A study of metal ratios in the Lepanto Cu-Au deposit with implications to ore formation and geochemical exploration

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The Lepanto Cu-Au deposit is a zoned ore deposit with distinct distribution and correlation of metals locally across veins and regionally across the entire deposit. Previous studies on paragenesis and metal distribution and correlation have shown a consistent relation between the presence and absence of minerals and corresponding metal values. The mineral and metal zoning studies which actually defined ore shoot distribution have provided protocols in the geochemical exploration of similar deposits as Lepanto. In attempting to evaluate further the physical and chemical regimes of the deposit, metal ratios were studied. This study used the commonly analyzed metals in mine operations, which through time could provide a large inventory of information on metal values which could be statistically analyzed. Ratios Pb/Cu, Ag/Pb and Au/Ag were evaluated based on their spatial distribution throughout the mine and the interpreted contouring of ratio values. Concave contours indicated possible flow direction of mineralizing fluids. The flow directions are dominantly from relatively low to high values. This is drawn in vertical and lateral dimensions.

In plotting the metal ratios, it was apparent that Pb/Cu, Ag/Pb and Ag/Cu ratios showed distinct variations within the different ore zones thus were used in this study. In appreciating these different metal ratios, it was important to consider the associations of each metal with the formation of specific ore minerals. The presence of Pb is indicated by the deposition of galena, Ag by the deposition of tennantite-tetrahedrite and Au by its deposition as electrum. The Ag/Cu and Au/Cu ratios are monotonically distributed thus were not considered in this study. It appears based on correlation that in most of the ore bodies the apparent increase in Cu, consequential increases in Ag and Au were observed. This could be explained by the paragenetic occurrences of Ag and Au tellurides. Tellurides were noted to be associated with enargite-luzonite during regimes of higher sulfur activity.

Previous studies have strongly supported the evolution from magmatic to predominantly magmatic-meteoric type of ore formation for Lepanto and this is exemplified by the deposition of tennantite-tetrahedrite, chalcopyrite and galena-sphalerite after the enargite-luzonite stage. Based on the characteristics and distribution of the ore shoots, areas that are highly fractured and brecciated are along the Lepanto fault and related fractures. The
mineralizing fluids that formed the ores in these areas were interpreted to have greater magmatic contribution. These are exemplified by the deposition of energite-luzonite in the main ore body, northwest ore body and some parts of the hanging wall and the foot wall branch veins. Previous studies have indicated multiple stages of brecciation were observed in the main ore body. The eventual increase in meteoric dilution is exemplified by the predominant deposition of tennantite-tetrahedrite, chalcopryite and galena-sphalerite in vein type ore bodies such as those found in the hanging wall and foot wall branch veins and the easterlies and TPLs.

These changes from dominantly magmatic to magmatic-meteoric are manifested in the flow directions of mineralizing fluids. The contoured Pb/Cu ratios indicated flow directions that originated from the brecciated parts of the Lepanto fault. It is along the Lepanto fault where the fluids are predominantly magmatic. The contoured Ag/Pb and Au/Ag ratios indicated flow directions of mineralizing fluids with greater meteoric dilution and these were deposited in conjugate fractures relatively far from the main Lepanto fault.

Studies in mineral and metal zoning and metal ratios using large inventory of metal analyses in mine operations could help not only in understanding further the physical and chemical characteristics and conditions of ore formation but also the flow directions of mineralizing fluids which in total would have a greater implication in the search for new Lepanto type ore deposits.