MINERAGRAPHY AND FLUID INCLUSION STUDIES OF THE LALAB OREBODY, SIBUTAD, ZAMBOANGA DEL NORTE: IMPLICATION FOR THE STYLE OF MINERALIZATION IN EPITHERMAL GOLD SYSTEMS

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Abstract

Larayan and Lalab gold orebodies occur in Sibutad, Zamboanga del Norte. They and, at least, seven gold prospects are underlain wholly by the Malindang Volcanics. The Malindang Volcanics is composed of a lower member and an upper member. The Malindang Volcanics is intruded by an andesite porphyry body. The lower member is made up of the andesite flow and dacite tuff/tuffite, whereas the upper member is composed of basaltic to andesitic volcanic breccia and tuff breccia. In Lalab, hydrothermal processes marked by attendant gold and base-metal mineralization, occur at shallow to near-surface environment in andesite flow rocks. Lalab orebody is divided into the West Lalab and Main Lalab mineralized areas, in the northwestern and southern portions of the deposit, respectively. Both are hosted by aphanitic and porphyritic andesites. Other rocks found within, and around, the Lalab deposit are the hydrothermal breccias and siliceous rocks. Variably-altered hydrothermal breccia bodies are characterized by flaring-upward geometry and highly angular breccia clasts, often exhibiting jigsaw-puzzle fit, set in finely-comminuted matrix. Formation is related to hydrothermal eruption through hydraulic fracturing. In-situ massive siliceous deposit, having amorphous texture, occurs in the Main Lalab. Rock clasts of the siliceous deposit are identified in the hydrothermal breccia bodies, thus containing the pre-breccia formation of the siliceous deposit. Gold-bearing milky quartz veins and veinlets are oriented in a NW=SE, NNE-SSW to almost N-W and NE-SW directions.

The geology, mineralogy and fluid geochemistry of the Lalab orebody point to its epithermal character, as shown by its shallow occurrence, from the paleosurface to, at least, 800m below. The paleodepths were calculated using the location of boiled fluid inclusions and temperature. The temperature regime lies between 186°C and ≥250°C. The style and mineralogy of wallrock alteration, suggestive of precipitation from reduced, near-neutral pH solution, the boiling-indicator bladed texture and the low-salinity composition of the hydrothermal fluid farther show Lalab deposit to be an adularia-sericite type.

Mineragraphic determination, in terms of gold, sulfide and oxide contents of different altered rocks, including the hydrothermal breccia bodies, resulted into the division of mineralization in Lalab into three stages, namely Stage I, Stage II and Stage III. The Stage I mineralization is related to the fluid that produced the pre-breccia wallrock alteration, principally silicification. Stage I has pyrite, sphalerite+galena, chalcopyrite and bornite as the ore minerals. The Stage II mineralization was formed by hydrothermal fluid that produced the post-breccia wallrock alteration, characterized by silicification, sericitization and argillization. The present alteration zonation of Lalab orebody was produced by these alteration types. Silicification, which grades outward to sericitic alteration with an increase in the amount of illite, formed the inner zones. Surrounding these zones is the extensive argillic zone, made up of the smectite-illite grading to illite-smectite-kaolinite. A kaolinite together with the relict illite overprint of argillic alteration zone formed the illite-kaolinite zone. Mineralization brought by the Stage II fluid is
composed of pyrite, chalcopyrite, bornite and gold. Stage III mineralization is associated with hydrothermal fluid that formed the milky quartz veins and veinlets. Mineralization by the Stage III fluid is characterized by pyrite, bornite, chalcopyrite and gold. Mineralization if the Stage I fluid point to chloride metal-ligand as the principal species. A possible magmatic water input for the Stage I fluid can be inferred. Similarly, mineralization in the Stage III fluid indicated significant magmatic water component, on the basis of the predominance of bornite over chalcopyrite. The relatively oxidizing environment is typical for the magmatic environment. The association of barite in milky quartz veins is consistent with the magmatic water input in the Stage III fluid since barite connotes a SO$_2$-rich solution that may have been produced from the degassing of magma.

Ore grade gold mineralizations, defined by assay of >0.5 g/ton Au, are associated with the Stage II and Stage III fluids. Elevated gold grades, with assay of 5.0 g/ton Au to as high as 79.09 g/ton Au, however, are related to the Stage III fluid and preferentially localized. High grade ore zones are continuous within the depth of 200m to 620m below the calculated paleodepth. This focusing of gold-bearing Stage III fluid in specific horizon is probably controlled by the occurrence of efficient fracture system at this deeper horizon in the West Lalab, specifically in the competent silicified andesite and hydrothermal breccia bodies.

Fluid inclusion microthermometry showed that the Stage I fluid has a temperature regime greater than 238°C, the Stage II fluid within 210°C to 235°C and the Stage III fluid within 186°C to 215°C. The salinity of the fluids for the three stages is between 1.0 and 2.0 eq. wt. % NaCl. The decrease in temperature of the fluid at nearly uniform salinity from the Stage I through to Stage II to the Stage III fluids suggests simple cooling process. This is consistent with the decreasing temperature of the fluids approaching the paleodepth level. Fluid inclusions that were trapped in boiling condition indicate depth of trapping between 225m and 400m below the paleosurface. The difference between the present surface and the calculated paleodepth is equal to the thickness of the eroded rocks, which in Lalab is between 100m and 290m. Ore-grade gold mineralization associated with the Stage II and Stage III fluids had undergone simple cooling process, as indicated by progressive decrease in temperature at nearly uniform salinity range. This may have contributed to achieve condition favorable for the precipitation of gold from the hydrothermal solution.