Mapping Carbonate Alteration Footprints

MDRU
MINERAL DEPOSIT RESEARCH UNIT

DETECT ORE FLUIDS IN CARBONATE ROCKS

Carbonate minerals are very effective recorders of mineralizing fluid flow and their isotopic variations form detectable alteration halos around many mineral deposit types such as Carlin, CRDs and skarns.

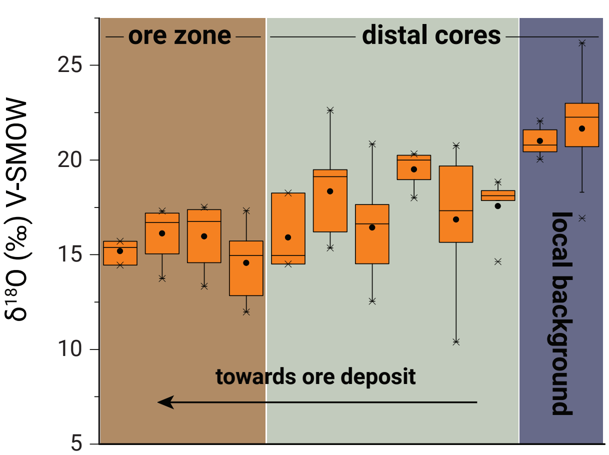
ALS

MDRU, in partnership with ALS Minerals, offers rapid stable isotope measurement in carbonate minerals and rocks. These carbon and oxygen isotopes can host diagnostic signatures in and around ore deposits that indicate the location and degrees of mineralizing fluid interactions, even where geochemical responses may be weak or missing.

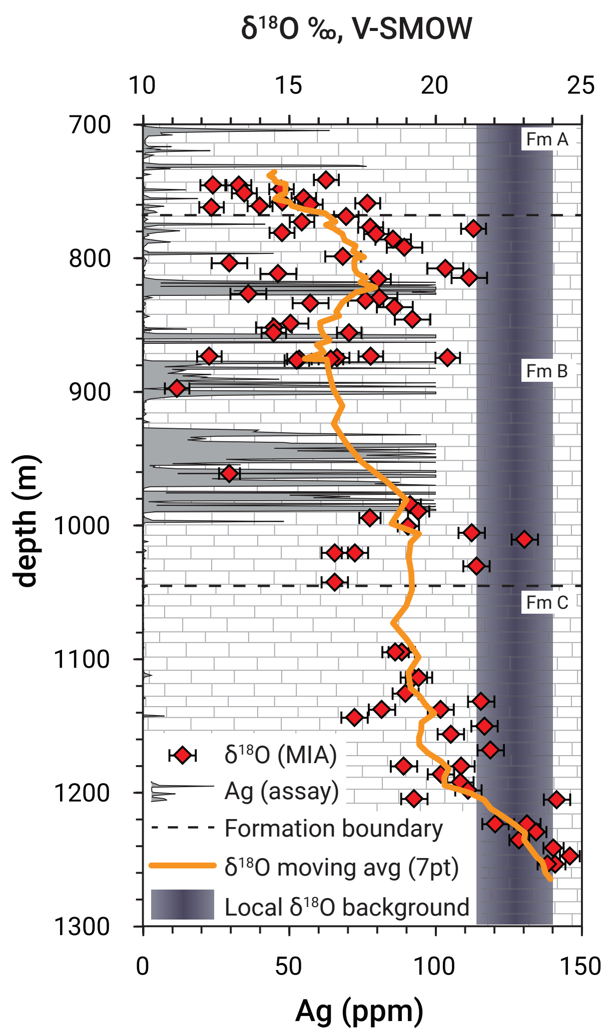
Hydrothermally-altered host rocks around ore systems may have large (up to several kms) alteration halos that define their alteration footprints, but in carbonate rocks, mineral deposits may not alter surrounding rock to form visible mineral assemblages. However, carbonate-hosted deposits may have much broader "cryptic" alteration footprints that can easily be detected with carbon and oxygen isotopes which record rock interactions with mineralizing fluids.

Although isotopic analysis has been historically time-consuming expensive, and inconsistent, new technology developed by MDRU now make obtaining these data a fast, easy and relatively cheap, method to improve exploration decision-making. C and O isotopes are measured on gases generated by a weak acid digestion in a specialized, purpose-built instrument developed and optimized by MDRU. Uniquely, this instrument can also overcome H2S interferences so that sulfide-rich samples can now be analyzed.

Samples can be submitted to directly to MDRU or through ALS Minerals.



Oxygen isotopic (δ^{18}O) composition of syn-mineralization calcite veins around a carbonate replacement deposit shown as a function of distance from the main ore body. The vein oxygen isotopic composition shows an increase of ~7‰ over a distance of 12 km. This type of alteration footprint was previously undetectable, particularly in sulfide-bearing carbonate rocks.



Downhole δ^{18}O variations in a drill core intersecting mineralized and unmineralized zones of a carbonate replacement deposit. The mineralized host rocks are characterized by a wide (~200 m) interval of highly "shifted" isotope ratios to lower values which is surrounded by moderately shifted intervals up to 200 m further downhole. This indicates the extent of the detectable footprints associated with these systems

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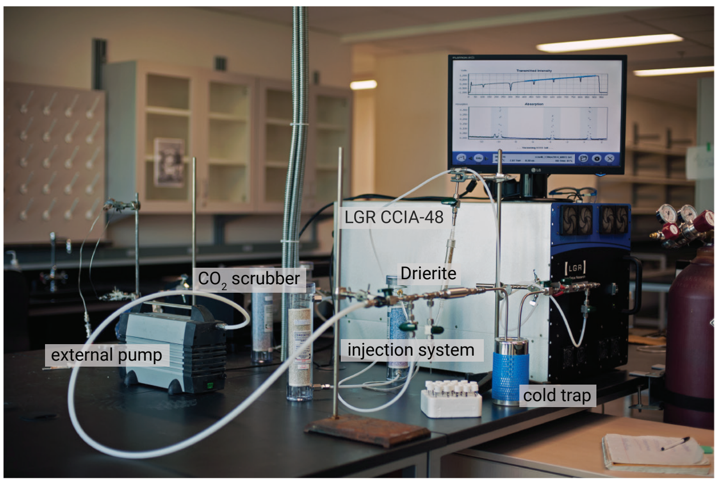
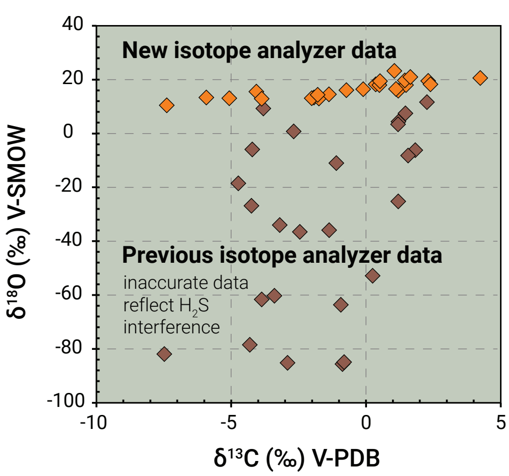
Mineral Isotope Analyzer

NEW ANALYTICAL SYSTEM

LGR CCIA-48 Isotope Analyzer



The new MDRU Mineral Isotope Analyzer is based on Off-Axis Integrated Cavity Output Spectroscopy (OA-ICOS), characterized by relatively low initial capital cost, low maintenance, and inexpensive consumable requirements. The off-axis laser alignment is particularly robust, introducing the potential for field or mine site deployment.



The new analyzer's greatest advantage compared to MDRU's former stable isotope analyzer is the ability to analyze sulfide-bearing carbonate samples and pulps which was previously impossible because of interference of H_2S and CO_2 during laser absorption. This now allows detection of isotope ratios in ores, mineralized rocks, and host rocks containing diagenetic pyrite.

HOW IT WORKS

Variations in light stable isotopes of elements in ore systems, such as oxygen, carbon, hydrogen, and sulfur, have been instrumental in understanding fluid-rock interactions in and around ore deposits for more than half a century. Typically, the relatively "heavy" isotopic values in the host rocks are shifted towards lighter values during interactions with hydrothermal fluids. Stable isotope ratios therefore provide information on f fluid flow during hydrothermal ore mineralization, and it is now possible to map the extent of fluid interactions, discern fracture-controlled vs pervasive fluid flow, determine fluid temperatures, alteration intensity and mineralizing fluid sources - all of which contribute improved ore deposit and exploration models.

Carbon isotope ratios can identify the carbon source in carbonate minerals (e.g., mantle, sedimentary rock or biogenic) as well as the role of oxidation in hydrothermal systems. Oxygen isotope ratios in carbonate minerals typically vary according to the origin and temperature of mineralization. Generally, heavy ^{18}O-enriched host rocks will become depleted in ^{18}O upon interaction with the ^{18}O lighter hydrothermal fluids to produce the distinct isotopic signatures of altered, relative to fresh, host rocks.

As an exploration targeting tool, stable isotopes can identify: 1) regions or structures of fluid flow in 'apparently' unaltered rocks; and 2) identify the locations, nature and relative intensities of fluid-rock interactions. Smart explorers will recognize that such information can be used to recognize and rank targets, prospects and acquisitions, as well as to recognize and follow up on near-misses.

FOR MORE INFORMATION

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Expertise in fluid-rock interactions with a focus on driving forces for mineral reactions

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Exploration methods and strategies, regional metallogeny and exploration targeting