Geophysical Signature of the Bafq Iron Oxide-Apatite Deposits in Central Iran: Implications for Exploration

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The Bafq iron oxide-apatite (IOA) district in central Iran is well known for its operating Fe ore mines, such as Esfordi, Choghart, Sechahun, and Chador Malu. In addition, the district contains several smaller Fe deposits and occurrences, most of which were successfully identified by airborne magnetic surveys conducted in the late 1960s and 70s. Recently completed airborne magnetic and radiometric surveys explored the northern extension of the Bafq district in the Posht-e Badam area, thereby providing an opportunity to identify further IOA and potentially related iron oxide copper-gold (IOCG) deposits.

To assist IOA and IOCG mineralization targeting, the geophysical signatures as well as geological and structural settings of known IOA mineralization in the Bafq district were characterized. Historical magnetic and radiometric data were stitched into recent airborne surveys, providing a continuous regional coverage for a district-wide structural interpretation. Magnetic data were inverted to create susceptibility volumes, which were queried to isolate anomalous magnetic sources and regionally elevated magnetic signature.

Airborne geophysics provides an excellent means of identifying a number of regional vectors to mineralization associated with both IOA and IOCG districts. In general, these include (i) presence of volcanic/volcaniclastic host rocks containing significant ferrous iron minerals, typified by a regionally high magnetic response; (ii) presence of associated gabbrodiorite-diorite bodies, easily detectable as discrete magnetic anomalies; (iii) widespread magnetite alteration, often apparent as zones of regionally elevated magnetic response; (iv) associated batholithic granitoids, characterized by arcuate magnetic anomalies; and (v) a regionally elevated radiometric response.

From a structural perspective, the magnetic data assist with identification of major terrane-bounding faults, orogeny-parallel faults coeval with metallogenetically relevant intrusives, and, potentially, demagnetization along faults, providing evidence of an extensive hydrothermal system. Based on the review of known deposits, IOA mineralization in the studied area is highly magnetic and, in many places, associated with anomalously high Th and K radiometric responses. Laterally extensive, terrain-bounding Cambrian to Precambrian structures host and control the positions of primary NNW-SSE– to N-S–trending IOA mineralization. The known deposits occur in areas of regionally elevated magnetic susceptibility and are, in most cases, spatially associated with magnetic intrusive bodies. These variables can be easily combined to identify targets of interest.

Unlike the magnetite-rich IOA targets, potential IOCG mineralization may be associated with hematite-rich, less magnetic breccias, which may be located off-center or even displaced completely from magnetic anomalies. Although a similar targeting process for IOCG mineralization can be applied, the results typically identify priority areas rather than direct targets.