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Theophrastite, $Ni(OH)_2$, a new mineral from northern Greece

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Abstract

The new mineral theophrasite is a nickel hydroxide with the formula $Ni(OH)_2$. Chemical analysis gave 80.21%, Fe and Co < 0.1%, and H_2O 19.30%, total 99.51%. These correspond to $Ni_{1.00}(OH)_{2.00}$. Infrared study showed only OH. It is soluble in acids.

The X-ray powder diffraction pattern agrees with that of synthetic $Ni(OH)_2$ (JCPDS Card No. 14-117). The strongest lines in the pattern are: 4.61(95)(0001), 2.708(30)(10$\bar{1}$0), 2.335 (100)(10$\bar{1}$1), 1.755(50)(10$\bar{1}$2), 1,563(25)(11$\bar{2}$0), 1.480(18)(11$\bar{2}$0), 1.336(10)(10$\bar{1}$3). The pattern is indexed on a trigonal cell with a 3.131, c 4.608Å. The parameters are very close to those of synthetic $Ni(OH)_2$ which is $P\bar{3}m1$, a 3.126, c 4.605Å, $Z = 1$.

The mineral is emerald green, translucent with vitreous luster and pale green streak. The cleavage is basal perfect and fracture conchoidal. H (mohs) is 3.5 and the specific gravity is 4.00 (meas.) and 3.95 (calc.), it is optically uniaxial positive, has refractive indices ω and ε = 1.759–1.760, and very weak birefringence. It is pale green in thin section and weakly pleochroic.

The new mineral is found in the Vermion region, northern Greece, as small crystals of 0.n mm order on surfaces, in cavities and fractures of magnetite–chromite ore, with idocrase, Ni-bearing serpentine minerals, chlorite and calcite.

Introduction

A nickel hydroxide mineral occurs at the surfaces and fractures in an ore consisting of magnetite with minor amounts of a chromite and sulfide minerals, mainly millerite. The ore is found in relatively small lenses within serpentinites in the Vermion region of northern Greece, 50 km west of Thessaloniki. The main gangue minerals are idocrase, chlorite, garnet (andradite–grossularite), Ni-serpentine minerals and calcite (Economou and Marcopoulos, 1980).

We report here on the Ni-bearing new mineral theophrasite.

Description of the nickel hydroxide

Theophrasite (Fig. 1) is emerald green in color and translucent. The luster is vitreous, and streak is pale green. Cleavage is basal perfect and fracture is conchoidal. The Mohs hardness is 3.5. The specific gravity determined using heavy-liquid techniques, is 4.00 g/cm^2; the calculated value is 3.95 g/cm^2.

The mineral is found as small crystals of 0.n mm but usually forms thin layers, thickness less than 0.5 cm. In some cases the new mineral forms successive layers consisting of very fine fibrous crystals alligned perpendicular to the boundaries of idocrase or chlorite crystals (Fig. 2). It is pale green in thin section and weakly pleochroic. Optically, theophrasite is uni-

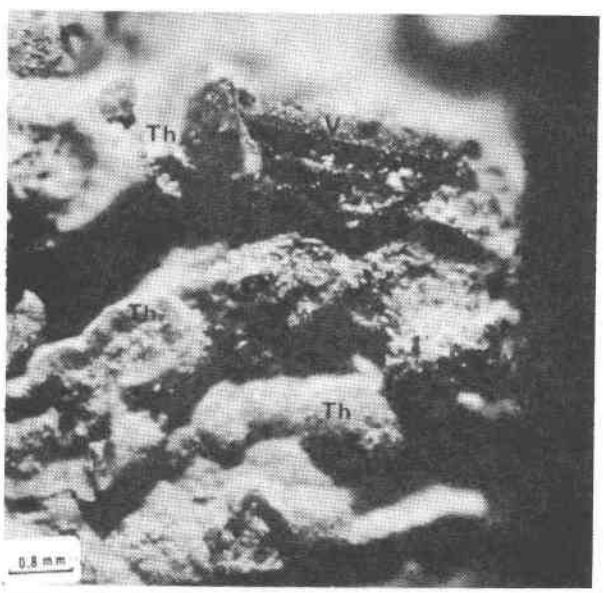

Fig. 1. Botryoidal structure of theophrastite (Th) around aggregates of idocrase crystals (V), Vermion.

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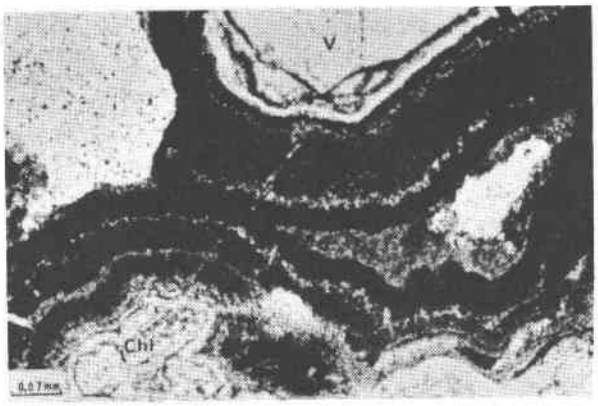

Fig. 2. Photomicrograph of theophrastite, dark, covering idocrase (V) and chlorite (Chl), cross section, Vermion.

axial positive. Refractive indices were measured using λ-variations according to the method of Piller (1952), ω and ε are 1.759–1.760. The birefringence is very weak.

X-ray powder diffraction patterns agree with synthetic $Ni(OH)_2$ (JCPDS No. 14-117), Table 1. The pattern is indexed on a trigonal cell with a 3.131, c 4.608Å. These parameters are very close to those of synthetic $Ni(OH)_2$, which is trigonal, $P\bar{3}m1$, a 3.126, c 4.605Å, $Z = 1$.

Theophrastite was analyzed with an ARL-SEMO electron microprobe, operating at 15 kV and 150 nA.

Table 1. X-ray diffraction data for theophrastite and synthetic $Ni(OH)_2$. Data obtained using a polycrystalline sample in a Philips goniometer with monochromator, Cu$K\alpha$ radiation, Ni filter, Si internal standard, with intensities visually estimated.

Theophrastite			Syn. $Ni(OH)_2$, JCPDS Card No. 13-117	
$d_{(Obs)}$	I/I_o	h k l	d	I/I_o
4.61	95	0001	4.605	100
2.708	30	$10\bar{1}0$	2.707	45
2.335	100	$10\bar{1}1$	2.334	100
2.305	4	0002	2.302	2
1.755	50	$10\bar{1}2$	1.754	35
1.563	25	$11\bar{2}0$	1.563	25
1.536	1	0003	1.535	1
1.480	18	$11\bar{2}1$	1.480	16
1.355	1	$20\bar{2}0$	1.354	4
1.336	10	$10\bar{1}3$	1.335	8
1.299	8	$20\bar{2}1$	1.299	10
1.294	2	$11\bar{2}1$	1.293	2
1.168	6	$20\bar{2}2$	1.167	8
1.165	5			
1.153	1			
1.096	1			
1.060	2			

Data obtained using a polycrystalline sample in a Philips goniometer with monochromator, Cuka radiation, Ni filter, Si internal standard, with intensities visually estimated.

Table 2. Chemical composition of theophrasite and synthetic $Ni(OH)_2$

	Theophrastite	theor. for $Ni(OH)_2$
NiO	80.21	80.57
Fe	trace	--
Co	trace	--
H_2O	19.30	19.43
total	99.51	100.00

Pure metal standards for Ni, Co and Fe were used. The spectra was processed using a commercial version of the MAGIC-Program of the Geophysical Laboratory, Washington, D.C. The nickel content is 80.21 NiO, iron and cobalt < 0.1 wt.%. The water determined by Penfield method is 19.30 wt.% H_2O. This composition is in excellent agreement with synthetic $Ni(OH)_2$ (Table 2).

The infrared spectrum of the theophrasite showed only an absorption band at 3640 cm^{-1}, which is attributed to OH. The mineral is soluble in acids.

In summary, theophrasite is a nickel hydroxide corresponding to the formula $Ni(OH)_2$, which occurs as a gangue mineral in the magnetite–chromite ore occurrences of the Vermion region, northern Greece. In the common mineral assemblage of the ore theophrasite shows a subsequent deposition on idocrase and/or chlorite. The name is for Theophrastos, the first Greek mineralogist, 373/372–288/287 B.C. The new mineral and the name were approved by the Commission on New Minerals and Mineral Names, IMA, prior to publication.

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