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Final Technical Report

for

NAGW-372

"Magnetic Properties of Martian Surface Material"

submitted
by

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"Magnetic Properties of Martian Surface Material"

During the tenure of this grant, we continued our investigation of the hypothesis that the magnetic properties of the Martian surface material was due to the production of a magnetic phase in the clay mineral nontronite by transient shock heating. In the course of this, we unexpectedly produced what may be a new magnetic material, with rather unusual properties.

Specifically, we have found that (1) heating to 900°C to 1000°C, of natural samples of nontronite leads first to the production of what appears to be Si-doped maghemite (γ-Fe_2O_3). Although apparently metastable, the growth of γ-Fe_2O_3 at these temperatures is unexpected, and its relative persistence for several hours at 1000°C is most surprising.

(2) Continued annealing of this material for longer periods promotes the crystallization of αFe_2O_3 and cristobalite (high-temperature polymorph of SiO_2), as revealed by x-ray and of αFe_2O_3 and the new magnetic phase as revealed by magnetic property measurements. This "new magnetic phase" has (1) bulk magnetization of ~5 Am^2/kg, (2) remanent coercivity of >800 mT, (3) high ratio of saturation remanence to saturation magnetization (J_{rs}/J_s), (4) an apparent Curie temperature of ~220°C, and (5) room-temperature coercivity that is dependent on the magnitude of the applied magnetic field during thermomagnetic cycling between room-temperature and 300°C. All available data correlate this "new magnetic material" with the cristobalite - hence our naming it "magnetic ferri-cristobalite". Formation of this magnetic cristobalite, however, may require topotactic growth from a smectite precursor.

Publications include:

Moskowitz, B. M. and Hargraves, R. B. (1983), Magnetic 'ferri'-cristobalite, EOS, 64, 681.

Moskowitz, B. M. and Hargraves, R. B. (1984), Magnetic cristobalite (?) - a possible new magnetic phase produced by the thermal decomposition of nontronite, submitted to Science.