5.3.18

Is the slab component in arc magmas produced by fluid-induced eclogitisation of subducted lower oceanic crust?

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Closely associated gabbros and eclogites represent relics of subducted lower oceanic crust within a *ca*. 200 km long Proterozoic suture zone in central Zambia. Gradual stages of the prograde gabbro-to-eclogite transformation are preserved by disequilibrium textures of incomplete reactions. No evidence for prograde blueschist- or amphibolite-facies mineral assemblages was found in the eclogites. Instead, fine-grained intergrowths of eclogite-facies minerals replacing plagioclase indicate the direct eclogitisation of gabbroic precursors. Eclogitisation occurred at 630-690°C and 2.6-2.8 GPa and was accompanied by a channelised fluid flow that produced veins of the peak metamorphic assemblage. Although all of the mafic rocks were subducted, only the gabbros infiltrated by fluid were eclogitised. The eclogites and their veins thus represent relict fluid pathways through subducted oceanic crust, providing direct evidence of channelised fluid flow within a slab.

The mafic rocks have MORB-like trace element and initial Nd and Hf isotope compositions. In some *eclogites* however, the LREE have been strongly fractionated from the HFSE and HREE, an effect that cannot be of magmatic origin but must have occurred during metamorphism. Garnet-whole rock ages based on the Sm-Nd (relatively mobile) and Lu-Hf (relatively immobile) isotope systems are identical within error, suggesting, in conjunction with the petrological evidence described above, that the LREE were fractionated *during* eclogitisation. Eclogitisation was limited by fluid availability, and the flow of fluids through the rock is the most likely mechanism of LREE fractionation. Fluid-rock ratios reveal that the fractionated rocks reacted with an amount of fluid up to 80% of their mass to create the most depleted REE patterns. The lower gabbroic part of the oceanic crust is an unlikely source for such a large volume of fluid and thus we hypothesise that the fluid originated in the underlying serpentinised lithospheric mantle. If this LREE-rich, HFSE+HREE-poor slab fluid reaches the zone of partial melting in the mantle wedge, it may contribute significantly to the arc signature. We speculate whether this process (i.e., trace element mobilisation during fluid-induced eclogitisation) could be generally responsible for producing the slab component in arc magmas.

5.3.21

The role of fluids in an adakitic volcano: Constraints from U-series in lavas of Guagua Pichincha (Ecuador)

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Adakites are geochemically well defined and thought to represent magmas resulting from melting of young (<25Ma) subducted oceanic crust. They often have ($^{238}U/^{230}Th$) < 1 due to the fact that eclogitic residue will retain uranium more than thorium during partial melting of a metabasaltic crust. However, it is not clear if all adakites have ^{230}Th excess over ^{238}U.

We studied radioactive disequilibria of historical lavas (between 550 and 2000 AD) from the Guagua Pichincha, an Ecuadorian stratovolcano located near the capital city Quito in the NVZ (Northern Volcanic Zone) related to the subduction of the Nazca plate, under the influence of the Carnegie ridge. Major and trace elements indicate that this volcano erupts adakitic lavas (high MgO dacites showing, for example, elevated La/Yb ratios (up to 18)).

The historical lavas show 9% variations in ($^{230}Th/^{232}Th$) and 11% in ($^{238}U/^{230}Th$) and ^{226}Ra-^{230}Th disequilibria (all mesured by TIMS). All lavas have excess of ^{238}U that increases toward present. Moreover a strong linear correlation exists between ($^{238}U/^{232}Th$) and ($^{230}Th/^{232}Th$) in the lavas similar to what is observed in normal volcanic arcs lavas. These observations indicate that the ^{238}U-excesses most likely reflect a stronger role played by fluids than by melts of subducted crust during magma genesis. The fluid contribution vary with time and is the most important in products of the 2000 AD eruption. Furthermore these results suggest that adakites are not only formed by melting of oceanic basaltic crust but could result from a combination of processes. In the case of Guagua Pichincha, the lavas appear to be generated from fluid-induced flux melting of metasomatised mantle wedge (by adakitic melt and fluids from the slab, rich in mobile elements) and that the magma so formed quickly reach the surface (<8000 y) as indicated by Ra-Th disequilibria.