Transmission electron microscopy of exsolution lamellae in ilmenite-hematite: Implications for "lamellar magnetism"

Takeshi Kasama[1], Toru Asaka[2], Ryan K.K. Chong[1], Rafal E. Dunin-Borkowski[1], Edward T. Simpson[1], Richard J. Harrison[3], Ute Golla-Schindler[4], Suzanne A. McEnroe[5], and Andrew Putnis[4]

[1] Dept. of Materials Science, Univ. of Cambridge, Pembroke Street, Cambridge, UK
[2] National Institute for Materials Science, 1-1 Namiki, Tsukuba, Ibaraki, Japan
[3] Dept. of Earth Sciences, Univ. of Cambridge, Downing Street, Cambridge, UK
[4] Institut für Mineralogie, Universität Münster, Corrensstrasse 24, Münster, Germany
[5] Geological Survey of Norway, Trondheim, Norway

McEnroe et al. (2002) found fine exsolution lamellae of hematite and ilmenite in rock samples with high coercivities and stable natural remanent magnetizations (NRMs). They suggested that the exsolution lamellae may be related to the acquisition of NRM. Robinson et al. (2002) used Monte Carlo simulations to suggest that the ferrimagnetic moment of an intergrowth of hematite and ilmenite could be associated with the arrangement of cations and spins at the interface between hematite and ilmenite. They described this "lamellar magnetism" as being due to "contact layers", which are cation layers at the interface between hematite and ilmenite that do not correspond to the chemistry of either hematite or ilmenite

Transmission electron microscopy (TEM) is powerful tool for the examination of the crystallographic and chemical structure and microstructure of rock samples at the nanometer scale. Lorentz electron microscopy can be used to observe magnetic microstructure in minerals directly at high spatial resolution. Electron tomography allows nanometer-sized minerals to be imaged in the three dimensions, to provide their three dimensional morphologies and distributions. Here we apply all of these TEM techniques to the characterization of fine lamellae in hematite-ilmenite, with the aim of understanding their effect on the NRM of these samples.

References:
McEnroe et al. (2002) Geophysical Journal International 151, 890-912.
Robinson et al. (2002) Nature 418, 517-520.