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Geochemistry of Archean adakites from the Lake of the Woods greenstone belt, Western Wabigoon Subprovince, Superior Province

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The Lake of the Woods greenstone belt, Western Wabigoon Subprovince, Superior Province is composed of Lower Keewatin (ca. 2.74 Ga), Upper Keewatin (ca. 2.72 Ga) and Electrum (ca. 2.70 Ga) assemblages (Ayer and Davis, 1997). Archean adakites occur in the Upper Keewatin and Electrum assemblages. We geochemically studied the origin of the Upper Keewatin adakites (SiO_2 = 57-75 %) having high Sr/Y and La/Yb and poor in Yb and Y. The origin of these adakites, which have geochemical characteristics very similar to Archean TTG (tonalite, trondhjemite and granodiorite), is a clue to better understanding of the evolution of the continental crust. Archean adakites (and TTG) are often considered to have been produced by partial melting of subducted oceanic crusts, but there is another possibility that they were derived from partial melts of mafic basal parts of thickened crusts leaving garnetiferous residues (e.g., Condie, 1997; Martin, 1999).

The primitive mantle-normalized plot shows that many of the Upper Keewatin adakites lack positive Sr spikes. We speculate that plagioclase, which has large partition coefficient for Sr, was one of important residual phases during the genesis of the adakite magmas. This is in accordance with that they tend to be poorer in Al_2O_3 than Cenozoic adakites having significant positive Sr spikes in general.

The Upper Keewatin adakites are higher in molar Mg/(Mg+Fe.t) (up to 0.67 and Fe.t is total iron) than experimental slab melts, suggesting that they reacted with ultramafic material during the ascent to the surface (e.g., Rapp et al., 1999). They tend to be rich in compatible elements (up to 100 ppm Ni and up to 270 ppm Cr) supporting this interpretation. Thus we favor the oceanic slab melting model rather than the lower crust melting model in which extensive ultramafic material is hardly expected to exist between the place of magma generation and the surface.

The Upper Keewatin adakites show wide ranges of highly incompatible element contents at a given compatible element level (e.g., La =12-30 ppm at Ni ~25 ppm), thereby suggesting that they were derived from primary adakite magmas having different chemical compositions before their interaction with ultramafic material. The following is additional observation suggesting that the primary adakite magmas were different in chemical composition: the studied samples show no negative correlations between Mg/(Mg+Fe.t) and SiO_2 and Mg/(Mg+Fe.t) and Zr/Y, while results of melting experiments simulating the interaction of adakitic magmas with peridotite (Rapp et al., 1999) indicate that a magma decreases both in SiO_2 and Zr/Y with increasing Mg/(Mg+Fe.t) during the interaction. The primary adakite magmas appear to have formed under varying physical conditions as long as their source was not significantly heterogeneous. This interpretation is again in harmony with the slab melting model, since a subducted oceanic crust, and not basal part of the buoyant crust, could have easily attained different temperatures and pressures as it went down. We will discuss the origin of the Upper Keewatin adakites in more detail using results of high pressure melting experiments on basaltic rocks (e.g., Sen and Dun, 1994) and our model calculations.

References

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