

Off-axis integrated cavity output spectroscopy (OA-ICOS) holds promise for locating mineral deposits

Los Gatos Research (LGR)



OA-ICOS as an aid to the study and location of mineral deposits

Measurement made easy

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Introduction

Since the 1950s, geologists have used analysis of the stable isotope ratios of certain elements, such as hydrogen, carbon, oxygen and sulfur to aid in studying and locating mineral deposits. For example, gold deposits often form via tectonic plate collisions. The gold moves up faults by hydrothermal waters and is deposited when the water cools and precipitates gold from solution. Past studies have demonstrated that stable isotope ratios differ in rocks surrounding ore-bodies compared to rocks unaffected by hydrothermal alteration. So, stable isotope ratios have the potential to be a valuable tool for mineral exploration by defining regions of rocks that have been altered by hydrothermal fluids.

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Problem

In the past, these measurements were usually made using isotope ratio mass spectrometry (IRMS). But the cost per sample, slow collection and reporting speeds, need for specialty laboratories and uncertain benefits have precluded widespread application of IRMS for mineral exploration.

Solution

Recent advances in analytical technologies have been made in laser absorption spectroscopy that show promise for mineral exploration. One such technology is Off-Axis Integrated Cavity Output Spectroscopy [OA-ICOS], from Los Gatos Research, a member of the ABB Group. OA-ICOS permits collection of stable isotope data in far greater quantities than has been previously possible. This analytical method allows significantly faster and less expensive stable isotope measurements. OA-ICOS uses a tunable laser source that produces light at a suitable wavelength for interacting with the gas of interest. The laser light enters a highly reflective mirrored cavity, reflecting thousands of times before exiting onto a photodetector. This creates an extreme long optical path (many kilometers), increasing sensitivity and producing strong absorptions as the infrared light interacts with a gas present within the cavity. By changing the wavelength over which the laser operates, the concentration of different isotopologues of the same gas can be measured to determine isotopic ratios with precision similar to IRMS.

The documented advantages of OA-ICOS compared to IRMS include relatively low initial capital cost, low power consumption, bench-top size, lack of a high-vacuum system, no requirement for high-purity carrier gases and relatively simple operation. All of these factors contribute to field portability and significantly reduced operating costs. As a result, OA-ICOS instruments have many of the required properties for deployment into different mineral exploration environments, such as fly camps, core logging facilities and mine site assay labs. What's required are techniques to turn solid-phase mineral samples into gases suitable for isotopic analysis.

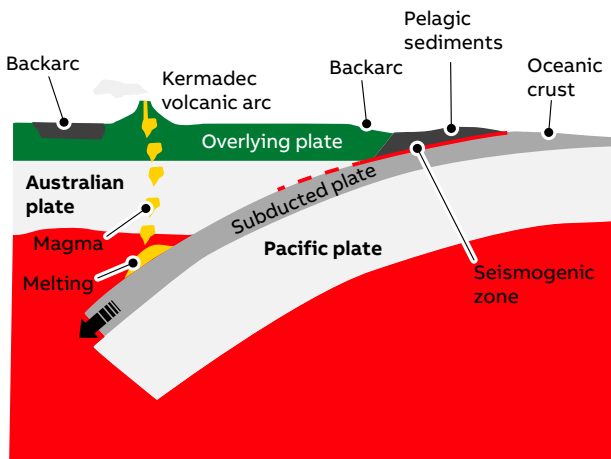


Figure. 1 Gold deposits often form via tectonic plate collisions

Results

As an example, geologists recently applied OA-ICOS technology to produce carbon and oxygen isotope data collected from carbonate rocks surrounding the Screamer Carlin-type gold deposit in Nevada (Economic Geology, Volume 108, No. 1, 2013). To assess the size of the stable isotope alteration and to evaluate controls on fluid flow around gold deposits, they analyzed more than 5,000 samples for their carbon and oxygen isotope composition.

These came from two deposits:

- in the northern Carlin trend, consisting of 60 million ounces [Moz] of contained gold
- in northeast Nevada with about 3 Moz of contained gold.

Some samples were collected from hand specimens from diamond drill core. But the majority of samples came from crushed and powdered samples (pulp) that had been produced for gold assaying and litho-geochemical analysis. These studies demonstrate that carbonate rocks surrounding the Screamer Carlin-type gold deposit in the northern Carlin trend, Nevada, have significant oxygen isotope alteration. The results support earlier studies of isotopic alteration of carbonate rock-hosted ore deposits. The earlier studies revealed that the carbonate rocks surrounding different types of hydrothermal ore deposits have variable intensity and sizes carbon and oxygen isotope alteration halos. The data measured via OA-ICOS suggest that isotopic alteration can be used to vector toward mineralization in several different ways, depending on the deposit type of interest and the exploration environment.

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