A flux-ingrowth model for melt generation in mantle wedges

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Observations of U-series isotopes (U-Th-Pa-Ra) and trace element systematics of arc lavas suggest the following generalizations about the source regions of arc lavas: (1) Lavas with high ($^{226}Ra/^{230}Th$) derive from sources that have experienced substantial addition of a slab component (as evidenced by Ba/Th), which is younger than 8 kyr. (2) Sources with greater added slab component partially melt to a greater extent (3) ($^{231}Pa/^{235}U$) ratios >1 suggest that melts separate from the wedge at low porosities and that melt extraction from wedge sources occurs over time scales that are long relative to the half-life of ^{231}Pa (33 kyr). (4) Increasing ($^{231}Pa/^{230}Th$) with increasing indices of slab component suggest that more daughter ingrowth occurs in strongly-fluxed sources.

There are a number of puzzling features to these observations. The time scale of fluid transit from the slab to the surface is much shorter than the time needed to explain ingrowth of ^{231}Pa during melting of the wedge. Also, young slab signatures occur in lavas with large slab components and by inference, large extents of melting in their wedge source, which might otherwise be assumed to require longer residence in the wedge. For example, models invoking upwelling to explain melting (and ingrowth of ^{231}Pa) do not produce significant extents of melting on time scales similar to the half-life of ^{226}Ra.

To reconcile these observations, we propose a flux-ingrowth model, which has the following features: (1) peridotite transits through the source region of arc lavas over a long time interval, moved by corner flow in the wedge. (2) slab-derived fluid is added to all parts of the source, leading to partial melting and rapid melt extraction. Parcels of peridotite that have only recently entered the source produce liquids with small slab signatures, low apparent extents of melting, and relatively little ingrown ^{231}Pa, and the inverse is true for parcels that have resided in the source for longer intervals. (3) erupted lavas represent partial integrations of melts derived from sources that have experienced a range of fluid addition and extents of partial melting.

This model may be non-unique, but if it is accurate, it has the following implications: (1) Flux melting dominates over decompression melting in mantle wedges. (2) Rapid delivery of slab components means that fluid migration dominates over mechanisms involving hydration/dehydration of hydrous silicates. (3) U-series isotopes of arc lavas are governed by the superposition two time scales – a rapid fluid and melt transport time and a very slow transit time of residual peridotite through the partially molten portion of the wedge.

Mercury pollution in the Thur river basin (North-East of France): DOC and chloride concentration control on mercury partitioning between dissolved and particulate phases

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The Thur river has historically been a site contaminated by mercury, mainly due to a factory producing chlor-alkali chemicals.

River water and suspended matters have been collected in the main channel at 11 stations from upstream to downstream during low (September 2001) and high (March 2002) water periods. Mercury was measured by CVAFS, major cations by AAS, major anions by IC and DOC by combustion at 550°C and CO_2 detection.

The concentrations of total dissolved mercury ranged from 3×10^{-1} ng.l^{-1} in the unpolluted part of the river to 1.1×10^2 ng.l^{-1} in the contaminated river waters and the concentrations of particulate mercury ranged from 0.2 µg.g^{-1} to 23.5 µg.g^{-1}.

Then, we calculated a mercury partitioning coefficient (K_d^{Hg}) between dissolved and particulate phases for all samples collected during the study. The behavior of mercury during low and high water periods was different. Upstream the chemical plant, K_d^{Hg} was higher during the high water. On the contrary, downstream the chemical plant, K_d^{Hg} was higher during the low water period. The different K_d variations that could be observed on both sides of the factory could be explained by DOC and chloride concentration controls. K_d^{Hg} increases with DOC content downstream the pollution point particularly during the low waters, showing that Hg complexing capacity of DOC increases. In the same way, K_d^{Hg} increases, going downstream, when the chloride concentrations increase, showing Hg desorption from the suspended matters to the solution.