Melt inclusions in rhyolite tuff of the Spor Mountain Formation, Utah track Be, U, Li through the magmatic-hydrothermal transition

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The fluorine- and lithophile-rich topaz rhyolites of the Miocene Spor Mountain Formation in western Utah host the Earth's largest Be deposit and a small U deposit. Beryllium is essential for aerospace, defense, computer, medical, and telecom applications, and has been catagorized as a strategic and critical element by the U.S. Department of the Interior [1] and the European Union [2]. In 2015, Spor Mountain produced ~90% of the world's beryllium with a ~70-year supply remaining [3]. It is enriched in Li, a potential byproduct [4]. Thus, it is an important location to investigate the process of Be, U, and Li enrichment [4, 5, 6].

We combine new melt inclusion geochemistry (EMP, LA-ICP-MS), estimates of intensive parameters (P, T, a_{TiO2}), experimental phase equilibria [7], and experimental-thermodynamic fluid-melt partitioning models [8, 9] to track Be, U, and Li through the magmatic-hydrothermal transition to establish how these elements partitioned during magma ascent and degassing.

Concentrations of Be (~10-100 ppm) and F (~0.05-1.70 wt%) in melt inclusions show coherent incompatible variations, whereas Li (~2500-5100 ppm) and U (~15-48 ppm) are buffered by biotite, euxenite, and thorite [6, 7]. Entrapment P and T define magma ascent (~560-3 MPa) with melts cooling ~55°C/100 MPa. Experimental phase equilibria suggest saturation with a CO_2-bearing aqueous fluid that likely caused lithophile elements to remain in the silicate melt [8]. Melt F/Cl ratios increase exponentially with magma ascent indicating that degassing induced crystallization accelerated at <200 MPa, at which point CO_2 degassed rapidly and large amounts of Cl partitioned into the aqueous fluid [9]. These conditions theoretically favor an increase in lithophile $D^{fluid/melt}$ [8], however, Be, U, and Li remained in the silicate melt as shallow as ~8 MPa. We favor a process by which Be, U, and Li enrichment occurred entirely post-eruption, i.e., from leaching of rhyolite tuff and lavas by meteoric fluids rather than from shallowly exsolved magmatic fluids.

[1] Fortier (2018) *USGS OFR* **20181021**. [2] Euro Com (2017) *COM* **490**. [3] Lederer (2016) *USGS FS* **20163081**. [4] Foley (2012) *USGS SIR* **20105070f**. [5] Foley (2017) *USGS PP* **1802E**. [6] Dailey (2018) *Am Min* **103(8)**. [7] Webster (1987) *Geo Cosmo Ac* **51(3)**. [8] Webster (1989) *Econ Geol* **84(1)**. [9] Burgisser (2015) *Comp Geo* **79**.