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Geology, petrography, alteration, mineralization and petrogenesis of intrusive bodies in the Hamech prospect area, Southwest of Birjand

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Introduction

The Hamech prospect area is located in the eastern Iran, 85 kilometers southwest of Birjand. The study area coordinates between 58˚53´00 ˝ to 59˚00´00˝ latitude and 32˚22´30 ˝ to 32˚26´00˝ longitude. Due to the high volume of magmatism and the presence of geo-structure special condition in the Lut Block at a different time, a variety of metal (copper, lead, zinc, gold, etc.) and non-metallic mineralization has been formed (Karimpour et al., 2012). The studied area (Hamech) includes Paleocene-Eocene igneous outcrops which contain a wide range of subvolcanic bodies (diorite to monzonite porphyry) associated with mafic intrusives, volcanic units (andesite), volcaniclastic and sedimentary rocks.

Material and Methods

This study was done in two parts including field and laboratory works. Sampling and structural studies were done during field work. Geological and alteration maps for the study area were also prepared. 200 thin and 60 polished sections for petrographic purpose were studied. The number of 200 thin sections and 60 polished sections were prepared and studied in order to investigate petrography and mineralogy. Major oxides (XRF method- East Amethyst Laboratory in Mashhad), rare earth elements and trace (ICP-MS method- ACME Laboratory in Vancouver, Canada) elements were analyzed for 13 samples that included subvolcanic units and intrusive bodies. Data processing and geological and alteration mapping is done by the GCD.kit and Arcgis software.

Discussion and Results

Based on lab work and XRF analysis, the rocks in the area are composed of intrusive-subvolcanic bodies and volcanic rocks (andesite, trachyandesite and dacite) together with volcano-classic and sedimentary rocks. Also, alteration zones consist of a variety of argillic, silicified, quartz-sericite-pyrite (QSP), propylitic and carbonate. Igneous rock textures are mainly porphyritic for sub-volcanic and granular for intrusive bodies. Phenocrysts mainly consist of plagioclase and hornblende dominated with minor of biotite and pyroxene. XRF studies and output charts show that rocks include monzonite, diorite, gabbro and gabbroic diorite. Intermediate subvolcanic units (monzonite, diorite) and mafic intrusives (gabbro and gabbroic-diorite) are related to high-potassium calc-alkaline (K_2O between 2.42 to 4%) and tholeiitic (K_2O between 0.15 to 0.27%) series, respectively. Subvolcanic units belong to the I-type granitoid (Chappell and White, 2001).

Mantle normalized , trace-element spider diagrams display enrichment in LREE, such as Rb, Sr, K, and Cs, and depletion in HREE, e.g., Nb, Ti, Zr that indicate magma formed in the subduction zone. Nb depletion (less than 6 ppm, between 0.5 to 5.2 ppm) in subvolcanic bodies represents a volcanic arc granitoids (VAG)

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tectonic setting that is related to the subduction zone (Pearce et al., 1984). Also, this reduction shows that these rocks are derived of oceanic crust (Wilson, 1989). Enrichment in LREE and depletion of HREE with a low $(La/Yb)_N$ ratio in the Hamech subvolcanic rocks (6/85 to 8/13) could represent a low degree of mantle partial melting (Wass and Rogers, 1980). Zr/Nb ratio of more than 10 for Hamech rocks (between 21 and 35 for intermediate subvolcanic and 67 to 72 for mafic bodies) indicates that parental magma has minimal crustal contamination (Karimpour et al., 2012). Sr enrichment (between 646 to 1124) and low negative Eu anomaly (Eu/Eu* ratio between 0.81 to 1/02) show that plagioclase is rare (or is not present) as residue mineral in the source and melt conditions have been in oxidation state (Tepper et al., 1993). Based on Sm/Yb vs. La/Sm (Shaw, 1970) and Ce/Yb vs. Sm/Yb (Wang et al., 2002) diagrams, parent magma is composed of 1 to 5% spinel-garnet lherzolite partial melting (with small amounts of garnet) at a depth between 65 to 67 km (upper mantle) for subvolcanic units and 5 to 20% spinel lherzolite partial melting (depletion mantle-NMORB) with a depth of less than 55 km for mafic bodies.

Suitable tectonic setting, existence of subvolcanic units with intermediate composition, magnetic activity with the nature of calc-alkaline and oxidants, data from major and REE studies, mineralization as disseminated and veinlets with high secondary iron oxides in surface show suitable conditions of porphyry and epithermal mineralization in the Hamech prospect area.

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