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Alteration mineralogy and the effect of acid-leaching on the Pb-isotope systematics of ocean-island basalts

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Abstract

The effect of alteration phases on the Pb-isotope systematics of weakly altered basalts from two major ocean islands (Hawaii and Kerguelen) was investigated using scanning electron microscopy (SEM), X-ray diffraction (XRD), and acid-leaching experiments. Alteration within vesicles and as replacement products of olivine and glass consists mainly of phyllosilicate mixtures (most commonly smectite ± talc, serpentine, chlorite, celadonite), goethite, and zeolite with minor pyrolusite, barite, apophyllite, dolomite, pyrite, and chalcopyrite. The presence of distinct alteration assemblages within the Hawaiian and Kerguelen basalts can be related to differences in their eruption environment, age, and sampling method. In particular, the Hawaiian basalts have been contaminated by highly radiogenic components (seawater and drilling mud), demonstrating the importance of acid-leaching prior to Pb-isotopic analysis even for young basalts that appear to be relatively unaltered. However, for some basalts, leaching may not remove the alteration completely or in a reproducible way, which may reflect variable extents of dissolution of secondary minerals that are not readily soluble in HCl (e.g., celadonite) or inconsistencies in the leaching procedure. The incomplete removal of foreign Pb components, which typically have distinct Pb-isotopic signatures, is a major source of uncertainty and may represent the ultimate limitation on high-precision Pb-isotopic compositions of ocean-island basalts. To achieve the highest precision and accuracy, we recommend that Pb-isotope studies of basalts include an investigation of the alteration mineralogy and an evaluation of the effectiveness of the leaching procedure as part of standard quality control protocols.

Keywords: Alteration minerals, ocean island basalts, Hawaii, Kerguelen, SEM, XRD, leaching, Pb-isotopes