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Primary Liquid Composition in Continental Collisional Setting: Inferences from the Adamello and Val Masino-Bregaglia Intrusions (Central Alps)

Massimo Tiepolo (tiepolo@crystal.unipv.it)[1], **Riccardo Tribuzio** (tribuzio@crystal.unipv.it)[1], **Piero Bottazzi** (bottazzi@crystal.unipv.it)[2] & **Riccardo Vannucci** (vannucci@crystal.unipv.it)[1]

[1] Dip. Scienze della Terra, Università di Pavia, via Ferrata 1, Pavia, Italy
[2] CNR-CSCC, via Ferrata 1, Pavia, Italy

The nature of primary melts in continental collisional settings is still poorly understood due to the extensive differentiation processes (e.g., fractional crystallisation or crustal assimilation) they usually undergo on route to the surface. Small bodies of amphibole-rich intrusives, mainly hornblendites and Amph-gabbros, considered as the least differentiated intrusive magmatic products, are occasionally associated with diorite-tonalite suites. These mafic and ultramafic intrusives may allow the composition of primary melts to be determined. Amphibole-rich mafic and ultramafic rocks (mainly hornblendites and amphibole gabbros) from the Tertiary calc-alkaline Adamello and Val Masino-Bregaglia intrusions of the Alps were taken into account. On the basis of Nd-Sr-O isotopic investigations, it was argued that these rocks crystallised from uncontaminated mantle melts (von Blanckenburg et al., 1992). Hornblendites and amphibole gabbros were collected in the well-known outcrops of Monte Mattoni and Cornone di Blumone in the Adamello, and of Val Sissone in the Val Masino-Bregaglia. As a whole the selected rocks have mafic phases with high mg# (e.g., Fo content in olivine is up to 84 mol%). In order to determine the chemical composition of the Adamello and Val Masino-Bregaglia primary melts, a detailed micro-analytical investigation of the trace element composition of the early crystallising minerals (Ti-rich amphibole and its clinopyroxene inclusions) was performed by means of secondary ion mass spectrometry (SIMS) and laser ablation microprobe - inductively coupled plasma - mass spectrometer (LAM-ICP-MS). The coupling of these analytical techniques allowed us to determine a great number of trace element (light and volatile elements, large ion lithophile elements, rare earth elements, high field strength elements and heavy elements) all relevant in deciphering petrological processes. The application of new set of amphibole/liquid partition coefficients (Tiepolo, 1999) experimentally determined at P, T and X conditions close to those inferred for the crystallisation of the studied rocks, allowed us to calculate the trace element composition of equilibrium liquids for the same number of elements. Calculated liquids for mafic and ultramafic rocks from both Monte Mattoni and Cornone di Blumone are nearly coincident and are characterised by a slight LREE enrichment and nearly flat HREE. Ba, K, Rb, Th and U are markedly enriched relative to REE and HSFE. A pronounced positive Sr anomaly is moreover evident, whereas Nb and Ta do not show significant depletion relative to REE. Calculated liquids from Val Masino-Bregaglia rocks commonly display a nearly flat REE pattern. Similarly to the Adamello primary melts, LILE are abruptly enriched (up to 90 times N-MORB) relative to REE and HFSE, and no significant Nb and Ta negative anomalies are observed. Peculiar of the Val Masino-Bregaglia liquids are the U enrichment relative to Th (up to 2.3 times), the Rb enrichment relative to Ba and the abrupt B enrichment relative to Be. The nearly flat HREE pattern of calculated liquids points against the presence of garnet in the melting assemblage, thus arguing for a spinel-facies peridotite source. When compared with typical calc-alkaline melts from oceanic arc, calculated liquids differ in the absence of Nb and Ta negative anomalies, thus ruling out the presence of buffering phases in the source region. In both Adamello and Val Masino-Bregaglia primary liquids a component derived from the subducted slab can be clearly identified. The extremely high LILE/REE values agree with a melting process occurring in the mantle wedge as a result of interaction of the mantle source with aqueous, LILE-enriched, slab-derived fluids. This process is supported by the high amphibole mode in these rocks, which imply a relatively high amount of H_2O in the primary melt. The differences in the light element, LREE and LILE signature of primary liquids from Adamello and Val Masino-Bregaglia suggest that the mantle sources interacted with different slab-derived fluids. The higher B/Be and Rb/Ba ratios of the Val Masino-Bregaglia primary melts agree with a mantle source metasomatised by fluids either released by subducted oceanic crust at shallower depth relative to those of Adamello or released by continental crust.

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