Texturally informed isotopic records of magma differentiation in intrusive settings

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Transition metal isotope systems (e.g. Fe, V, Zn, Cr, Ti) are increasingly used to investigate magmatic differentiation, mostly using whole rock analyses [e.g., 1]. Theoretically, stable isotopic fractionation responds to both co-ordination environment and redox state, potentially recording changing P-T-X-fO_2 conditions that control, for example, the timing of sulphide saturation. However, interpreting the stable isotopic composition(s) of whole rock analyses is problematic for intrusive rocks, as it averages the changing modal mineralogy. Furthermore, textural information (e.g., cumulates, phase (dis)equilibrium), which provides key petrologic context for the evolution of the system, is lost.

The Boggy Plain Zoned Pluton is a calc-alkaline intrusion in SE Australia. The pluton displays concentric zoning from a gabbroic rim to aplitic core (SiO_2: 52-74 wt. %), resulting from progressive fractional crystallisation within a crustal reservoir [2]. Primary oxide abundance decreases during magmatic differentiation, while bulk rock Fe^{3+}/Fe^{2+}, the magnetite: ilmenite ratio and Mn content of ilmenite increases [2], implying an increase in magma fO_2 of >1 log unit [3]. Here, textural analysis is used to assess modal mineralogy, phase (dis)equilibrium, and detect the timing of sulphide saturation, all of which likely impact stable isotopic compositions. We combine this information with intra-mineral isotope partitioning of both redox (Fe,V) and non-redox (Zn) sensitive elements to assess their co-variation with changing P-T-X-fO_2 conditions during differentiation.

[1] Foden et al. (2015) *Lithos* 212, 32-44. [2] Wyborn et al. (1983) PhD Thesis. [3] Czamanske and Wones (1973) *J. Petrol.* 14, 349-380.