Petrography, geochemistry, age and tectonic significance of the Paul's Lake dyke swarm in north-central Dunnage Zone

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Geological mapping, petrography, and major- and trace-element geochemistry, along with new U-Pb age determinations, of the Paul's Lake dyke swarm and associated host rocks have provided more insight into post-subduction Silurian magmatic processes that occurred in the north-central Dunnage Zone of the Newfoundland Appalachians. The magma-mingled Hodges Hill granite-diorite host rocks, as well as the dyke swarm, were emplaced into locally metamorphosed, Ordovician volcanic and sedimentary sequences of the Notre Dame Subzone, located immediately west of the Red Indian Line.

The dykes exhibit a full compositional range from basalt through rhyolite and are associated with diorite and gabbro-norite intrusions, most of which show well-developed chilled margins. Igneous textures observed during petrographic analysis include granophyric, myrmekitic and spherulitic and suggest variations in the cooling rate and depth of crystallization. Locally intense saussuritization and chloritization indicate low-grade metamorphism and deformation. Numerous petrographic similarities between dykes of contrasting trace-element geochemistry give insight into magmatic differentiation processes such as magma mixing, fractional crystallization and partial melting. Six geochemical groups were defined from the thesis outcrop, based on trace-element geochemistry, and consist of: (1) LFSE-enriched mingled granite-diorite Hodges Hill host rock exhibiting negative Nb anomalies and local prominent positive U anomalies; (2) a group of dykes ranging from depleted basalt – lacking a negative Nb anomaly and LFSE enrichment - to LFSE-enriched basalt and basaltic andesite; these latter all show similar geochemical trends and negative Nb arc-signatures; (3) a group of andesite dykes, showing prominent negative Nb anomalies and LFSE enrichment, and identical trace element geochemistry; (4) a group of intermediate to felsic dykes with granophyric texture that exhibit high degrees of LFSE enrichment and prominent negative Nb and Ti anomalies; this group is further subdivided based on similarities in trace element geochemistry with select basaltic andesite and andesite dykes; (5) LFSE-enriched rhyolite dykes, showing prominent positive U anomalies, along with negative Nb, Eu, and Ti; and (6) a group of medium-to coarse-grained diorite dykes, that share geochemical similarities with basalt and basaltic andesite dykes, and in comparison, LFSE-depleted gabbro-norite intrusions with less prominent Nb arc anomalies.

A minimum time frame of 6 million years, spanning the Middle (Wenlock) to Late (Ludlow) Silurian, has been determined for large scale bimodal magmatism occurring within the thesis outcrop and is bracketed by the 429.4 ± 1.3 Ma Hodges Hill granite host, and a cross-cutting rhyolite dyke, previously dated at 423 +/- 2 Ma. These ages correspond in time with within-plate Silurian magmatism throughout the Central Mobile Belt that has been previously suggested to be linked to lithospheric delamination at depth, or a slab-break off event that occurred upon closure of the Exploits back-arc-basin. Emplacement of the dyke swarm, and host rocks of the Hodges Hill suite, may have been initiated and localized during simultaneous sinistral transpressional-transtensional movement along regional arcuate faults that were active in central Newfoundland throughout the Silurian.

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