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^{238}U-^{234}U-^{230}Th-^{226}Ra and ^{235}U-^{231}Pa Radioactive Disequilibria in Volcanic Rocks from Kamchatka, Russia

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Subduction zones are a geodynamical setting of major interest for two main reasons: firstly, it is where actual continental crust grows; secondly, at subduction zones, materials that have interacted with the outer reservoirs of the Earth are recycled into the inner parts of our planet. The study of radioactive disequilibria in subduction zones allows us to give time constraints on the processes occurring beneath the volcanic arc and to determine the degree of elemental fractionation they involve. The ^{238}U-^{230}Th isotope disequilibria record U-Th fractionation on time scales <350ka. As U is highly mobile in fluids while Th is immobile, ^{238}U excesses in arc lavas are usually interpreted as slab-derived fluid addition to the mantle wedge, which is commonly believed to be the source of arc lavas. The time scales for ^{230}Th-^{226}Ra couple is much lower, around 6ka. Origins of ^{226}Ra excesses compared to ^{230}Th in arc lavas are thought to be derived either from partial melting or from slab-derived fluid (since Ra is highly mobile too). The present study focuses on the Kamchatka arc because of the low amount of subducted sediments (ca. 1%wt) (Turner et al., 1998). We analysed basalts and basic andesites from historical eruptions. All the samples were taken from three volcanoes located in the Central Kamchatka Depression: Bezymianny, Kliouchevskoi and Tolbachik.

^{238}U-^{230}Th is around secular equilibrium (as shown by Turner et al., 1998), displaying 10% deficit to 17% excess of ^{238}U relative to ^{230}Th (activity ratio ($^{238}U/^{230}Th$) ranging from 0.90 to 1.17). ^{226}Ra shows from 8% deficit to 215% excess. ($^{234}U/^{238}U$) is close to secular equilibrium values, ranging from 0.98 to 1.01. Finally, preliminary results for ($^{231}Pa/^{235}U$) ratio indicate excess ^{231}Pa relative to ^{235}U ranging from 20 to 70%, comparable to those observed for the Kermadec arc (Bourdon et al., 1999).

It is unlikely that ^{238}U-^{230}Th and ^{230}Th-^{226}Ra radioactive disequilibria could have been generated by the same process (i.e. fluid addition) because the first couple shows that the last fluid addition is older than 150ka whereas the latter indicates a fluid addition younger than 8ka. Results on ^{238}U-^{234}U suggest that ^{226}Ra excesses are not due to surficial processes. Similarly, high ^{226}Ra for high MgO rocks indicates the fractional crystallisation cannot explain ^{226}Ra data nor can partial melting because of high ($^{226}Ra/^{230}Th$) for low Th/Sm rocks. To reconcile ($^{238}U/^{230}Th$) and ($^{226}Ra/^{230}Th$) ratios, we propose a model including at least two stages of fluid addition to the mantle wedge. The first stage occurred some 150ka ago and involves a transfer of U and Ra to the mantle wedge. During the second stage, only ^{226}Ra which is produced in the slab by decay of ^{230}Th, is added to the mantle wedge. An implication of this model is that the time span between fluid transfer and eruption of magmas at surface must have been much less than 8,000 years.

^{231}Pa excesses are observed in both mid-ocean ridges and ocean islands basalts. They are associated with ^{230}Th excesses and such disequilibria are thought to represent Pa-U fractionation during partial melting in the presence of residual clinopyroxene ±garnet. Since ($^{230}Th/^{238}U$) activity ratios imply around 150,000 years since fluid addition, ^{231}Pa excesses must be related to the melting process. Over such a time scale, any ^{235}U excess relative to ^{231}Pa would have disappeared. Thus, this particularity makes Kamchatka an ideal location for looking at melting processes using 231Pa-^{235}U disequilibria.

Turner S, McDermott F, Hawkesworth C & Kepezhinskas P, *Contrib.Mineral.Petrol.*, **133**, 217-234, (1998).

Bourdon B, Turner S & Allègre C, *Science*, **286**, 2491-2493, (1999).