Uranium series analysis of 2006 Augustine volcanics: An investigation into the timescales of magmatic processes

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The frequent eruptions (5 eruptions in the last century) and the narrow range of erupted products (dacites to andesites) in conjunction with excellent documentation of the 2006 eruption by the Alaskan Volcano Observatory (AVO) make Augustine an ideal location for investigating the time-scales of magma mixing and differentiation. Toward this end, a set of 17 representative samples of the 2006 eruption were analyzed for ^{238}U, ^{230}Th, ^{226}Ra, and ^{210}Pb abundances, as well as major and trace element concentrations.

All samples from Augustine have consistent excesses of (^{230}Th) over (^{238}U). Similar excesses in other andesitic lavas have been explained by slab or lower crustal melting with residual garnet, or differentiation from basalt generated by melting mantle in the presence of garnet or Al-rich pyroxene. We prefer the latter explanation based on documentation for basaltic parental magmas (Larsen *et al*. 2010), and a lack of evidence for garnet fractionation with differentiation. Variations in ($^{230}Th/^{232}Th$) values vary independently of SiO_2 concentrations, suggesting that the mixtures of melts and crystals making up the differentiated magmas have average ages as high as 54 Ka.

Our most mafic sample (an enclave with 53 wt % SiO_2) has ($^{226}Ra/^{230}Th$) = ~1.2. With increasing concentrations of SiO_2, the ($^{226}Ra/^{230}Th$) values decrease to ~1 at SiO_2 ~ 56 wt. %, increase to 1.45 at SiO_2 ~ 59 wt %, then decrease to ~1 in samples with >61 wt. % SiO_2. These data suggest that three magmas mingled and mixed during the 2006 eruption: basaltic andesites with Ra excesses generated by mantle melting; a 59 wt % SiO_2 magma with Ra excesses generated from incongruent melting of youg plutonic materials, and 61-62 wt % SiO_2 andesites with relatively long crustal residence times.

Excesses of (^{210}Pb) over (^{226}Ra) were measured in the most mafic and silicic samples at Augustine, whereas intermediate samples had either equilbrium ($^{210}Pb/^{226}Ra$) or small ^{210}Pb deficits. The excesses in the basaltic andesites were likely generated during degassing within a compositional boundary layer. Excesses in high silica samples were likely produced by localized degassing through porous networks of vesicles.

Best practices for ensuring consistent coral geochronology

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The goal of geochronology is to supply an accurate timescale for earth processes, and U-Th coral dating has been sucessfully used to infer the history of sea level change. However, it is widely acknowledged that U-Th coral geochronology is strongly impacted by diagenetic artefacts over much of its practical dating range [1]. Improved understanding of the major diagenetic processes producing significant artefacts in coral ages has inspired a vigorous debate over best practices in coral geochronology [2]. Traditional approaches rely on screening criteria to identify corals that have behaved as a closed system, while newer approaches seek to quantify and correct for the diagenetic processes directly. Regardless of the preferred approach for U-Th age interpretation, it is clear that differences in screening criteria and assumptions about the oceans past uranium isotope ratio have considerable influence on the conclusions inferred from U-series coral data. Using new and existing data, and fundamental statistical analysis, we demonstrate the sensitivity of U-Th coral geochronology to small differences in age interpretation practices. Furthermore, we suggest simple and practical steps that can be taken now to make the interpretation of coral ages more objective and consistent; a fundamental goal of geochronology.

[1] Thompson, Andersen, Dutton & Siddall (2010) *PAGES News* **18**, 39–40. [2] Andersen, Gallup, Scholz, Stirling & Thompson (2009) *PAGES News* **17**, 54–56.