

EPITHERMAL GOLD-SILVER DEPOSIT – EXPLORATION CASE STUDY OF EUNSAN DEPOSIT IN SOUTHWEST KOREA

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ABSTRACT

Since the 1960's, the most attractive geological exploration for gold-silver deposits have been targeted on the sedimentary-host disseminated deposit, originating hydrothermal processes, low-grade (Au 2-8 g/t) but large reserves (5-20 M tons) and led to discovery of the Carlin deposit, following Battle Mountain, Round Mountain, Getchell and etc. in northeastern to central Nevada, USA. These gold deposits are commonly known as so-called 'Carlin Type Deposit'. A similar effort have been focused on the area of known epithermal lode gold-silver deposit in the volcano-sedimentary terranes and led to discovery of Pueblo Viejo gold deposit, the Dominican Republic, following also of many others along the Circum-Pacific Rim. The deposit is characterized by association of a broad zoning of hydrothermal clay alteration, together with intense silicification halos, forming quartz-chalcedony veinings with significant precious metal values. These deposits are commonly known as so-called 'epithermal low-sulfidation or high sulfidation gold deposit'.

The southern part of the Korean peninsula is geologically similar to those of the latter environ of volcano-sedimentary terranes where Cretaceous-age volcanic and sedimentary rocks host numerous epithermal gold-silver mines and deposits, typically associated with clay-altered and intense silicified rocks, which has been successfully used as a prospecting guide to locate gold mineralisation in southwest Japan and eastern China.

Systematic evaluation of clay deposits by Ivanhoe Mines' geologists has led to the discovery of four significant epithermal gold-silver prospects in Haenam area, southwest South Korea, some 80 km southwest of Kwangju city in the Province of Chollanamdo. All of the prospects are located in close proximity.

In the Haenam area, mineralized outcrop and float, consisting of vein quartz, quartz vein breccias and quartz flooded, brecciated dacitic tuff and tuffaceous lacustrine sediment. Quartz veins crop out as individual lodes up to 1 m across and form stockwork zones up to 15 m wide. These veins display many characteristics of multiphase zones of hydraulic brecciation with silica re-sealing, typified by crystalline comb and crudely colloform to cockade banded quartz and chalcedony. These are largely hosted in variably water re-worked dacitic lithic tuff, lesser massive fine-grained tuffaceous siltstone and black, variably laminated, carbonaceous mudstone. Dacitic tuff and tuffaceous siltstone exposures are moderate to intensely quartz-illite/sericite-adularia altered with minor paragenetically late calcite. The laminated mudstone is intensely silicified with rare segregations of fine-grained pyrite along fractures. This sequence may represent a shallow lacustrine lake setting, within an active caldera.

The Eunsan prospect is the most significant economic gold-silver deposit, explored by a network of surface trenching and diamond drillings. It is centered on Eunsan Hill approximately 30 meters high and 250 meters long located 2 km northwest of the Seongsan clay mine, currently the most active producing pyrophyllite-alunite mine in Korea. Drilling to date has tested some 700 m of strike length and 100-150 m of dip level along the mineralized structure.

Drill hole lithologies show that the upper tuff-tuffaceous sedimentary sequence intersected in most diamond drill holes is characterized by variably water re-worked, fine to coarse-grained ash to lithic-crystal tuff. Interbeds of coarse-grained pumiceous lapilli to minor accretionary lapilli tuff occur throughout the upper sequence. The tuffs are also interbedded with lesser grey-black, carbonaceous lacustrine mudstone lenses and beds that are often finely laminated and host very fine-grained pyrite. Coarse grained, water re-worked, pumiceous lithic-lapilli tuff, which displays varying degrees of welding, underlies the upper tuff-mudstone sequence. This unit contains pebble-like layers of very coarse-grained, fibrous pumic lapilli and grades down into finer-grained lapilli tuff with minor carbonaceous mudstone interbeds.

Economic gold-silver mineralisation at Eunsan is structurally controlled and is restricted to low-sulfidation epithermal quartz vein, breccia and quartz flooded to quartz vein stockworked zones in the tuff-sediment sequence. Coarse-grained, permeable pumiceous lithic tuff units are commonly quartz-adularia-calcite flooded and cut by stockworks and discrete veins of massive to crudely colloform banded, crystalline to lesser mesocrystalline quartz, adularia and calcite. Vugs and cavities are commonly lined by fine-grained drusy to medium-grained prismatic quartz. Massive blocky calcite veins intercepted in several holes are barren of precious metals. Hydraulic vein breccias and quartz to quartz-calcite re-healed host rock breccias largely occur in competent, intensely silicified tuffaceous siltstone and mudstone.

Vein ore mineralogy is dominated by fine to coarse-grained, commonly visible, silver-rich electrum (fineness 300 to 500). Electrum also occurs as inclusion in bluish-grey acanthite and grey pearceite. Argentite, acanthite, polybasite, and lesser silver-rich tetrahedrite (freiburgite) are the main silver bearing minerals. Native silver and gold occur intergrowth with pyrite, chalcopyrite and acanthite.

Dacitic ash to lithic-lapilli tuffs at Eunsan display variable degrees of hydrothermal alteration, including quartz-illite-adularia, quartz-illite-chlorite-pyrite and quartz-illite-albite-calcite bearing assemblages. Fiamme in welded pumiceous lithic tuffs are commonly altered to illite, and feldspar alters to adularia and chloritic clay. Accretionary lapilli, volcanic glass and lithic fragments have partially altered to an assemblage of quartz, chlorite and pyrite.

The highest grades are localized in crystalline to mesocrystalline quartz veins and silica flooded dacitic tuff, intersected by northwest-southeast trending mineralizing structures, hydraulically brecciated and quartz-calcite re-healed tuffaceous sediments and quartz-calcite stockworked dacitic tuff. Multiphase brecciation and silica and calcite self sealing textures, coupled with cockade to colloform band development, indicate that Eunsan represents a dynamic low sulfidation epithermal system conducive to the development of high grade gold-silver mineralisation. Abundant quartz pseudomorphs after bladed carbonate and the presence of adularia in veins indicate that the fluids responsible for mineralisation were boiling. The most high gold-silver grades (bonanza) obtained from trenched veins and drill core indicate that Eunsan represents a classical high-grade epithermal, low-sulfidation gold-silver target. Quartz vein textures, high silver to gold ratios, a lack of base metals and low to moderate fineness electrum indicate that Eunsan may represent the upper level of the epithermal system.