Geophysical Research Abstracts, Vol. 7, 06350, 2005
SRef-ID: 1607-7962/gra/EGU05-A-06350

Intracrustal Nb/Ta Fractionation in Island Arcs due to Dehydration Melting of Hornblende-bearing Plutonics: Evidence from the Kohistan Paleo-island Arc Complex (N. Pakistan)

C. J. Garrido (1) and J.-L.Bodinier (2)

(1) Departamento de Mineralogía y Petrología, Universidad de Granada, 18002, Granada, Spain (carlosg@ugr.es), (2) Laboratoire de Tectonophysique, ISTEEM, CNRS-Université de Montpellier 2, Montpellier, France.

The main contribution to Earth Continental Crust growth during the Phanerozoic is the accretion of oceanic island arcs to continents at convergent plate settings. Continental Crust is characterized by silica-rich composition similar to andesite and subcondritic Nb/Ta ratios (12.8). Magma erupted in modern island arcs, however, have a basaltic composition and display higher Nb/Ta ratios (15.8) in the range of oceanic basalts (MORB & OIB). If the initial bulk composition of the island arc crust is basaltic, genesis of Continental Crust via arc volcanism implies the operation of some intracrustal differentiation mechanism. One possibility is that the upper-middle arc crust evolves toward an andesitic composition due to igneous processes such as crystal fractionation or partial melting of basaltic crust, leaving dense cumulitic or restitic mafic rocks in the lower crust. Delamination of dense crustal roots would drive the composition of island arcs crust towards that of the andesitic Continental Crust.

The Kohistan paleo-island arc complex (N. Pakistan) comprises a complete sequence of an island arc and therefore is an ideal place to asses the differentiation-delamination hypothesis. The lower crust of the Kohistan paleo-island arc terrain is exposed along the Indus River (Kohistan Complex, N. Pakistan) and is constituted by the Jijal and Sarangar complexes. The Jijal section is composed of basal ultramafic tectonites topped by a gabbroic section of mafic garnet granulite, locally interbedded with lenses of garnet-pyroxene hornblendite, grading upward to hornblende-gabbronorite. Sarangar complex is mainly composed of metagabbros and minor metadiorites. The

Jijal hornblende-gabbronorite and Sarangar metagabbros have a melt-like plutonic composition resembling that of island arc basalts and basaltic andesites. Field, petrographic and geochemical evidence indicate that Jijal garnet granulite are restites produced by dehydration melting of a source similar to Jijal hornblende-gabbronorite and Sarangar metagabbro accompanied by variable extraction of hydrous granitic melts. These granitic melts intruded the upper level of the paleo-island arc and are now represented by intrusive leucogranites in the overlying Metaplutonic complex. The Jijal and Sarangar gabbroics, along with the intrusive granites, record intracrustal differentiation process whereby a dominantly basaltic juvenile arc crust evolves towards more acidic and highly-incompatible enriched composition akin to Continental Crust, leaving a dense restitic root of garnet granulite.

Restitic garnet granulites, gabbros and granites define altogether a negative covariation of Nb/Ta versus Th/La with three end-members: a) the garnet granulites and garnet-pyroxene hornblendites depleted in Highly Incompatible Elements (HIE) (Th/La < 0.02) and characterized by superchondritic Nb/Ta ratios (16-30). Similar suprachondritic Nb/Ta values are observed in our compilation of lower continental crust garnet granulite xenoliths; b) the garnet-free gabbros from Jijal and Sarangar showing Nb/Ta ratios ($13 <$ Nb/Ta < 18) with a similar variation to island arc basalts, although they tend to be more depleted in HIE ($0.02 <$ Th/La < 0.10) than island arc basalts; and c) intrusive granites in the upper levels of the Metaplutonic complex that are characterized by both superchondritic Th/La (> 0.1) and subchondritic, though variable, Nb/Ta ratios. Some granites are distinguished by particularly low Nb/Ta values (down to 9) comparable to those for the average Upper Continental Crust.

Kohistan results show that dehydration melting of amphibole-bearing lower arc basaltic plutonics with initial Nb/Ta ratios similar to island arc basalts resulted in intracrustal differentiation of the island arc crust leaving a dense restitic garnet granulite root with a suprachondritic Nb/Ta ratio. Extraction of small fractions of granitic melts generated by dehydration melting of these plutonics lead to a progressive enrichment of Th, U and LILE and decreasing Nb/Ta ratios in the uppermost levels of the island arc crust. Intracrustal differentiation by dehydration melting is hence a potential mechanism accounting for the maturation of basaltic island arcs towards the silica-rich and subchondritic Nb/Ta composition of the Continental Crust.