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Temporal Evolution of Arc Magmatism and Hydrothermal Activity, Including Epithermal Gold Veins, at Borovitsa Caldera, Southern Bulgaria

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Abstract

Plutonic, volcanic, and hydrothermal activity in magmatic arcs is commonly focused spatially, leaving behind complex records of multiple ore-forming processes that can be appreciated in detail only if the timing of igneous and hydrothermal systems is ascertained. The Spahievo ore district, Bulgaria, is adjacent to the Oligocene Borovitsa caldera, one of the largest in Europe. Juxtaposition of porphyry mineralization, barren advanced argillic alteration, and low-sulfidation epithermal alteration and mineralization zones along the caldera margin provides an uncommon opportunity to examine the temporal development of an evolved magmatic-hydrothermal system. $^{40}Ar/^{39}Ar$ ages determined using a CO_2 laser to fuse or incrementally heat minerals from fresh igneous and altered rocks indicate a rapid succession of (1) pre-caldera intermediate magmatism including monzonitic intrusion and coeval porphyry-style mineralization and advanced argillic alteration between 32.9 and 32.3 Ma; (2) rhyolitic ash-flow tuffs, dikes, and domes, with adularia-sericite alteration accompanied by epithermal precious metal mineralization at 32.1 Ma; and (3) nearly synchronous collapse of a nested caldera and intrusion of a ring-fault rhyolite dome and intracaldera dikes at 31.8 Ma. These ages link monzonitic intrusion, Cu-Mo mineralization, and advanced argillic alteration, and indicate that rhyolitic magmatism and adularia-sericite alteration with associated basemetal plus Au mineralization is slightly younger, about 100 to 500 k.y. Deposition of Au ore ca. 300 k.y. prior to caldera collapse distinguishes this ore district from many wellknown deposits in which ore formation accompanied andesitic or rhyolitic intrusions along ring fractures that postdate the collapse.