PLUTON-RELATED GOLD IN THE BATTLE MOUNTAIN MINING DISTRICT—AN OVERVIEW

By Ted G. Theodore

The Battle Mountain Mining District includes four Tertiary porphyry Cu and three Cretaceous stockwork Mo systems, as well as a large number of distal-disseminated Ag–Au deposits (Doebrich and Theodore, 1996; Theodore, 1998). This is the main site of pluton-related mineral occurrences in the northern Great Basin, and it is an area of substantial recent production of Au by Battle Mountain Gold Co., Marigold Mining Co., and Newmont Mining Ltd. Historically, the Battle Mountain Mining District intermittently has produced metals over a span of about 120 years. It has yielded approximately 3.5 million oz Au since 1978 when production shifted from base and precious metals to precious metals. Prior to 1978, production of Au from large-scale mining operations, which began in 1967, was mostly as a byproduct of production of Cu from two separate porphyry systems centered at Copper Canyon and at Copper Basin (see section below entitled "Regional Implications of Large Distal-disseminated Precious-metal Deposits, Battle Mountain Mining District, Nevada"). Study of pluton-related Au provides a geologic and geochemical baseline for these types of deposits to which others may refer during evaluations of mineral resources in similar geologic terranes—this includes the Humboldt River Drainage study currently (1998) being investigated by the U.S. Geological Survey. Previous investigations by the U.S. Geological Survey in the mining district elucidated a linkage between a geologic terrane where distal-disseminated Ag–Au deposits (Cox and Singer, 1992) predominate in the northern part, and the porphyry Cu and stockwork Mo systems predominate in the southern part (Theodore, 1998).

Porphyry systems are generally large volumes of rock characterized by disseminated concentrations of chalcopyrite ($CuFeS_2$), bornite (Cu_5FeS_4), molybdenite (MoS_2), or Au—as well as a number of other prograde and secondary sulfide minerals—in intensely fractured rocks filled by stockwork veins or disseminated grains in hydrothermally altered porphyritic intrusions and (or) in their hydrothermally altered adjacent wall rock (Peters and others, 1996). In the Battle Mountain Mining District, the Tertiary porphyry Cu systems contain relatively high concentrations of Au compared to porphyry Cu systems elsewhere in the southwestern United States. Much mineralized rock in these systems owes its origin to fluids that were expelled during the process of crystallization of genetically associated magma, typically present locally in intrusive centers that represent composites of a number of closely associated igneous phases. In the Battle Mountain Mining District, some recent studies suggest that source magma(s) responsible for generation of the important mineralized system at Copper Canyon crystallized at considerable depths, and that these magmas expelled mineralizing fluids which were focused by small, shallow-seated igneous bodies which had risen high into the crust (Kotlyar and others, 1998). Supergene-altered equivalents of many of these deposits also may be important economically because of enrichment processes that have a tendency to enhance their Cu grades. The Copper Basin area of the Battle Mountain Mining District is an excellent example of a site where secondary enrichment of Cu prevailed on the margins of a large Cretaceous stockwork Mo system (Theodore and others, 1992). Nonetheless, porphyry types of mineralized systems tend to be developed preferentially in generally shallow-level geologic environments. Further, a continuum exists among porphyry Cu deposits, skarn deposits, and polymetallic vein deposits (see also, Carten and others, 1993; Titley, 1993; Pierce and Boehm, 1995)—all of which are widespread in the Battle Mountain Mining District.

The mining district is near the northwest terminus of the Battle Mountain-Eureka mineral belt in north-central Nevada, where many porphyry systems are situated at broad intersections of north-south-and northwest-striking structures (Doebrich and Theodore, 1996). The mining district also includes, in its southern part, the Copper Canyon Au-enriched, skarn-related porphyry Cu system which has been site of 10 relatively recent discoveries of peripheral Au–Ag orebodies—one being the 2 million oz Au Fortitude gold skarn (Wotruba and others, 1986), which was in production between 1982 and 1993. If porphyry Cu systems also are present under some clusters of Au deposits in the northern part of the mining district, then as many as nine porphyry centers may be present in the mining district. This remarkable concentration of pluton-related mineralized systems results from a number of district- and regional-scale metallotects (Doebrich and Theodore, 1996; Peters and others, 1996). Consequently, study of pluton-related Au in the mining district currently involves, in part, three-dimensional evaluation and analysis of metal zonation in approximately 2,500 drill holes, which are being studied collaboratively with geologists from Battle Mountain Gold Co. This study will provide a well-grounded foundation for evaluating subtle base- and precious-metal anomalies in exposures well beyond orebodies in porphyry Cu, skarn-related environments (see also, Kotlyar and others, 1998). Some preliminary results of a three-dimensional evaluation in the Copper Canyon part of the mining district are presented in the paper below entitled "Multilevel Geochemical Patterns at the Fortitude Gold Skarn, Battle Mountain Mining District, Nevada," which demonstrates the complexities of metal distributions around large Au deposits in pluton-related geologic environments.

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