Investigating aqueously altered meteorites to characterize the intensity of the solar nebula magnetic field

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Résumé

The presence of magnetic fields in the solar nebula may have played a key role in the accretion of the solar system's first solid bodies. Some meteorites can record and preserve the memory of these magnetic fields. As such, they represent a unique source of data regarding the geometry and intensity of our own solar nebula magnetic field. Carbonaceous chondrites, in particular, formed beyond the orbit of Jupiter and underwent aqueous alteration on their parent body, resulting in the formation of magnetite and pyrrhotite. Because this aqueous alteration took place during the first million years of the solar system, these minerals may have recorded the solar nebula magnetic field in the form of a chemical remanent magnetization (CRM).

The aim of this study is to estimate the intensity of the solar nebula magnetic field by studying a series of aqueously altered carbonaceous chondrites. We studied 10 meteorites (7 CM2 and 3 C3 ungrouped) from the CEREGE collection. We conducted a complete characterization of the magnetic mineralogy (low temperature susceptibility, hysteresis loops, IRM acquisition, FORC diagram). We also used thermal demagnetization of the NRM to determine the unblocking temperature spectra. To estimate the paleointensities, we used non-heating ARM and IRM normalization methods, because alteration during heating is frequently observed in these meteorites.

Preliminary results indicate that all studied meteorites carry a stable, origin-trending NRM that is homogeneous in direction at least at the cm scale. The NRM is carried by pyrrhotite and magnetite in most cases, and only by pyrrhotite in a few samples. After ruling out other potential sources of magnetizing field, we interpret this NRM as a CRM acquired in the solar nebula field. The paleointensities estimated with the ARM method range from 0.9 ± 0.5 μT (2 standard error) to 27.4 ± 7.7 μT. This variability may be due, for example, to different magnetization epochs, radial distances, or geometry of the nebula field. These estimates are in agreement with previous paleomagnetic studies conducted on CM and ungrouped carbonaceous chondrites.

Mots-Clés: meteorites, paleointensity, chemical remanent magnetization, solar nebula magnetic field.

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