

Quantifying the spatial scale of chemical heterogeneity created by off-axis fluid-rock interaction in the ocean crust: An example from the lava sequence of the Troodos Ophiolite

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Many of the key elements recycled at subduction zones and redistributed between the oceans and ocean crust reside in lava sequences altered at low temperatures to clays, zeolites, and carbonates. The extent of low temperature alteration is largely dependent upon seafloor topography, lava morphology, and the rate and nature of sedimentation.

The Troodos ophiolite is used to examine the scale of chemical heterogeneity that results from off-axis alteration. A seafloor weathering zone (SWZ) occurs along the sediment-lava interface and is best developed at paleotopographic highs that were exposed to cold, oxidative seawater for up to 30 m.y. A low temperature zone (LTZ) underlies the SWZ. Lavas from the SWZ are more pervasively altered and show a greater change in primary porosity due to mineral precipitation than in the LTZ. Calcite is the dominant secondary phase in the SWZ, filling 6-8% of the primary porosity, whereas smectite dominates the LTZ, filling 4-5% of the primary porosity.

The distribution and proportions of alteration zones, different lava morphologies and secondary minerals in the lava sequence were measured in the field and the CY-1 drillcore. Bulk compositions of altered lava sequences were calculated using an additive approach that accounts for differing proportions of the SWZ and LTZ; pillows, flows, and breccias; and secondary minerals. Monte Carlo simulations were used to assess uncertainties in bulk compositions. Results show that varying the relative thickness of the SWZ substantially changes the bulk composition, e.g., up to 50% for K_2O and CO_2 contents; varying the proportion of pillows and flows leads to variations of 10-20% for these elements. These data show that development of a realistic geochemical model for an incoming slab at subduction zones must account for the geochemical heterogeneity in altered lava sequences that result from local parameters.

Solar Xenon in Genesis Silicon

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We have completed analyses of two samples of silicon from the Genesis mission (JSC60052 – 0.345 cm^2 and JSC60053 – 0.1 cm^2) and three unflown (“blank”) samples of identical material (CZ1 – 0.34 cm^2 , CZ2 – 0.37 cm^2 , FZ1 – 0.26 cm^2) – analysis of other samples is ongoing. Gas is extracted by heating with a continuous wave Nd:YAG laser (1064 nm) at sequentially increasing power densities.

Gas contents of both the flight and blank samples have shown some variability in concentration. Total ^{132}Xe in the flight samples ranged from $1\text{--}2 \times 10^6 \text{ atoms } ^{132}\text{Xe cm}^{-2}$, while that in the blanks ranged from $0.05\text{--}1 \times 10^6 \text{ atoms } ^{132}\text{Xe cm}^{-2}$.

A definitive isotopic composition will await a more comprehensive dataset. However, we find that the isotopic composition of the largest releases from the flight samples is consistent with solar xenon [1] (Fig 1) and currently prefer this to our preliminary data treatment that was based on total xenon released (included small releases) from JSC60052 [2]. There is a hint of a contribution from the terrestrial atmosphere to the smaller sample.

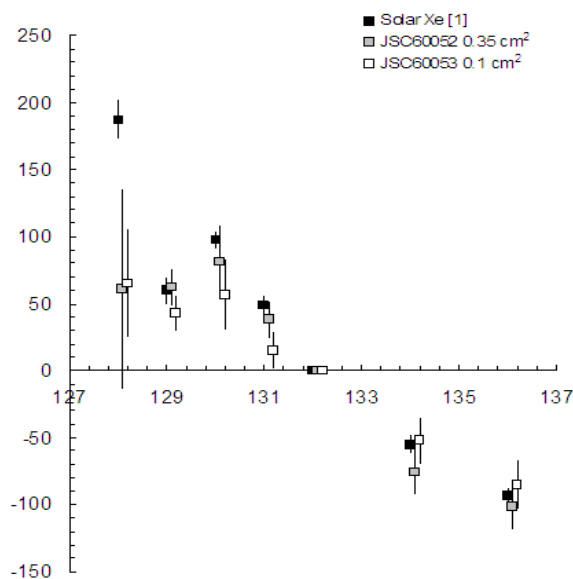


Figure 1: Isotope ratios from the largest releases (40,000 – 100,000 atoms ^{132}Xe) obtained from flight Genesis silicon samples JSC60052 and JSC60053.

- [1] Wieler, R. (2002) in *Rev. Mineral. Geochem.*, **47**, 21-70.
[2] Crowther *et al.* (2008) LPSC abstract #1762.