# EXPLORATION AND GENESIS OF METALLIC MINERALIZATION ASSOCIATED WITH THE WESTERN KOHISTAN ISLAND ARC, NORTH PAKISTAN

**Research Scholar: Israr Ud Din**

## Abstract

Western Kohistan Island Arc (KIA) covers the northwestern part of Dir Upper, where the rocks of Kamila amphibolite, Dir metasediments, Kohistan batholith, and Utror volcanics are exposed. Detailed mineralogical and geochemical studies of sulfide mineralization and host rocks (i.e., amphibolites, granites, granodiorites and metavolcanics) were carried out in four different localities (i.e., Kadikhel, Ushiri, Sheringal-Kohistan, and Haygai) of the study area. Based on field observations, four types of copper-bearing mineralized /altered zones have been identified. These are 1) copper mineralization along quartz veins, 2) copper mineralization in the host rocks, 3) supergene enrichment of copper mineralization, and 4) copper mineralization along foliation planes.

A detailed petrographic study of each area was carried out to determine different types of textures and mineralogical composition. Petrographic studies reveal that the amphibolites are fine- to medium-grained, inequigranular with hypidioblastic texture, and weakly foliated. The granite is medium to coarse-grained and consists of zoned, altered, and twinned plagioclase, feldspar, and quartz with a minor amount of opaque minerals, augite, amphibole, and epidote. It shows a myrmekite texture. The granodiorite is medium to coarse-grained, highly criticized, and has quartz sericite and epidote veins with sieve texture. Among the meta-volcanics, meta-basalt shows different degrees of alteration in various parts of the Kohistan arc, while andesite is highly altered with twinned plagioclase and Carlsbad twinning. Rhyolite is having porphyritic texture, dominated by undifferentiated ground mass with quartz and sericitized feldspar phenocrysts. At places, quartz-epidote micro-veins are also noticed.

The whole rock major, trace, and rare earth elements of the selected rocks were carried out to determine the petrogenesis, as well as the economic potential of sulfide mineralization of these rocks. The geochemical data of the host rocks indicate low values of HREEs, high values of LREEs, depletion of HFSE, enrichment of LILE with spiky pattern, negative trend of Zr and Ti and positive anomaly of Pb show mantle source in island arc tectonic setting. The metallic minerals in the form of chalcopyrite, bornite, chalcocite, malachite, azurite, pyrite, magnetite, and hematite, with minor amounts of galena, sphalerite, nickel, gold, and tungsten were identified through ore microscopy, SEM-EDX, XRD and geochemical analyses. The average concentration of copper in viii the mineralized host rocks has been observed as 5.31% in amphibolites, 2.67% in granites, 3.83% in granodiorite 3.42% in 3.42% in andesite, 5.45% in meta-basalt, 5.75% in rhyolite, and 11.33% in the mineralized quartz veins. The mineral paragenesis takes place in two stages: the hydrothermal stage consists of fracture filling, vein filling, patchy and massive types of different copper ores. The major ore minerals formed at this stage are chalcopyrite and bornite with minor

amounts of magnetite, pyrite, hematite and galena. In the replacement stage, the early-formed minerals were replaced by new minerals. The chalcopyrite and sometimes bornite are replaced by malachite, azurite, hematite, and limonite along the margins and microfractures, which are considered as alteration products.

The average $\delta^{34}S$ values (4.3%) and $\delta^{18}O$ values (8.7%) in the study area suggest that the sulfide mineralization is formed due to magmatic-hydrothermal activity. The magmatic-hydrothermal model is supported by the existence of ore/metallic mineralization occurs in fracture and vein fillings, as well as disseminated ore grains in the form of chalcopyrite, bornite, sphalerite and galena. Intergrown textures among these sulfides suggest simultaneous crystallization from hydrothermal fluids with early crystallization of the copper-rich phase (i.e., chalcopyrite). These ore phases mostly show mutual grain contact and linear sharp boundaries. The fracture-filling and micro vein nature of these sulfides, especially chalcopyrite, represent hydrothermal fluids activity. The replacement of early-formed ore minerals by new minerals and wall rock alterations such as sericitization, kaolinization, silicification, and propylitization also favor the hydrothermal environment.