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Geochemical evolution of the Late Devonian (375 Ma) South Mountain Batholith (Nova Scotia) by crystal fractionation

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The Late Devonian (375 Ma), post-orogenic South Mountain Batholith (SMB) of southwestern Nova Scotia, Canada, is the largest batholith of the Appalachian Orogen. It covers an area of 7300 $km^2$and consists of at least 11 peraluminous plutons which can be subdivided into four rock types: granodiorite, biotite monzogranite, leucomonzogranite and leucogranite. There is no clear consensus regarding the petrogenesis of the SMB as previous interpretations have stated that the plutons may represent a series of contemporaneous but genetically unrelated intrusions or that substantial (33%) country rock assimilation is required to explain the geochemical evolution of the granitoids. New geochemical data from the three largest plutons (i.e. Scrag Lake, Davis Lake and Salmontail Lake), augmented by over 500 previously published analyses, suggest that all rock types may be generated by continuous fractional crystallization. We apply MELTS modeling to constrain the chemical evolution of the SMB using the granodiorite as the parental composition, pressure of 4 kbar, fO_2equal to the FMQ buffer and initial water content of 4 wt%. The results show that Fe-Ti oxide (960°C) and phlogopite (920°C) dominate the early fractionation sequence followed by alkali feldspar fractionation at 800°C. The modeled temperatures of the biotite monzogranite (910°C), leucomonzogranite (860 to 790°C) and leucogranite (< 790°C) are higher than estimates using zircon saturation thermometry (T_{Zr}= 800 to 680 +/- 50°C), however there is overlap. The results indicate that the SMB represents large-scale, in situ differentiation of a common parental magma and that crustal assimilation, although an important process, is not required to form the leucomonzogranites or the leucogranite.

Keywords: Late Devonian, Appalachians, Peraluminous, Batholith, MELTS, Crystal fractionation