

## Drillcore imaging spectroscopy for exploration and mining

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Automated drill core logging techniques that measure the visible and infrared reflectance (e.g. line profiling systems such as HyLogging™) are increasingly used for mineral exploration and mining [1, 2]. Additionally, imaging spectrometers allow to capture mineralogical and textural information across the visible and infrared wavelength range (0.4 - 2.5µm). However, the automated extraction of mineral abundances and compositions from the resulting large spectral data sets is difficult and pure statistical methods can lead to questionable mineralogical conclusions.

This paper presents a case study using samples from orogenic gold deposits hosted by Archean greenstone belts of Western Australia, and iron-oxide copper gold deposits in the Mount Isa Inlier (Australia), to showcase the mineral feature extraction method [3, 4] for the interpretation of reflectance spectroscopic data and its application for drill core imaging spectroscopy. In this method mineral endmembers are not extracted from the analysed image, but are derived from physicochemical constraints characteristic for the minerals of interest. This enables the comparison of different samples and doesn't require spectral libraries for the interpretation of the reflectance spectra. Based on the image processing software ENVI™, routines were developed to create a suite of mineral maps, which show the spatial distribution and compositional changes of hydroxylated silicates and carbonates. The acquired mineral maps were compared with thin section petrography, SEM and electron microprobe work, and used to determine mineral phases that are visually difficult to identify in the greenschist to amphibolite facies host rocks. The results can be used to 1) better understand cross cutting and phase relationships of Au-related alteration assemblages (e.g. prehnite, white mica composition), and 2) improve the interpretation of automated drill core logging techniques, to deliver objective core logging results. The developed method is aimed to be globally applicable to a wide variety of mineral mixtures and geological settings.

[1] Cudahy *et al.* (2009) *Econ. Geol.* **16**, 223–235.

[2] Huntington *et al.* (2006) *MESA Journal*. **1**, 33–34.

[3] Cudahy *et al.* (2008) *CSIRO report*. **P2007/364**, 161pp.

[4] Laukamp *et al.* (2010) *AIG Bulletin*. **51**, 73–76.

## The effect of sulfur on PGE solubility in silicate melts

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The solubility of platinum-group elements (PGE) in silicate melts depends on oxygen partial pressure, temperature, pressure and melt composition. In addition, sulfur plays an important role for PGE geochemistry in the Earth's mantle. Due to their chalcophile character, PGE are thought to be predominantly hosted by sulfides in the Earth's mantle. However, little is known about the possible effect of sulfur partial pressure ( $pS_2$ ) on the solubility of PGE in silicate melts. In addition to oxygen, dissolved  $S^{2-}$  may associate as a possible ligand with the PGE and enhance their solubility in a silicate melt relative to a S-free melt. A better understanding of the influence of sulfur on PGE solubility in silicate melts will provide deeper insights into the processes leading to the enrichment of PGE in sulfide in a sulfide-melt/silicate-melt system, as observed in sulfides of magmatic PGE ore deposits (e.g. Merensky Reef, Bushveld Complex).

In order to experimentally investigate the effect of  $S^{2-}$  on the solubility of PGE in silicate melts, a natural picrite was equilibrated with Ru or Pt metal at 1300°C in a 1 atm vertical gas mixing furnace under controlled  $pS_2$  and  $pO_2$ . Sulfur fugacity was held below sulfide saturation. Run products were quenched to silicate glasses, which were subsequently analyzed for major elements and dissolved S by EMP. Ru or Pt concentrations were determined by LA-ICP-MS to allow the detection of heterogeneities such as discrete metallic nanonuggets.

Experiments show that the solubility of Ru or Pt in the picritic melt is enhanced up to a factor of 20 in sulfur-bearing systems when compared to S-free melts at identical  $pO_2$ . Our results appear to indicate that Ru and Pt, and possibly other PGE as well, bond with  $S^{2-}$  anions dissolved in the silicate melt. This observation has important implications for ore-forming processes: The proportion of Ru or Pt associated with the  $S^{2-}$  ligand will be extracted straight into an exsolving sulfide melt, once sulfide saturation is reached. This leads to the observed enrichment of PGE in sulfide liquids forming magmatic sulfide ore deposits. Our results imply that our current understanding of PGE enrichment processes in sulfide melts have to be re-thought.