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Domain observations of multidomain magnetite: sub-micron structures, dislocations and viscosity

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There are large gaps in our understanding of multidomain (MD) viscous behaviour and MD remanence theory in general. For example, Dunlop and Özdemir (2000) have demonstrated that multidomain (MD) viscous remanent magnetisation (VRM) acquired at 200°C in crushed and sized natural crystals of magnetite persists on thermal demagnetisation up to the Curie temperature, that is, there is a MD VRM component which is metastable. This goes against the classic MD theory of Néel which predicts that domain walls which move at low-temperatures in the earth's field, are easily reorganised by small increases in temperatures. That is, theory predicts that any VRM acquired by domain walls at 200°C will not persist to the Curie temperature.

In an attempt to improve our understanding of MD systems, we have studied magnetic viscosity and the relationship between magnetic structures and dislocations through direct observation of magnetic domains and domain walls using both Bitter pattern imaging techniques and magnetic force microscopy (MFM). Bitter pattern imaging allows us to examine the magnetic behaviour of domain walls as a function of time (and temperature). MFM has a much greater resolution and allows us to examine magnetic micro-structures. In an attempt to identify pinning sites, dislocations were identified using etch-pit analysis.

In such a study it is very important to have well-characterised samples. So, to conduct these experiments we have examined a synthetic and selected natural multidomain magnetite samples. In particular we have grown a new set of sized (mean grain sizes between 1-100 μm) MD magnetites by hydrothermal recrystallisation. These hydrothermally produced samples are thought to be ideal for viscous studies as they have very low dislocation densities and coercivities. In addition to these samples, we have considered sized MD synthetic magnetites of commercial origin, and large natural individual crystals of magnetite.