Chemical and Isotopic (Pb, Sr) Zonation in a Peraluminous Granite Pluton: Origin by Crystal-fluid Fractionation[1]

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The Davis Lake pluton (DLP, ~800 km^2) of southwestern Nova Scotia, Canada, part of the large peraluminous South Mountain batholith of ca. 380 Ma (U/Pb zircon, Ar/Ar mica), consists of granite and subordinate topaz-muscovite leucogranite that is host to greisen tin-base metal mineralization. A new Pb-Pb isochron age for leucogranite from the most evolved part of the DLP indicates a crystallization age of 378 ± 3.6 Ma, coincident with other radiometric ages in the area (Rb-Sr, Re-Os, Pb-Pb). The intrusion displays a compositional zonation defined by lead and strontium isotopic ratios, as well as some major elements (e.g., Si, F), incompatible trace elements (e.g., Li, Rb, Ta, U, Sn), and elemental ratios (e.g., K/Rb and Nb/Ta). The greisens and the leucogranites that host them are characterized by extreme radiogenic compositions for Pb and Sr, and their chemical-isotopic trends are extensions of the trends displayed by the less evolved granites. The granitoid magma underwent extensive fractional crystallization of feldspars, minor biotite and accessory minerals (monazite, apatite and zircon) in a compositionally zoned magma chamber that was subsequently accompanied by fluid fractionation during which time the internally-derived fluorine-rich fluids modified the Rb/Sr, U/Pb and Th/Pb ratios leading to distinct variations of $^{87}Sr/^{86}Sr$, $^{206}Pb/^{204}Pb$, $^{238}U/^{204}Pb$ and $^{232}Th/^{204}Pb$ isotopic ratios. These data document, therefore, the transition of a primitive magma through the stages of magmatic (i.e., crystal fractionation), orthomagmatic (i.e., crystal-fluid fractionation) and hydrothermal (i.e., fluid fractionation) that culminated in formation of a tin-base metal deposit. The Pb isotope data also constrain the source region for the DLP as being Avalonian basement which, by inference, must underlie much of the Meguma Terrane.

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