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# Exsolution, Fractionation and Magnetisation: Petrophysical Insights into PGE Prospectivity in the Giles Mafic-Ultramafic Intrusive Complex, Australia.

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In this study we examine the relationship between platinum group element (PGE) prospectivity and magnetisation in a major mafic-ultramafic magmatic province known as the Giles Complex. It focuses on the processes that control the strength and stability of both induced and remanent magnetism, as a means of identifying better PGE targets in a large terrain. A large representative suite of samples were obtained from two geophysically distinct Giles intrusions from the Musgrave Block in Central Australia. Magnetic susceptibility, density and remanent magnetisation were measured for the suites of samples, and were interpreted in conjunction with a large geochemical database in order to identify the interrelationships between petrophysics and mineralisation. The data were also used to constrain accurate 3-D models of both the intrusions.

The Mt Harcus intrusion causes a sharp, high-amplitude negative magnetic anomaly that corresponds with very strong, stable, and relatively homogeneous remanence plunging moderately down toward the NW. The intrusion must have cooled relatively quickly in order to preserve its uniform mineralogy, and crystallised titanomagnetite at very high temperatures. However, the extreme magnetisation developed much later, as the rock cooled through ~600°C and titanomagnetite was reduced to ilmenite with fine exsolution lamellae of magnetite [1].

By contrast, Mt Caroline's magnetic signature consists of alternating high and low linear anomalies at the top of the intrusion, with a magnetically flat base. This distinct magnetic layering and the corresponding cyclical lithology are characteristic of layered intrusions and are caused by fractional crystallisation of the parent magma. The alternating high and low magnetic anomalies correspond with two main phases. 1. Magnetite-rich anorthosite with predominantly induced magnetisation (i.e., minor remanence), held in multi-domain magnetite. 2. Gabbro and gabbronorite which preserve stable remanence, in single-domain magnetite, that is oriented moderately down toward the south. The lower horizons have a flat magnetic signature, and consist of alternating pyroxenite and gabbronorite, which is mostly devoid of magnetite. PGEs should sit in this lower cumulate phase of the intrusion. Hence, at Mt Caroline, the magnetite-rich parts of the intrusion are devoid of PGE potential, and the mineralised parts of the intrusion are (for the most part) devoid of magnetisation (devoid of magnetite). However, this is not necessarily true of other Giles intrusions, because the timing of sulphide saturation is what controls the localisation of sulphides. At Caroline this happens very early, which is why the upper magnetite-rich parts of the intrusion have no PGE potential. But, in other cases, the S-saturation event happens much later and can be correlated with the precipitation of magnetite, e.g., the Jameson Range, in the western Musgraves.

The results of the study illustrate that the mechanisms by which magnetisation is acquired in mafic-ultramafic rocks are linked to its PGE prospectivity. The conditions required to create strong, stable, homogeneous remanence in a mafic body are entirely different to those required to facilitate fractional crystallisation of magma, which is critical for the concentration of economic PGE mineralisation. Hence, strong remanent magnetic anomalies are not good targets for PGE mineralisation in the Giles Complex rocks of Central Australia, but strong induced anomalies may be.

*Reference:* [1] Church, N., et al. (2015). Abstracts, 26th IUGG, Prague, 2015.