

Gold Exploration Through Integrating Machine Learning, Remote Sensing, Aeromagnetic, and Spectrometric Gamma-Ray Data. A Case Study from the Egyptian Eastern Desert

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Mineral exploration is the initial stage that constitutes the basic framework for more expensive exploration and exploitation operations. Consequently, adequate preliminary explorations help in saving time, effort, and money in the whole mining industry process. The current research is an attempt to make the best use of integrated data to raise the chance of productive mineralized zones. This is achieved by applying multi-sensor remote sensing data, airborne geophysical data, including aeromagnetic and spectrometric gamma-ray data, machine learning algorithms, and field observations for accurate lithological discrimination and precise hydrothermal alteration delineation that is mostly associated with orogenic gold deposits in the central Egyptian Eastern Desert. Instead of using remote sensing data or gamma-ray data independently, an excellent lithological map for the examined terrain is created by noting the variable concentrations of K, Th, and U and the distinctive spectral signatures of the rock units. Additionally, the concentrations of K, Th, and U have been used for the delineation of hydrothermal alteration zones, which is confirmed by informative remote sensing combinations and field observations. Thorough structural delineation is required for adequate mineral potentiality mapping as it controls the pathways through which hydrothermal solutions flow and plays a role in concentrating mineral deposits. Thus, automatic lineament extraction and the center for exploration targeting (CET) technique were utilized to create accurate maps of structural complexity by analyzing aeromagnetic information. Our results distinguish various types of alteration zones, including fies, argillic, and propylitic. Spatial overlay analysis of the detected structural features and hydrothermal alteration zones highlighted higher potential zones of gold mineralization within the study area. Our field investigations have confirmed the outcomes of the current research, and several random mining sites were observed during our field verification. Thus, we strongly recommend adopting the utilized approach for further investigation and gold exploration in similar terrains.