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Title: NEOGENE VOLCANISM OF THE JAPAN ISLAND ARC: THE K-h RELATIONSHIP REVISITED

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Abstract: Japan is the archetypical island arc, and its many volcanoes invite re-examination of one of Bill Dickinson's many seminal contributions: the K-h relationship. This describes the covariation of depth to a subduction zone (h) to potassium contents of arc magmas (K). The K-h relationship is generally validated but what processes control it largely remain enigmatic. Japan is a good place to advance K-h theory because of detailed understanding about the igneous geochemistry, geochronology, tectonic evolution, plate kinematics, and sediment distribution for the region. These datasets are especially revealing because Japan has endmember subduction zones: one subducting cold Cretaceous lithosphere rapidly (NE Japan or NEJ), the other subducting warm Neogene lithosphere slowly (SW Japan or SWJ). SWJ has a growing accretionary prism and subducts more terrigeneous sediment, whereas NEJ experiences forearc tectonic erosion and subducts mostly pelagic sediment. NEJ subducts ~350m of siliceous sediments on Cretaceous crust, whereas SWJ subducts ~500m of Neogene carbonate and clay. Compilations of potassium contents for individual volcanoes to a common silica content indicates different but nearly parallel K-h slopes for NEJ and SWJ arcs. The NEJ slope is like the global curve of Dickinson (1975) but SWJ lies well above the Dickinson and NEJ curves. In fact, basalts erupted along the SWJ magmatic front (FA) are remarkably similar to those from the NEJ rear-arc (RA). Other incompatible trace element concentrations (except Sr and Pb) show similar covariations. Thermal modeling of the NEJ and SWJ subduction zones indicates that the slab beneath SWJ is much hotter

than that beneath NEJ, but HFSE data indicate an order of magnitude less melt generation. It could be that more sediment is involved in magmagenesis beneath SWJ but similar compositions between SWJ FA lavas and NEJ RA lavas indicate that the degree of melting is mostly controlled by slab thermal structure. Different melting regimes of the NEJ and SWJ subduction zones reflects different extents of slab hydration, with the older oceanic crust and perhaps mantle peridotite beneath NEJ carrying much more water deep into the subduction zone than does the hot, relatively dry SWJ. The much greater water flux beneath NEJ relative to SWJ results in much greater degrees of mantle wedge melting (F = 20-25% vs. 3-5%) in spite of the much hotter nature of the SWJ subducted slab. Both slabs release first low-T then high-T fluids as they are subducted. The different K-h slopes for NEJ and SWJ reflect two main effects: 1) Hotter SWJ slab is less hydrated than cold NEJ slab and has less water to release; and 2) low-T fluid is released from the SWJ slab at shallower depth compared to that beneath NEJ, but the SWJ low-T fluid is not involved in magmagenesis because the mantle that it is released into is not hot enough to melt.