Sulphide and Arsenide Mineralization at Limassol Forest, Cyprus*)

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Zusammenfassung

Die Fe-Ni-Co-Cu-Erze des Limassol Forest auf Zypern treten in Linsen, Gängen und Imprägnationen in serpentinisierten Duniten und Harzburgiten auf. Die wichtigsten Erzminerale sind Pyrrhotin, Pentlandit, Chalkopyrit, Maucherit, Cubanit, Valleriit, Westerveldit, Magnetit und Chromit. Auflichtmikroskopische Untersuchungen und Mikrosondenanalysen zeigen, daß die Mineralisation durch Remobilisation und hydrothermale Aktivität während früh einsetzender Serpentinisierung gebildet worden ist. Die geotektonische Position des Limassol Forest nahe der Arakapas Faltenzone, einer Transform Störung, unterstützt diese Interpretation.

The Fe-Ni-Co-Cu ores of Limassol Forest occur in form of veins, disseminations and partly in lenticular or irregular bodies in serpentinites which are interpreted as dunites and harzburgites forming the basal part of the ultramafic sequence of the Troodos ophiolite complex (PANAYIOTOU, 1978, 1980).

The mineralization is dominantly concentrated in two localities known as Lakxia tou Mavrou and Pevkos and is associated with small podiform chromite deposits.

The mineral association of Pevkos comprises pyrrhotite with near-stoichiometric composition, pentlandite, maucherite, chalcopyrite, cubanite, valleriite, chromite, magnetite and traces of ilmenite, westerveldite, cobaltite, bornite, molybdenite and gold (Tab. 1). With the exception of the arsenides (maucherite, westerveldite) all the minerals show various alteration textures and transformation into secondary ore minerals such as bravoite.

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The mineralization at Lakxia tou Mavrou consists mainly of pyrrhotite, pentlandite, chalcopyrite, cubanite, löllingite, chromite, magnetite and minor amounts of pyrite, maucherite, valleriite and gold (Tab. 1)

At both localities chromite grains are characterized by a "bleached rim" containing many secondary silicate inclusions. The chemical composition of these rims reveal typically high Fe and low Cr_2O_3, MgO and Al_2O_3 contents.

Detailed reflected light and microprobe investigations show that mineralization at both localities is affected by distinct remobilization and hydrothermal activity. Typical features such as the occurrence of ore minerals on cracks and as fissure

Table 1. Mineral assemblages in Limassol Forest

Mineral Type	Mineral Name	Chemical Composition	Occurrence	
			Pevkos	Lakxia tou Mavrou
Sulphides	Pyrrhotite	FeS	××××	×
	Pyrrhotite	$Fe_{1-x}S$	×	××××
	Mackinawite	$Fe_{1+x}S$	×	–
	Pyrite	FeS_2	–	××
	Pentlandite	$(Fe, Ni, Co)_9S_8$	××	×
	Co-rich Pentlandite	$(Fe, Co)_{6.4}Ni_{2.6}S_8$	–	××
	Bravoite	$(Fe, Ni)S_2$	×	×
	Chalcopyrite	$CuFeS_2$	×××	×××
	Cubanite	$Cu\ Fe_2S_3$	××	××
	Bornite	Cu_5FeS_4	×	–
	Chalcocite	Cu_2S	×	×
	Neodigenite	Cu_9S_5	×	×
	Covellite	CuS	×	–
	Cu-Valleriite	$(Fe_{0.65}Cu_{0.50}S_{1.40})\cdot Mg_{0.14}Ca_{0.25}Fe_{0.97}(OH)_2$	×××	×
	Fe-Valleriite	$Fe_2S_2\ .\ Mg(OH)_2$	×××	×
	Molybdenite	MoS_2	×	–
Arsenides	Maucherite	Ni_3As_2	×	–
	Löllingite	$(Fe, Co, Ni)_{2+x}As_{4-x}$	–	××
	Westerveldite	$(Fe_{0.77}Ni_{0.22}Co_{0.04})As_{0.97}$	×	–
	Cobaltite	$(Co_{0.58}Ni, Fe_{0.42})AsS_{0.9}$	×	–
Oxides	Chromite	$(Fe, Mg)_{1.1}(Cr, Al, Fe)_{1.9}O_4$	×××	×××
	Magnetite	Fe_3O_4	××	×
	Rutile	TiO_2	×	–
	Ilmenite	$FeTiO_3$	×	–
Elements	Gold	(Au, Ag)	×	×

× rare
×× common
××× very common
×××× main constituent

fillings, large amounts of arsenides and stoichiometric pyrrhotite, magnetite which is pure Fe_3O_4, etc., reveal distinct differences to magmatic sulphide deposits. They indicate a complex polyphase origin for ore mineralization at Limassol Forest which was linked to serpentinization and hydrothermal processes.

The initial formation of magnetite as a byproduct of serpentinization is followed by liberation of metallic elements like Fe, Ni, Co and Cu, from primary magmatic olivine. These elements tend to form sulphides or arsenides during various stages of the serpentinization process (RAMDOHR, 1967, ECKSTRAND, 1975, and others). Finally, the formation of löllingite and maucherite by reaction of hydrothermal fluids with preexisting niccolite (OEN et al., 1971, 1977, IXER et al., 1979) has taken place in a temperature range of about 500—300° C.

During the late Upper Cretaceous the Troodos ophiolite was obducted onto the Afro-Arabian continental margin. This tectonic event resulted in extensive deformation and fracturing of parts of the ophiolite facilitating percolation of sea water which is considered responsible for the continuation of serpentinization processes. Serpentinizing solutions under slightly oxidizing conditions lead to the following features: peripheral resorption of stoichiometric pyrrhotite and its partial substitution by pyrrhotite (Fe_9S_{10}), formation of pyrite, decomposition of Cu-minerals resulting in the formation of valleriite and magnetite, distinct deformation of pyrrhotite at Lakxia tou Mavrou. In addition, they signify tensional stress at temperatures of about 200° C (ANTUN et al., 1966, RAMDOHR, 1967, ECKSTRAND, 1975, ATKINSON et al., 1975, TEWARI & CAMPDELL, 1976).

Apart from the cores of chromites no member of the complex mineral association at Limassol Forest can be linked to "magmatic" processes. Quite on the contrary, mineralization is attributed to hydrothermal activity in an area which, due to its vicinity to a fossil transform fault, the Arakapas fault zone, was exposed to particularly intense tectonism and serpentinization. These processes probably commenced in an early stage of Troodos ophiolite formation and continued long after the obduction of the ophiolite.

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