Needles in cumulate stacks: characterising magnetic recorders in layered intrusions

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Abstract: The magnetic stability of coarse-grained mafic and ultramafic rocks commonly defies easy explanation, yet they have been observed to create stable remanence-dominated aeromagnetic anomalies. One such anomaly has been measured at Mt. Harcus, part of the Giles layered intrusions in the Musgrave Complex, Western Australia. It is a 7 x 0.5 km negative anomaly and is recorded by rocks that have not been metamorphosed or otherwise heated for >500 Ma. The magnetisation required to model this feature are up to 50 A/m, an order of magnitude higher than most strongly magnetic igneous rocks.

To investigate the carriers of this strong and stable magnetisation, a suite of samples were selected from five >100 m long drill cores. They contain multiple candidates for remanence carriers, including 10s—100s μm oxide grains with multiple generations of both oxy-exsolution and reduction-exsolution, and elongate oxide laths or needles that exsolved within both pyroxene and plagioclase. This study examines the magnetic properties of each of these phases in turn, and compares analogous mineral separates from the Bushveld complex, South Africa.

Multidomain magnetite dominates Mt. Harcus bulk rock measurements and those of oxide separates, with hysteresis loops showing very low coercivity (<8 mT) and high saturation magnetisation. The silicate single crystals consistently show an additional component with a coercivity of 30—50 mT and yield Mr/Ms ratios of nearly 0.5, and rare specimens show a further prominent coercivity distribution centred >130 mT. Plagioclase separates from the Bushveld complex show a similar high-coercivity signal despite containing much less oxide exsolution. Curie temperature measurements suggest that the primary magnetic phase is magnetite, but other possibilities are examined in light of the extremely high coercivity of some specimens. The morphology of the exsolved oxides is characterised and the role of such particles in creating the Mt. Harcus anomaly is discussed.

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Exsolution in silicates, magnetic anomalies, layered intrusions