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Nevado de Longaví Volcano (Chilean Andes, 36.2 ˚S): adakitic magmas formed by crystal fractionation from hydrous basalts

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The formation of adakites by partial melting of oceanic lithosphere is limited to regions where young, hot slabs are subducted. Adakitic melts also occur in continental arcs related to subduction of cold oceanic lithosphere, where they have been explained in terms of remelting of basaltic material underplated at the base of thickened orogenic crust (e.g., Petford *et al*., 1996; Kay and Mpodozis, 2002) or as the result of modification of the sub-arc mantle related to tectonic erosion of the forearc crust (e.g. Kay *et al*., 2004 in press). The only occurrence of Quaternary magmas in the accessible Andean Southern Volcanic Zone (SVZ 33-41˚ S) with an unequivocal adakitic signature is at Nevado de Longaví (NLV; 36˚12'S – 71˚10' W; Sellés *et al.* 2004), which is located to the south of the region that has been strongly affected by Tertiary crustal shortening and thickening, and associated eastward arc migration. We propose that the generation of adakitic melts at NLV has occurred via fractional crystallization of water-rich basalts. The unusual chemistry and unusually high modal abundance of hornblende in dacitic magmas at NLV appears to be ultimately related to an exceptionally high fluid-flux from the subducted Mocha Fracture Zone (Eocene-age Nazca plate), which projects beneath NLV, and which is inferred to have generated water-rich but incompatible element-poor basalts through flux-melting.

NLV is a mainly andesitic late Quaternary edifice whose magmatic suite progressively diverges from early basalts and basaltic andesites towards adakitic Holocene dacites (63-65 wt% SiO_2), which are the youngest, most evolved, and oxidized (NNO+1.7) magmas preserved at this edifice. Although the mafic lavas at NLV have concentrations of K_2O and incompatible trace elements within the 'low-normal' range for this arc, increasingly evolved magmas define a trend that diverges from the SVZ compositional field in two ways: (1) K_2O and incompatible trace elements increase at much lower rates than are observed at other SVZ volcanoes, and (2) Y and HREE concentrations decrease with increasing SiO_2. Both trends are inconsistent with assimilation of upper crust. However, high Ba/Th and Pb/Th relative to other SVZ centers, and unusually high B (19-55 ppm), are consistent with important slab-derived fluid contributions. The NLV adakitic dacites have high Sr ($\sim$590 ppm) and Sr/Y ($\sim$70), indicative of suppression of plagioclase crystallization combined with the fractionation of phases for which Y and HREE are compatible. This chemical signature is associated with high modal abundances of amphibole, and the absence of clinopyroxene, in the most evolved products. The major-element differentiation path from wet mafic magmas to dacites is well modeled by 50% fractionation of an assemblage consisting of: 0.5 Hbl + 0.37 Plag + 0.07 Opx + 0.03 Aug + 0.03 Mgt. Early fractionation of minor garnet + apatite is necessary to account for decreased abundances of HREE and Y. This combination of fractionating phases explains the observed Y+HREE depletions in NLV andesites and dacites relative to mafic magmas, as well as minimal enrichments in elements that are incompatible relative to anhydrous silicates. Fractional crystallization from water-rich magmas is independently supported by abundant amphibole-rich cumulate xenoliths throughout the volcano, and amphibole-rich mafic enclaves in Holocene dacites. The feasibility of such a model for a crustal thickness of 35-40 km is supported by experimental results on water-saturated arc-basalt melts (e.g. Grove *et al.*, 1997; Müentener *et al.*, 2001; Grove *et al.*, 2003; Ulmer *et al*. 2003). This model may be broadly applicable to some cases of adakites in cold-subduction environments.

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