World Academy of Science, Engineering and Technology
International Journal of Geological and Environmental Engineering
Vol:18, No:07, 2024

Geological, Geochronological, Geochemical, and Geophysical Characteristics of the Dalli Porphyry Cu-Au Deposit in Central Iran; Implications for Exploration

Authors : Hooshag Asadi Haroni, Maryam Veiskarami, Yongjun Lu

Abstract : The Dalli gold-rich porphyry deposit (17 Mt @ 0.5% Cu and 0.65 g/t Au) is located in the Urumieh-Dokhtar Magmatic Arc (UDMA), a small segment of the Tethyan metallogenic belt, hosting several porphyry Cu (Mo-Au) systems in Iran. This research characterizes the Dalli deposit to define exploration criteria in advanced exploration such as the drilling of possible blind porphyry centers. Geological map, trench/drill hole geochemical and ground magnetic data, and age dating and isotope trace element analyses, carried out at the John De Laeter Research Center of Curtin University, were used to characterize the Delli deposit. Mineralization at Dalli is hosted by NE-trending quartz-diorite porphyry stocks (~ 200m in diameter) intruded by a wall-rock andesite porphyry. Disseminated and stockwork Cu-Au mineralization is related to potassic alteration, comprising magnetite, late K-feldspar and biotite, and quartz-sericite-specularite overprint, surrounded by extensive barren argillic and propylitic alterations. In the peripheries of the porphyry centers, there are N-trending vuggy quartz veins, hosting epithermal Au-Ag-As-Sb mineralization. Geochemical analyses of drill core samples showed that the core of the porphyry stocks is low-grade, whereas the high-grade disseminated and stockwork mineralization (~ 1% Cu and ~ 1.2 g/t Au) occurred at the contact of the porphyry stocks and andesite porphyry. Geochemical studies of the drill hole and trench samples showed a strong correlation between Cu and Au and both show a second-order correlation with Fe and As. Magnetic survey revealed two significant magnetic anomalies, associated with intensive potassic alteration, in the reduced-to-the-pole magnetic map of the area. A relatively weaker magnetic anomaly, showing no surface porphyry expressions, is located on a lithocap, consisting of advanced argillic alteration, vuggy quartz veins, and surface expressions of epithermal geochemical signatures. The association of the lithocap and the weak magnetic anomaly could be indicative of a hidden mineralized porphyry center. Litho-geochemical analyses of the least altered Dalli intrusions and volcanic rocks indicated high Sr/Y (49-61) and Eu/Eu* (0.89-0.92), features typical of Cu porphyries. The U-Pb dating of zircons of the mineralized quartz diorite and andesite porphyry, carried out by laser ablation inductively coupled plasma mass spectrometry, yielded magmatic crystallization ages of 15.4-16.0 Ma (Middle Miocene). The zircon trace element concentrations of Dalli are characterized by high Eu/Eu* (0.3-0.8), (Ce/Nd)/Y (0.01-0.3), and 10000*(Eu/Eu*)/Y (2-15) ratios, similar to fertile porphyry suites such as the giant Sar-Cheshmeh and Qulong porphyry Cu deposits along the Tethyan belt. This suggests that the Middle Miocene Dalli intrusions are fertile and require extensive deep drillings to define their potential. Chondrite-normalized rare earth element (REE) patterns show no significant Eu anomalies, and are characterized by light-REE enrichments (La/Sm)n = 2.57–6.40). In normalized multi-element diagrams, analyzed rocks are characterized by enrichments in large ion lithophile elements (LILE) and depletions in high field strength elements (HFSE), and display typical features of subduction-related calc-alkaline magmas. The characteristics of the Dalli deposit provided several recognition criteria for detailed exploration of Cu-Au porphyry deposits and highlighted the importance of the UDMA as a potentially significant, economically important, but relatively underexplored porphyry province.

Keywords : porphyry, gold, geochronology, magnetic, exploration
Conference Title : ICESRE 2024 : International Conference on Earth Science and Resource Engineering
Conference Location : Paris, France
Conference Dates : July 18-19, 2024