Goldschmidt 2021 Abstract
https://doi.org/10.7185/gold2021.3562

The Complicating Influence of Source Variability on the Applicability of U-Th-Ra Disequilibria as a Simple Chronometer of Deep Fluid Addition During Magma Genesis: A Case Study from the Eastern Lau Spreading Center

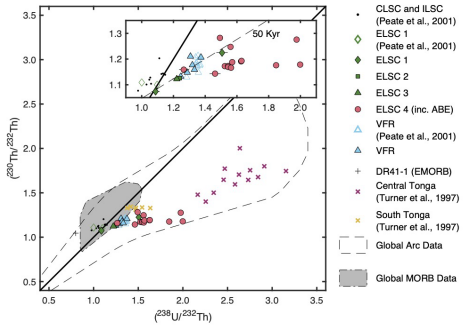
LISA B KANT[1], KENNETH WW SIMS[1], CHARLES LANGMUIR[2], JARED J STANDISH[3] AND PETER J MICHAEL[4]

[1]University of Wyoming
[2]Harvard
[3]University of Minnesota
[4]University of Tulsa

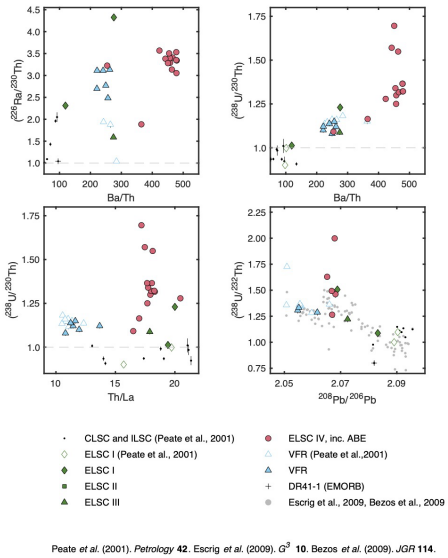
Presenting Author: lkant@uwyo.edu

In arc lavas, correlation between ($^{238}U/^{230}Th$) and Ba/Th suggest that U enrichment reflects recent fluid addition. Positively sloped linear arrays on the ($^{230}Th/^{232}Th$) vs ($^{238}U/^{232}Th$) equiline diagram are often treated as isochrons with slopes that suggest 10-80 Kyr elapsed since metasomatism. However, this interpretation assumes that 1) the slab component is U-rich fluid with negligible Th and 2) the mantle wedge has constant ($^{238}U/^{232}Th$). If either assumption is false, the time-significance of these arrays becomes less clear. Additionally, timescales given by ($^{238}U/^{230}Th$) conflict with those of ($^{226}Ra/^{230}Th$), which suggest fluid addition occurred within 10 Kyr. Although previous studies proposed explanations that reconcile these timescales [1], further research is needed. To examine this problem, we measured ^{238}U-series disequilibria in Eastern Lau Spreading Center samples (ELSC, 19.4-22.6°S). Excluding samples from ELSC-IV (20.8-21.1°S), which have distinct ^{238}U-^{230}Th systematics, the data form a positively sloped array in ($^{238}U/^{232}Th$) vs ($^{230}Th/^{232}Th$) space, which could be interpreted as a 50 Kyr isochron. ($^{238}U/^{230}Th$) correlates well with Ba/Th, whereas ($^{226}Ra/^{230}Th$) correlates weakly, suggesting fluid enrichment influences ^{238}U-^{230}Th-^{226}Ra disequilibria. Arc-ridge distance also effects ($^{238}U/^{230}Th$). Since the ELSC axis is oblique to the Tonga arc, distance between the two increases from 35-100 km moving S-N. This is reflected in northward decreasing ($^{238}U/^{230}Th$), ($^{238}U/^{232}Th$) and Ba/Th, and a transition from ($^{238}U/^{230}Th$) > 1 to ($^{238}U/^{230}Th$) < 1 at ~19.5°S between the ELSC and the CLSC [2]. While ($^{226}Ra/^{230}Th$) disequilibria suggest that fluid addition occurred within 10 Kyr, ($^{238}U/^{230}Th$) disequilibria suggest that ~50 Kyr has passed. However, other factors besides fluid addition have influenced ($^{238}U/^{230}Th$) systematics. For instance, ($^{238}U/^{232}Th$) and $^{208}Pb/^{206}Pb$ are negatively correlated, indicating long-term ($^{238}U/^{232}Th$) heterogeneity in the mantle. Additionally, trends between ($^{238}U/^{230}Th$) and trace element ratios such as Th/La indicate that the slab component varies from N-S, and that volcanoclastic sediments influence ^{238}U-^{230}Th systematics in the southern ELSC. Consequently, the observed ($^{230}Th/^{232}Th$) vs. ($^{238}U/^{232}Th$) array is not a true isochron, and thus caution is warranted when using ($^{238}U/^{230}Th$) and ($^{226}Ra/^{230}Th$) as chronometers of fluid addition during arc magmatism.

[1] Turner *et al.* (2000). *EPSL* **179**. [2] Escrig et al. (2009). *G*^{3} **10**.



Turner *et al.* (1997). *GCA* **61**. Peate *et al.*, (2001). *Petrology* **42**.



Peate *et al.* (2001). *Petrology* **42**. Escrig *et al.* (2009). *G*^{3} **10**. Bezos *et al.* (2009). *JGR* **114**.