Identifying the sources of iron in reservoir fluids at a CO_2 injection pilot in Alberta, Canada

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The Pembina oil field is situated in western-central Alberta, Canada. After decades of water-flooding, a CO_2 injection pilot project was constructed to enhance tertiary oil recovery. A detailed geochemical monitoring program was conducted to study the impact on the geochemistry of reservoir fluids and rocks [1]. Increased iron concentrations, up to 144 µg/g, were measured at observation wells in the vicinity of the two CO_2 injectors after CO_2 injection commenced.

Iron isotopic compositions were measured and two possible sources of iron were investigated: leaching from the production pipes and siderite dissolution. Iron isotope data are summarized in Figure 1.

Data suggest that neither siderite dissolution nor iron leaching are the only processes occurring at the site. Either a third source of iron or BSR are responsible for the measured iron delta values.

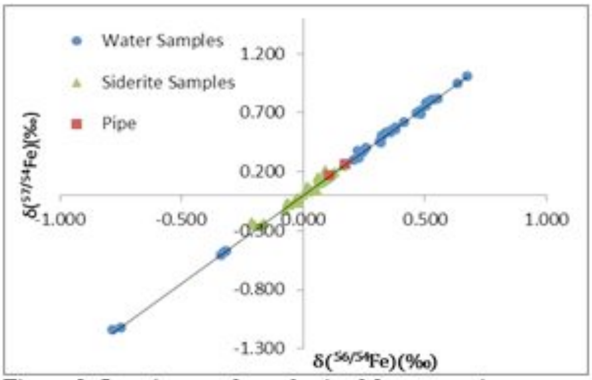

Figure 2: Iron isotope data obtained for reservoir water obtained from observation wells, siderite samples from the reservoir and production the pipe.

[1] Michael Nightingale (2010). Unpublished MSc. Thesis. University of Calgary.

EARTHTIME: Past, Present, and Future

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The last ten years have seen a revolution in geochronology. Recognizing that the apparent precision achievable by a new generation of mass spectrometers and laboratory techniques outstripped inter-laboratory agreement and revealed unrecognized inter-chronometer biases, the EARTHTIME initiative was formed to move science forward through community engagement and collaboration. A series of inter-related experiments in the U-Pb and Ar-Ar communities, including inter-lab comparisons, community tracer calibration and distribution, and adoption of software and data reduction norms, have been broadly successful, in large part due to international cooperation.

The success of the U-Pb and Ar-Ar experiments have since inspired the same approach from other chronometers whose increasing measurement precision and proliferation of laboratories has elicited the same questions. The U-series community is now embarking on a large international inter-laboratory comparison, in conjunction with first-principles calibration efforts; the LA-ICP-MS U-Pb community has completed an inter-laboratory comparison and is presently engaged in software package comparison and development of data reduction norms; and the EarlyTime initiative, focused on geochronology of meteorites, is organizing an inter-laboratory comparison. These efforts seek to replicate, and strive to be informed by, the progress made by EARTHTIME.

As these parallel projects advance and the accuracy of each system improves, it is worthwhile considering both the limiting uncertainties and the ultimate goals involved. Minimizing and correctly estimating inter-laboratory biases by measuring multiple 'secondary' standards across many laboratories yields a community-wide measure of the external reproducibility of each method. As measurement uncertainties and internal repeatability improve, along with our ability to estimate them, this external reproducibility and the ability to tie each system back to first principles measurements define accuracy and precision for each system.

These uncertainties also determine how well we can compare between isotopic systems, an ultimate goal of EARTHTIME and the larger geochronology community. Decay constant uncertainties dominate our ability to combine data from multiple chronometers, and active research and debate is focused on inter-relating these decay constants through geologic comparisons, for instance dating the same discrete event in time with multiple chronometers.

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