Synthetic Fe-rich basalts as Mars analogs: Mineral magnetic and remanence properties

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**AB:** Synthetic basalts with 18.9% total FeO were synthesized at 4 fO$_2$, from 3.4 log units below the quartz-fayalite-magnetite buffer (QFM) to 5 log units above QFM, and 6 cooling rates from $10^5$ to $3^\circ$ C/hr. The resulting array of samples was analyzed using room temperature magnetic hysteresis loops, temperature dependence of saturation magnetization and saturation remanence (10 to 1000 K), and via the acquisition and demagnetization of ARM and TRM imparted at varying field strengths. The magnetic mineral assemblage characteristics are strongly dependent on fO$_2$. Samples synthesized at the iron-wustite (IW) buffer have a very low concentration of remanence-carrying grains, which are likely near the superparamagnetic-stable single domain boundary. Samples synthesized at the QFM and nickel-nickel oxide (NNO) buffers contain a slightly higher concentration of remanence-carrying grains, which are stable-single-domain to fine pseudo-single-domain particles, respectively. Samples synthesized at the manganese oxide (MNO) buffer contain the highest concentration of magnetic grains, which are up to 100-µm in diameter. The dominant Fe-Ti oxide produced is an Mg- and Al-bearing titanomagnetite with 2.4-2.7 Fe cations per formula unit. The Curie temperatures of the QFM samples are consistent with the electron-microprobe derived compositions. The Curie temperatures of the NNO and MNO samples are elevated, ~75$^\circ$ C and ~200$^\circ$ C, respectively, above what they should be for their composition. We attribute the Curie temperature elevation to maghemitization of the titanomagnetite. The QFM, NNO, and MNO samples acquired TRMs up to 40 A/m in a 10-µT applied field, and up to 200 A/m in a 50-µT field, with little or no dependence on cooling rate. Our results suggest that Fe-rich melts that crystallize extensive titanomagnetite can generate an intensely-magnetized layer in the Martian crust, even if the remanence was acquired in a weak field.

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**DE:** 1595 Planetary magnetism: all frequencies and wavelengths
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