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Short note

Megacrysts of kyanite from Baranec Mt., Western Tatra Mountains, Slovakia

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Abstract. Large crystals of kyanite (<15 cm in size) occur in quartz segregations in Paleozoic gneissess on Baranec Mt., Western Tatra Mountains, northern Slovakia. Blue kyanite crystals coexist with quartz and plagioclase. The kyanite contains inclusions of apatite, monazite, garnet, rutile and biotite and overgrowths of retrograde sillimanite, muscovite and biotite. The kyanite crystals are the largest found up to now in the Tatra crystalline massif or in the other Western Carpathians crystalline cores. Kyanite, with the co-existing mineral assemblage, is indicative of a HP stage during Hercynian metamorphism of the Western Tatra Mountains.

Key-words: kyanite, metamorphic envelope, Western Tatra Mts, Western Carpathians

1. Introduction

Kyanite is a triclinic polymorph of the aluminosilicate (Al_2SiO_5) series which also includes andalusite and sillimanite. Kyanite is an indicator of high-pressure conditions. The mineral occurs in metamorphic rocks, mostly in paragneissess and schists, and also in veins resulting from high-pressure regional metamorphism of principally pelitic rocks. It also occurs as detrital grains in sedimentary rocks. In metamorphic rocks, kyanite usually forms crystals up to a few milimeters long. Sporadically, these may exceed 3 cm. Kyanite crystals <10 cm have been noted in, e.g. Switzerland, Germany, England, Brasil, Argentina, Antarctica, Australia and Czech Republik (Allaz et al. 2005; Běluša 2000; Faye, Nickel 1969; Kerrick 1990; Müller 1984). In this paper, we describe a new locality with unusually

large, euhedral, blue kyanite crystals 12-15 cm in length on the NW slopes of Baranec Mt., Western Tatra Mts, Slovakia.

2. Geological setting

The Tatra Mountains are the northernmost crystalline massif of the Inner Western Carpathians and belong to the Tatric Unit (e.g. Andrusov 1968; Mahel', Buday 1968). The crystalline basement of the Tatra Mts (Fig. 1a, b) is composed of a Variscan granitoid intrusion and its metamorphic envelope. Within the metamorphic succession, two superimposed tectonic units (Lower and Upper) differing in lithology and metamorphic grade have been distinguished (Janák 1994; Gawęda et al. 1998).

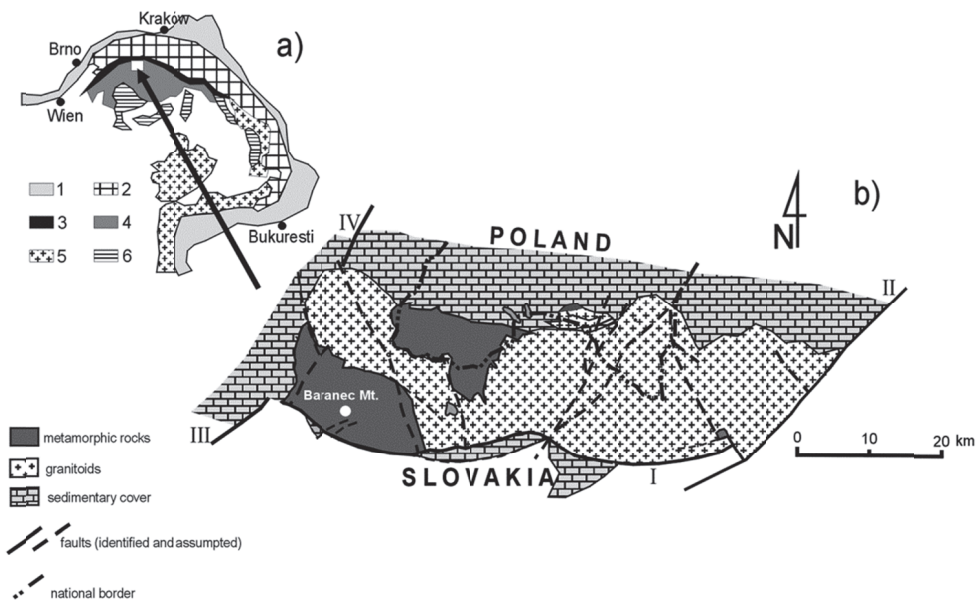


Fig. 1. The geology of the Tatra Mts. a) Simplified geological sketch of the Carpathian chain. Explanations: 1 – Carpathian Foredeep, 2 – Outer Carpathians, 3 – Pieniny Klippen Belt, 4 – Central Western Carpathians, 5 – Dacides and South-East Carpathians, 6 – Neogene volcanics. b) Geological map of the Tatra Mts massif according to Kohút and Janák (1994), Bac-Moszaszwili (1996) and Gawęda (2009). White dot indicates the location of the kyanite that is reported in this article.

The Lower Unit is composed mostly of mica schists gneisses and rare amphibolites. The Upper Unit is composed of migmatites, orthogneisses and amphibolites with eclogitic remnants (Janák et al. 1996; Gawęda et al. 2000). In the latter unit, kyanite is a relatively widespread metamorphic mineral. The kyanite usually forms microscopic crystals in association with garnet, biotite and muscovite (Kahan 1965; Janák et al. 1988; Janák 1994). However, kyanite crystals <10 cm long have been described in quartz lenses in micashists from the Jamnická- and Račkova valleys, and in the Ostredok and Baranec areas (Kahan, Hvožd'ara 1967; Kahan 1968; Hovorka 1981).

3. Analytical techniques

The kyanite crystals were investigated using a scanning FET Philips 30 electron microscope (15 kV and 1 nA) equipped with an EDS (EDAX) detector at the Faculty of Earth Sciences, University of Silesia, Sosnowiec, Poland.

Electron microprobe analyses were performed on a CAMECA SX-100 electron microprobe in the Inter-Institution Laboratory of Microanalysis of Minerals and Synthetic Substances, Warsaw. Analytical conditions were 10 s counting time per element, 15 kV accelerating voltage and 20 nA beam current. Sets of natural- and synthetic standards were used for calibration.

4. Kyanite occurrence

Kyanite in the metamorphic rocks of the Tatra Massif is usually found as small crystals ranging from microns to millimeters in size (Janák et al. 1988; Kahan 1968, Gawęda 2009). On the NW slopes of Baranec Mt., lensoid kyanite-quartz segregations <20 cm thick and <1.2 m long occur (Fig. 2, 3a; Pyka et al. 2013). Some kyanite crystals are rimmed by sillimanite, muscovite and biotite (Fig. 4b). Apatite is present both as inclusions in kyanite and in the surrounding metapelite. Rutile, garnet, biotite and monazite-(Ce) occur as inclusions in apatite. Ilmenite and zircon are accessory components. The kyanite-quartz segregations are rimmed by biotite-garnet schistose selvages. Chloritization of primary biotite is evident. The hosting metapelite is composed of biotite, muscovite, garnet, plagioclase as well as accessory tourmaline and kyanite (up to a few mm long).

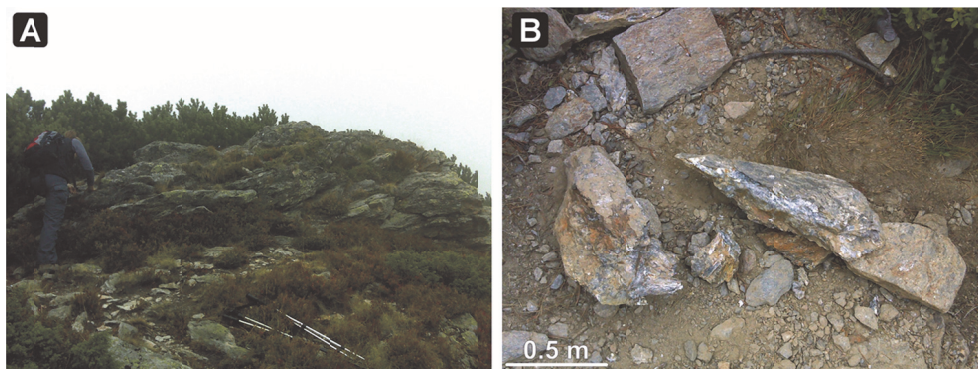


Fig. 2. Outcrop on the NW slope of Baranec (A) hosting the kyanite-quartz segregation (B).

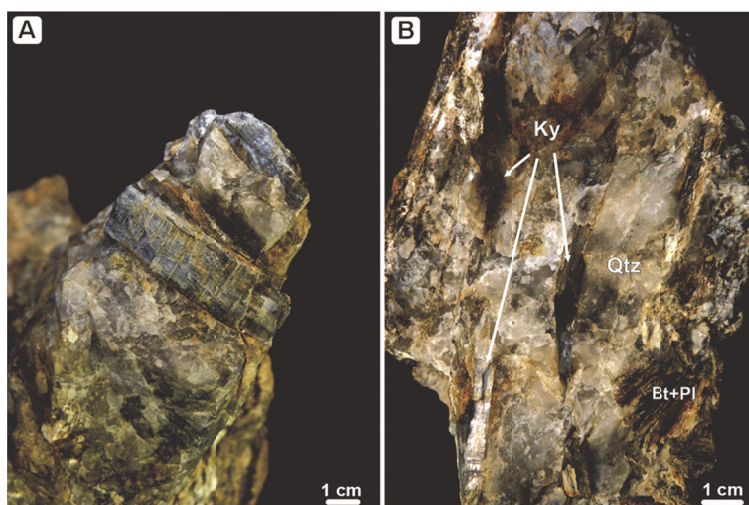


Fig. 3. (A) General view of the kyanite crystals (Ky). (B) Kyanite crystals associated with quartz (Qtz), biotite (Bt) and plagioclase (Pl).

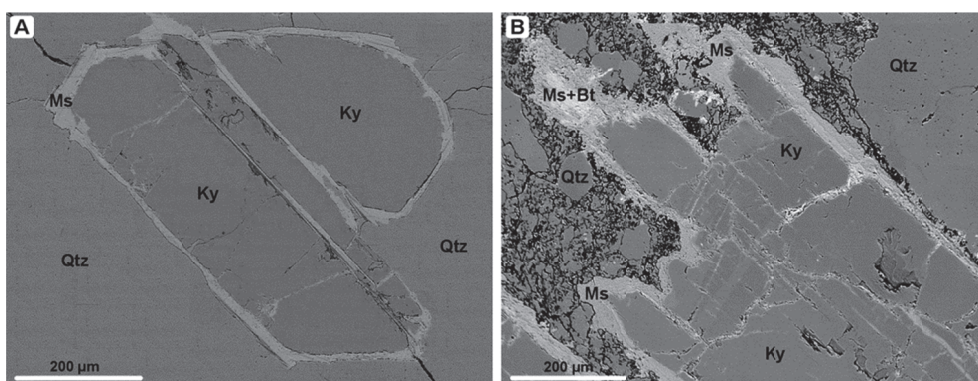


Fig. 4. BSE images of the kyanite crystals (Ky). Euhedral kyanite (Ky) crystals (A) are often overgrown by muscovite (Ms) and totally enclosed by quartz (Qtz). Sometimes biotite (Bt) associated with muscovite (Ms) is evident in the kyanite coronas (B).

The kyanite crystals from the segregation, with elongation $<7:1$, are pale-blue to navy blue in colour (Fig. 3) and show the typical $\{100\}$ cleavage. The crystals are homogeneous in chemical composition without any visible zonation (Table 1).

TABLE 1

Chemical composition of the investigated kyanite crystals from the Baranec Mt. area based on EMPA.

Compound (wt.%)	Analysis						
	#1	#2	#3	#4	#5	#6	#7
SiO ₂	37.24	37.14	37.28	37.01	37.01	37.26	37.35
Al ₂ O ₃	63.34	62.74	62.66	62.58	63.09	63.00	62.88
Cr ₂ O ₃	0.08	0.00	0.08	0.02	0.01	0.00	0.00
MgO	0.00	0.00	0.02	0.00	0.01	0.02	0.00
CaO	0.00	0.00	0.01	0.02	0.00	0.00	0.00
MnO	0.02	0.00	0.02	0.00	0.02	0.00	0.00
FeO	0.10	0.10	0.14	0.20	0.21	0.06	0.00
Na ₂ O	0.00	0.00	0.01	0.00	0.00	0.00	0.00
K ₂ O	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	100.79	99.98	100.24	99.83	100.36	100.35	100.22

5. Conclusions

Microscopic geochemical investigation, and geothermometric calculation, show that the formation of the kyanite-quartz segregations took place in extensional fractures related to shearing. Probably the fluid rich in silica and alkalis (Newton, Manning 2008), generated and liberated during dehydration of the host rocks, caused local overpressure that in turn led to the formation of the kyanite-quartz segregations. Solubility of aluminium could also have been enhanced by the presence of other volatile components, e.g. fluorine, phosphorus and boron, retained in some minerals, present in the investigated rock. The formation of large kyanite crystals in lenses might have been stimulated also by the inhibition of feldspar crystallization due to the high activity of hydrogen in the fluid (Nabelek 1997).

The kyanite-quartz segregations were probably formed as a result of the reaction garnet + rutile = kyanite + quartz + ilmenite as pressure dropped below 9 kbar in the temperature range 440-510°C in the extensional fractures related to shearing (Pyka et al. 2013).

The kyanite-bearing segregations on Baranec Mt. contain the largest, well-shaped kyanite crystals described to date from the crystalline massifs of the Western Carpathians. Over and above the aesthetic aspect of the crystals, the kyanite and its associated minerals are indicators of metamorphic conditions in the pre-Variscan metamorphic cover of the Tatra pluton.

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