Apatite from Sakar Mountain, Bulgaria – morphology and physical properties

Апатит от Сакар планина, България – морфология и физични особености

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Keywords: apatite, morphology, Raman, Kanarata quarry, Sakar Mountain.

In the present study apatite crystals $Ca_5(PO_4)_3(F,OH,Cl)$ from the Kanarata open-cast quarry, located 3 km north of the village of Hlyabovo, Topolovgrad Municipality, Haskovo District, Sakar Mountain, are investigated. The examined samples of apatite are gray-blue, up to 1 cm width and up to 2 cm height, single terminated monocrystals with jewelery quality (Fig. 1).

Refractive indices are measured on a System Eickhorst refractometer. Values of 1.629 to 1.631 for n_ω and n_ε respectively have been obtained. Their specific gravity is between 3.13 and 3.26. According to data from X-ray diffraction pattern measured, refractive indices and specific gravity the studied samples are predominantly composed of fluorapatite $Ca_5(PO_4)_3F$.

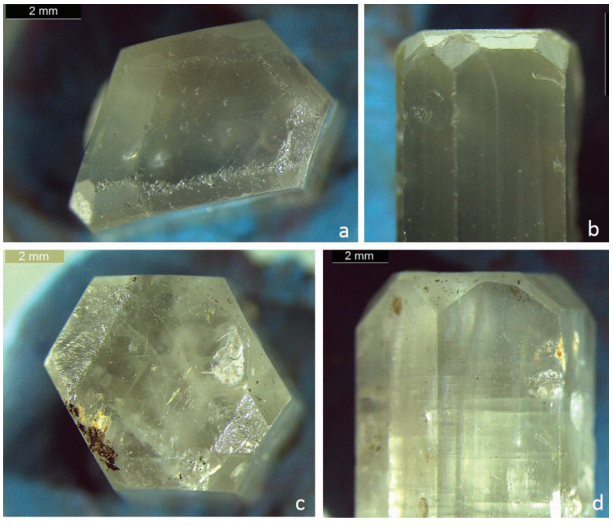

Fig. 1. Microphotographs of selected apatite crystals from Sakar Mountain: *a*, ap1; *b*, ap3; *c*, ap2; *d*, ap2

Cell data: $P6_3/m$, a = 9.3973Å, c = 6.8782Å (Hughes et al., 1989) (Table 1).

The angles between corresponding faces of crystals are measured for all specimens with one circle

Table 1. The order of the morphological importance (MI) of crystal faces, d_{hkl}, refractive indices and specific gravity for natural apatites

Terpstra et al., 1986			Hughes et al., 1989			This work	
hkl	MI	d_{hkl}	F	Cl	OH	d_{hkl}	faces
$10\bar{1}0$	1	8.17	8.14	8.31	8.15	8.13	√
$01\bar{1}1$	3/4	5.26	5.25	5.25	5.26	5.25	√
$11\bar{2}0$	5	4.72	4.70	–	4.71	4.72	
$11\bar{2}1$	3/4	3.88	3.88	3.92	3.88	3.88	√
$02\bar{2}1$	6	3.51	3.50	3.54	3.51	3.50	√
0002	2	3.44	3.44	3.39	3.44	3.44	√
$01\bar{1}2$	7	3.17	3.17	–	3.17	3.17	√
$21\bar{3}0$	11	3.08	3.076	3.14	3.082	3.077	
$12\bar{3}0$	11	3.08	3.076	3.14	3.082	3.077	
$21\bar{3}1$	8	2.81	2.808	2.850	2.812	2.801	
$12\bar{3}1$	8	2.81	2.808	2.850	2.812	2.801	√
$11\bar{2}2$	9	2.78	2.775	2.768	2.776	2.773	
$30\bar{3}1$	?	2.53	2.524	2.565	2.527	2.516	
$31\bar{4}0$			2.257	2.305	2.261	2.256	
$11\bar{2}3$			2.061	2.044	2.060	2.059	
$12\bar{3}3$			1.838	1.834	1.839	1.835	
Refractive indices		n_ω	1.631–1.650	1.675	1.651	1.631	
		n_ε	1.627–1.646	1.668	1.644	1.629	
Specific gravity			3.1–3.25	3.17–3.18	3.10–3.21	3.13–3.26	

Reflection goniometer R.FUESS-STEIGLITZ and the Miller's indices of simple forms of apatite are determined by the Wulff's method (Cosine Ratio Method). The crystals are drawn using VESTA (Momma, Izumi, 2011). The crystals are elongated along the [001] zone, with dominant simple forms for most of the studied crystals: M $\{10\bar{1}0\}$, c $\{0001\}$, X $\{10\bar{1}1\}$ and S $\{11\bar{2}1\}$. In several cases are found faces: y $\{20\bar{2}1\}$, f $\{20\bar{2}3\}$, $\{22\bar{4}3\}$ and $\{24\bar{6}3\}$. The observed results correspond to the classical law of Bravais-Friedel that the morphological importance of a crystal form $\{hkl\}$ decreases with decreasing interplanar spacing d_{hkl} (Terpstra et al., 1986) (Fig. 2).

Unpolarized Raman spectra of apatites are recorded in back scattering geometry on Micro-Raman Spectrometer LabRAM HR Visible (HORIBA Jobin Yvon), 633 nm, He-Ne laser, 7.3 mW. According to the expectation, the intensities of observed peaks depend on the orientation of the apatite crystals. Some

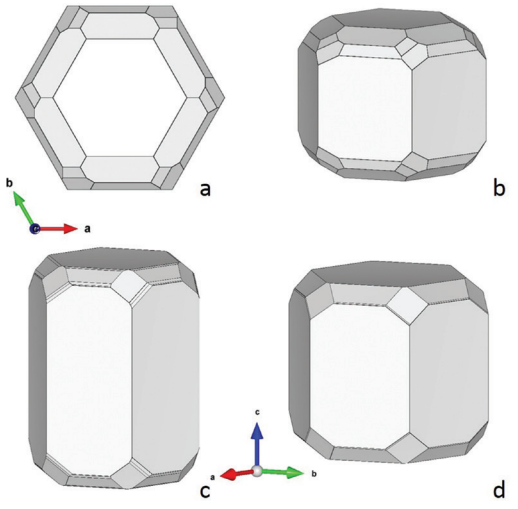

Fig. 2. Idealized morphology of investigated apatite crystals: *a*, ap1; *b*, ap1; *c*, ap3; *d*, ap2

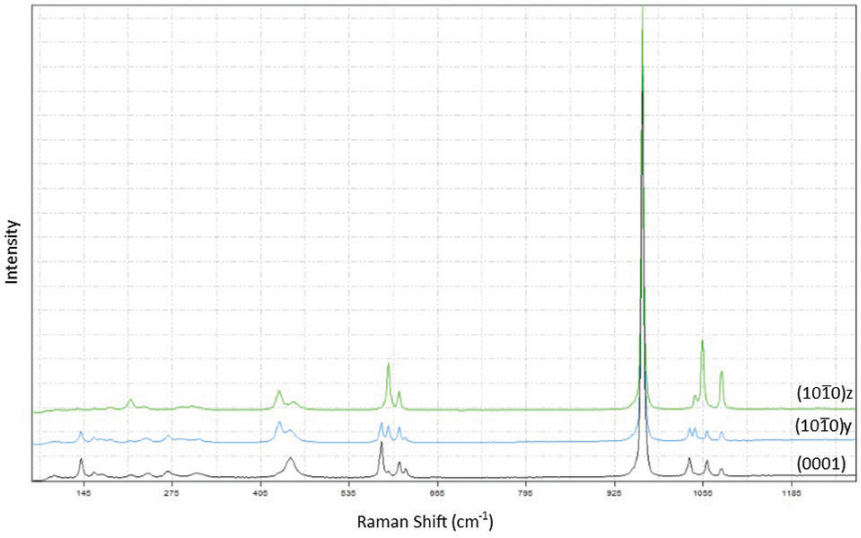

Fig. 3. Raman spectra of apatites in different orientations

of the reflexes disappear. A deeper analysis of the results obtained will be the subject of further work. Thin needles of actinolite included in apatite were determined on their Raman spectra (Fig. 3).

Acknowledgments: Thanks due to Vesselina Nakova for X-ray diffraction, Petja Boteva for specific gravity measurements, Prof. Dr. M. Abrashev for the help with Raman spectroscopy and first of all to Nikolay Gospodinov for the crystals provide.

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