Rock Magnetic Properties of the Chipman Dike Swarm, Athabasca Granulite Terrain, Canada: Possible Target for Paleomagnetic Studies?

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Abstract: The Athabasca Granulite Terrain (AGT) represents a section of metamorphic rocks now exposed at the surface in northern Saskatchewan, Canada, with measured maximum temperatures (750°C - 1000° C) and pressures (1.0 – 1.5 GPa) indicating a lower crustal origin. Concurrent with the last metamorphic event (1.9 Ga) the eastern part of the region was intruded by an extensive complex of mafic dikes, termed the Chipman dike swarm, and subsequently uplifted to the surface. Aeromagnetic anomalies over the region in the order of 2000 nT have long been assumed to be related to the dike swarm, but rock magnetic studies do not support this supposition. We have studied a number of the dikes, from the Cora Lake shear zone eastward to the Legs Lake shear zone in the AGT. Magnetic susceptibility ranges over several orders of magnitude from 5 x 10^{-5} to 2 x 10^{-2} SI units, but with a bimodal distribution; most samples yield low susceptibilities with only a few dikes having values closer to those expected of mafic intrusions. NRM values also show a wide range, from 8 x 10^{-5} to 1.6 A/m, also with most samples being in the "weakly magnetic to non-magnetic" category. Hysteresis, IRM experiments, and low temperature measurements identify magnetite as the common magnetic mineral in stronger samples, although many weaker cores yield only paramagnetic signals. Optical examination reveals plentiful magnetite in the stronger magnetized samples, but with rare or no magnetite observable in the weakly magnetized samples. AF and thermal demagnetization of unoriented cores indicate although stability is seen in a few samples, most of the samples yield noisy and internally scattered directions. There is indication that the degree of anatexis observed in some samples is related to the magnetization, and that original magnetite grains have been altered to non-magnetic phases. It is evident from this work that the Chipman dikes do not play a role in the observed magnetic anomalies in the AGT, and furthermore, they are not appropriated rocks for paleomagnetic studies.

Keywords: Mafic dikes, natural remanent magnetism, magnetic susceptibility, hysteresis, demagnetization