Goldschmidt 2024 Abstract
https://doi.org/10.46247/gold2024.23688

Detailed investigation of alteration to oceanic crust via in-situ quartz $\delta^{18}O$ measurements in pillow basalts and sheeted dikes from ODP 504B

ZACHARY STEVENS[1], DAVID ZAKHAROV[2] AND DR. ANNE-SOPHIE BOUVIER[3]

[1]Western Michigan Univeristy

[2]Western Michigan University

[3]University of Lausanne

Presenting Author: zachary.r.stevens@wmich.edu

Beginning life at the surface by erupting from mid-ocean ridges, oceanic lithosphere quickly begins experiencing alterations that affect the isotopic signature and record its evolution through the process of subduction. These alteration processes are recorded in the O-isotope composition of altered oceanic crust, which can be used to understand reactions between the hydrosphere and basaltic materials that constitute seafloor. To fully understand how the O-isotope composition of oceanic lithosphere evolves through geologic time, single mineral grains can provide a profound amount of data for scientists to work with.

A common secondary mineral in altered oceanic crust is quartz which precipitates from seawater-derived hydrothermal fluids and records $\delta^{18}O$ as a function of temperature and balance of the seawater-basalt reaction. Previous studies on ophiolites and drilled oceanic crust provide an excellent foundation of bulk O-isotope data to work from, and our work pushes this further by measuring in-situ $\delta^{18}O$ in single quartz crystals. In-situ measurements are complimentary to bulk, as individual crystals can record multiple generations of fluid infiltration, and crystals often provide insights into fluid(s) they crystallize from.

Here we present new Cathodoluminescence (CL) images of quartz crystals from depths of 911 meters below seafloor (mbsf), 996 mbsf, and 1672 mbsf. These images show internal oscillatory zoning, mottled textures, and filled micro-fractures. We use CL images to guide Secondary Ion Mass Spectrometry (SIMS) data collection in quartz to understand fine-scale differences in $\delta^{18}O$ (Figure 1). These results reveal individual quartz grains have variable $\delta^{18}O$ between +7 to +10‰, which correspond to formation temperatures from seawater-derived fluid of 360-480 ̊C. These crystals have also been measured for triple O-isotope values indicating that they precipitated from fluids with $\delta^{18}O$ of up to +3.0 ‰. We also present $\delta^{30}Si$ measurements in one sample, which vary between -0.5 and +0.7‰. This falls within the range of $\delta^{30}Si$ values for quartz interpreted to be derived from basaltic silicon. Overall, our data indicates that single grains are useful recorders for the processes which alter oceanic crust, and that further research can only expand our understanding of how the two most dominant features of Earth's outer shell interact.