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KYANITE FROM EARLY PALEOZOIC ROCKS OF THE GEMERICUM (WESTERN CARPATHIANS) AND ITS IMPLICATIONS FOR BARIC CONDITIONS OF VARISCAN METAMORPHISM

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Abstract: A first occurrence of kyanite from low-grade sequences of the Gemericum is discussed here. It was found in volcano-sedimentary rocks overprinted by contact metamorphism. The presence of kyanite clarifies metamorphic conditions, namely the pressure conditions of Variscan regional metamorphism that were due to the lack of index minerals in these low-grade rocks, subject of various speculations.

Key words: kyanite, pressure conditions, Variscan regional metamorphism.

Introduction

Apart from a few bodies of amphibolite facies conditions (the so called Klátov Group, Hovorka et al. 1984, or gneiss-amphibolite complex, Faryad 1990, occurring along the northern and eastern boundary of Gemericum) the Early Paleozoic sequences (Gelnica and Rakovec Groups, Fig. 1) are metamorphosed under greenschist facies conditions. Sedimentary and volcanic rocks usually comprise quartz, muscovite, chlorite and albite mineral assemblages. Occasionally epidot, actinolite and biotite are also present.

The first attempt to establish the pressure conditions for Variscan regional metamorphism in this area was made by Sassi & Vozárová (1987). Using the bo values of muscovite they considered low-pressure geothermal gradient (40 *°C/km*) for this metamorphism. Compared to the baric conditions of Variscan regional metamorphism calculated by various thermodynamic parameters in the other Western Carpathian Crystalline Complexes, the supposed geothermal gradient is very low.

According to the recent radiometric data (Kovách et al. 1979; Kantor 1979), the greenschist facies sequences (namely those in the central part of Gemericum) were intruded by granitoids in the Permian. Andalusite was reported by a few authors (Krist et al. 1979; Dianiška 1983) from Hnilec and Prakovce (borehole SG-2), but until now no kyanite was described from the area. Except for the blueschists in the southern part of the Gemericum, the Alpine overprint is considered to be under very low-grade conditions.

Petrography

Kyanite with andalusite was found in the country rocks near the granite body in the Zlatá Idka locality (Fig. 1). The white-grey-color massive rock containing both minerals occurs in salic metapyroclastics overprinted by contact metamorphism and metasomatism. Besides kyanite (up to 30%) and andalusite (up to 5%) the country rock consists of muscovite and quartz. Colorless kyanite forms columnar to tabular crystals up to 8 *mm* in length. Some crystals show polysynthetic twinning with (100) as the twinplane.

The reddish andalusite (up to 1 *mm* in size) occurs either isolated or in small clusters. Both andalusite and kyanite are partly replaced by muscovite. Although exact succession of these two minerals remains unclear due to strong muscovitization, some of their textural relationships (Fig. 2) indicate the andalusite is younger that the kyanite. Two forms of muscovite (tabular and fine flaky aggregate) can be distinguished in the rock.

Andalusite occurring in metapelite forms large (up to 8 *mm*) irregular porphyroblasts being partly replaced by fine-scaled margarite. Margarite is rich in a paragonite constituent (Fig. 3). Apart from two forms of muscovite (columnar or tabular, and fine-scaled), biotite, quartz and graphite are also present in this rock. The columnar white mica penetrates biotite clusters. In contrast to the fine-scaled white mica, it is rich in muscovite composition (Tab. 1).

Discussion

Kyanite is supposed to represent a critical mineral of regional metamorphism usually appearing in Al-rich rocks under medium-pressure conditions. The low-temperature stability field of andalusite and kyanite is considered to be at 350 - 420 *°C* and 50 - 500 *MPa* (Fig. 4). Although pyrophyllite was not found in thin-sections, its presence in the Early Paleozoic chloritoid-bearing volcanoclastic rocks was confirmed by X-ray method (Korikovsky et al. 1991). The pressures for kyanite appearance in the Gemericum were above 230 *MPa*. On the other hand andalusite was up to the present related to contact metamorphism in the Gemericum (Krist et al. 1979; Dianiška 1983). According to the recent petrological data (Faryad & Dianiška 1989; Rozložník et al. 1989) the granitoids were emplaced at shallow levels (probably 3.5 - 6 *km* and 100 - 150 *MPa*) into low-grade

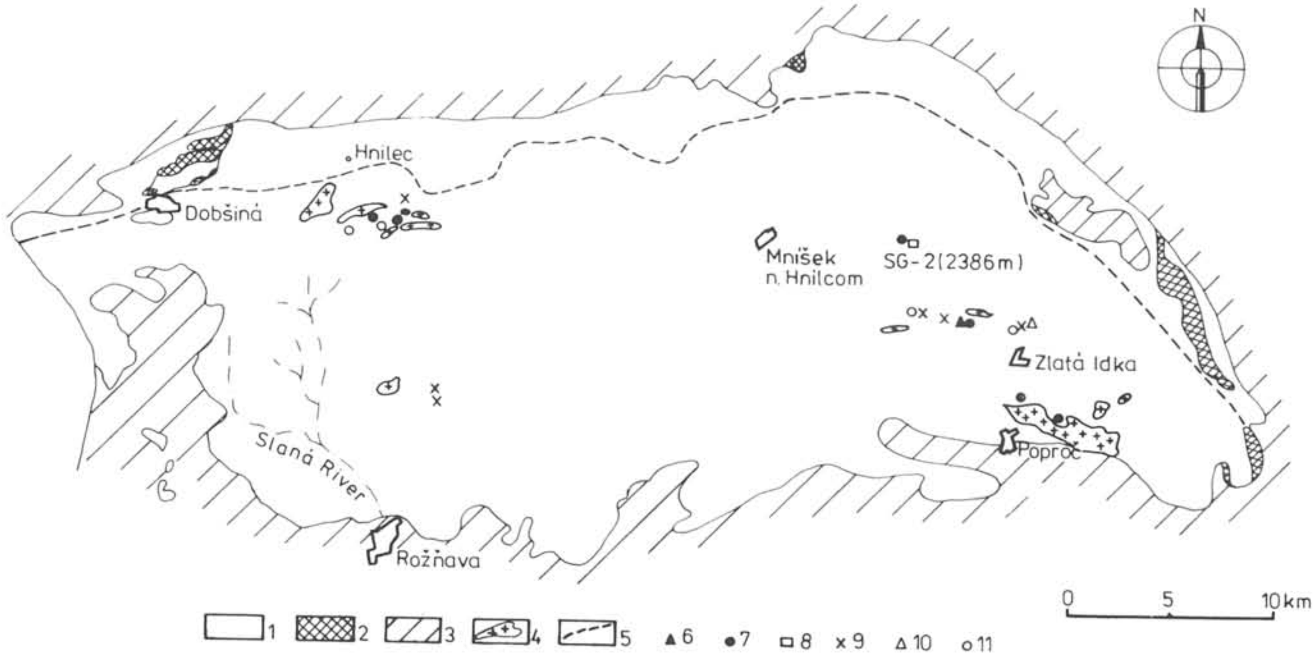

Fig. 1. Occurrences of kyanite and some high-temperature minerals around Gemeric granitoid bodies.
1 - greenschist facies sequences; 2 - gneiss-amphibolite complex; 3 - Late Paleozoic and younger formations; 4 - granitoids; 5 - boundry of Gelnica (to the south) and Rakovec (to the north) Groups; 6 - kyanite; 7 - andalusite ;8 - pseudomorph of margarite after andalusite; 9 - hornblende; 10 - pyroxene; 11 - garnet.

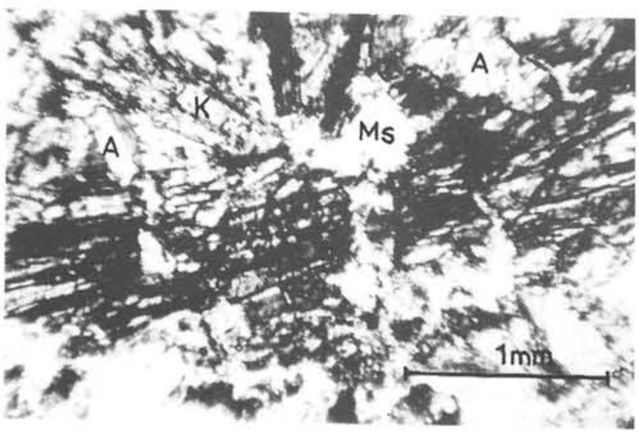

Fig. 2. Large kyanite crystal (K) penetrated by muscovite (Ms) and partly also by andalusite (A).

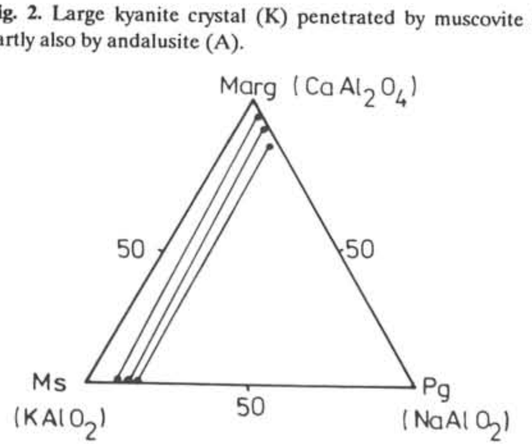

Fig. 3. Composition of margarite associating with muscovite.

Table 1: Compositions of muscovite and margarite from andalusite-bearing metapelit (borehole SG-2, 2386 *m*) in weight %.

	muscovite			margarite	
	1	2	3	4	5
SiO_2	46.11	44.74	32.94	32.56	30.19
Al_2O_3	37.58	36.04	49.21	52.80	48.76
TiO_2	1.10	1.00	0.01	0.02	0.03
FeO	0.73	1.90	0.28	0.09	0.28
MgO	0.36	0.87	0.15	0.07	0.06
MnO	0.00	0.01	0.00	0.08	0.01
CaO	0.00	0.00	7.41	9.75	11.43
Na_2O	0.59	0.34	2.57	1.65	1.15
K_2O	10.70	10.27	0.66	0.07	0.03
Sum	97.17	94.80	93.23	97.09	91.94
		recalculated to 22 (0)			
Si	6.008	5.962	4.413	4.193	4.142
Al^{IV}	1.992	2.038	3.587	3.807	3.858
Al^{VI}	3.778	3.669	4.184	4.207	4.027
Ti	0.108	0.101	0.001	0.002	0.003
Fe	0.080	0.214	0.031	0.010	0.032
Mg	0.070	0.174	0.003	0.013	0.012
Mn	0.000	0.001	0.000	0.009	0.001
Ca	0.000	0.000	1.064	1.346	1.681
Na	0.149	0.089	0.668	0.412	0.306
K	1.778	1.760	0.113	0.011	0.005

Analyses 1 and 2 correspond to tabullar and fine-flaky white mica, respectively.

sequences. The crystallization of kyanite can therefore be related to the Variscan regional metamorphism. During contact overprinting kyanite has partly been replaced by andalusite but mainly by muscovite.

The pressure conditions of Variscan regional metamorphism estimated from bo values of muscovite correspond to 220 - 270 *MPa* (Sassi & Vozárová 1987; Mazzoli & Vozárová 1989) and 270 - 370 *MPa* (Faryad 1991). The medium-pressure conditions preceeding the low-pressure ones is indicated also by Si content in muscovite (3.12 - 3.34, methode after Massonne & Schreyer 1987). Supposing a geothermal gradient of 33 - 35 *°C/km*, metamorphic temperatures reached up to 400 *°C*.

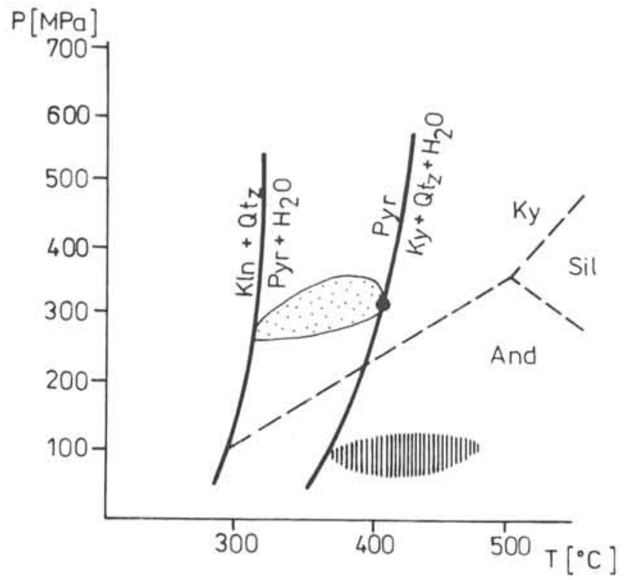

Fig. 4. Likely P-T diagram for kyanite (full circle) and andalusite (dashed field) formation in the Gemericum.
Dotted field corresponds to metamorphic conditions of the Variscan regional metamorphism producing low-grade rocks in the Gemericum (Faryad 1991). Reactions of kyanite and andalusite crystallization are after Frey et al.

Thermal heating during the contact overprinting at 350 - 550 *°C* (Faryad & Peterec 1987) also results Ca andalusite formation within Al-rich rocks. Due to extensive postmagmatic and hydrothermal processes, andalusite and probably also cordierite were replaced by white mica. Margarite replacing andalusite was reported by several authors (Guidotti & Cheny 1976 etc.). It usually appears in graphitic rocks, and the necessary CaO content for this reaction derives from anorthite or from fluid formed during the metamorphism (Guidotti et al. 1979).

Conclusion

The kyanite occurrence in the low-grade Palezoic rocks indicates that these rocks were metamorphosed at medium-pressure conditions. Such interpretation is consistent with other mineral assemblages related to the Variscan regional metamorphism and also with the lack of metamorphic zonation within the extensive area of the Gemericum (Faryad 1991). According to the crystallization of kyanite the metamorphic temperature reached up to 400 *°C*. Simultaneously, the relation of andalusite formation to contact metamorphism is confirmed from several localities. Similar to other high temperature minerals occurring in the contact zones, it is mostly replaced by younger white mica. Some muscovite varieties (mainly the fine-scaled sericite) and margarite seem to be products of hydrothermal and metasomatic processes terminating thermal overprint in the Gemericum.

References

Dianiška I., 1983: Post-magmatic endo- and exocontact alterations of granitoids in the eastern part of the Spišsko-gemerské rudohorie Mts. Thesis, Geofond, Bratislava, 1 - 231 (in Slovak).

Faryad S.W., 1990: Gneiss-amphibolite complex of Gemericum. *Miner. slovaca* (Bratislava), 22, 303 - 318.

Faryad S.W., 1991: Metamorphism of maphic rocks in Gemericum. *Miner. slovaca* (Bratislava), 23, 109 - 122.

Faryad S.W. & Dianiška I., 1989: Garnet from granitoids of the Spišsko-gemerské rudohorie Mts. *Geol. Zbor. Geol. carpath.* (Bratislava), 40, 6, 715 - 734.

Faryad S.W. & Peterec D., 1987: Manifestation of skarn mineralization in the eastern part of the Spišsko-gemerské rudohorie Mts. *Geol. Zbor. Geol. carpath.* (Bratislava), 38, 111 - 128.

Frey M., 1987: Very low-grade metamorphism of clastic sedimentary rocks. In: Frey M. (Ed.): Low temperature metamorphism. 9 - 58.

Guidotti C.V. & Cheny J.T., 1976: Margarite pseudomorphs after chiastolites in the Rangley area, Maine. *Amer. Mineral.*, 61, 431 - 434.

Guidotti C.V., Post J.L. & Cheny J.T., 1979: Margarite pseudomorphs after chiastolite in the Georgetown area, California. *Amer. Mineral.*, 64, 728 - 732.

Hovorka D., Ivan P. & Spišiak J., 1984: Nappe with amphibolite facies metamorphites in the Inner Western Carpathians. *Miner. slovaca* (Bratislava), 16, 73 - 88.

Kantor J. & Rybár M., 1979: Radiometric ages and polyphasis character of Gemeride granites. *Geol. Zbor. Geol. carpath.* (Bratislava), 32, 333 - 344.

Korikovsky S.P., Borisovsky S.Y. & Grecula P., 1991: Metamorphic equilibria in the beginning stage of the biotite subfacies in the Early Paleozoic volcano-sedimentary rocks of Gemericum. *Miner. slovaca* (Bratislava), 23, 1 - 8.

Kovách A., Svingor E. & Grecula P., 1979: New data about the ages of Gemeric granites. *Miner. slovaca* (Bratislava), 11, 71 - 77 (in Slovak).

Krist E., Siegl K. & Šímová M., 1979: Contact metamorphism on the sheet Hnilec 1:25 000. Arch. of Geological Survey Spišská Nová Ves, 1 - 51 (in Slovak).

Massonne H. J. & Schreyer W., 1987: Phengite geobarometry based on the limiting assemblage with K-feldspar, phlogopite, and quartz. *Contrib Mineral. Petrology*, 96, 212 - 224.

Mazzoli C. & Vozárová A., 1989: Further data concerning the pressure character of the Hercynian metamorphism in the West Carpathians. *Rend. Soc. Ital. Mineral. Petrol.*, 43, 635 - 642.

Sassi F.P. & Vozárová A., 1987: The pressure character of the Gemericum. *Rend. Soc. Ital. Mineral. Petrol.*, 42, 73 - 81.

Zvyagintsev L.I. & Rozložník L., 1989: Petrophysical types of Gemeric granitoids (West Carpathians, Czechoslovakia). *Geol. Zbor. Geol. carpath.* (Bratislava), 40, 547 - 562.