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High field strength element behaviour during subduction: constraints from high precision concentration and Hf isotope measurements in W-Pacific arc rocks

C. Münker (1,2), S. Schuth (2), T. Worthington (3), G. Wörner (4), G. Yogodzinski (5)

(1) Mineralogisch-Petrologisches Institut, Universität Bonn, Germany (2) Institut für Mineralogie, Universität Münster, Germany (3) Institut für Geowissenschaften, Universität Kiel, Germany (4) GZG, Universität Göttingen, Germany (5) Dept. of Geological Sciences, University of South Carolina, USA

High field strength elements (HFSE) show characteristic depletions in subduction-related volcanic rocks, thus providing essential informations on distinct petrogenetic processes in the subarc mantle. Ratios of high field strength elements such as Nb/Ta and Zr/Hf are particularly fractionated (1) during mantle depletion and (2) by slab melting or dehydration processes involving rutile and amphibole. To assess the effect of these different processes on the composition of arc magmas, we measured HFSE concentrations and Hf isotope compositions in a comprehensive set of W-Pacific arc magmas from Kamchatka, the W-Aleutians, the Solomon Islands and Tonga-Kermadec. HFSE concentrations were measured by isotope dilution using MC-ICPMS after separation by ion-exchange chromatography. Strongly negatively correlated arrays of Lu/Hf versus Zr/Hf for samples suites, where slab-derived fluids dominate in the subarc mantle, indicate that the degree of mantle depletion controls the budget of Zr and Hf. In contrast, Nb/Ta ratios are always decoupled from Zr/Hf, suggesting that small amounts of Nb and Ta are added by subduction components. The Nb/Ta ratios mostly overlap with compositions of MORB. Some arc samples, however, display strongly elevated ratios (up to ca. 25). Hence, the subduction components appear to display similar or higher Nb/Ta than the subducting slab, implying that rutile has a major control on the Nb-Ta inventory of subduction components. Rutile was re-

cently reported to display DNb/DTa$<$1 with both melts and fluids. In arc rocks, where subarc slab melts play a major role (e.g., N-Kamchatka, W-Aleutians) both Zr-Hf and Nb-Ta abundances are controlled by the subduction components. Rutile (Nb and Ta) and clinopyroxene-garnet or zircon (Zr and Hf) most likely control the HFSE budget in the slab melts.

Previous studies on mid ocean ridge basalts revealed systematic differences in Hf-Nd isotope compositions between the Indian and Pacific mantle domains. Therefore, coupled Hf-Nd isotope relationships are a potentially powerful tool to discriminate mantle domains along convergent plate margins in the W-Pacific region. Haf-nium-Nd isotope compositions of arc rocks from the Solomon Islands, Kamchatka, and Tonga-Kermadec all overlap with compositions of Indian-type MORB, suggesting that this mantle domain is widespread beneath the Australian and Asian plates. Nevertheless, rocks of the different arc systems display distinct fields in Hf-Nd isotope space, reflecting regional variations in mantle composition and possible mixing with material from the Pacific mantle domain.