

SPECIAL COLLECTION: FROM MAGMAS TO ORE DEPOSITS

Geochemistry, petrologic evolution, and ore deposits of the Miocene Bodie Hills Volcanic Field, California and Nevada

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ABSTRACT

The southern segment of the ancestral Cascades magmatic arc includes numerous volcanic fields; among these, the Bodie Hills volcanic field (BHVF), astride the California-Nevada border north of Mono Lake, is one of the largest (>700 km²) and most well studied. Episodic magmatism in the BHVF spanned about 9 million years between about 15 and 6 Ma; magmatic output was greatest between ca. 15.0 to 12.6 Ma and ca. 9.9 to 8.0 Ma.

About two dozen contiguous and coalescing eruptive centers above middle- to shallow-crustal-level reservoirs generated several trachyandesite stratovolcanoes and numerous silicic trachyandesite to rhyolite flow dome complexes whose compositional variations are consistent with fractionation of observed phenocryst phases. BHVF rocks have high-potassium calc-alkaline compositions consistent with generation of subduction-related continental margin arc magmas beneath thick continental crust. Radiogenic isotope ratios in BHVF rocks vary considerably but suggest somewhat enriched, crustal sources; isotopic ratios for some of the more primitive units are consistent with more depleted, mantle sources. Neither age nor whole-rock compositions of BHVF rocks are well correlated with isotopic variations. Textures and compositions of phenocrysts in BHVF rocks are in accord with the associated magma reservoirs evolving via open-system behavior. Reservoir recharge and subsequent incomplete homogenization are evidenced by the broad compositional diversity characteristic of many BHVF eruptive units. Significant compositional diversity among the products of coeval eruptive centers further suggests that centers responsible for BHVF magmatism were underlain by small, discrete, compositionally distinct, and closely spaced reservoirs.

Volcanic rocks of the BHVF host quartz-adularia and quartz-alunite epithermal gold-silver deposits, from which about 3.4 Moz. of gold and 28 Moz. of silver have been produced. The volcanic rocks and contained deposits are broadly coeval, which suggests that the associated magmas are the sources of heat, fluids, and metals involved in deposit genesis. Characteristics of the quartz-adularia deposits are consistent with derivation from near-neutral pH fluids at ≤ 250 °C, whereas those of the quartz-alunite systems require more acidic, oxidized, and sulfur-rich fluids at temperatures <250 °C. Economically viable precious metal accumulations are in fault-hosted vein deposits in the Bodie and Aurora districts. Circulation of hydrothermal fluids through permeable pyroclastic deposits but lacking prominent structural conduits resulted in large areas of altered but unmineralized rock.

Keywords: Arc magmatism, geochemistry, petrogenesis, mineral deposits, tectonic setting