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Serpentinization of the Martian early lithosphere to produce magnetite, CO2 and H2

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The magnetic measurements made on board the Mars Global Surveyor (MGS) probe revealed the intense nature of the lithospheric magnetic field at Mars. Since most of the strong anomalies at satellite altitudes (between 100 and 400 km) were measured over Noachian surfaces, crustal magnetization and / or demagnetization in the presence of an early axial, global and dipolar magnetic field is the most likely scenario to explain the anomaly distribution. Martian lithospheric magnetization contrasts derived by numerous studies range from 10 to more than 60 A/m, much larger than classical terrestrial values. In this study, we show that the chemical remanent magnetization (CRM) through the serpentinization can produce such large values. This produces magnetite as well as CO2 and H2. The Noachian period gathers all the necessary ingredients for this process to be emplaced: a strong magnetic field, a basaltic crust, large amounts of water causing hydrothermalism, and local heating due to the internal mantle convection. Predicted magnetization values are computed according to different hypotheses on the intensity of the main paleofield and the serpentinization process. This latter aspect is investigated with respect to the initial iron content of the mafic mineral, the water abundance and the reacting rock volume. The amounts of released H2 and CO2, possibly combining in CH4, are also studied.