

Petrochemical Investigation of Sulfide Mineralization and Host Rocks of Kusham Area, Upper Chitral, Pakistan

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The Kusham region of upper Chitral contains sulfide mineralization in the form of ~5 cm thick mineralized quartz veins. These veins are primarily limited to the Wakhan Formation's meta-greywackes bed near its contact with the Sarikol Shales. Based on petrographic, geochemical, and field characteristics, the rocks in the research area are classified as Fe-rich shales and meta-greywacke. The meta-greywackes, primarily composed of angular to sub-angular quartz, mono- crystalline, alkali kaolinized and alkali sericitized feldspar, and matrix, are immature, fine-grained, and compact rocks of poorly sorted. The rock has undergone low-grade metamorphism and has quartz veins that are mineralized and barren, arranged in various directions. The primary ore phases found in mineralized quartz veins are sphalerite, chalcopyrite, and galena. Fine-grained ore phases are found as inclusions, whereas coarse- to medium-grained ore phases are prevalent. The oxidation products are hematite, olivenite, plattnerite, and limonite. The intergrowth textural nature of sulfide minerals (sphalerite, galena and chalcopyrite) implies that they have been precipitated simultaneously. On average, the meta-greywackes have the following compositions in wt%: SiO₂, TiO₂, Al₂O₃, Fe₂O₃, and MnO of 72.89, 0.8, 13.39, 0.93, 0.04 respectively. On the other hand, the average trace element values for Cu=145 ppm, Pb=1530 ppm, Zn=530 ppm, Ni=29 ppm, Cr= 30 ppm, Co=33 ppm, Cd=11. The Fe-shales exhibit average wt% concentrations of SiO₂, TiO₂, Al₂O₃, Fe₂O₃, MnO, MgO, CaO, Na₂O, K₂O, and P₂O₅ as 53.8, 0.32, 14.6, 13.3, 0.50, 2.31, 3.73, 0.74, 2.48, and 0.09 respectively. The average trace element values are: Cu=58 ppm, Pb=100 ppm, Zn=206 ppm, Ni=23 ppm, Cr=50 ppm, Co=61, Cd=2 ppm, and Ag=7 ppm. The mineralized quartz veins are substantially enriched in Pb, Cu and Zn, with average concentrations of 71427, 3195 and 746 ppm,

respectively. The average concentration of Ag is high, at 71 ppm, although the amounts of the other trace elements are rather low. Majority of the samples include Au in concentrations below the revealing limit (0.05 ppm), although insufficient have Au in minor amount (<0.72 ppm). The solution of hydrothermal yields an important role in the creation of mineralized quartz veins and nearby alteration of wall rock, which resulted in the enrichment and depletion of various chalcophile elements from the host rock. During the fluid interaction, the altered rocks gained a considerably higher amount of Cu, Pb, and Zn, with just a modest increase in Cd and Ag. The hydrothermal solution could be magmatic or metamorphic metalliferous fluid; nevertheless, field factors strongly favor the contribution of metamorphic fluid.