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Sulfide mineralization in ultramafic rocks of the Faryab ophiolite complex, southern Kerman

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Introduction

Worldwide, Ni-Cu and PGE magmatic sulfide deposits are confined to the lower parts of stratiform mafic and ultramafic complexes. However, ophiolite mafic and ultramafic complexes have been rarely explored for sulfide deposits despite the fact that they have been extensively explored and exploited for chromite. Sulfide saturation during magmatic evolution is necessary for sulfide mineralization, in which sulfide melts scavenge chalcophile metals from the parent magma and concentrate them in specific lithological zones. The lack of exploration for sulfides in this environment suggests that sulfide saturation is rarely attained in ophiolite-related magmas. Some ophiolites, however, contain sulfide deposits, such as at Acoje in Philippines, and Cliffs in Shetland, U.K. (Evans, 2000; Naldrett, 2004). The Faryab ophiolite complex in southern Kerman Province, the most important mining area for chromite deposits in Iran, is located in the southwest part of the Makran Zone. Evidence of sulfide mineralization has been reported there by some authors (e.g. Rajabzadeh and Moosavinasab, 2013). This paper discusses the genesis of sulfides in the Faryab ophiolite using mineral chemistry of the major mineral phases in different rocks of the ophiolite column in order to determine the possible lithological location of sulfide deposits.

Materials and methods

Seventy three rock samples from cumulate units were collected from surficial occurrences and drill core. The samples were studied using conventional microscopic methods and the mineralogy confirmed by x-ray diffraction. Electron microprobe analysis was carried out on different mineral phases in order to determine the chemistry of the minerals used in the interpretation of magma evolution in the Faryab ophiolite.

Lithologically, the Faryab ophiolite complex is divided into two major parts: the northern part includes magmatic rocks and the southern part is comprised of rocks residual after partial melting of the upper mantle. Sulfide mineralization in the complex is confined to cumulate rocks in northern part of ophiolite column. The mineralization is olivine-rich clinopyroxene and wehrlite. Petrographic investigation of sulfides in host ultramafics indicated two sulfide generations. In the first generation, primary magmatic sulfides occurred as interstitial disseminations, generally as anhedral grains. In the second generation, sulfides formed as veinlets along host rock fractures. The primary sulfides include pyrrhotite, pentlandite, and secondary digenite and pyrite. The primary sulfide content increases with increasing size and amount of clinopyroxene in host rocks. Associated chromian spinels in host ultramafics display disseminated and massive textures.

Discussion

Generally, mineralization in ophiolites is controlled by two major steps: a) partial melting of upper mantle rocks and b) crystal fractionation in a magma chamber (Rajabzadeh and Moosavinasab, 2013). The chemical compositions of the analyzed minerals were then used in estimating the conditions in these two steps. The composition of chromian spinel corresponds to chromite of boninitic melts formed in supra-subduction zone environments. Boninitic melts are produced at high degrees of partial melting of mantle peridotites in the presence of water (Edwards et al., 2002). Silicates of the host rocks

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are mainly clinopyroxene (diopside and augite) of the composition $Wo_{47.50}$ $En_{45.48}$ $Fs_{3.4}$, olivine Fo_{92} and orthopyroxene (enstatite - bronzite) of En_{85} to En_{88}. The main host ultramafic rocks of sulfides are wehrlite and clinopyroxenite, indicating that the sulfide saturation occurred during magmatic evolution of these rocks. This suggests that sulfide mineralization will occur in the northern part the ophiolite. The sulfide grains are anhedral, amoeboidal in shape, and appeared as disseminated interstitial phases, indicating that they were trapped as liquid phases during increase in sulfur fugacity and decrease in FeO content and temperature of crystallization of clinopyroxene-rich rocks (Talkington et al., 1984; Von Gruenewaldt et al., 1990). Nickel-rich pentlandite is the main sulfide in the Faryab complex. The composition of this is mineral is consistent with the crystallization in an equilibrium condition (Song et al., 2008). The sulfide may have been introduced from external sources during upward movement and emplacement of parent magma.

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