POLYTYPISM OF CRONSTEDTITE FROM THE NAGYBÖRZSÖNY ORE DEPOSIT, NORTHERN HUNGARY

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Introduction

Nagybörzsöny is a well-known Au-Ag-Pb-Zn ore deposit in northern Hungary, exploited since the Middle ages. It is located in the Börzsöny Mountains, the part of the Neogene Intra-Carpathian Volcanic Arc. Volcanic activity occurred in Middle Badenian during two periods (Lower and Upper units), of the age of 15.2±0.8 My and 14.2±0.9 My, respectively. The Lower Unit was affected by hydrothermal processes in its central area and the deposit was formed during this event (KORPÁS & LANG, 1993). More than 120 minerals were described from this locality (*e. g*. PANTÓ & MIKÓ, 1964; SZAKÁLL *et al*., 2012). The rare mineral cronstedtite was identified in a piece of the ore material collected in 2000 from the dump of the Alsó-Rózsa adit, about 5 km ENE from the village of Nagybörzsöny (GPS coordinates: 47.9408644°N, 18.8943714°E).

Cronstedtite, $(Fe^{2+}_{3-x} Fe^{3+}_x)(Si_{2-x}Fe^{3+}_x)O_5(OH)_4$, where $0 < x < 0.85$ is a trioctahedral 1:1 layered silicate of the serpentine-kaoline group. It forms many polytypes by stacking equivalent structure building layers composed of octahedral and tetrahedral sheets, with trigonal protocell $a = 5.50$, $c = 7.10$ Å, layer group $P(3)1m$. Polytypes are subdivided into four OD (Ordered-disordered) subfamilies (Bailey's group A, B, C, D), representing the four possible stacking rules of layers. For the accurate determination of polytypes, the single-crystal diffraction techniques are needed – precession photographs, reciprocal space (RS) sections generated from the data collected by the single-crystal diffractometer with an area detector, and/or electron diffraction tomography (EDT) (HYBLER *et al*., 2016, 2017, 2018, 2020).

Experimental

Single crystals of cronstedtite were selected from the sample, glued on the glass fiber, and put on the four-circle (double-wavelength) X-ray diffractometer Gemini A Ultra (Rigaku Oxford Diffraction, Wroclaw, Poland) equipped with the CCD area detector Atlas in the Institute of Physics, Czech Academy of Sciences. The Mo$K\alpha$ radiation, with graphite monochromator, $\lambda = 0.71070$ Å, Mo-enhance fiber optics collimator were used throughout all experiments.

The RS sections $(2h\bar{h}l_{hex})^*$, $(hhl_{hex})^*$, $(\bar{h}2hl_{hex})^*$, $(h0l_{hex})^*$, $(0kl_{hex})^*$, and $(\bar{h}hl_{hex})^*$ were created by the diffractometer software and used to determine the OD subfamilies and particular polytypes. The chemical composition of some specimens was thereafter determined by electron probe microanalysis (EPMA) (HYBLER *et al*., 2020).

Results

With one exception, all crystals studied belong entirely to the subfamily A. The rare polytype 1M, $a = 5.51$, $b = 9.54$, $c = 7.33$ Å, $\beta = 104.5°$, space group Cm is relatively abundant in the occurrence. Another polytype 3T, $a = 5.51$, $c = 21.32$ Å, space group $P3_1$ was found, too. Both polytypes occur separately or in the mixed, mostly 1M dominant crystals. Some 1M polytype crystals are twinned by order 3 reticular merohedry with a 120° rotation along the $\mathbf{c}_{hex}$ axis as the twin operation. A rare 1M+3T mixed crystal with 1M part twinned contains also a small amount of the subfamily C. A possible presence of the most common 1T polytype of this subfamily cannot be confirmed because of overlapping of characteristic reflections with these of 3T. Several completely disordered crystals produce diffuse streaks instead of discrete characteristic reflections on the RS sections. EPMA reveals Fe, Si, traces of Mg, Al, S and Cl. The 1M polytype is known from Eisleben, Germany (HYBLER, 2014), and from the synthetic run product (PIGNATELLI *et al*., 2013).

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