# ABSTRACT

## INTEGRATED GEOPHYSICAL AND GEOLOGICAL TECHNIQUES FOR IDENTIFICATION OF SULFIDE ORE DEPOSITS IN GAWUCH FORMATION, CHITRAL, NORTHERN PAKISTAN

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Integrated geophysical and geological exploration techniques have been employed for sulfide minerals prospection in the Gawuch Formation, Chitral, northern Pakistan. The core objectives of the study were to map sulfide mineralization, analyze structural lineaments and their influence on mineralization, ascertain the depth of causative source bodies, pinpoint economically viable drilling prospects in the area and validate integrated geophysical interpretations by cross-referencing them with surface-based geological data, geochemical results, and information obtained from shallow boreholes. The geophysical surveys were conducted using the electrical self-potential and ground magnetic techniques. The self-potential tool served to qualitatively delineate lateral variances in the dispersal of shallow sulfide minerals, notably pyrite and chalcopyrite, by analyzing the differences in natural surface potential while magnetic tool was employed to map the lateral heterogeneities in the Earth's magnetic field, aiming to delineate the distribution of magnetically susceptible mineralization, including magnetite associated with sulfide mineralization, as well as to qualitatively map geologic structures like faults or fractures that influence the distribution of mineralization

The acquired magnetic data reveals a shallow and sporadic network of circular to semicircular magnetic discontinuities which is one of the characteristic of porphyry deposits which is further supported in places by low SP signatures that might represent a stock work of

fractures/veins in the subsurface that could potentially be the target zones for sulfide mineral prospection in the area. Structural delineation using horizontal and vertical gradient maps of magnetic method shows that the area is characterized by NE-SW trending structural lineaments i.e faults or fractures. Based on the analysis of self-potential and magnetic anomaly maps and profiles, the average depth to the top of the anomaly sources in the study area ranging from near surface to 22.37 meters. To validate the results, two shallow boreholes were drilled in the study area which intersects disseminated and fracture filled sulfide mineralization within the uppermost 6 feet of the surface, with the potential for continued mineralization at deeper depths.

The geochemical analysis of the selected representative core and grab samples from the identified geophysical anomalous sites corresponds with the geophysical findings, revealing an average composition of 7.84% Cu, 28.34% Fe, 55.5ppm Ag, and 0.14 ppm Au in the study area. Further, XRD analysis has identified the presence of propylitic alteration mineral assemblages, such as chlorite, albite, epidote, and pyrite suggesting that the rocks in the study area have undergone a porphyry-style alteration process. Based on the insights derived from integrated analysis of geophysical responses, core drilling data, surface-based geological observations, and the outcomes of geochemical analyses, it can be inferred that sulfide mineralization in the Gawuch Formation at Drosh-Kaldam Gol, Chitral region is governed by northeast-southwest trending fault/fracture system and is intricately linked with diorite-granodiorite intrusion, exhibiting characteristics akin to porphyry systems.