Geochemistry of melange formation: Identifying contributions from mechanical and metasomatic mixing

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Models for the geochemistry of arc volcanic rocks and geochemical cycling through subduction zones are substantially hampered by the unknown variables that affect subducted lithologies deep within subduction zones. While inferences regarding apparent element mobility or retention during slab metamorphism have been made from indirect sources (i.e., arc volcanic suites), comparatively little direct evidence exists regarding the geochemical evolution of melange. To address the dual effects of mechanical and metasomatic mixing in the production of melange geochemistry, we are developing trace element and Li-B-Sr-Nd-Pb isotopic data for melange matrix at a variety of metamorphic grades from a well-characterized subduction complex, the Catalina Schist, CA, USA.

Field relations, petrology, and major-element geochemisty for amphibolite-facies melange matrix from the Catalina Schist indicate mixing of mafic and ultramafic components, with negligible evidence for mechanical incorporation of sediments (Bebout and Barton, 2002). We model trace element contributions using a binary mixing model assuming Yb and Lu are fluid-immobile reference frame elements. "Residual" compositions for other trace elements predicted by the mixing model then ideally reflect the enrichment or depletion of trace elements in the melange by fluid flow. Residual compositions indicate overall depletion for Cs, Rb, B, Zr, and Hf, yet enrichment for Ba, Sr, Li, U, Th, Pb, Nb, and Ta, suggesting decoupling of traditional geochemical groups within melange zones. Positive REE residuals smoothly decrease in normalized concentration from LREE to HREE, consistent with higher LREE partitioning in fluids. While NMORB-normalized trace element concentrations range from <0.01 to ~1, $[La/Yb]_N$, Th/Yb, and Nb/Ta ratios for the melange matrix (as well as metasomatic rinds on mafic blocks in melange; Sorensen and Grossman, 1989) appear to reflect the influence of a fluid derived from or equilibrated with sediments, in agreement with existing $\delta^{18}O$ and δD data (Bebout, 1991).

References

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Reconstruction of lake levels and recharge altitude by atmospheric noble gases

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Since more than two decades dissolved atmospheric noble gases (daNG) in waters have been successfully used to reconstruct the environmental conditions prevailing gas/water partitioning. The physical conditions control-ling gas exchange determine the abundance of dissolved atmospheric noble gases via Henry's law. At equilibrium the dissolved noble gas concentrations are proportional to atmospheric pressure that is given by the altitude, whereas the partitioning constant depends on the temperature and salinity of the exchanging water.

Although since the beginning of the applications of atmospheric noble gases in waters determination of the recharge altitude of ground waters was headed for, daNG have mainly been used to reconstruct (soil) temperatures since p and T affect the equilibrium concentrations in a very similar manner preventing the simultaneous determi-nation of p and T in practice.

In cases where the p-T relation is available from exter-nal information recent progress in interpreting daNS allows the concurrent determination of (soil) temperature and recharge altitude.

Two examples will be presented. In Lake Tanganyika the calculated water temperatures from daNG concentrations only match the measured temperature profile if the assumed pressure is preset to the recent atmospheric pressure at the lake surface. Hence together with transient tracer evidence of slow but significant deep water exchange daNG concen-trations exclude significant lake level changes in the past.

DaNG concentrations of ground water entering the Gotthard tunnel that cuts the central Alpine massif consistently point to a common recharge altitude of about 2500 m. This high recharge altitude matches with the topographic height of a saddle in the Alpine mountain crests. No evidence was found in favour of the previous assumed infiltration site at lower altitude. The high recharge altitude change the concepts of the hydrological setting of the Alpine ground waters dynamics and indicates much deeper penetration of the circulating waters into to the mountain body.