Giant Ore Deposits, Giant Stable Isotope Alteration Footprints?

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Stable isotope (C, O, H and S) alteration haloes around hydrothermal ore deposits have been recognized for more than 50 years. The theory of stable isotope exchange and alteration during hydrothermal fluid flow is very well established. However, despite the well-recognized presence of stable isotope alteration haloes around hydrothermal ore deposits, and a large body of knowledge to enable interpretation of the data, there are only a few documented examples of stable isotopes being used to assist mineral exploration (e.g. Naito et al, 1995).

Stable isotopes can potentially be used to define alteration haloes around ore bodies, identify structures which controlled hydrothermal fluid flow and their three-dimensional architecture, and determine the direction of hydrothermal fluid flow.

One of the most exciting potential applications of identifying stable isotope alteration haloes is the hypothesis that the isotopic halo size reflects the overall flux of hydrothermal fluid, and therefore could be used at during the generative stage of mineral exploration to predict whether the area under exploration has the potential to yield a giant ore deposit. One stand out example of this is the oxygen isotope alteration identified around the giant Mt. Isa Cu deposit, with a ^{18}O-isotoper alteration halo of ~ 9 x 2 km (Waring et al., 1998), which is the largest known isotopic alteration halo we are aware of around a known mineral deposit.

We have been utilizing a newly developed carbon and oxygen isotope analytical system, based on off-axis integrated cavity output spectroscopy (OA-ICOS), developed at the Mineral Deposit Research Unit, University of British Columbia (Barker et al, 2012) to define isotopic alteration haloes around Carlin-type gold deposits, carbonate-replacement deposits as well as Mississippi-Valley type deposits. The analytical technique developed is rapid (~5 minutes per sample), inexpensive (very few consumables) and can be carried out by any person with basic laboratory skills. We have analyzed microdrilled samples, crushed hand specimens as well as pulped samples from 1 to 5 metre core and RC intervals produced for assay and lithogeochemical analysis.

Our results from the northern Carlin Trend (Betze-Post-Screamer deposits), Pipeline deposit and Long Canyon Carlin-type gold deposits all have significant oxygen isotope alteration haloes within the carbonate rocks that host these deposits. The size of these haloes varies from ~ > 200 m (Long Canyon, > 2 Moz gold) to > 3 km (Northern Carlin Trend, > 50 Moz gold). In a study of the Cinco de Mayo CRD deposit in Mexico, we have identified a oxygen isotope alteration halo > 10 km in strike length, indicative of a very large hydrothermal system.

Research is ongoing to delineate isotopic alteration haloes around other deposits, with an overall goal of helping to improve exploration and targeting of deposits within carbonate host rocks, as well as extending our research to ore deposits hosted in silicate rocks through the development of new analytical techniques.