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Evolution of Silurian to Devonian magmatism associated with the Acadian orogenic cycle in Newfoundland Appalachians: Evidence for a three-stage evolution characterized by episodic hinterland- and foreland-directed migration of granitoid magmatism

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The migration and character of magmatism over time can provide important insights into the tectonic evolution of an orogen. We present evidence for three separate episodes of compositionally distinct granitoid magmatism associated with the Acadian orogenic cycle in the eastern and southern Newfoundland Appalachians. The interpretations are based on new zircon U-Pb ages, geochemical data, and Sr-Nd-Hf-O isotopic data for 18 samples from 15 Silurian and Devonian granitoid plutons, combined with previously published data. The three episodes outline hinterland and foreland-directed migration trends and represent subduction (435-420 Ma), syn-collision (415-405 Ma), and post-collision (395-370 Ma) settings in the Acadian orogenic cycle. The Silurian plutons (435-420 Ma) consist mainly of quartz diorite, tonalite, granodiorite, monzogranite, and syenogranite, with high-K calc-alkaline and enriched Sr-Nd-Hf-O isotopic compositions (e.g., $\epsilon\text{Nd}[t] = -5$ to -2 ; $\epsilon\text{Hf}[t] = -3$ to -1 ; $\delta^{18}\text{O} = +6$ to $+8$). They are interpreted to record the subduction of oceanic lithosphere of the Acadian seaway that separated the leading edge of composite Laurentia represented by the Gander margin and Avalonia. The Early Devonian plutons (415-405 Ma), containing more voluminous monzogranite and syenogranite, have calc-alkaline to high-K calc-alkaline features, adakite-like compositions, and more-depleted Sr-Nd-Hf-O isotopic compositions (e.g., $\epsilon\text{Nd}[t] = -6$ to 0 ; $\epsilon\text{Hf}[t] = +1$ to $+3$; $\delta^{18}\text{O} = +5$ to $+6$). This stage occurs mostly to the northwest of the Silurian, indicating a regional scale northwestward (hinterland-directed) migration of magmatism with a rate of > 9 km/Ma. The migration is interpreted to be related to the progressive shallow underthrusting of Avalonia beneath the Gander margin (composite Laurentia) at least as far as 90 km inboard. The Middle to Late Devonian plutons (395-370 Ma) consists mainly of monzogranite, syenogranite, and alkali-feldspar granite, which are silica- and alkali-rich with large negative Eu anomalies. These rocks are concentrated along both sides of the Dover - Hermitage Bay fault zone, which represents the boundary between Avalonia and composite Laurentia, to the southeast of the Silurian-Early Devonian igneous rocks. This stage of magmatism represents a foreland-directed (retreating) migration. The Early Devonian and Middle to Late Devonian magmatism were separated by a gap between 405 and 395 Ma, and recorded an evolution from (high-K) calc-alkaline to alkaline compositions, which is ascribed to partial delamination of Avalonian lithospheric mantle in a post-collisional setting.

