Geology, mineralogy and alteration of Chehelkureh polymetallic ore deposit, southeast Iran

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Chehelkureh is an ancient copper mine in the Kuh-e-Lunka area, located 120 km NW of Zahedan (SE of Iran) at longitude 060°, 07.480' N and latitude of 30°, 14.155' E. The Kuh-e-Lunka area is in the eastern part of Dasht-e-Lut, which is located near the border with Pakistan and Afghanistan. The area is underlain by a sequence of Eocene intercalated greywackes, siltstones, and shales that host the ore deposit, and is bordered to the west by ophiolitic mélange and to the east by Middle Eocene limestones. Several dykes and small stocks of a monzodiorite intruded the sedimentary sequence; they are oriented parallel to the major NW–SE fault set.

The Chehelkureh ore field is complex with numerous lenses and veins, with an irregular outline. The ore field has an overall strike of N23°W and is displaced by faults striking roughly E–W. The proven strike length of the mineralization at 1500m above sea level is 1350m. The mineralization occurs along the major N–S striking faults. The fault-fill mineralization includes quartz, dolomite, ankerite, siderite, calcite, molybdenite, pyrrhotite, arsenopyrite, pyrite, chalcopyrite, sphalerite, galena, Se-rich galena, bornite, marcasite, ilmenite, and rutile. In spite of high contents of base metals (4.1% Cu+Zn+Pb) and silver (22 ppm) in the ores, they are poor in Au (average 0.14 ppm in 45 samples). The oxidized upper part of the ore includes: limonite, goethite, malachite, azurite, smithsonite, native copper, cerrusite, plombojarosite, chrysochola, and anglesite. The major portion of the secondary copper leached from oxidized chalcopyrite should be precipitated at or below the ground water table at Chehelkureh as covellite or chalcocite, although a secondary supergene sulphide zone enriched in copper is not evident here. There is also a large oxidized to sulphide transition zone at depths between 50–110m. The limited precipitation and the deep-seated groundwater table in the area are two mainly factors, which play important roles in the absence of economic amounts of secondary covellite or chalcocite in Chehelkureh.

Complex primary intergrowth textures, some of which represent exsolution textures, are common in ore minerals and include intergrowths of chalcopyrite in sphalerite, sphalerite in chalcopyrite, chalcopyrite in pyrrhotite, pyrrhotite in sphalerite, bornite in Se-rich galena and chalcopyrite in Se-rich galena. Blebs of chalcopyrite in sphalerite are more or less uniformly distributed through sphalerite in Chehelkureh, giving an emulsion texture. Texturely, the Chehelkureh deposit formed at temperatures greater than 400°C and is a unique type of hydrothermal ore deposit.

The base-metal mineralization is also accompanied by chloritization, carbonatization, silicification, pyritization, sericitization, and alunitization of the host sequence within and around the faults. They extend a few metres to tens of metres from the faults, depending on the amounts of mineralization. Chloritization and dolomitization are especially very strong and widespread. There is a general depletion in REE contents associated with different alteration types, such as chloritization, dolomitization, kaolinization, silicification, and minor sericitization. Samples with carbonatization (magnesite and siderite) have been enriched in REE contents. SEM-EDS evidence indicates that enrichment by REE-bearing phosphates occurred with carbonatization.