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Knowledge-driven Approach to Exploration of Carbonate Hosted Zinc and Lead Deposits, Case study: North Irankuh district, Isfahan - Iran

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Introduction

This research study is based on knowledge-driven approach to synthesize the different parameters which rule on the formation of carbonate hosted zinc and lead deposits. The analysis of available data sets of the north Irankuh district demonstrates the complexity of decision making due to the different anomalous prospects introduced by geophysical, geochemical and surface evidences.
Five known deposit/active mines, namely Gushfil, Zone 1 Gushfil, Blind, Tapeh Sorkh and Zone 5 Romarmar with total geological resources quoted as 13.4 million tons at 5.53% combined lead and zinc (Fig. 10) were selected to be examined in order to asset a knowledge-driven approach to the exploration of carbonate hosted zinc and lead deposits. The diversity of geometry, mineralogy and host rock of the deposits is tightly confined by the parameters surrounding the genesis of MVT deposits such as genetics of solutions, temperature of deposit formation, tectonic channel ways, different episodes of deposition of sphalerite and galena, hydrologic system of area, solution direction, wall rock reactions (Leach et al., 2010), depth of solution penetration, solution response to the Magnesian regime and metal bearing.

Materials, Methods, and Procedures

The present study consists of detailed underground and surface mapping, reinterpretation of district geology, detailed logging of about 100000 meters' diamond drilling, ore geology, tectonic settings, deposits geometry, geochemical and geophysical survey within 7 square kilometers of north Irankuh district between the Gushfil and Tapeh Sorkh deposits.

Discussion and Results

Five known deposits in the north Irankuh district occur in the area of an intense detachment faulting (Fig. 1 and Fig. 5). The Gushfil, Zone 1 Gushfil and Blind deposits occur in north Irankuh reverse fault and Tapeh Sorkh and Zone 5 Romarmar in the trust fault. The deposits are confined to a certain stratigraphic unit locally called K3D (Figs. 2 and 3). Widespread regional selective dolomitization shows an extensive lateral movement from NW to SE and the depth of dolomitization in certain units drastically decreases. Two main regimes of solutions initially started with sphalerite and they were subsequently followed by galena the later of which is found in the secondary porosity. Mineralogy of the deposits is simple but the pyrite amount of the deposits varies from 2% to 20% which reflects the higher temperature of the solutions responsible for sulphide precipitation (Marie et al., 2001), geometry of the deposits and their distance to the current topography effect on chargeability values (Fig. 20).
Sparry dolomite is found in three types as barren,

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with pyrite and light color sphalerite that occur in country rocks of all deposits except for the blind deposits. They can be used as a guide, addressing potential deposits.

EPMA analysis revealed a considerable amount of Cadmium, Silver, Antimony, Arsenic and Copper within Sphalerite and Galena minerals (Fig. 12). Because of the semiarid climate in the area the decomposition of sphalerite, galena (Hitzman et al., 2003) and carbonate host rock has caused widespread distribution of Zn, Pb, Ag, Cd, Sb, As, Cu, Mn, Mg, Fe and Ca in the secondary halo of the area. The soil samples have been studied based on the static and machine learning methods (Figs. 13–A and B) by different researchers (Zekri et al., 2019). The anomalous areas based on geochemical studies have been tested by core drilling and the results are considered to be negative even in the area called Zone 3 which coincides with both geochemical and geophysical anomallies. In a different approach to understand the structure of geochemical elements the distribution of Zn, Pb, Ag, Cd, Sb, As, Cu, Mn, Ba together with elements such as Mg, Fe and Ca has been compared (Figs. 14, 15 and 16).

The soils are heavily polluted due to widespread mineralization and no background value (Reimann and De Caritat, 2012) can be recognized.

The comparative analysis of element concentrations in 5 selected populations in the studied area (Fig. 15) did not show any signs that could help recognize important anomalies from the false anomaly. However, it seems that the sudden decrease of Mg content (Fig. 17–C) in the area of Zone 3 (Zekri et al., 2019) is meaningful. Two geochemical profiles of soil samples crossing along this population and the next one crossing an active mine (Zone 5 Romarmar) (Fig. 18) provide us with a better understanding of the important anomalies versus the false anomaly since in the false anomaly the increase of Zn, Pb, Ag, Cd, Sb, As, Cu coincides with a sudden drop of concentration of Mg, Fe and Ca (Figs. 18–A and B).

Recognition of ore containing strata (Sangster, 1995) is very important (Figs. 2 and 3) in locating successful drill holes in the exploration of carbonate hosted zinc and lead deposits. Eventually the use of data driven methods even opting advanced machine learning methods is not properly sufficient to recognize productive areas and we recommended the knowledge -driven approach.

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