Do ^{226}Ra-^{230}Th isochrons provide realistic crystallization ages?

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In this contribution we investigate the timescales of magma genesis, melt evolution, crystal growth rates and magma degassing in the Mt Erebus magmatic system using measurements of ^{238}U-^{230}Th-^{226}Ra-^{210}Pb-^{210}Po; ^{232}Th-^{228}Ra-^{228}Th and ^{235}U-^{231}Pa-^{227}Ac. These are the first measurements of ^{231}Pa-^{227}Ac in volcanic samples and thus this is the first data set to present the entire suite of relevant ^{238}U, ^{235}U and ^{232}Th decay series nuclides in a volcanic system. Our sample suite consists of 22 historic bombs, ranging from 1972-2005; and 5 anorthoclase megacrysts separated from historic bombs for the years 1984, 1989, 1993, 2004, 2005. These samples ^{238}U-^{230}Th and ^{230}Th-^{226}Ra are significant and uniform over the 36 year historical record. The anorthoclase megacrysts and phonolite glass show complimentary ^{226}Ra/^{230}Th disequilibria. In all samples, ^{210}Pb/^{226}Ra are in secular equilibrium for both phases. For phonolite glass separates ^{227}Ac/^{231}Pa is also unity. For the phonolite glass ^{228}Ra/^{232}Th is in equilibrium, whereas in the anorthoclase megacrysts ^{228}Ra/^{232}Th is significantly greater than unity..

Instantaneous crystal fractionation, with long magma residence time (> 100 years, < 3 kyrs, depending on D_{Ba}/D_{Ra}), can account for the ^{238}U-^{230}Th-^{226}Ra-^{210}Pb and ^{235}U-^{231}Pa-^{227}Ac systematics. However, the significant ^{228}Ra/^{232}Th disequilibria in the anorthoclase megacrysts preclude this simple interpretation. To account for this apparent discrepancy we have developed an open-system, continuous crystallization model, which incorporates both nuclide in-growth and decay during crystallization and recharge. Our model can successfully reproduce all of the measured ^{238}U- ^{235}U- and ^{232}Th- decay series disequilibria. More importantly, this model shows that when the timescale of crystallization is comparable to the half-life of ^{226}Ra, the simple ^{230}Th-^{226}Ra isochron techniques typically used in most U-series studies likely provide erroneous ages.

Dissolved ^{230}Th-^{232}Th dynamics in the Eastern Tropical Pacific Ocean

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We present data for dissolved ^{230}Th and ^{232}Th concentrations in seawater from nine depth profiles along a transect (~85°W) from about 7°N to 8°S in the eastern tropical Pacific Ocean. Our sampling sites cover the highly productive regions of the Pacific cold tongue close to the equator, and less productive regions of the Panama and Peru Basins. Dissolved ^{230}Th is thought to be scavenged onto sinking particles, and reversible exchange between dissolved and particulate phases takes place throughout the water column. As a result vertical dissolved ^{230}Th profiles should show a linear increase in ^{230}Th concentration with increasing water column depth.

Filtered (dissolved fraction of ^{230}Th-^{232}Th) and unfiltered (dissolved and particulate fraction of ^{230}Th-^{232}Th) seawater samples have been processed following established protocols developed by GEOTRACES. Our data thus far show little evidence for a linear increase in the concentration of dissolved ^{230}Th with depth, and the observed vertical structure may be related to either water mass or particle flux effects. Dissolved ^{230}Th concentrations range from 0.25 to 1.46 dpm/1000L for filtered samples. Dissolved ^{232}Th concentrations are low and range from 0.002 to 0.007 dpm/1000 L for filtered samples. While concentrations of ^{230}Th are slightly higher in the unfiltered samples, ^{232}Th concentrations are ususally much higher in the unfiltered samples (up to 170% higher), compared to those concentrations in the filtered samples. The greatest differences between filtered and unfiltered Th concentrations occur in the bottommost samples. Our preliminary results also indicate that that there is a concentration gradient along the transect—higher concentrations of ^{230}Th are found in the low-particle-flux Peru Basin while very low concentrations of ^{230}Th have been determined in profiles closer to the Panama Basin. Like the ^{230}Th data, the ^{232}Th concentrations are highest the further south in the transect. However, in contrast to the ^{230}Th concentrations, there is little structure in the ^{232}Th concentrations, which vary little with depth.