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Interaction between slab melts and mantle peridotite: An example of adakitic granites in the Kitakami Mountains, Japan

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Early Cretaceous plutonic rocks in the Kitakami Mountains attract special interest because of the coexistence of adakitic granites and normal subduction-related rocks. These plutonic rocks intrude into the North and South Kitakami belts. The North Kitakami belt, consisting of Jurassic accretionary complex, was formed by oceanic plate subduction just before the beginning of the Early Cretaceous magmatism. On the other hand, the South Kitakami belt is composed of collided microcontinental block mainly consisting of post-Ordovician sedimentary rocks (Ichikawa et al., 1990; Otsuki, 1992). Adakitic granites occur in central part of zoned plutonic bodies surrounding by calc-alkaline granites in marginal part. These plutons are distributed in eastern margin of the Kitakami Mountains (Hashikami, Tanohata, Miyako, and Kinkasan plutons) and inner part of the South Kitakami belt (Tono and Senmaya plutons). Distribution of the former plutons corresponds to that of the Ishikari-Kitakami positive magnetic belt (Makino et al., 1992; Finn, 1994).

Petrochemical evidence indicates that the adakitic granites can be derived by direct partial melting of subducted oceanic crust leaving garnet, clinopyroxene, and minor amounts of rutile. These adakitic granites show similar characteristics to those of Archean TTG compiled by Martin (1995) and of experimental slab melts (e.g., Rapp et al., 1991; Winther and Newton, 1991; Sen and Dunn, 1994). From the detailed investigation of bulk rock chemistry, however, adakitic granites in inner part of the South Kitakami belt are characterized by slightly higher MgO, Cr, and Ni contents and mg-values (= Mg/(Mg+Fe*)) than those in eastern margin of the Kitakami Mountains. In addition, the adakitic granites from inner part of the South Kitakami belt are slightly but clearly higher in MgO contents and mg-values than those of Archean TTG and of experimental slab melts. On the other hand, there is no remarkable local variation in incompatible element compositions among the adakitic granites in the Kitakami Mountains. From this, degree of fractional crystallization cannot explain the difference in commpatible element contents in the adakitic granites between the two districts. Moreover, since 87Sr/86Sr initial ratios are rather higher in the adakitic granites in inner part of the South Kitakami belt than those in eastern margin of the Kitakami Mountains, the difference in compatible element contents between the two districts is not consistent with the explanation of upper crustal contamination. Therefore, the adakitic granites in inner part of the South Kitakami belt may be interacted with mantle peridotite during their ascent, while those in eastern margin of the Kitakami Mountains may not. Such difference in the degrees of mantle contamination in the adakitic granites is analogous to the case of the difference between Cenozoic adakites and Archean TTG. Namely, Cenozoic adakite suites suggest interaction with mantle peridotite, whereas most of early Archean TTG show no evidence of such mantle interaction (Smithies, 2000).

Smithies (2000) stated that early Archean TTG suites are not analogues of Cenozoic adakite but products of hydrous melting of basaltic thickened crust. On the other hand, Martin (1999) discussed that Archaean TTG show less efficient mantle-magma interactions due to the shallower depth of slab melting and thinner mantle wedge. In the case of the adakitic granites in the Kitakami Mountains, since there is no remarkable local variation in bulk rock chemistry except Mg, Ni, and Cr contents, these adakitic granites may be derived by slab melting under similar conditions. Contrary to this, the difference in compatible elements of the adakitic granites may have been produced by the difference in deep structure around the conduit of slab melts between the accretionary complex and the collided microcontinental block.