

SEG 2022 Conference: Minerals For Our Future

High-REE Mafic Magmatism in the Mojave: The Shonkinite Connection Between Mountain Pass and Bobcat Hills, California

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The Bobcat Hills are located ~55 km southeast of the Mountain Pass rare earth element (REE) mine in the Mojave Desert of southeastern California. Recent mapping at Bobcat Hills has delineated a shonkinite dike swarm that correlates to the Mountain Pass system. The dikes crosscut Paleoproterozoic gneiss host rocks. Over a dozen dikes, most 1-2 m wide, are similar to Mountain Pass shonkinites, with a dark gray groundmass and conspicuous black phlogopite crystals. Whole-rock geochemistry demonstrates a chemical affinity to Mountain Pass shonkinites, with 50-52 wt % SiO₂, 8-10 wt % K₂O, 10-12 wt % MgO, 1-2 wt % F, and light REEs up to ~1,000x chondritic. Chemical differences include lower Ba (<0.5 wt %) and Sr (<700 ppm) for Bobcat Hills shonkinites. Zircons from four shonkinite dikes yielded error-weighted mean ²⁰⁷Pb/²⁰⁶Pb ages and paired concordia ²⁰⁶Pb/²³⁸U-²⁰⁷Pb/²³⁵U ages of 1425-1428 ± 2-3 Ma. These ages are on the older end of the zircon age range determined for Mountain Pass shonkinites (~1430-1400 Ma). The Bobcat Hills shonkinites lack inherited Paleoproterozoic zircons indicative of crustal assimilation, which are ubiquitous in Mountain Pass shonkinites. This may be due to relatively small-volume and ephemeral shonkinite intrusions in cold crust (Bobcat Hills) vs. more voluminous and protracted shonkinite intrusions in warm crust primed for assimilation (Mountain Pass). Zircon trace elements are similar, with low Hf (<10,000 ppm), high Eu/Eu* (~0.8-1.3), and high Th/U (>1.5). Bobcat Hills zircons have the highest Th (>2,000 ppm) and Th/U (3-5). Zircon Ti concentrations (~50-200 ppm) and crystallization temperatures (~900-1,100 °C) overlap to exceed Ti concentrations (<100 ppm) and crystallization temperatures (<1,000 °C) for Mountain Pass zircons. Bobcat Hills may be a critical locality for understanding mafic Mesoproterozoic magmatism in the region and mantle sources of REEs that led to the formation of the world-class Mountain Pass REE deposit.