Magnetic moments of fine particles from micromagnetic surveys

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A new scanning magnetic microscope to image magnetic fields with micrometric resolution has been constructed based on a giant magnetoresistance (GMR) sensor. Operating in zero-field, the GMR sensor is sensitive to the components of the magnetic field arising from the remanent magnetisation parallel to the plane of the cut rock surface. The field component perpendicular to the surface therefore has to be calculated using FFT relationships. The spatial resolution of the system is 20 μm, and its peak-to-peak noise during operation is 250 nT. Its high spatial resolution and a minimum sensor- to-sample distance of only 30 μm compensate for its rather modest field sensitivity.

Once all three components of the field are known it is possible to determine the magnetic moments of individual fine particles. The individual moments of fine particles can be combined vectorially and the total magnetic moment per volume (i.e. the magnetic intensity) can be estimated and compared with macroscopic measurements, either on standard samples or through ground- or aero-magnetic surveys.

This procedure has been performed on a hemo-ilmenite - magnetite norite sample from the 930 Ma Bjerkreim-Sokndal (BKS) layered intrusion of south Norway. The BKS is a 7 km-thick norite to quartz mangerite layered intrusion, part of the early Neoproterozoic Rogaland Anorthosite Province. The sample with a strong lattice preferred orientation (LPO) of orthopyroxene and moderately strong LPO of hemo-ilmenite, has an NRM of 53-60 A/m inclined at ~65^{o} to the polished surface. Highly variable magnetisation in the BKS, caused by progressive magmatic crystallization giving rise to differing combinations of opaque minerals, highlights some of the possibilities to be considered in evaluating crustal magnetic anomalies.