A NEW MINERAL «DELAFOSSITE» OBSERVED FOR THE FIRST TIME IN TURKEY

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SUMMARY. — In association with some secondary minerals such as limonite, malachite, native copper, cuprite, tenorite and covelline; delafossite is found along the fractures of phyllitic rocks within the oxidized zone in the Malatya-Pötürge area. A detailed mineralogic study has been carried out about delafossite since it is observed first time in Turkey.

INTRODUCTION

A rock sample showing phyllite characteristics and containing a rarely encountered mineral delafossite is collected and brought for identification by Aykut Tümer (from the Geophysical Department of the M.T.A.) from a locality to the south of Kılışık, near Çanakçı village, north of Pötürge (Malatya Province). Delafossite is found within the cracks of this phyllitic rock (Microphoto I), which underwent strong cataclastic deformation and silicification. The location where the sample is taken is shown in Figure I.

Delafossite, which occurs in association with other secondary minerals, is studied under the ore microscope of Leitz-made Oftholux II Pol-Bk. In addition, reflection and Vickers microhardness tests are carried out on the delafossite with the aid of a Vickers microscope. The reflection measurements are taken by using a Wolfram Carbide Standard of Zeiss-made, Standard number: 474253, no. 061. The X-ray diffraction studies on delafossite are carried out by the aid of a Phillips X-ray diffractometer.

DELAFOSSITE

Chemical formula.— Ramdohr (I960) gives the chemical composition of delafossite as $CuFeO_2$. Buist, Gadalla and White (1966), who carried out an experimental investigation on the Cu-Fe-O system, found that the natural delafossite resembles a synthetic phase of this system in $3Cu_2O.Fe_3O_4$ composition.

Crystal system.— Rhombohedral, c/a ~ 1.945. Delafossite is generally observed as thin lamellas or the aggregates of sub-parallel crystals and rarely in the form of rhombohedral crystals under the ore microscope.

Unit *cell structure.* — D^s_{3d} ; a_o = 3.02 C_o = 17.10 A°; (a_{rh} = 5.96 A_o, a_{rh} = 29°26'), Z = I

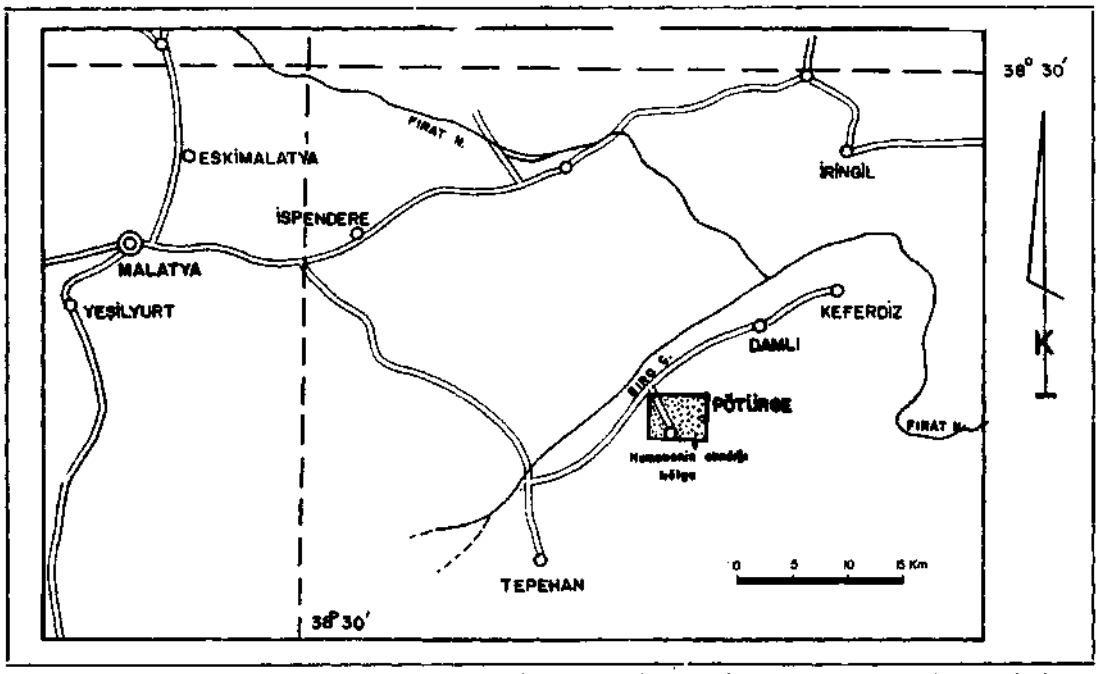


Fig. 1 - Index map of the area under study showing the location from which the sample described in this paper was collected.

Physical properties. — Delafossite has an excellent cleavage along (0001) direction while the cleavage along (1010) direction is not developed so well. The Vickers-microhardness values for delafossite are given in Table I. The other physical properties of delafossite are as follows:

Hardness: 4.5

Specific gravity: 5.5

Luster: metallic

Streak: black

Polishing property: easily polished

Table - 1

The Vickers microhardness values of delafossite*

Applied load (gr)	*The average readings of indentations across both diagonals (micron)*	*Vickers values (VHN kg/mm²)*
20	94	526
50	137-160	362-494
100	196-226	363-483

* Buist, Gadalla and White (1966) give the Vickers microhardness value for the synthetic delafossite as 167.

Microscopic properties. — Under the ore microscope delafossite has a pinkish - light brown color while the reflectivity is medium and it resembles tenorite and enargite by its color and reflectivity. The reflectivity values taken from delafossite are given in Table 2.

Conditions:

Stop: 5

Objective: x40

Standard: Wolfram Carbide, 061, Zeiss

Table - 2

The reflectivity percentages of delafossite*

nm	Reflectivity of the sample	Reflectivity read on the standard	Standard coefficient	Reflectivity in per cent
550	7-8	14	45.70	22.85-26.14
580	7-8	14	45.40	22.70-25.92

*Buist, Gadalla and White (1966) give reflectivity values of the delafossite as 22.2-22 8 %.

Reflection pleochroism is particularly clear around the grain boundaries and sometimes on the grains themselves when the delafossite crystals are studied under the ore microscope in air. Colors vary between light yellow-brown and pinkish-brown. The anisotropy of delafossite changes from medium to strong grades according to positions of sections of crystals or the aggregates of crystals. The colors under the crossed-nicols are bluish-gray (schist gray) and the extinction is straight. The internal reflection is not observed in delafossite.

Delafossite is observed as intergrown with limonite (goetite) or side by side with limonite. It usually displays afibrous, radial, kidney-shaped structure with a concentric crust (Microphoto 2). By its structure, the sample under study resembles the mineral delafossite from Kimberley (Buist, Gadalla & White, 1966). In addition to this type of structure in delafossite, which is generally formed within the large fractures, the delafossite-limonite association is also observed as fillings of the smaller cracks and the aggregates of delafossite lamellas extend along the strike of these small fractures (Microphoto 3).

Sometimes along with limonite, the presence of some idiomorphic delafossite crystals shows that they are probably derived from pyrite or arsenopyrite. The rhombohedral forms of these crystals, which range from 100 to I50 microns in diameter, clearly indicate that they are the pseudomorphs after those two former minerals (Microphoto 4,5).

It is suggested that the delafossite is formed by a strong reaction of solutions rich in $FeSO_4$, which derives from the decomposition of pyrite or arsenopyrite, on the secondary covelline. As a result of this reaction, the resulting delafossite with limonite replaces the idiomorphic pyrite or arsenopyrite crystals which are limonitized throughout the chemical process (Ramdohr, I960).

Under the ore microscope, delafossite shows great similarity with tenorite. However, delafossite is slightly lighter in color than tenorite and tenorite also shows wavy extinction. Like tenorite, delafossite is formed in the depths of oxidation zone with other secondary ore minerals which generally show kidney-shaped, radial and crust-like textures. Therefore the determination of delafossite is difficult and it could be only detected by the X-ray diffraction methods, as it is shown in our case in Table 3.

Formerly, delafossite was considered as a rare mineral because it is usually mistaken for tenorite. However, it has now been established that it is more widespread than previously believed. The following are the places where the delafossite is encountered:

Bisbee-Arizona (U.S.A.); Mina Copreasa, Sonoripa, Sonora (Mexico); Yauricocha (Peru); Cartagenera/Pedrosa-Rio Tinto (Spain); Waldsassen-Oberpfalz (West Germany); Tilva-Mical Bor (Serbia-Yugoslavia); Sverdlovsk-Urals (U.S.S.R.); Cornwall (U.K.); Kimberley (South Africa).

The microscopic evidences suggest that the paragenesis of delafossite from the Malatya-Potiirge area is similar to that from the Bisbee district ih the U.S.A.

Conditions:

Cu K & radiation

Ni filter

40 kv, 20 mA

Table - 3

X-ray diffraction data of delafossite from the Malatya-Pötürge area

d A°	*Intensity*	*Minerals*	*Massive ore Bisbee, Arizona**	*Intensity*
5.03	m	M		
4.18	m	G		
3.62	m	M		
2.83	s	D	2.86	s
2.75	w	M		
2.54	w	M		
2.51	vs	D	2.51	vs
2.44	s	M, G		
2.23	w	D	2.239	s
2.17	w	M, G		
2.12	w	M, G		
1.90	vw	D	1.909	vvw
1.80	vw	D	1.804	vvw
1.70	w	M, G		
1.67	w	M		
1.66	w	D	1.660	m
1.65	vw	M		
1.50	m	D	1.514	s
1.42	w	D	1.432	m
1.33	vw	D	1.339	m
1.28	m	D	1.296	m

D — delafossite; M — malachite; G — goethite.

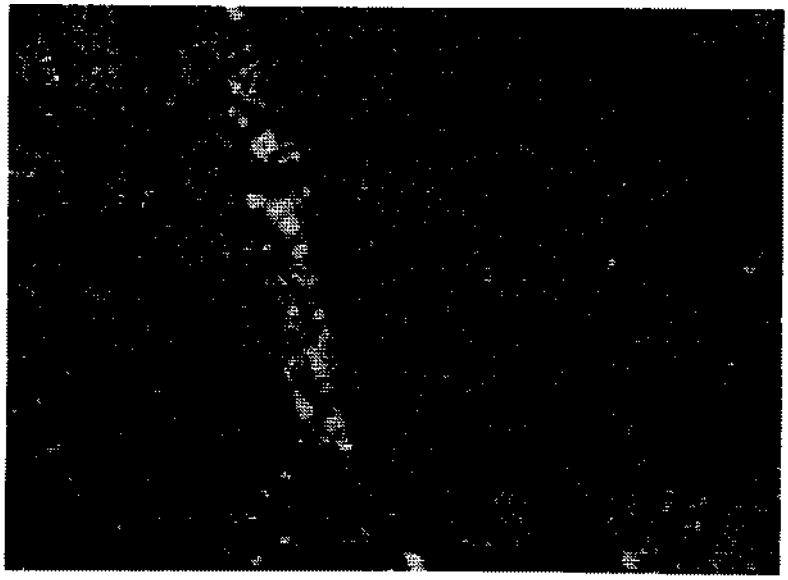
s — strong; m — mean; w — weak; v — very.

* Buist, Gadalla and White (1966).

OTHER MINERALS ASSOCIATED WITH DELAFOSSITE

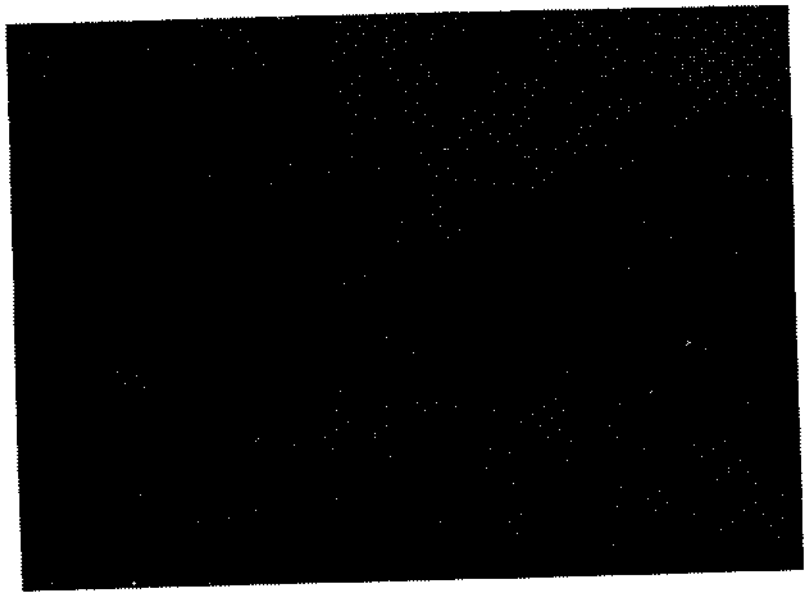
Minerals found in association with delafossite in the studied sample, are described briefly as follows:

Limonite (goethite). — This mineral is generally found in close association with delafossite. It also contains small amounts of cuprite, tenorite and native copper. Limonite is determined as geothite by X-ray diffraction, as it is shown in Table 3.

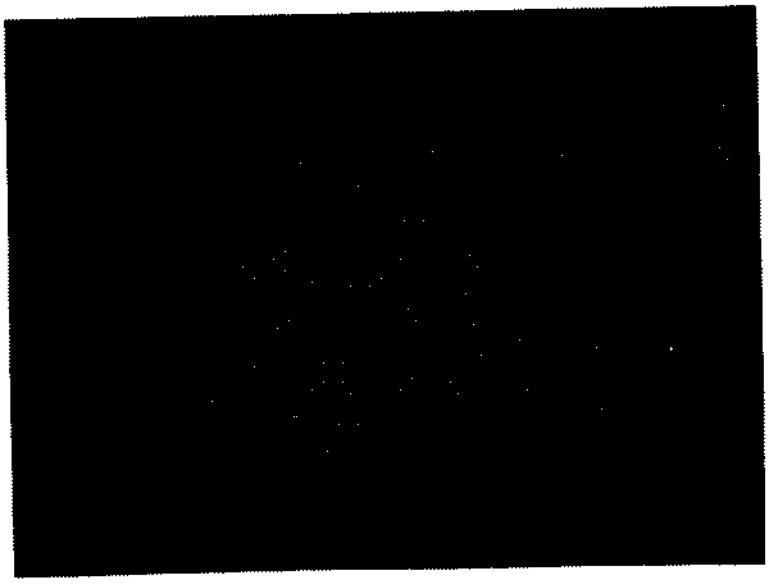


Microphoto 1 - Thin section, X 25. Silicified, strongly cataclastic phyllite. A secondary vein cuts across the rock in center. Cracks contain delafossite and other minerals (black).

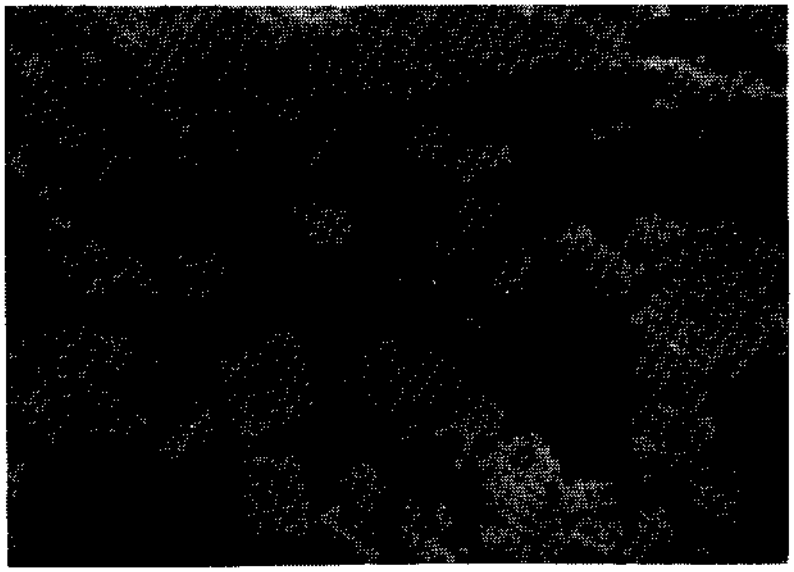
Microphoto 2 - Polished section, X 160. Delafossite (light gray) is closely associated with limonite (gray) showing a kidney-like structure. Gangue mineral (dark gray), cavities and lines (black).



Microphoto 3 - Same as Microphoto 2, but under crossed-nicols.



Microphoto 4 - Polished section, X 160, under crossed-nicols. Platy delafossite. (The color varies between gray and dark gray because the sample is viewed through the crossed-nicols.) Limonite around delafossite (dark gray). Gangue minerals (black).



Microphoto 5 - Polished section, X 160. Delafossite (light gray) with limonite (gray) occur in idiomorphic and sometimes distinct rhombohedric forms. Gangue minerals (dark gray), cavities (black).

Malachite. — Malachite is found as veinlets filling the fractures. It shows kidney-like, radial, fibrous, and crusty concentric structure and it contains minerals, such as native copper, cuprite and tenorite in small quantities. Its existence is proved by X-ray diffraction study (see Table 3).

Native copper. — This occurrence is found in very small amounts partly within the limonite-delafossite association or partly within the malachite.

Cuprite. — Cuprite is also observed in small amounts, but it is more than the native copper in quantity. It exists either by itself as isolated grains or around the native copper from which the cuprite is derived. Sometimes it forms thin veinlets and sometimes it occurs in xenomorphic forms.

Tenorite. — This mineral is found in trace amounts either around the cuprite or at the corners and boundaries of cuprite crystals from which it originates.

Covelline. — Some trace amounts of covelline (max. size 15-20 microns) are observed within the malachite and limonite occurrences.

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