LUDWIGITE FROM OCNA DE FER (VASKŐ, BANAT, RUMANIA)

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One of the most interesting minerals of the classic contact region of the Rumanian Banat is ludwigite which was discovered there. Ludwigite forms between Vaskő (Ocna de Fer formally Moravica) and Dognácska (Dognacea) at the foot of the Mountain Dániel in the magnetite between the old mine of Reichenstein, Jupiter and Archangel at a length of 300 m lenselike embeddings, scattered patches and irregular bands. In the mine district of Archangel along the fissures and layers of crystalline limestone, recrystallized to marble of Mezozoic age, the magnetite veins also contain nests, veins and smaller patches of ludwigite.

In larger masses the ludwigite is very finely fibrous. The fibres varying in length form concentrically radiated, or fanlike aggregates starting from the centre. The aggregates are black, silky and have a lustre resembling astrakhan. The length of the single fibres may amount to some cm. The fibres of the aggregates, interwoven with those of the aggregates in the vicinity, form entangled feltlike, very tough masses. The coarsely fibrous masses are more rare where the interwoven dense aggregate of the 5—6 cm long and about 1 mm thick fibres arranged radially or fanlike resemble delusively to the dense black turmaline (schörl) occurrences.

The coarser ludwigite fibres are not monocrystals but aggregates of parallel grouping of very fine fibres varying in length according to the *c* crystallographic axis. The growth of the parallel groupings of fibres often stops and then continues in an oriented manner. The place of the interrupted growth is shown by the separation of the fibres vertically onto the *c* crystallographical axis. Such separations, which are never sharp and do not indicate a cleavage direction, may be often seen an thicker ludwigite fibres, their weathering starts along these directions. Far thinner ludwigite fibres not showing separation directions are still quite intact when the weathering of the thicker fibres

already starts along the separation lines (Photo 1). Both the very fine fibres and the thicker ones (crystal bundles) are very often curved (Photo 2). The fine fibrous masses are extremely tough, the coarser fibres are rigid, their surface of fracture is irregular and of greasy submetallic lustre.

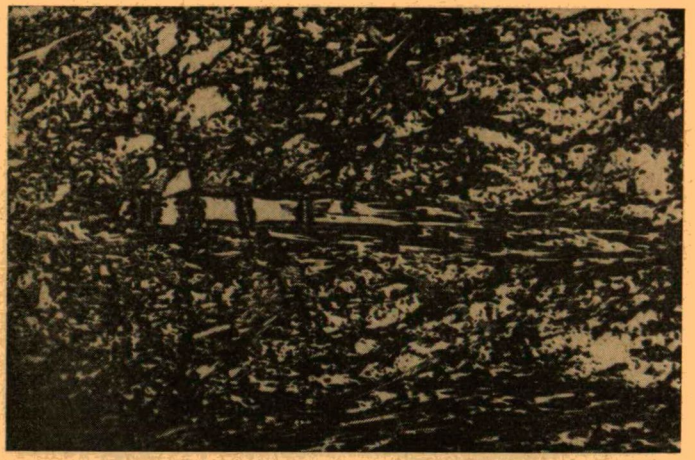

Fig. 1. Coarser ludwigite thread showing separation-lines. The weathering begins along these directions, Plain light, x100.

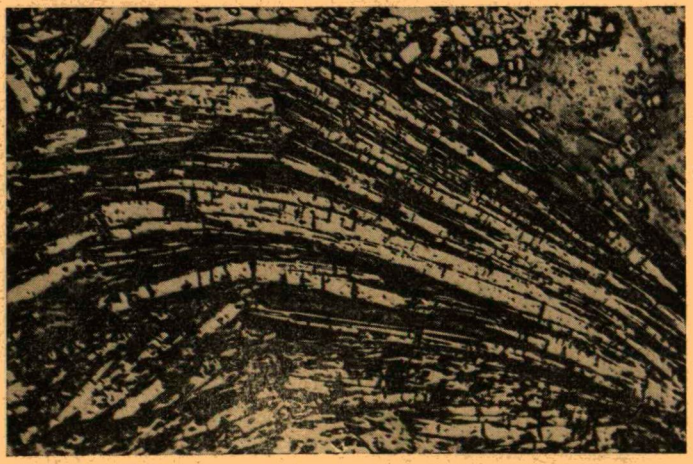

Fig. 2. Curved threads of ludwigite. Plain light, x50.

Generally the ludwigite masses are embedded in magnetite. More rarely one can also find smaller fibrous needle aggregates in marble. The ludwigite fibres reaching into calcite granules which show beautiful polysynthetic twin lamellae, branch into fine needles (Photo 3). Beside the marble, green contact serpentine is also present as an

accessory rock associated with the magnetite-ludwigite ensemble. Very fine ludwigite needles dissolved with dilute HCl from marble show a wonderful pleochroism: bluish green - dark oil green - pinkish light brown, brown. The intensity of the colours depends upon the thickness of the fibres. On the ludwigite needles terminal planes cannot be de-

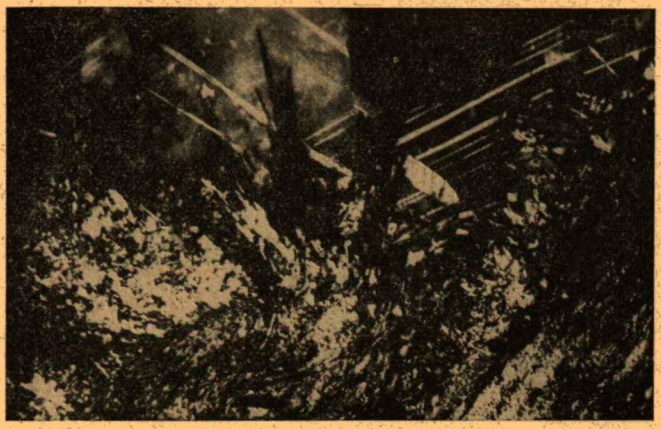

Fig. 3. Ludwigite threads branched into fine needles embedded in calcite. Crossed nicols, x50.

tected, the end of the fibres is irregular i. e. they separate into still finer needles.

The round, small, scattered particles of larger magnetite granules surrounded and replaced by ludwigite can very often be found in the fine-threaded ludwigite masses mostly coeval but partly younger than the magnetite (Photo 4).

Fig. 4. Rounded grains of magnetite replaced by ludwigite. Plain light, x50.

Beside the dominating magnetite and ludwigite, the granules not exceeding 0,1 mm in size or rarely the well developed octahedrons of the younger franklinite can be found overgrown on the edges of the ludwigite fibres or at the separation lines of the fibre-bundles. Its amount is insignificant. Of the sulphide ores pyrite and sphalerite could be observed replacing magnetite and ludwigite (Photo 5).

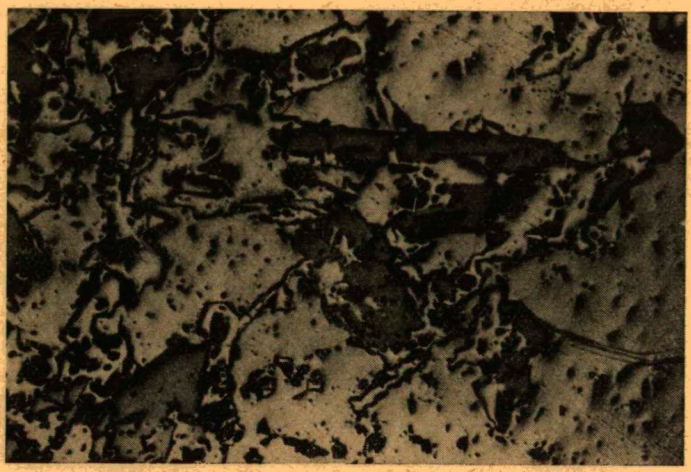

Fig. 5. Ludwigite (gray) replacing sphalerite (white) and pyrite (white with strong relief) as well as magnetite. Plain light, x100.

The dense fine-threaded ludwigite can be well ground and the aggregates perpendicular to the *c* crystallographical axis can excellently be polished, the parts parallel with the longitudinal direction

Fig. 6. Aggregates of ludwigite crystals perpendicular to c axis surrounded by fine threaded ludwigite parallel with the c axis. Crossed nicols, x50.

of the fibres have a duller silky lustre, in this direction the breaking off of the fibres is frequent. Parallel to the longitudinal direction of the fibres, the section is a partly finer and partly coarser fibrous, whereas perpendicular to the *c* axis it shows a »pavement«-structure (Photo 6).

Under the microscope the magnetite is far darker than the ludwigite, beside it magnetite shows a slightly brownish white colour. Franklinite is white still lighter than magnetite. Beside sphalerite, the ludwigite is dark, the magnetite is lighter with a light pinkish shade.

The reflection pleochroism of ludwigite is significant. Parallel to the *c* crystallographical axis it is slightly pinkish lighter or darker grey, perpendicularly to the *c* crystallographic axis it is darker grey — slightly greenish dark grey. In oil the colours are a little more intensive.

Under crossed nicols the extinction is parallel, the interference colors are vivid and change strongly with the orientation. Parallel to the crystallographic axis *c* the color is always pinkish yellowish brown, brown, on the sections perpendicular or nearly perpendicular to the crystallographic axis *c* the colors are far darker: dark bronze red — violet red — bluish red. In oil the intensity of the colors is a littler duller.

Internal reflexes can never be observed. The dark red internal reflexes, mentioned in the Lehrbuch der Erzmikroskopie (Berlin 1931. Bd. II. S. 567.) by *Schneiderhöhn-Ramdohr*, originate from the extremely small franklinite crystals associated with ludwigite.

Etching with ccHNO_3, aqua regia, ccHCl, ccH_2SO_4 is negative. On dropping ccHCl onto the section it shows a mildly green color.

Its structure is always fibrous, the fine fibres compose a dense feltlike network. On the section prepared from coarser fibres, several fibres show a rhombic cross section perpendicular to the crystallographical axis *c*, the obtuse angle of the rhombus measured under the microscope is 113°. Hence the dominating form of the crystal is prism (110).

The result of the analysis of the sample:

MgO	28,55 per cent
FeO	16,39
Fe_2O_3	36,06
MnO	trace
B_2O_3	(17,50)
H_2O	1,50
	100,00 per cent

(Analyst Mrs. Klivényi)

The analysis was prepared from coarsely fibrous substance, the B_2O_3 content is calculated from the difference.

Franklinite and kotoite of pneumatolytic origin are associated in traces with ludwigite. The occurrence of franklinite is not surprising considering that from the ludwigite of this region the Mn could be detected at least in traces, whereas the Zn appears as sphalerite in the

hydrothermal phase. The franklinite is overgrown on the edges of the ludwigite fibres and the aggregate of their extremely small granules quasi rims the ludwigite. Its tiny octahedrons with an adamantine lustre are overgrown on thin ludwigite needles which reach into small hollows. In section, under crossed nicols, it shows a white color and a stronger lustre than magnetite, but particulary in oil it has dark red internal reflexes. It is isotrop. Qualitative determinations showed that it contains both zinc and manganese.

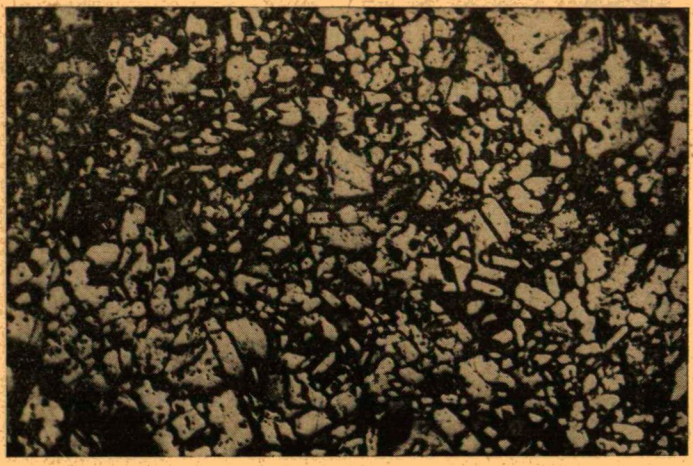

Fig. 7. Kotoite grains showing »Pavement-structure« in calcite. Plain light, x100.

In the places where ludwigite is in contanct with marble, in the rounded calcite granules of the marble a mineral harder than calcite having a nearly similar, or higher refraction, could be observed (Photo 7). The size of the granules does not exceed 1 mm. Owing to the extremely small amount their magnesium and boron content could only be qualitatively demonstrated. A thin section from a sample of szájbélyit from Rézbánya (Baita, Rumania) was made in view of the fact that *T. Watanabe* [1939] the discoverer of kotoite found the kotoite beside the szájbélyit of Rézbánya. In this section kotoite could also be detected and on comparing it with the mineral from Vaskő it could unequivocally be established that it is kotoite. Unfortunately, more thorough investigations could not be carried out because of the rare borate minerals from the Banat there was not enough substance available.

On the action of hydrothermal solutions ludwigite and kotoite decompose into szájbélyite. The fine needles, and needle aggregates of szájbélyit — as has already been established by *M. Lőw* [1911] — occur fairly plentifully in the hollows of ludwigite subsequently filled up by calcite. They can also be found as inclusions in the calcite granules of the marble in contact with ludwigite. The needles showing a very strong birefringence are arranged in radial aggregates.

Among the sulphides pyrite occurs far more rarely. I could only once observe its crystalline band along the ludwigite fibres. The sphalerite replaces both magnetite and ludwigite. Judging from its resin yellow internal reflexes it has a low Fe content. Calcite is the youngest primary mineral of the paragenesis. Its granules, always showing polysynthetic twin lamellae, contain the crystals and granules of the minerals mentioned hitherto, occur as inclusions (Photo 8). The ludwigite

Fig. 8. Polysynthetic twinned calcite with magnetite and ludwigite inclusions. Crossed nicols, x50.

alters into limonite. On the sections prepared from the altered samples splendid orange yellow coloured internal reflexes can be seen, the substance is pseudomorph after ludwigite, the thicker fibres of this mineral pass intactly through the parts already limonitised showing a ludwigite structure. As mentioned the breakdown of the thicker ludwigite fibres begins in the separation-directions perpendicular to the crystallographical axis *c*, thus sometimes dividing the ludwigite fibres into 3—4 parts (see Photo 1).

The dominating members of the interesting and rare mineral-associations are:

magnetite, ludwigite associated rock: contact marble, serpentine

Minerals of pneumatolytic origin only appearing in traces:

franklinite, kotoite.

Ores of hydrothermal origin only appearing in traces:

pyrite, sphalerite.

Mineral formed secondarily on the action of hydrothermal solutions:

szájbélyit.

Hydrothermal accessory mineral:

calcite.

Secondary weathering product:

limonite.

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