

Modifying the diffusive gradients in thin films technique for the geochemical exploration of gold

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Using DGT for Gold

Gold is a precious metal that exists in the environment in extremely low concentrations (>1ppb). Any technique which is sensitive enough to usefully determine ultra-low quantities of metals such as gold is of interest to exploration geochemists and mining companies alike. As such, the diffusive gradients in thin films (DGT) technique, which has been used extensively to monitor ultra-low concentrations of metals in soils, sediments and freshwater [1], is likely to be ideally suited for geochemical exploration of gold in the environment.

Methodology and Discussion

This research details the development of a DGT method for the geochemical exploration of gold, and introduces a new binding-layer based on activated carbon. The performance of this new technique was assessed by: 1) determining the diffusion coefficient of gold (as soluble gold (III) chloride); 2) assessing the new binding layer's capacity to uptake gold; 3) determining the elution methodology from the binding layer; 4) assessing possible interference from other environmentally labile metals, and; 5) the effect of ionic strength and pH on performance.

The results of this study show that the technique has significant potential to be used for the geochemical exploration of gold in aqueous environments. Further method development will include assessing the technique's potential with gold species other than the gold (III) chloride used in this study, and further modification to measure gold concentrations in soils and sediments.

[1] Zhang & Davison (1999) *Anal. Chim. Act.* **398**, 329–340.

Element redistribution during rutile dissolution and titanite precipitation

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We investigated the dissolution-precipitation reaction rutile + Ca, Si, Al in fluid = titanite at 400 MPa and 600°C. Solid sources of Ti, rutile (Nb, W bearing natural or Cr doped synthetic rutile) and Ca, Si, Al (wollastonite and Al₂O₃ or grossular) are separated by using a double capsule technique. All element exchange is via an aqueous NaCl fluid. The purpose of the study is to find out what are the rate controlling steps and how are major (Al-Ti) and trace elements distributed.

Titanite growth is very rapid; overgrowth is complete after 1 day. With longer run-time, substantial increase of crystal size and changing crystal habits of the titanite imprint spatially related dissolution patterns on the rutile surface. The reaction progress is controlled by the low solubility of Ti and element transport from and to the dissolution front on rutile along titanite-titanite grain boundaries. Titanium is not transported away from the reaction site, but Al, which is always present in the quench, is perfectly mobile. This contrasting behaviour leads to an irregular 'patchy' Al-Ti distribution in titanite [1]. The Ti/Al is likely dominated by the availability of Ti rather than of Al. We assume quantitative incorporation of dissolved Ti in titanite.

Trace element (Nb, W) contents in titanite around rutile is variable and shows no clear spatial relation to the variable trace element contents of the zoned natural rutile. It is also neither related to core-rim relations in titanite corresponding to the time of the experiment, nor controlled crystallographically. Chromium (source: homogeneous synthetic rutile with 2000 ppm Cr) shows a similar behaviour. It is between ~400 to ~1400 ppm with a few higher values up to ~5000 ppm. From mass balance calculation, ~800 ppm Cr are expected if Cr is quantitatively incorporated and homogeneously distributed in the titanite. Chromium and Ti/Al are not correlated. Decoupling of Cr and Ti, which are released together by rutile dissolution, must originate from randomly different transport of both elements.

[1] Lucassen *et al.* (2010) *American Mineralogist* **95**, 1365–1378.