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# Metallogenic evolution and exploration strategies for alkaline volcanic rocks hosting the world-class Spor Mountain Be deposit, Utah, USA

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Virtually all global beryllium (Be) supplies are obtained from a single world-class volcanic-hosted Be-(F-Li-REE-U) deposit located at Spor Mountain, Utah, USA. Unique properties of Be make it critical to international energy portfolios; for example, Be is a key element in high-performance components used in both oil and gas industries and in emerging energy sources due to its high thermal conductivity and tensile strength. Providing a broader understanding of the genesis of Spor Mountain is critical for evaluating regional and global exploration strategies for additional deposits of the volcanogenic Be type.

The deposit occurs in lithic-rich, base-surge deposits of the Spor Mountain Formation (SMF), which is part of an extensive sequence of Oligocene to Miocene calc-alkaline to alkalic tuffs and lavas. New U-Pb SHRIMP zircon ages (n=37) and geochemistry for regionally distributed volcanics and granites yield a range from ca. 37 Ma to 5 Ma (overlapping the U-Pb SHRIMP zircon age of SMF) and establish the temporal and metallogenic evolution from calc-alkaline to alkaline volcanism amid the transition from convergent to extensional tectonic regimes. Key attributes of SMF include a magmatic Be-U-F enrichment stage from melting of continental lithosphere and later hydrothermal/metasomatic Be-enrichment stages. The SMF shows evidence of prolonged fractional crystallization (e.g., large Eu anomalies) and pervasive hydrothermal alteration by F-rich aqueous fluids. A shared source and evolution for the SMF rhyolite and tuff are indicated by (1) regular, stacked subparallel, chondrite-normalized REE patterns, (2) overlapping sub-vertical arrays for Pb isotopes ($^{207}Pb/^{204}Pb$ ~15.60-15.70 at $^{206}Pb/^{204}Pb$ ~18.60), and (3) negative values of $e_{Nd}$ (average ~-8.0). The SMF occurs near the boundary between crustal domains. Crustal ages from Nd isotopes (average $T_{DM}$ ~2.2 Ga) are older than basement ages obtained by Pb isotopes. Rare-metal indices of granite-related mineralization (e.g., Nb/Ta, Zr/Hf) show SMF values overlap fields for globally distributed granitic/rhyolitic Be deposits, for example, Ermakovka F-Be (Russia) and Baiyanghe Be-U (China); however, none of these deposits are known to match the mineralogy, rare metal chemistry, nor the unique geologic setting of the Spor Mountain system.