

Magmatic evolution of the Late Devonian Mount Douglas leucogranites, southwestern New Brunswick, Canada: an example of extreme fractional crystallization

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The Late Devonian Mount Douglas intrusive suite (MD, ~600 km²) of southwestern New Brunswick, Canada, eastern part of the Saint George Batholith, is a suite of peraluminous leucogranites extended from Red Rock Lake to Mount Douglas. Extreme fractional crystallization associated with formation of this suite is the most important factor affecting the magmatic evolution, producing three compositionally and chronologically different intrusive units, Dmd1, Dmd2, and Dmd3. Petrochemical data show that the subunits of the Mount Douglas Granite have within-plate geochemical character with evidence of hybrid I- and S-type affinity. Very low K/Rb (average 102.7), Nb/ Ta (≤ 6.8), and Zr/Hf (≤ 37.45) ratios in Dmd3 compared to Dmd1 possibly reflect significant involvement of extreme low T crystal fractionation in the last-stages of magmatic differentiation; The continuous variation trends for many major and trace elements (e.g., Zr vs. TiO₂, Zr/Hf vs. K/Rb, F vs. K/Rb, and Pb vs. Ba) suggest that probably Dmd2 and Dmd3 were generated by extensive fractionation of the parental Dmd1 magma. Also, normalized to the leastevolved sample of the MG granites (Dmd1), the Dmd3 unit is the most enriched in Rb, Th, U, Ce, Ta, Pb, Nd, Sm, Dy, Y, Yb, and Lu, and depletion of Cs, Ba, Sr, P, Zr, Eu, and Ti content, reflects their production of the same parental magma by crystal fractionation from Dmd1 to Dmd3. A flat "birdwing shape" REE patterns with the most pronounced negative Eu anomalies and the lowest (La/Yb)_N (ranging from 1.7–7.4) ratios of Dmd3 show the highly evolved attributes of Dmd3. Calculation of zircon saturation temperatures supports an interpretation of crystal fractionation from Dmd1 to Dmd3. Estimated average temperatures using the bulk rock Zr composition for Dmd1, Dmd2, and Dmd3 range 747–826°C, 733– 817°C, and 729–816°C, respectively. All above data suggest that they might have a single genetic group with different fractionation originated from a homogenous parental magma, in which this fractionation increases from the early unit (Dmd1) to the latest unit (Dmd3); significant mineral occurrences, such as Sn, W, and Mo, seem to be mostly associated with the latest and most highly differentiated Dmd3 intrusive phases.