

## **Integrative geochronology of hydrothermal ore deposits: towards a 4D evolution model**

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In this contribution, we review the application of multiple more traditional (U-Pb, Pb-Pb, Ar-Ar), as well as more recent (Re-Os) isotope systems [1] for direct dating of either ore or gangue minerals in order to establish a comprehensive 4D model of mineral deposits evolution in some Paleozoic (Urals) and Archean (Yilgarn Craton) settings.

### **Geochronology of hydrothermal mineralisation events**

Re-Os geochronology of ore sulphides is known to be a robust method of geochronology, and has found its successful application in direct dating of the VHMS-style mineralisation [2, 3], Cu-porphyry [4] and epithermal gold deposits [5] worldwide. Limitation of the Re-Os systematics, however, is a possibility of an open-system behaviour, which is usually due to Re loss/addition, and, in turn, modifies the initial Re/Os ratio and regression line slope on an isochron diagram.

Pb-Pb model ages appear to be accurate for some epithermal gold and VHMS deposits [6], but can also reflect the age of older underlying host rocks in subduction zone settings [7]. A limitation of Pb-Pb systematics, being model dependant, requires a necessity to establish a regional model for more accurate age estimates [8].

Traditional mass-spectrometry methods for these isotope systems were recently complimented by a nanoscale in-situ method using Atome Probe [9].

### **Geochronology of alteration events**

Alteration minerals such as sericite can be dated by the Ar-Ar technique, and appear to be in many cases postdating the main mineralisation event by up to several Ma, generally showing multi-stage hydrothermal activity/fluid flow [2, 3]. Mineralisation-related hydrothermal monazite can be dated using U-Pb systematics.

[1] Tessalina *et al.* (2015) *RSC Detection Sci* 49-93. [2] Tessalina *et al.* (2017) *OGR* 85, 131-139. [3] Barrote *et al.*, *in prep.* [4] Tessalina & Plotinskaya (2017) *OGR* 85, 174-180. [5] Mueller *et al.* (2008) *Min Dep* 43, 337-362. [6] McNaughton *et al.* (1996) *J Royal Soc WA* 79, 123-129. [7] Tessalina *et al.* (2016) *OGR* 72, 22-36. [8] Hollis *et al.* (2017) *Prec Res* 291, 119-142. [9] Saxey *et al.*, *MinMag*, this volume.

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