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Developing new stable isotope tools for mineral exploration: Applications and complications

Shaun L L Barker*, John A Mering, Benjamin S Andrew, Gregory M Dipple, Andreas Beinlich

*University of Waikato, Hamilton, New Zealand, Email: sbarker@waikato.ac.nz

The ratios of the stable isotopes of hydrogen, carbon, oxygen and sulfur are known to systematically vary around many types of hydrothermal ore deposits. Changes in stable isotope ratios reflect a variety of processes, including temperature, the intensity of water-rock interaction and oxidation-reduction processes. While it has been recognised for sometime that stable isotope ratios could be used to help aid mineral exploration, they have not been routinely applied as exploration tools. We have developed two new analytical approaches, based on OA-ICOS to measure (1) the carbon and oxygen isotope composition of carbonate minerals and (2) the hydrogen isotope composition of hydrous silicate minerals. These instruments are considerably cheaper and easier to run than IRMS instruments, can obtain data more quickly, and have comparable precision and accuracy. In this presentation, we will provide an overview of the capabilities of the analytical instrumentation.

As an example, asystematic oxygen and carbon isotope dataset collected at ~ 100 metre spacing down multiple drill holes from the Mount Isa copper deposit in Queensland, Australia, demonstrates systematic changes in oxygen isotope composition of the carbonate-rich shales which host the deposit. Changes in the oxygen isotope composition of the host rocks is interpreted to reflect variations in the amount of fluid-rock reaction across the deposit, as well as the generation and migration of isotopic reaction fronts. Therefore, mapping the oxygen isotopevariations is mapping hydrothermal fluid flow pathways.Three dimensional modelling of the oxygen isotope data reveals multiple fluid escape pathways and suggests that fluids exploited both horizontal and vertical fluid flow pathways. Understanding the 3D nature of the fluid flow is critical for subsequent targeting of unknown ore bodies. In a second example, the Carlin-type gold deposits of the northern Carlin Trend, Nevada, reveal broad oxygen isotope haloes which extend for at least ~ 4 km around the major gold deposits. Research is ongoing to understand controls on hydrothermal fluid pathways in these, as well as other ore deposits.