CAN WE TRACE AQUEOUS ALTERATION IN CHONDRITES USING MAGNETIC PROPERTIES?

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Introduction: Aqueous alteration is a widespread process in chondrites, and attests the major importance of water in the evolution of asteroidal parent bodies [1]. A number of techniques, focused on the detection and quantification of secondary phases (serpentines, clays, carbonates…) are presently used to assess the occurrence and intensity of aqueous alteration in chondrites: transmission electron microscopy [2], Raman spectroscopy [3], X-ray diffraction [4], low temperature magnetism [5] etc. For some groups, an alteration index has been proposed based on some of these techniques [3, 4] or a combination of proxies [6].

It is noteworthy that aqueous alteration products comprise a number of oxides (magnetite, maghemite) and sulfides (pyrrhotite) that are ferromagnetic at room temperature. As such, these products can be easily detected, and their content quantified, using magnetic measurements [7]. Here we discuss the possibility of using bulk magnetic measurements of chondrites to characterize their aqueous alteration.

Samples and methods: Magnetic properties allow determining what magnetic minerals are present in a chondrite, and estimating their bulk content. Magnetic techniques have a number of advantages: they are very sensitive to the presence of ferromagnetic minerals, they are bulk measurements, they are fast and non destructive. As such, they allow large numbers of meteorites to be studied.

We present results for about thirty carbonaceous chondrite falls, with a focus on CM chondrites. We measured mostly hysteresis properties and magnetic susceptibility (at room temperature, and its evolution with low and high temperature for some samples).

Results: Our measurements evidence the presence of magnetite and pyrrhotite in most aqueously altered chondrites, together with metal in chondrites with low aqueous alteration. Preliminary interpretation seems to show an absence of correlation between the absolute or relative abundance of magnetite and pyrrhotite with the degree of aqueous alteration determined by other methods. For instance CM chondrites that display a wide range of aqueous alteration do not show specific trend in their magnetic properties. For some chondrites (CV, CO, some CMs) the combination of aqueous alteration and thermal metamorphism affects the redox state and the magnetic mineral assemblage, which further hinder the use of magnetic properties to trace aqueous alteration alone.

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