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# Do $^{226}Ra$-$^{230}Th$ Isochrons Provide Realistic Crystallization Ages?

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In this contribution we investigate the timescales of melt evolution and crystal growth in the Mt Erebus magmatic system using measurements of $^{238}U$-$^{230}Th$-$^{226}Ra$-$^{210}Pb$-$^{210}Po$ and $^{232}Th$-$^{228}Ra$-$^{228}Th$. 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 $^{226}Ra/^{230}Th$ disquilibria. In all samples, $^{210}Pb/^{226}Ra$ are in secular equilibrium for both phases. 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. For the 2005 bomb, whose eruption date is known explicitly, $^{210}Po$ was not completely degassed. In-situ ion probe measurements of Ba and Th in the anorthoclase and phonolite glass show that our anortholase and phonolite glass separates are pure with regard to $^{226}Ra/^{230}Th$ systematics. Instantaneous crystal fractionation, with long magma residence time (> 100 years, < 3 kyrs, depending on $D_{Ba}/D_{Ra}$), can account for the $^{238}U$-$^{230}Th$-$^{226}Ra$-$^{210}Pb$ 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 a continuous crystallization model, which incorporates both nuclide in-growth and decay during crystallization. Our model can successfully reproduce all of the measured $^{238}U$- 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.