An estimate of water fraction in fluid-fluxed mantle melting for arc basalts using Arc Basalt Simulator version 2 (ABS2) model

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Convergent-margin magmas typically have geochemical signatures that include elevated concentrations of large-ion-lithophile elements, depleted heavy rare-earth elements and high field-strength elements, and variously radiogenic Sr, Pb, and Nd isotopic compositions. The origin of these characteristics has been attributed to the melting of depleted mantle peridotite by the fluxing of fluids or melts derived from subducting oceanic crust. High Mg# (Mg/(Mg+Fe) molar ratio) basalts and high Mg# andesites are inferred to make up the bulk of subduction-related primary magmas and may be generated by fluid- or melt-fluxing of mantle peridotite, respectively. The difference in contributions from the subducted slab found among various arcs appears to be mostly controlled by thermal structure, cold slabs yielding fluids and hot slabs yielding melts. Recent experimental studies and thermodynamic models better constrain the phase petrology of the slab components during prograde metamorphism and melting, mantle-wedge melting, and mantle-slab melt reaction. Experimental results also constrain the behavior of many elements in these processes. In addition, geodynamic models allow increasingly realistic, quantitative P-T models to be developed for subducted slabs and mantle wedges. These developments together enable generation of forward models to explain arc magma geochemistry. The Arc Basalt Simulator (ABS) version 2 (ABS2) uses an Excel spreadsheet-based calculator to predict the partitioning of incompatible element and Sr-Nd-Pb isotopic compositions in a slab-derived fluid and in arc-basalt magma generated by an open-system fluid-fluxed melting of mantle-wedge peridotite. The ABS2 model is intended to simulate high Mg# basalt geochemistry in relatively cold subduction zones. Necessary %XH_2O mass fraction to the arc basalts in cold subduction zones are as much as 3-5 % of the mantle mass resulting in 5-15 % XH_2O in the primary basalt, almost equal to XH_2O saturation at the given mantle depth. The ABS2 assumes maximum contribution of the contemporaneous slab derived fluid. Therefore any preceding metasomatism of the mantle peridotite should reduce XH2O. Recent reports on H_2O contents in primitive arc magmas suggest XH_2O greater than 6%. Therefore, ABS2 provides a reasonable estimate.