# Monazite dating of base-metal mineralization, Earaheedy Basin, Western Australia

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The Paleoproterozoic Earaheedy Basin occupies the eastern end of the Capricorn Orogen that separates the Archean Pilbara and Yilgarn Cratons. The maximum depositional age of the Yelma Formation at the base of the Earaheedy Group is less than ~2.0 Ga from detrital zircon dating [1], while the minimum age is very poorly constrained. Sandstones of the Yelma Formation overlie granitic rocks of the Yilgarn Craton in the Earaheedy Basin, and outliers that extend up to 100 km south of the basin overlie Yilgarn Craton rocks or metasedimentary rocks of the Yerrida Group. The Yelma Formation was deposited on a broad shallow shelf over an extensive area of the northern margin of the Yilgarn Craton. Within the basin, carbonates of the Sweetwaters Well Member of the Yelma Formation host minor Pb-Zn sulphide mineralization of Mississippi Valley type [2]. Secondary Pb mineralization, interpreted to have resulted from weathering and remobilization of sulphide mineralization [3, 4], is being mined in ouliers of Yelma Formation at Magellan and Cano.

$^{207}Pb/^{206}Pb$ dating of authigenic monazite in sandstones of the Yelma Formation within the Earaheedy Basin gave an age of 1.81 Ga, which is interpreted to be the age of metamorphic or hydrothermal fluid flow, and may be related to the MVT mineralization. This age provides a firm minimum for deposition of the formation. At Cano, monazite is intergrown with iron oxides, interpreted to have replaced pyrite, in Pb-bearing greywacke. $^{207}Pb/^{206}Pb$ dating gave a similar, though imprecise, age, with many analyses recording high levels of common Pb. A Pb/Pb isochron age derived from outgrowths of xenotime on detrital zircon gave the same age, within error, and Pb isotope compositions support consanguinity with the MVT mineralization.

REE phosphates are very sensitive to the passage of metamorphic and hydrothermal fluids, often recording multiple fluid events. In the Earaheedy Basin, they constrain the depositional age of the Yelma Formation to ~2.0-1.81 Ga, and the timing of base metal mineralization to ~1.81 Ga.

[1] Halilovic *et al*. (2004) *Precambr. Res.* **128**, 343–366. [2] Teen (1996) BSc (Hons) thesis, U. Tas, 128 pp. [3] McQuitty & Pascoe (1998) *Aust. Inst. Min. Metall. Mon.* **22**, 293–296. [4] Pirajno (2004) *Precambr. Res.* **128**, 411–439.

# Volatiles in the mantle: Impact on intraplate magmatism

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Concentrations of the volatiles $H_2O$, $CO_2$, S, Cl, and F and elemental compositions of primary magmas and their sources can be estimated through the study of olivine-hosted melt inclusions in volcanic rocks, thereby providing insights about melting processes in the mantle. These volatiles play a major role in both the formation and evolution of mantle melts, and yet their impact on intraplate volcanism on the continents and in the ocean basins may be grossly underestimated. We have determined the major-oxide, trace-element and volatile ($H_2O$, $CO_2$, S, Cl, and F) concentrations of olivine-hosted melt inclusions from the Columbia River Plateau (CRP)-Snake River Plain (SRP) large igneous province, West Antarctic Rift System, and Iceland, all three areas with intraplate volcanism hypothesized to be related to plume activity.

Most of the samples we have analyzed record minimum $H_2O$ concentrations of 1 wt% or higher, exceeding the largest values obtained for subaerial eruptions in Hawaii of 0.8 wt%. The most $H_2O$-rich lava in the SRP has 3.3 wt%, and in the Columbia River Basalts (CRB) values reach 4.2 wt% $H_2O$. Concentrations in Icelandic and West Antarctic Rift melt inclusions reach values of 3.0 and 2.2 wt% $H_2O$, respectively. Water and $CO_2$ are correlated and follow magmatic degassing curves. Furthermore, the highest volatile concentrations are always found in the more primitive melt inclusions, based on major oxide and trace element abundances, indicating that the volatiles are of mantle origin, not artefacts of differentiation in the crust. The trace element and volatile variability, high concentrations of water, and recent studies of Os isotopes in these tectonic settings provide compelling evidence that the volatiles and chemical heterogeneity of the magma sources may be caused by the recycling of ancient oceanic crust.