Bcr of 80 mT, S ratio of -0.75, etc). Ms is about 0.15 Am2/kg, equivalent to 1 wt.% pyrrhotite. Micromagnetometric investigation should allow to identify the mineral phase responsible for remanence and solve the debate on chromite [2] versus pyrrhotite [1].
Magnetic anisotropy and NRM are directionally consistent in oriented subsamples. The meteorite shows no sign of remagnetization by magnet application (a customary practice among meteorite hunters). NRM is very hard with respect to alternating field demagnetization with a median destructive field of about 70 mT. Very low NRM/IRM derivative ratio (REM' integrated between 10 and 80 mT is about 2 10-4, the lowest ever measured in a meteorite) suggest NRM acquisition in very low ambient field (<1 μT). Moreover, the high coercivity of the NRM and the increasing REM' value with alternating field suggest that the NRM may be a shock-hardened magnetization (for instance a primary thermoremanent magnetization acquired in a crustal remanent field of a few μT, and later shocked in a similar field). Indeed this meteorite has suffered high shock pressure, as evidenced by amorphization of plagioclase and formation of numerous large melt pockets.

[1] Rochette P et al. Meteorit. Planet. Sci, 40, 529-540 (2005) [2] Yu Y.J., Earth Planet. Sci. Lett. 250, 27-37 (2006)