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Geochemistry and U-Pb hydrothermal monazite geochronology of uraniferous greisen veins in the high heat production Mt. Douglas Granite, NB Canada: implications for post-magmatic hydrothermal activity

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Medium- to fine-grained porphyritic high heat production peraluminous leucogranites of the units Dmd2 and Dmd3 of the Late Devonian Mt. Douglas body ($\sim$ 370 Ma), southwestern New Brunswick, Canada, are associated with mineralized greisen and sheeted veins. Gamma-Ray Spectrometry surveys, microscopic observation, SEM-BSE imaging, μXRF, and laser ablation Q-ICP-MS measurement of the related veins demonstrate the locally uraniferous nature of the Mt. Douglas's greisen veins. Typical assemblage of greisen minerals, including sericitized pseudomorphed K-feldspar and plagioclase, quartz, fluorite, chlorite with minor muscovite, are accompanied by a complex hydrothermal paragenesis of oxide and sulfide minerals. The associated oxide and sulfide minerals commonly are pyrite, arsenopyrite, hematite, martite, cassiterite, and galena, but also Ta-rich wolframite, In-Cd-rich sphalerite, chalcopyrite, and native bismuth. However, locally, some greisen veins are uraniferous and exhibit considerable U- and Th-, and also REE-bearing minerals. Not only common U- and Th-bearing minerals, such as monazite, zircon, xenotime, thorite, bastnaesite, and uraninite occurring in these veins, but also other sulfide and oxide minerals display significant anomalies and have notably high concentration of these elements. These anomalous assemblages are more evident in oxide minerals, including wolframite ($\leq$ 143 ppm U; $\leq$ 83 ppm Th), hematite and martite, in which radiating fibrous to platelet-shaped hematite reaches up to 41 ppm U and 6 ppm Th. Some sulfides, such as galena, show high values of these elements, as well (up to 1.5 wt.% U and 5.2 wt.% Th). Previous airborne radiometric (Gamma-Ray Spectrometry) surveys in New Brunswick demonstrated that the eastern part of the Saint George Batholith has a high potential of U enrichment; this is in agreement with Gamma-Ray spectrometry measurements in the Mt. Douglas Granite including down to the micro-scale using LA-Q-ICP-MS. The anomaly that is generated by higher U and Th in this body is mainly associated with the most highly differentiated, youngest phases, units Dmd2 and Dmd3 exhibiting $\leq$ 71 ppm Th and $\leq$ 22 ppm U. Mineralization age derived from in situ laser ablation ICP-MS U-Pb of hydrothermal monazite taken from earthy-red greisen and sheeted veins, guided by SEM-BSE imaging, yielded a range of 358.2$\pm$2.4 to 360.9$\pm$6.6 Ma, which is around 10 Ma younger than the crystallization age of the Mt. Douglas granite ($\sim$370 Ma). 10 Ma younger mineralization age reveals post-magmatic hydrothermal activity within the Mt. Douglas pluton. This is consistent with previous investigations showing the pluton lies within an area of present high heat production (HHP), where there is a high heat flow (70 mW/m2) produced by a 1.4-3.3 km radiogenic layer. Redistribution of U and Th by ground-water movement through fractures is probably caused by this heat flow anomaly. The HHP nature of this pluton may be the reason for post magmatic hydrothermal activity producing uraniferous greisen veins 10 Ma younger than the intrusion.