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GOLD AND ARSENIC MINERALIZATION ASSOCIATED WITH SEDIMENTARY ROCKS OF ZARSHURAN MINE, NORTH OF TAKAB, IRAN

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ABSTRACT

Zarshuran mine is located 49 km north of Takab, in southeast of East Azerbayjan State, Iran. Stratigraphically, different rock types of late Precambrian and younger rocks Crop - out in the area. Mineralization mainly occurs in the units, which are late Precambrian or early Paleozoic in age. The main ore minerals in the deposit are orpiment and realgar. Gold as extremely fine grains is distributed in the arsenic sulfide minerals. Mineralogical and geological evidences in the Zarshuran deposit indicate that this is deposit similar to Carlin type gold deposits formed under epithermal conditions. A geothermal cycle was responsible for the formation of the deposit, and in this cycle meteoric water percolated through joints of the rocks, became warm and dissolved ions before ascending toward the surface, due to changes in pH and CO_2 fugacity of the ore solutions were precipitated from the hydrothermal system in the present host rocks.

KEY WORDS: gold mineralization, gold and arsenic mineralization, Zarshuran Mine, sediment - hosted gold deposits, Carlin - Type deposits, Iran.

1. INTRQDUCTION

Fine-grained disseminated gold deposits of Carlin-type are typically low in grade and high in tonnage (Arehart, et al, 1993). These deposits are characterized by replacement of carbonate rocks by silica and minor pyrite, and they contain very fine grains of gold associated with some other elements such as mercury, arsenic and antimony (Tingtey and Bonhamn 1986). The type example of these deposits is the Carlin gold deposit in the State of Nevada, USA (Radtke, 1985).

In the north of Takab (Fig. 1) the important potential for gold and arsenic deposits in carbonate rocks and shales has been recognized. The Zarshuran mine is a deposit that has been active as an arsenic deposit. The discovery of getchellite in this deposit (Bariand, 1967; Bariand and Pelissier, 1972), and knowledge that this mineral occurs in the Getchell gold deposit in the State of Nevada, USA, (Weissberg, 1965) was the reason for more detailed studies regarding the gold mineralization in this area.

Over 1000 samples were collected from different tunnels, trenches, and surface. The samples was taken from the ore body, fresh end altered rocks. They were analyzed by atomic absorption analyses, X-ray, and electron microprobe techniques.

2. GEOLOGY

The Zarshuran area consists of members of late Precambrian, early Cambrian, Oligomiocene, Miocene formations Couered by Quaternary alluvium. The oldest rock units in the area include late Precambrian serpentinite schists, amphibole - epidote schists, mica schist, marbles and crystalline

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limestones. The Zarshuran member, the main host of the deposit, is also late Precambrian and includes some gray limestones with intercalated black and dark gray schists.

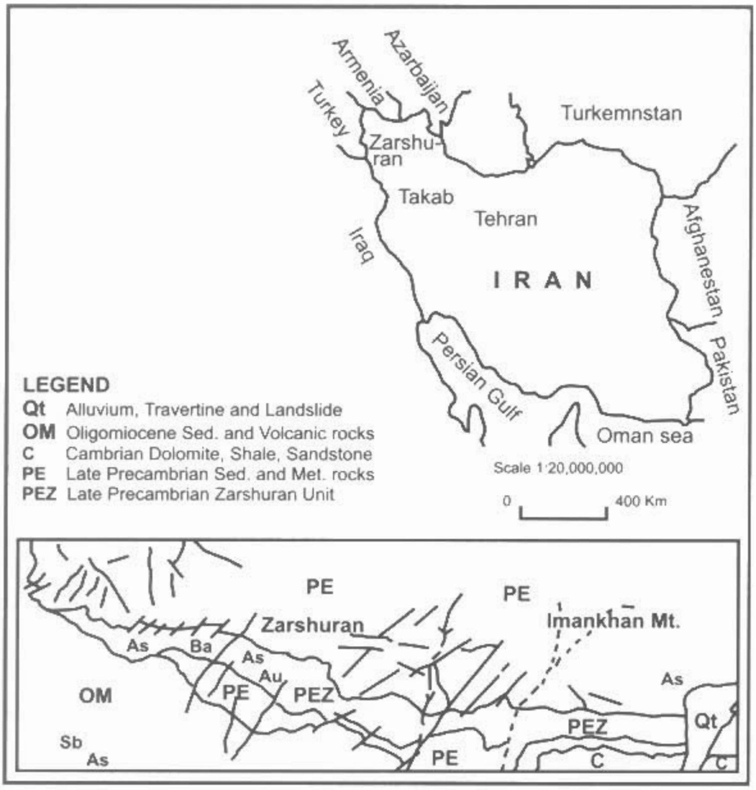

Fig. 1: Location and Geologic Map of Zarshuran Prospect

Tuff, sandstone and limestone overlie the Zarshuran member, which is also late Precambrian in age (Fig. 1). These rock units are partly overlain by early Cambrian dolomite, shale and red sandstone. Unconformably overlying the Cambrian rocks are Oligocene to Miocene sandstones, limestones, tuffs, shales, and red sandstones. During Miocene, volcanism was active in the region and volcanic rocks covered large areas in the northern part of Takab (Fig. 1). The volcanic rocks primarily include trachyandesite and porphyrytic andesite. In the study area these rocks are altered to sericitic, epidotitic, and chloritic types. The youngest rock units of the area include Quaternary travertine, which formed during hot - spring activity.

3. MINERALOGY OF THE DEPOSIT

The main mineralization consists of arsenic one minerals. Orpiment is presently produced from the Zarshuran deposit and is seen in different types of disseminated subhedral crystals to some zoned colloform minerals. Inclusions of pyrite, stibnite, realgar and sphalerite ere recognized in the Orpiment grains. Electron microprobe data indicate that the gold is disseminated as extremely fine grains in orpiments.

Realgar is the second important mineral in the deposit and usually accompanies the orpiment. In somesamples realgar with orpiment are seem in a colloform texture. Inclusions of pyrite and stibnite are also seen in realgar.

Stibnite is the antimony ore in the Zarshuran deposit. The amount of this mineral is over 1 wt% and it increases toward the west forming stibnite veinlets. Inclusions of pyrite and sphalerite were also recognized in some stibnite crystals.

Pyrite, which formed in different stages of mineralization, is a common sulfide mineral in the Zarshuran deposit (fig.2). It is found in euhedral to xenomorphic crystals with spongy, skeletal, and colloform textures. Pyrite is also seen as disseminated grains or as inclusions in other minerals. In some parts of the deposit impurities of arsenic in pyrite caused the formation of melnicovite. This mineral is mostly seen in the margins of other sulfide inerals.

Other sulfide minerals found in the deposit include galena and sphalerite which are mostly found together and the amount of these minerals increases in the stibnite-rich zones. Occasionally some boulangerite forms along joints in the stibnite-rich zones. Traces of chalcopyrite at the margin of some pyrite grains, minor amounts of cinnabar that usually accompany sulfides of antimony and lorandite are also recognized in some of the ore minerals. Another important arsenic - sulfide mineral in the Zarshuran deposit is getchellite, which was first described in this area by Bariand (1967).

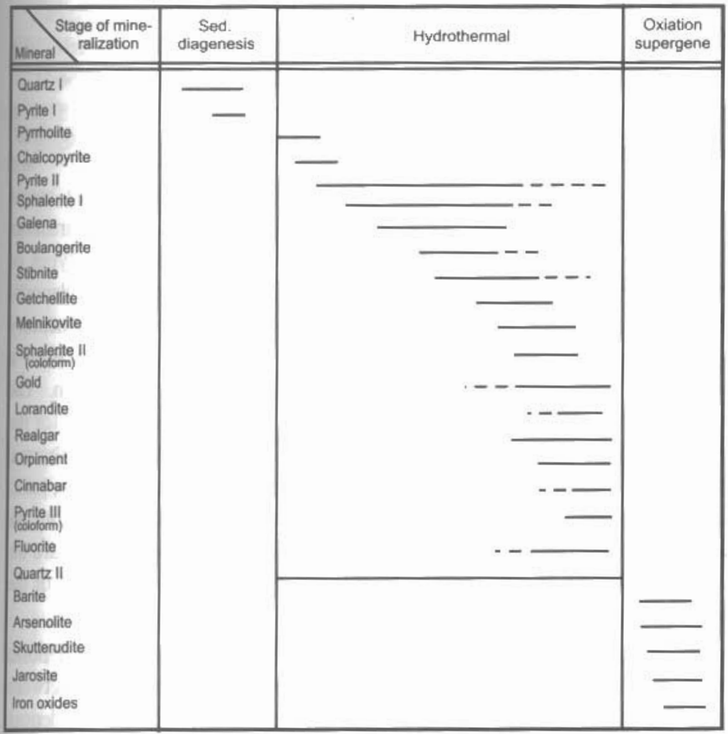

Fig. 2: Paragenetic sequence of mineralization in Zarshuran deposit

Other minor minerals, which are recognized in the Zarshuran deposit, include fluorite, iron sulfate, and iron arsenate minerals such as jarosite, carphosiderite, scorodite, and beudantite. A paregenetic sequence of the mineralization is shown in figure 2.

Gold is rarely found as euhedral to subbedral crystals on orpiment quartz, or cinnabar crystals. In some polished-thin sections of silica veins, gold was hardly seen at very high magnification. It should be mentioned that several veinlets of cryptocrystalline silica occur within the Zarshuran member that carries disseminated very fine grain gold and could be similar with the late gold ore (LGO) of Kuehn and Rose (1995).

4. ALTERATION

An important type of alteration in the Zarshuran area is silicification, which is more obvious in the ore zones. The rocks are mostly brecciated and in some places barite mineratization also occurs. Siliceous zones contain mainly jasperoid. The silicification of crystalline limestone occurs in many places, where silica minerals appear to replace calcite. In addition to silicification, sericitizatian and kaolinization are other types of alteration found in high-grade zones where sericite and kaoline accompany fine – grained quartz.

The alunite alteration is another characteristic feature of the Zarshuran deposit. It appears that sulfate - rich hydrothermal solutions caused the hydrolysis of potassium-alluminium rich rocks and alunite formed in the upper zone of the deposit. This zone is located on the upper part of the mine and besides alunite it contains massive cryptocrystalline jasperoid accompanied by kaolinite and illite. This type of alteration, as mentioned by White (1990), c

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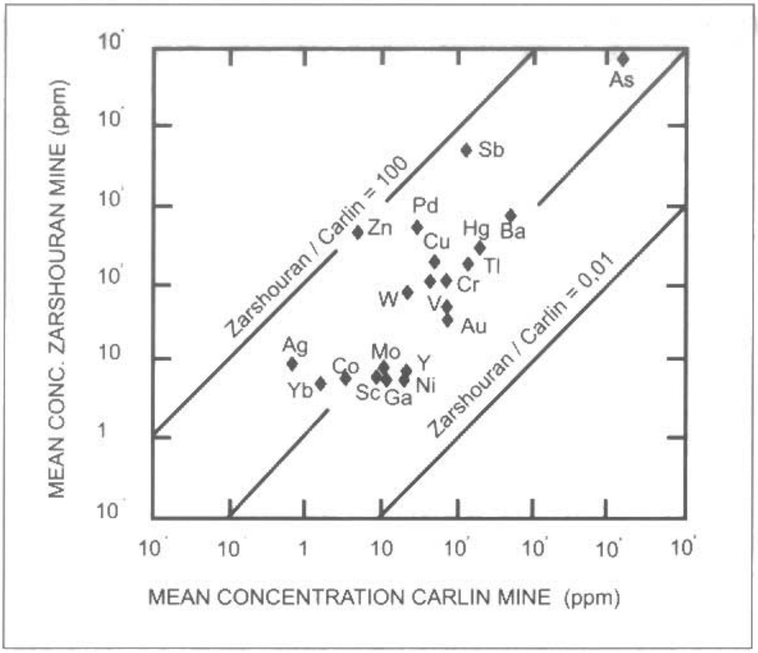

Fig. 3: Comparison of mean concentration of some selected elements in arsenic ore samples between Zarshuran deposit and Carlin deposit (after Karimi, 1993)

4. ORIGIN

Based on geology, mineralogy, and geochemical data it seems likely that the Zarshuran deposit like other types of disseminated gold deposits hosted by sedimentary rocks originated from a hydrothermal system. The probable heat source for the local geothermal system is Oligocene to Miocene volcanism in the area as evidenced by active thermal springs in the vicinity of the Zarshuran. We suggest that meteoric water percolated downward along joints and faults and gradually became warmer and dissolved metal along its flow path, particularly from the basement rocks in which the gold content is 10 to 20 ppb. While the heated solution ascended toward the surface, with decreasing temperature, CO_2 and H_2S fugacities decrease and so the metal content of the solution precipitates concurrently with silicification of the host rock.

Based on several similarities in lithology, mineralogy and geochemistry between Carlin-type deposits and the Zarshuran deposit and companion of the mean concentration of some selected elements between Zarshuran deposit and Carlin-type deposits (Fig. 3) we came to the conclusion that Zarshuran deposit could be formed with the same mechanism of formations as the Carlin-type deposits.

5. CONCLUSIONS

The Zarshuran deposit was studied on the basis of geology, mineralogy, and geochemistry and was compared to several gold deposits in other localities in the world. Based on several similarities with the Carlin-type gold deposits in the State of Nevada, USA., at the present time, we believe that the Zarshuran deposit could be considered as a Carlin-type deposit Iran.

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