

## Trench to subarc: Metamorphic chemical flux in subduction zones

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The compositional effects of subduction-zone metamorphism are not yet sufficiently understood for *quantitative* inclusion in models of subduction-zone chemical cycling. Further study of subduction-related metamorphic rocks is required to better reconcile seafloor sediment-crust inputs with subduction outputs (arcs, forearc fluids, serpentinite seamounts) and elucidate chemical contributions of subduction to the mantle beyond subarcs.

Prograde subduction P-T paths, related to subduction-zone thermal structure, dictate depths and extents of devolatilization and related element release. Most modern subduction zones are sufficiently cool to promote deep subduction of even relatively fluid-mobile components. Today, warmer subduction results in greater forearc release of fluid-mobile components, a pattern likely to have affected older-Earth efficiency of volatiles recycling into the mantle and thus long-term mantle-surface budgeting.

Integrated study of near-trench seafloor sediment sections and forearc metasediments subducted to 5-50 km indicates that chemical processing of sediment begins during early diagenesis and, for some elements (e.g., N, B, C, perhaps Cs, As, and Sb), can be profound at shallow levels in forearcs as pore fluids are mobilized and mineral reservoirs evolve. HP and UHP metasediments representing deeper subduction often show extreme exhumation-related overprinting of prograde assemblages and geochemistry. Compositions of HP and UHP metabasalts fall within the compositional range for altered oceanic crust, leading some to propose little or no element release and mobility during prograde metamorphism. However, uncertainty regarding protolith compositions could obscure element release and mobility that is significant when integrated over the large volumes of subducting oceanic crust. Yet unknown is the volumetric significance of mélange capable of impacting slab-mantle interface geochemistry.

Further work on texturally complex HP and UHP rocks must carefully distinguish between geochemical effects of prograde metamorphism and exhumation through use of microanalytical methods affording high spatial resolution. Hopefully, recently published consistencies between compositions of subduction outputs (notably, cross-arc trends) and geochemical records in subduction-zone metamorphic suites will drive more vigorous geochemical study of these important metamorphic lithologies.

## On fluid and trace element mobility in eclogite-facies rocks

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Evidence for fluid mobility is omnipresent. Occurrence of high-pressure veins (qtz+omp±ky±phe±rt) are visible in most high pressure localities, documenting fracture-controlled fluid movement. Percolative fluid movement is also indicated by near-equilibrium trace element partitioning between minerals in a number of eclogite-facies rocks, at least on a thin section scale.

Trace element mobility on a meter to km scale is more difficult to prove in eclogite-facies rocks. The crucial point is that in environments with low fluid fluxes most trace elements are not mobile enough to be significantly depleted. Significant depletion can be defined as the depletion of a residuum remarkable beyond the expected scatter associated with the rock protolith composition. The clearest evidence is a general decrease in B concentration in metamorphic rocks with increasing grade (e.g., Moran et al. 1992).

With the exception of accretionary wedge environments, it should be recognized that fluid fluxes in high pressure rocks are mostly extremely low (e.g. blueschist-facies mafic rocks have only stored a few wt% H<sub>2</sub>O). However, "trace element mobility" should not only be observed from a rock viewpoint, but also as a trace-element component in fluids. Simple mass balance calculations involving protolith concentrations, D(Min/Fluid) values and modal abundance of relevant minerals clearly demonstrate that trace element concentration of moderately mobile elements (e.g. Rb, Sr, Cs, Ba, Pb) can be 100x enriched in a fluid compared to primitive mantle values, while the residual rock has lost less than 10% of these elements. What is needed in the future are estimates of the trace element composition of high pressure fluids, either directly by measuring fluid inclusions in omphacite or indirectly by investigating minerals in the high pressure veins.