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SHOCK-INDUCED PHASE TRANSFORMATION AND METALLIC IRON NANOPARTICLES IN OLIVINE-RICH MARTIAN METEORITES

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Maps of the magnetic field of Mars display strong magnetic anomalies attributed to crustal remanence. In order to interpret these anomalies, knowledge of the nature of magnetic carriers and magnetic properties of Martian rocks is necessary. In contrast with terrestrial rocks for which the major magnetic mineral is magnetite, studies of the SNC (Shergotty-Nakhla-Chassigny type) meteorites have shown that alternative phases, such as pyrrhotite, dominate the magnetic properties of most basaltic shergottites, while titanomagnetite is the magnetic carrier in nakhlites and a few basaltic shergottites. We studied ultrabasic SNC meteorites using low- and high-temperature magnetic property measurements and mineralogical characterization. It is shown that transformations attributed to shock cause strong modifications of olivine optical and mineralogical properties in chassignites and lherzolitic shergottites. We combined several electron microscopic techniques to fully characterize these mineralogical transformations. The observations point to transformation of olivine to a metastable high-pressure phase, possibly related to metastable transformation of olivine that were recently evidenced by X-Ray diffraction at high pressure. In the meteorites, a reduction or dissociation process of iron in olivine takes place, likely during the shock event and transformation of olivine, causing the formation of metallic precipitates in olivine. Thus, iron may be a significant magnetic carrier in Martian crust, and a precursor phase for iron-rich oxides or hydroxides in the Martian regolith.

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