Phosphorus-enriched, S-type Middle River rhyolite, Tetagouche Group, northeastern New Brunswick

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In the Middle River area north of the Brunswick No. 12 massive-sulphide deposit, flow-banded rhyolite lenses are underlain by Middle Ordovician, passive margin sedimentary rocks of the Miramichi Group and overlain by immature wackes and black shales of the Boucher Brook Formation (Tetagouche Group) in the autochthonous part of the Bathurst Mining Camp, in northern New Brunswick. Some elements are disturbed by very weak to moderate alteration and mass-balance changes. The least-altered rhyolites are mesoscopically aphyric, although they have well developed microscopic, alkali feldspar spherulitic textures (<0.5 mm). Limited berlinite substitution is evident in these feldspars (P-Al for 2Si) with up to 0.32 wt.% P_2O_5 that may represent disequilibrium partitioning associated with diffusion-limited feldspar growth during devitrification of glass.

The least-altered Middle River rhyolites are peraluminous (ASI = 1.1 to 1.4) and have high silica (73 to 76 wt.%) and low CaO (<0.5 wt.%) contents. They also have very low TiO_2 (0.043 to 0.053 wt.%), Zr (36 to 42 ppm), Th (1.5 to 2.4 ppm), Y (9 to 14 ppm), Nb (12 to 14 ppm), V (<1 to 3 ppm), Sc (2 to 3 ppm), and rare-earth elements (REE = 16 to 19 ppm), but have high P_2O_5 contents (0.2 and 0.3 wt.%), relative to other subalkaline, felsic volcanic rocks in the camp. The low Zr contents indicate that the eruption temperature of these rhyolites was less than 700°C, based on zircon saturation thermometry. The low TiO_2, V, Sc, Zr, Hf, Th, Nb and Ta probably reflect their low fusion temperature, although their strong covariation within these small rhyolite lenses probably reflect very low-temperature process of fractionation. The weak covariance of P_2O_5 and Y indicates fractional crystallization is probably controlling the decrease in rare-earth elements (REE), although the correlation with other REE is poor. Restite REE-bearing phases in the source protolith may account for the overall very low REE abundances. The high Nb/Y (>0.7), Ta/Yb (>4.3), Nb/Ta (<6) and Rb (>200 ppm) values indicate an S-type parentage, which is consistent with the high ^{18}O (13.4 to 15.4‰) for three of the least-altered rhyolite samples. Elsewhere along the belt, these rhyolites seem to be comagmatic with alkaline mafic igneous rocks erupted in a continental back-arc setting. Analogous to the younger felsic volcanic rocks in the camp, these rhyolites are interpreted as fusion products of supracrustal rocks associated with heat advection from intruding mafic magmas and then underwent further low-temperature fractionation of Fe-Ti oxides, zircon and apatite.