Are U-series disequilibria in arc lavas inherited from subducted slabs or from in-growth mantle melting?

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^{238}U-^{230}Th-^{226}Ra and ^{235}U-^{231}Pa disequilibria in arc lavas provide a unique tool to constrain the time-scale of material transferring from the subducted slabs to the mantle wedge and crust. There is an increasing consensus on observations of U-series disequilibria in arc lavas. Most young arc lavas have ($^{231}Pa/^{235}U$) and ($^{226}Ra/^{230}Th$) > 1; majority of young lavas have ($^{238}U/^{230}Th$) > 1, while about one-third samples have ^{230}Th excess. However, the origin of the disequilibria is still in debate with two main groups of models. First, U-series disequilibria are inherited from the subducted materials added to the mantle wedge (e.g. [1,2]), implying that the transfer time-scale is strictly within several $\tau_{1/2}$ of short-lived nuclides; and second, U-series disequilibria may reflect a long in-growth process during mantle melting [3,4].

In this talk, I will present a critical reappraisal on these two models. The inheritage model assumes that residual minerals can hold some U-series nuclides relative to the others during dehydration and partial melting of the subducted slab, producing U-series diseqilibria in hydrous fluids or sedimentary melts. However, there are difficulties to account for disequilibria between different parent-daughter pairs in a self-consistent scenario. On the other hand, the in-growth model emphasizes the "in-growth" of short-lived nuclides in melting. This model is complicated by the varible fO_2, partition coefficients, subduction rates, melting rates, and porosities in the mantle wedge of global subduction zones, requiring more studies on geophysics, experimental petrology, and U-series analyses for primitive lavas. Finally, the correlations between U-series disequilibria and other geochemical data (such as Sr/Th and Ba/Th) have been used to understand the source effect on U-series disequilibria. However, such correlations are more likely to be produced by magma differentiation in the crustal level instead of the source effect, because most arc lavas are highly evolved.

[1] Turner *et al* (2003) Rev. Mineral. Geochem. ***52***, 255–315. [2] Avanzinelli *et al* (2012) GCA ***92***, 308-328. [3] Huang *et al* (2011) GCA ***75***, 195-212. [4] Reubi *et al* (2011) EPSL ***303***, 37-47.