

Age of the Pueblo Viejo Gold-Silver Deposit and Its Significance to Models for High-Sulfidation Epithermal Mineralization

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Abstract

Isotopic analyses were undertaken to clarify age relationships between mineralization in the Pueblo Viejo high-sulfidation epithermal deposit and its host Los Ranchos Formation. This study is important to models for high-sulfidation epithermal deposits because the Los Ranchos Formation is a largely submarine, island-arc tholeiite sequence, very unlike the subaerial, calc-alkaline volcanic sequences that host most high-sulfidation epithermal deposits.

Previous U-Pb analyses of zircons from the Los Ranchos Formation show that it formed between about 118 and 111 Ma and was intruded by the Cotui stock at about 112 Ma. New U-Pb isotope analyses of zircons from quartz porphyries at two different levels in the ore-hosting, upper Los Ranchos Formation indicate an age of 111.4 ± 0.5 Ma (MSWD = 1.92), essentially the same as that of the Cotui stock, confirming that the stock was probably the source of the quartz porphyry magmas and mineralizing fluids. Rb-Sr analyses of sphalerite from gold-bearing veins reflect mixing between magmatic and seawater Sr reservoirs but yield no age constraints. Ar-Ar analyses of illite from advanced argillic alteration in the Moore orebody yield a plateau age of 58 Ma interpreted to represent complete resetting or neocrystallization, probably related to the thermal effect of small diorite intrusions immediately south and west of the district.

These measurements, combined with geologic relationships, confirm that high-sulfidation mineralization at Pueblo Viejo was coeval with deposition of its host Los Ranchos Formation, part of the island-arc tholeiite sequence that forms the base of the Greater Antilles arc. This greatly expands the types of volcanic terranes that might be prospective for high-sulfidation mineralization beyond subaerial calc-alkaline sequences to more mafic, dominantly submarine, island-arc tholeiite sequences. At present, relatively few high-sulfidation deposits are known in island-arc tholeiite sequences. This could reflect the greater difficulty of developing large advanced argillic alteration zones in these dominantly mafic rocks or simply a failure to recognize island-arc tholeiite sequences in volcanic arcs that contain mineralization. Exploration might also have been discouraged by the fact that most island-arc tholeiite sequences are dominantly submarine and contain exhalative mineralization. That both types of mineralization might form in these arcs is suggested by relationships in the Tonga-Kermadec ridge and adjacent areas, where dacitic calderas in island-arc tholeiite sequences host exhalative and high-sulfidation mineralization.

The presence of an unusually large deposit such as Pueblo Viejo in an island-arc volcanic sequence is attributable to the iron-rich nature of the wall rocks, which promoted early deposition of gold by sulfidation, and to the presence of carbonaceous sedimentary rocks that isolated the hydrothermal system and promoted ore deposition. The age and isotopic data show further that these carbonaceous sedimentary rocks were deposited during ocean anoxic event (OAE) 1b, encouraging speculation that other island-arc tholeiite volcanic sequences containing ocean anoxic event sediments might also be favorable for high-sulfidation epithermal mineralization.

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