

GEOCHEMICAL TRACERS OF SLAB CONTRIBUTIONS TO ARC MAGMAS: THE USE OF BORON

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Thermal structures of subduction zones (SZs) dictate the metamorphic evolution of subducted slabs with regard to devolatilization and the partitioning and recycling of chemical components and consequent magmatism. We use the fluid-mobile element (FME) boron as a tracer for slab-derived fluid contributions to magma sources for representative arcs. For comparative purposes, B-enrichment (BE) is here defined for a given suite of lavas as the interpolated B/Zr value at a fixed B content, normalized to a similarly determined MORB B/Zr value.

BE variations in volcanic front basalts worldwide (~1 to 15) are best explained by small but varied additions of B-rich fluids to arc magma sources. B isotopic compositions ($\delta^{11}\text{B}$) inferred for such fluids also vary (~2 to 16 permil); this range points to a dominantly oceanic crustal source for B. Correlation between these parameters is consistent with variable loss of B (and carrier fluids) from subducted slabs. Attenuation of the BE signal correlates with estimated slab surface temperature (SST), which differs between arcs (~300-700°C at ~100 km depth).

Arc basalts with large BE values are interpreted as products of flux-melting (FM) of fluid-modified mantle wedge. B-poor arc lavas associated with the warmest SZs (or from back-arc regions) seem to sample mantle sources that are relatively unmodified by slab-derived fluids; such magmas may form by decompression melting (DM) of warm convecting mantle wedge material. From the perspective of FMEs, arc basaltic magmas appear to represent a spectrum of FM-DM contributions that depends on SZ thermal structure (cool to warm). Both types of melts may occur in some arcs. E.g., in the Cascades arc, estimated P-T conditions for magma segregation indicate a stratification of sources with shallow fluid-modified and deeper unmodified mantle sources.

⁸¹Kr-calibration of ³⁶Cl- and ⁴He-evolution in the western Great Artesian Basin, Australia

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The isotopic ratios ⁸¹Kr/Kr and ³⁶Cl/Cl and the ⁴He-concentrations measured in groundwater from 4 artesian wells in the western part of the Great Artesian Basin (GAB) in Australia are discussed. Based on radioactive decay along a water flow path the ⁸¹Kr/Kr-ratios are directly converted to groundwater residence times. Results are in a range of 225 to 402 ky. Using elemental analyses of rock samples from the sandstone aquifer as well as from the confining Bulldog shale the in-situ flux of thermal neutrons and the corresponding ³He/⁴He- and ³⁶Cl/Cl-ratios are calculated. From a comparison of (i) the ³He/⁴He-ratios measured in the groundwater samples with the calculated in-situ ratios in rocks and (ii) of the measured $\delta^{37}\text{Cl}$ -ratios with the ⁴He-concentrations measured in groundwater it is concluded that both, helium and chloride, are most likely added to the aquifer from sources in the stagnant porewaters of the confining shale by diffusion and/or mixing. Based on this "working hypothesis" the ³⁶Cl-transport equation in groundwater is solved numerically. It turns out that the four samples fall in two groups: (i) for two of the samples initial ³⁶Cl-concentrations are high and ³⁶Cl-dating based on radioactive decay is possible. The ⁴He-accumulation rate for these two samples is low (0.2·10⁻¹⁰ cm³ STP ⁴He/(cm³ wateryear)). (ii) for the other two samples the initial ³⁶Cl-concentration is low and therefore subsurface processes dominate resulting in almost constant ³⁶Cl-concentrations with time; ³⁶Cl-groundwater dating is hardly possible. The ⁴He-accumulation rate for these two samples is about 10 times higher (1.9·10⁻¹⁰ cm³ STP ⁴He/(cm³ wateryear)).