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Taapaca Volcanic Complex (North Chile) versus El Misti volcano (South Peru) distinct evolution of two CVZ volcanoes and a comparison based on U-series isotopes

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Taapaca volcano (North Chile) and El Misti (South Peru) of the Central Andean Volcanic Zone (CVZ) have been studied in order to place constraints on the evolution of their distinct magmatic systems. Taapaca is along-lived dome cluster (3,7 Ma to Holocene, Wörner et al., 2004; Clavero et al., 2004), which erupted magmas ranging between 60 and 71 wt%. However, the large majority (69%) of samples fall into the narrow range of 63 to 67wt% SiO2. By contrast, the composition of El Misti magmas shows a wider range between 58-68 wt% SiO2.

Eruption rates at El Misti volcano are of 0.63-0.75m3/a based on a volume of 70-83km3 and an age for the main stratocone of 112 ka (Thouret et al., 2000). Taapaca erupted 95km3 magma at a rate of 0,026m3/a during the 3.7 Ma maximum age of Taapaca (Wörner et al, 2004a).

The two distinct volcanic systems are also very different in their U-Th disequilibria measured by TIMS. In fact, Th/U isotopic compositions of the Taapaca and El Misti volcanoes define the end members of the whole of CVZ: El Misti volcanics have very low (230Th/232Th) activity ratios of 0.32-0.40, possibly the lowest ever measured in volcanic rocks. (230Th/232Th) at Taapaca is 1.0-1.32 and at the upper bound of CVZ rocks (Wörner et al, 2004b). El Misti volcanics are also 238U enriched with surprisingly high values of (238U/230Th) of up to 1.6 for El Misti samples, the highest measured in the CVZ. Samples of the "slower" Taapaca system all fall close to the equiline with (238U/230Th) =0.97-1.0.

Radiogenic Sr- and Nd-isotopic compositions are slightly higher for El Misti

(87Sr/86Sr of 0.7075-0,70779 than for Taapaca (0,7063-0,7067). Pb istotopic compositions are different, most likely reflecting the composition of assimilated continental crust (e.g. 206Pb/204Pb = 17.68 -17.84 for El Misti and 18.10 for Taapaca).

These radiogenic isotopes suggest that both, Misti and Taapaca magmas suffered significant (up to 20%) of assimilation during passage through 70 km of continental crust. Taapaca volcano evolved over a long time and this is also shown in the absence of significant U-series disequilibria even in the youngest rocks. This suggests that the system remained undisturbed with respect to U/Th for up to 350 ka and potential 238U enrichment from fluid addition to the source has decayed away during magma ascent and evolution. Taapaca is thus a "slow" system where magma evolution may take more than hundred thousand years. In this respect, it is similar to the Parinacota "Old Cone" (Bourdon et al., 2000). Considering the thickness of the crust, it is surprising to still see 35 % of U-isotopic enrichment in Misti lavas that usually is attributed in arc volcanism to slab-fluids in the mantle wedge. Apparently, melting, ascent, assimilation and eruption all occurred in a relatively short time of 30 to 60 ka as estimated from U-series isotopes. In this respect, El Misti is similar to the Parinacota "Young Cone" (Bourdon et al., 2000).

The difference in U-Th isotopic compositions and thus the rates and styles of magma evolution between these two Andean volcanic centers can have several reasons :

Magma production rate in the mantle, depth of magma evolution and thermal contrast to surrounding rocks and composition of the local crust may play a role. Structures and stress in the crustal basement could be also control why in one case the magma ascends more easily and rapidly, resulting in frequent magma mixing events and a large range of erupted compositions at El Misti or whether magma is stored and evolves at depth in relatively undisturbed reservoirs for longer time (Taapaca).

Bourdon B, Wörner G, Zindler A (2000) U-series evidence for crustal involvement and magma residence times in the petrogenesis of Parinacota Volcano, Chile. Contrib Mineral Petrol 139, 4, 458-469.

Clavero JE, Sparks RSE, Pringle MS, Polanco E, Gardeweg MC (2004) Evolution and volcanic hazard of Taapaca Volcanic Complex, Central Andes of Northern Chile. J Geol Soc London 161: 603-618.

Hora J, Singer B, Wörner G (2004) Eruptive flux during periods of cone growth and collapse at Volcan Parinacota, Chilean CVZ based on high-resolution eruptive chronology using 40Ar/39Ar dating. IAVCEI conference, Nov.15 - 19, Pucon Chile.

Wörner G, Wegner W, Kiebala A, Singer B, Heumann A, Kronz A, Hora J (2004a) Evolution of Taapaca Volcano, N. Chile, evidence from major and trace elements,

Sr-, Nd-, Pb-, and U-series isotopes, age dating and chemical zoning in sanidine megacrysts. IAVCEI conference Nov.15 - 19, Pucon Chile.

Wörner G, Mamani M, Mercier R, Kilian R (2004b) Geochemistry, radiogenic and U-series isotopes in Andean magmas: crustal assimilation and adakite-like magmatism in the Central and Southern Andes. IAVCEI conference Nov.15 - 19, Pucon Chile.