Microprospecting for platinum group minerals by X-ray fluorescence mapping using the Maia detector

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X-ray fluorescence microprobe mapping (XFM) has been used to locate micron-sized grains of platinum group element minerals in mantle nodules, komatiites and nickel sulfide ores using the Maia massively paralleled detector on the XFM beamline at the Australian Synchrotron [1]. The technique enables whole thin sections to be mapped at a pixel resolution of 2 microns, producing images up to 80 Mpixels in a few hours.

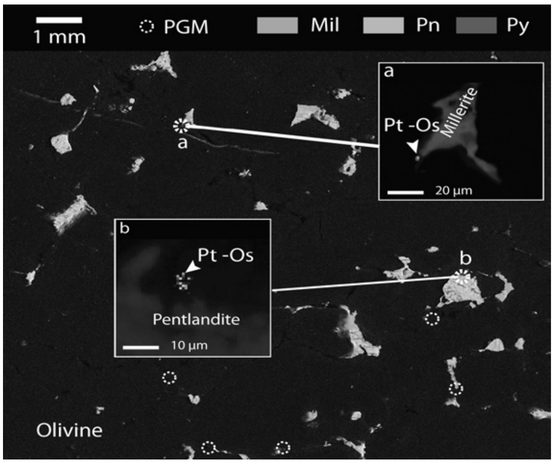

Figure 1. XFM image of sulfide-bearing dunite, Betheno, WA. Mil = millerite, Pn pentlandite, Py pyrite.

The example presented in Fig 1. shows one quarter of a standard thin section of a disseminated sulfide bearing fresh komatiitic dunite [2] containing 16 ppb Pt. XFM mapping revealed presence of 7 distinct PGM grains, only one of which had been located in a previous SEM search. This follows from the capability of the XFM method to detect buried grains within the 100 micron thickness of the section. PGMs are commonly found close to, but not in direct contact with, base metal sulfide globules.

[1] Ryan C.G. *et al*. (2010) *Nuclear Instruments & Methods in Physics Research Section A* **619**, 37-43. [2] Barnes *et al*. (2011) *Australian Journal of Earth Sciences*, in press.

Chalcophile elements in magmas and magmatic sulfide deposits: Can we see the mantle signals?

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Magmatic sulfide deposits are associated with a very wide variety of magma compositions from komatiites to andesites, spanning ranges of more than an order of magnitude in Ni content and three orders of magnitude in platinum group elements. Similar ranges are seen in sulfide ore tenors.

Late Archaean komatiites[1,2] show a strong consistency in PGE and Ni contents implying lack of S saturation except in the immediate environment of ore formation, and a broad homogeneity of deep mantle plume sources after 3 Ga.

Three trends are evident in post-Archaean basalts: source sulfide control, resulting in Pt and Pd depletion at high Mg#; cotectic sulfide fractionation, resulting in steady decrease in Pt and Pd with decreasing Mg#; and catastrophic depletion due to bulk crustal S assimilation [1]. Mantle signals are overprinted and difficult to discern in the latter two trends.

Basalts show very wide variability, and fall under a near-universal envelope of maximum Pt and Pd contents when normalised to moderately incompatible elements such as Ti. This maximum is lower than that for komatiites, implying either that all post-Archaean mantle sources are Pt-Pd depleted compared with Archaean plume sources, or that there is a universal global control owing to retention of sulfide in source mantle. However, source sulfide should produce a larger depletion, as seen in the Pt and Pd signal in primitive MORB and OIB. Within post-Archaean mafic magmas, only the Bushveld Complex sills stand out as being unusually PGE enriched, and even then the signal is only evident as a twofold enrichment in Pt [3]. Otherwise the Bushveld magmas appear to fall on extensions of the komatiite trends.

Iridium, Ru and Os are decoupled from Pt and Pd in basalts and komatiites, and show evidence for control by solubilities of Ir-rich phases [4]. This greatly limits the ability to read mantle abundances from magma compositions, and may have implications for Os iotope signals.

[1] Fiorentini *et al* (2010) *Journal of Petrology*, **52**, 83-112. [2] Fiorentini *et al* (2010) *Economic Geology*, **105**, 795-823. [3] Sarah Barnes *et al*. (2010) *Economic Geology* **105**, 1491-1512. [4] Barnes and Fiorentini (2008) *Chemical Geology* **257**, 44-58.