Role of Oligocene intrusion in copper mineralization at Shoorazgah copper deposit, Zanjan, Iran

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Abstract
The aim of this study is to investigate the relation between the Oligocene intrusive body and copper mineralization in Eocene volcanic lavas and related pyroclastic rocks in the study area, and its paragenetic elements as well as copper minerals variation with increasing distance from intrusion. The deposit located in northeast of Zanjan city on Tarom Mountains. From geologic point of view, Tarom Mountain rang trending northwest southeast is generally composed of Tertiary volcanic and pyroclastic rocks mainly consist of andesite, lavas, tuffs and tuffits. There are two big granitoid intrusive bodies on Tarom Mountains, intruded into Eocene volcanic and pyroclastic rocks. Copper, Iron and Lead mineralization in the study area has occurred at the vicinity of intrusive body and Eocene volcanic and pyroclastic rocks. Hydrothermal fluids of the quartzmonzonitic intrusion, has caused alteration and vein mineralization in neighboring volcanic and pyroclastic rocks at the study area. Generally as we get closer to the intrusion the alteration and mineralization is intensified. The Tarom River crossing the study area has exposed widespread outcrops of mineralization and wall rocks with various lithologies. Copper and copper-iron mineralization is observed at several localities in the study area. In the contact of surrounding rocks with the intrusive body, there exist abundant veins of copper, iron and lead ores. In the study area from north to south (toward the intrusion), the amount of iron is increased. Based on the geologic, mineralographic and geochemical studies, we can conclude that the mineralization in the study area is a digenetic polymetal type. There are two forms of mineralization including disseminated form in lava units and vein form, which is generated by intrusion hydrothermal fluids. In veins copper minerals such as native copper, chalcocite, malachite, azurite, cuprite and minor amount of bornite are accompanied with oligist, hematite and galena.

Keywords: *Shoorazgah; Tarom; Copper; Mineralization; Paragenesis; Intrusion*

Introduction
The study area is located in west Alborz – Azerbaijan structural zone, northwest of Iran (Aghanabati, 2004). Because Of abundant metallic and nonmetallic mineralization in west Alborz – Azerbaijan zone, many geologists have been interested to study it. Shoorazgah area has situation in northeast of zanjan city and about 80 km far away. Zanjan – Tarom and Zanjan – Taham roads crossing the study area make the fieldwork easy. There is collection of Cenozoic geological units in the study area. Oligocene intrusive bodies have affected Cenozoic geological sequences in Shoorazgah area including Eocene tuffs, lavas and in less amount tuffaceous sandstone and shale of Karaj formation. The outlook of the area has been shown in the figure 1.

General Geology

Vein type of copper mineralization in Shoorazgah area is in relation to Oligocene plutonic bodies. Tarom plutonic bodies have intruded into Karaj formation volcanic and pyroclastic rocks. These plutones dated post Eocene due to their contact metamorphism. It seems that the Pyrenean orogenic phase has caused the generation of these plutones (Aghanabati, 2004). Based on previous studies these plutones belong to I type granitoids and they are high k calk – alkaline or shoshonitic in composition. These intrusions belong to a post collisional magmatic arc (Moayed, 2002). There are several plutonic bodies in Tarom Mountains, which are sub-parallel trending northwest southeast. Shoorazgah copper deposit, situated at central part of Koohian intrusion, which is quartzmonzonite or quartzmonzodiorite in composition (Aghanabati, 2004). This Oligocene plutonic body has affected the Shoorazgah Eocene lithological sequences. In addition to thermal effects of this intrusion on neighboring rocks, its hydrothermal solutions have formed some mineralized veins that filled the fractures and other pore spaces (fig. 2).

Petrography

We can roughly classify the study rocks in two groups, lavas and pyroclastics.

Lavas

The lavas contain pyroxene andesitic basalt, andesitic basalt and trachyandesite. Below these rocks are explained in detail.

Pyroxene andesitic basalts are dark grey in hand specimen. Their topography is rough. In fresh surfaces of pyroxene andesitic basalts, black large crystals of clinopyroxene are striking. In these rocks, the main texture is porphyritic with microlithic matrix. Major mineral in these rocks are plagioclase, pyroxene (fig.3) and in less amount olivine (fig.4). Plagioclase crystals frequently show polysynthetic twinning and zoning. Sieve textured plagioclase crystals are also present in these rocks (fig.5). Secondary minerals such as calcite, chlorite, serpentine and iron oxides are present in these rocks due to alteration.

Andesitic basalts in comparison to pyroxene andesitic basalts are lighter in color and they are gray. The dominant and main texture in this kind of rocks is porphyritic texture. Sometimes glomeroporphyritic texture is also seen (fig.6). The most abundant mineral in andesitic basalts is plagioclase. The main mafic mineral in these rocks is clinopyroxene that obviously shows sieve texture in some cases. Different disequilibrium processes including magma mingling, magma mixing, assimilation (Kuscu & Floyd, 2001**;** Kawabata & Shuto, 2005**;** Kurum et al., 2008) and variation in water pressure can cause sieve texture **(**Stormer, 1972; Tscuchiyama, 1985). Various secondary minerals like chlorite, sericite, calcite and iron oxides that are products of alteration exist in these rocks. Additionally veinlets of calcite have cut these rocks (fig.7).

Thrachyandesitic lavas are gray to pink in color and their texture is porphyritic. In some cases, their cavities are filled with secondary minerals such as iron oxides and calcite.

Pyroclastic rocks

Generally, the studied pyroclastic rocks can be divided into two groups namely tuffs and tuffits. There are two types of tuffs in the area including lithic crystal tuffs and green ash tuffs.

Lithic crystal tuffs are brownish gray in color. Their lithics are volcanic rock fragments with vitrophyric texture. Crystals present in lithic crystal tuffs include plagioclase and pyroxene crystals. In some places, these tuffs become sandy and show onion-skin weathering (fig. 8). Green ash tuffs are susceptible to erosion and they are cut with calcite veinlets in some places (fig.9).

Mineralization

In the study area, copper mineralization and related paragenetic ore minerals occurred in suitable spaces particularly at the contact of lavas and nearby fractures in the form of veins and veinlets. Ore mineral assemblage of veins and veinlets in Shoorazgah area composed of native copper, chalcocite (fig.10), bornite, galena, Hematite and oligist which are accompanied by several secondary minerals such as cuprite, malachite and azurite (fig.11). It is worth mention that some of the above ore minerals are not present in some veins. These secondary minerals are alteration products of native copper and copper sulfides in surface parts. In polish sections, galena is alterated to cerusite and just some of its relicts have remained as islands (fig.12). In some cases is completely altered to cerusite. Based on the analyses of 20 samples taken from trenches, the average grade of copper in Shoorazgah copper ore deposit is calculated 8.2 percentages.

In additional to mention epigenetic mineralization, syngenetic ore forming processes have occurred during the formation of the host rocks. These processes have generated disseminated native copper in some lavas in the study area. The average grade of copper calculated from the analyses of 15 samples of host rocks is about 0.3 percentages. Therefore, in Shoorazgah area copper is both deposited as syngenetic and epigenetic forming a diplogenetic ore deposit.

Genesis

The Eocene volcanic activity in Tarom Mountains is as result of early Pyrenean orogenic phase and the final movements of these phase led to the formation of some plutonic bodies, which have intruded into the Eocene volcanic rocks. These plutonic activities in Tarom area have produced some fractures and deep faults, which facilitate the passage of hydrothermal solutions (Aghanabati, 2004). The emplacement time of the quartz monzonitic body located at south part of the study area is Oligocene (Darvishzadeh, 1991). This pluton has intruded into Eocene pyroclastic and lavas including pyroxene andesitic basalt, andesitic basalt, trachyandesite, tuffs and tuffits. Hydrothermal solutions released from this pluton while passing the mentioned extrusive rocks have caused vein mineralization. The main ore minerals in these veins are copper minerals, which are accompanied with lead and iron ore minerals. Furthermore, in Shoorazgah area disseminated copper mineralization has also occurred in Eocene volcanic rocks. This syngenetic mineralization is due to high concentration of copper in the magma and its large ionic radius. Because of large dimensions, copper can not enter the structure of the silicate minerals, therefore remains in the melt. Finally, as the melt crystallize disseminated particles of native copper also crystallize.

Conclusion

- There are two different mineralization types in the study area, which are different in age. The first is disseminated type, which is syngenetic, and its generation is simultaneous with the formation of Eocene lavas. The second is vein type mineralization that is epigenetic and its formation is in relation to the hydrothermal solutions derived from the Oligocene intrusive bodies. The vein type mineralization in the study area is younger than the disseminated mineralization type. Therefore, in Shoorazgah area mineralization is a diplogenetic one.
- The primary ore minerals in the study area are native copper, chalcocite, bornite, hematite and oligist. Some of these primary ore minerals are altered to secondary ore minerals such as cuprite, malachite, azurite and cerusite by surface processes.

Fig. 1- General outlook of the study area.

Fig. 2- Copper mineralized vein in Shoorazgah.

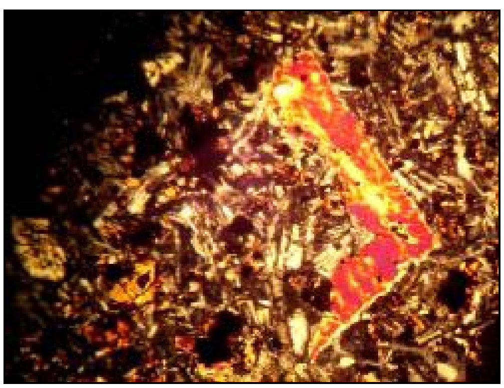

Fig. 3- Subhedral alterated pyroxene (×40).

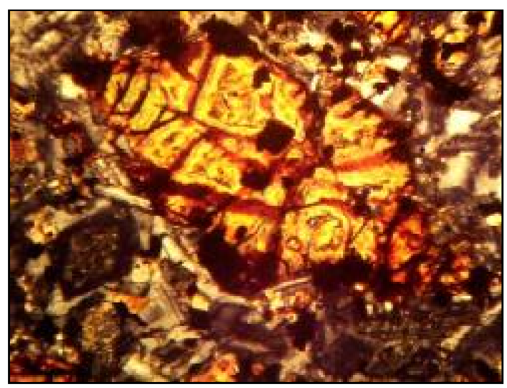

Fig. 4- Olivine in pyroxene andesitic basalts (×40).

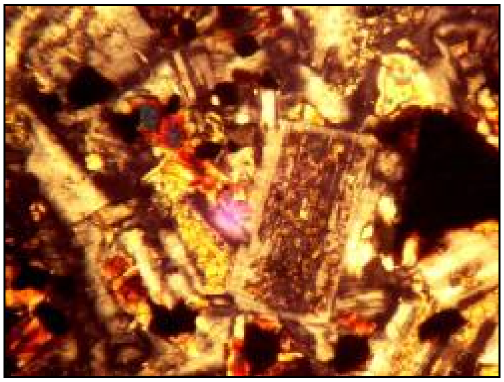

Fig. 5- Sieve textured plagioclase crystals (×40).

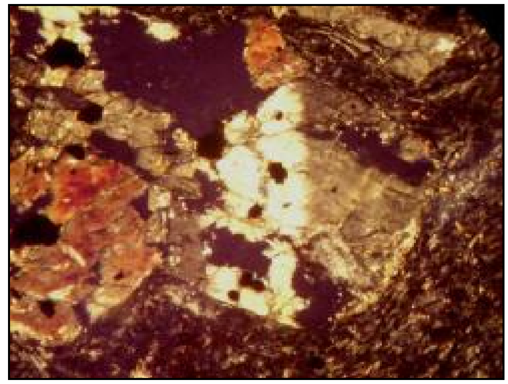

Fig. 6- Glomeroporphyritic texture (×40).

Fig. 7-Calcite veinlet cut through andesitic basalt.

Fig. 8- Sandy tuff with onionskin weathering.

Fig. 9- Green ash tuff cut by calcite veinlet.

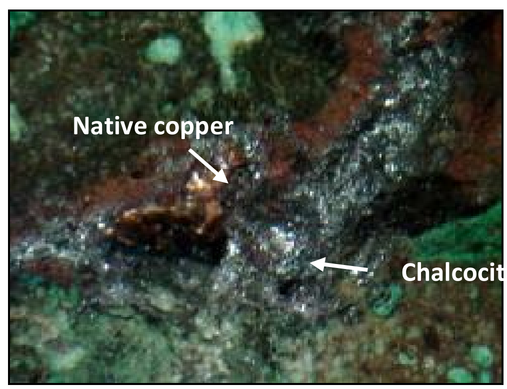

Fig.10- Native copper and chalcocite.

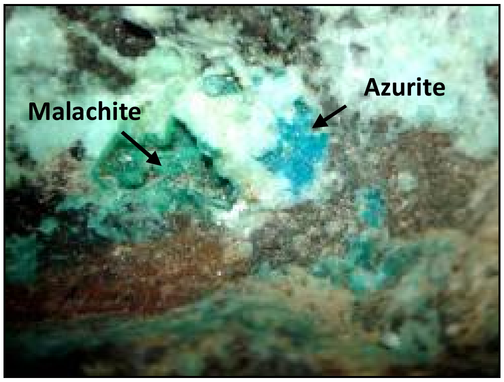

Fig. 11- Malachite and azurite in hand specimen.

Fig.12- Galena is alterated to cerusite (×40).

References

1- Aghanabati, S.A., 2004, Geology of Iran: mines geological survey of Iran publication, 486 p. (in Persian)

2- Dardvishzadeh, A., 1991, Geology of Iran: Amirkabir publication, 901 p. (in Persian)

3- Kawabata, H., Shuto, K., 2005, Magma mixing recorded in intermediate rocks associated With high-Mg andesites from the Setouchi volcanic belt, Japan: implications for Achenn TTG Formation: Journal of Volcanology and Geothermal Researches, v. 140, p. 241-271.

4-Kurum, S., Onal, A., Boztug, D., Sper, T., Arslan, M., 2008, Ar40/Ar39 age and geochemistry of the post-collisional Miocene Yamadag volcanics in the Arapkir area (Malatya province), Eastern Anatolia, Turkey: Journal of Asian Earth Sciences, v. 33, p. 229-251.

5- Kuscu, G. G., Floyed, P., 2001, Mineral compositional and textural evidence for magma Mingling in the Saraykent volcanic rocks: Lithos, v. 56, p. 207-230.

6- Moayed, M., 2002, New insight regarding the formation of the Neothetys and its relation to the Tertiary magmatism in Orumieh – Dokhtar and Alborz – Azerbaijan: Proceeding of sixth Geological society of Iran Conference, Kerman University, p. 274-278. (in Persian)

7- Stormer, J. C., 1972, Mineralogy and petrology of the Raton-Clayton volcanic field Northeastern New Mexico: Geological Society of American Bulletin, v. 83, p. 3299-3322.

8- Tscuchiyama, A., 1985, Dissolution kinetics of plagioclase in the melt of the system diopside-albite - anorthite and origin of dusty plagioclase in the andesites: Contribution to Mineralogy and Petrology, v. 89, P.1-16.