Metamorphic evolution along the slab/mantle interface within subduction zones

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One view of the metamorphic subduction system supposes that coupled deformation and prograde/metasomatic reaction between the chemically enriched slab and the depleted mantle wedge promotes the formation of complexly hybridized lithologies along the slab/mantle interface. This type of model is based upon direct observations of the structure and petrology of high-P/T metamorphic complexes [e.g., *Bebout and Barton*, 2002; *King et al.*, 2006] and detailed thermo-mechanical numerical models that also account for chemical mass transfer [e.g., *Gerya and Yuen*, 2003; *Gorczyk et al.*, 2006]. Direct analyses of metamorphic mélange zones indicates hybridization via mechanical mixing dominates petrochemical evolution, while some elemental or isotopic systems are fractionated by metamorphic reactions or metasomatism. In such mélange zones, geochemical signatures of particular input reservoirs are heterogeneosly recorded by metamorphic products whose phase equilibria are poorly known, but will be clearly distinct compared to the record of the oceanic lithosphere. Furthermore, the enhanced permeability structure of these mélange zones indicates they are the most ideal site for fluid flow [*Ague*, 2006], suggesting that progressive reaction between mobile fluids not in equilibrium with ambient mineralogy may control fluid chemistry [*Zack and John*, 2006; *King et al.*, 2006].

Integrating results from this body of research results in only one important conclusion: It appears unlikely that inputs to subduction zones are representative of the bulk petrology or geochemistry of the metamorphic system that actively promotes arc magmatism. While these results should be scrutinized due to the paucity of the metamorphic record as compared to the voluminous data for arcs and subduction inputs, this body of recent data suggests traditional models for magmatism and recycling within convergent margins may dangerously over-simplify the system. The metamorphic evolution of subducted material along the slab/mantle interface is largely unconstrainted, and this represents the most significant dilemma facing subduction-zone research.

References

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