A Penobscottian arc system along the margin of Ganderia: evidence from geochemistry and U-Pb zircon dating of the Annidale Group in southern New Brunswick

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Late Cambrian to Early Ordovician rocks of the Annidale Group are preserved within a northeast-trending, fold-thrust belt along the northwestern margin of the peri-Gondwanan New River belt in southern New Brunswick. The Annidale Group is comprised of an imbricated assemblage of mafic-intermediate flows, tuffs and coeval felsic dome complexes, wacke, shale, volcaniclastic rocks, felsic tuffaceous rocks and associated intermediate and plagiogranite intrusions. Mafic-intermediate volcanic rocks are subalkaline, tholeiitic to calc-alkaline basalt, basaltic andesite, and andesite that mostly exhibit negative Nb and Ta and positive Th anomalies on extended rare earth plots and fall clearly within volcanic-arc fields on trace-element discrimination diagrams. A notable exception is a group of extreme LREE-depleted basalts that display concave-upwards REE patterns typical of N-MORB affinity, but with uncharacteristically low TiO_2 (0.48–0.54%) more typical of arc tholeiites. These basalts are also magnesian-rich (13.7–17.2% MgO) and strongly enriched in Cr (1180–4910 ppm) and Ni (390–880ppm). Overall, the mixed arc and MORB chemistry of the Annidale Group is most characteristic of basalts erupted in a rifted arc or back-arc setting.

The age and geochemistry of the Annidale Group are in accord with recent models for the tectonic development of the Penobscottian arc system in the Exploits Subzone in Newfoundland. In such a model the ca. 497–489 Ma rocks of the Annidale Group represent supra-subduction zone magmatism associated with the Penobscot arc along the Gander margin in southern New Brunswick. Preliminary U-Pb data constrain the timing of tectonic interleaving of the Annidale Group and its juxtaposition with ca. 540 Ma New River belt

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basement to between ca. 489–478 Ma, which is consistent with the timing of Penobscottian obduction in Newfoundland. Post-Penobscottian magmatism (ca. 478–469 Ma) that affected both the Annidale Group and adjacent rocks of the New River belt is similar in age to the younger Victoria arc in Newfoundland and associated Tetagouche-Exploits back-arc basin in northern New Brunswick. A $^{40}Ar/^{39}Ar$ age of 444 ± 5 Ma for metamorphic muscovite in schistose felsic tuff in the Annidale Group indicates that unroofing of the arc volcanics was coincident with the final closure of Iapetus.