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Provenance of tourmalines from the Kanina Beds (Magura Nappe, Polish Flysch Carpathians)

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Abstract. The composition of tourmalines which occur in sandstones of the Kanina beds (Bystrica Subunit of the Magura Nappe, Polish Flysch Carpathians) was studied. SEM-EDS analyses have revealed that all studied tourmalines belong to the schorl-dravite series. Diagrams exhibiting Al, Fe, Mg and Ca molecular proportions indicate that tourmalines originate from various kinds of granitoids and metapelites.

Key words: Magura Nappe, Kanina beds, tourmalines, source rocks.

Geological setting

The studied area is situated on the southern rim of the Mszana Dolna tectonic window and stratigraphically belongs to the Bystrica Subunit of the Magura Nappe (Polish Flysch Carpathians) (Fig. 1a, b). The investigated Kanina beds (Campanian), exposed in the Koninki Stream, are the lower member of the Senonian-Palaeocene turbidite deposits. They are composed of thin-bedded turbidites with intercalations of turbidite limestones (Oszczypko et al., 1999). The Kanina beds overlay the Malinowa shales and are followed by the Szczawina sandstones.

Sampling

Three samples were investigated from sandstones intercalating shales and turbidite limestones from the Kanina beds.

Sample 2/97 was collected from thick bedded sandstone which revealed palaeotransport from NW whereas sample 4/97 from sandstone derived from the S (Fig. 2). Sample 6/97 (not marked in the Fig. 2) was collected from sandstone occur in the Kanina beds although palaeonthological investigations determined its age as Palaeocene of the Grybów Unit.

Analytical techniques

Analyses were carried out on the detrital grains of tourmalines as well as in polished sections of the heavy fraction. SEM-EDS investigations were performed using a standard less analyses using a JEOL-JSM-5410 Pioneer microscope fitted with a Noran Voyager 3100 spectrometer. Analysed points were located in centres as well as in the rims of tourmaline crystals. Boron amounts were calculated assuming 3 boron atoms in the structural formula and that total amount of Fe is present as FeO. Since the amount of B_2O_3 and H_2O is not known the structural formula was calculated on the basis of 24,5 oxygens.

Tourmaline composition

Tourmaline is one of dominating minerals in heavy mineral fraction in which, zircon, garnet, rutile and sporadically apatite and staurolite, are also present. Tourmaline grains are unzoned or slightly zoned and display pleochroic colours from dark-greenish brown to brownish yellow.

The analyses have revealed narrow compositional variability of investigated tourmalines (Fig. 3, Tab. 1). They generally belong the schorl-dravite series although they display a difference in Mg/Fe proportions: tourmalines of sample 4/97 in comparison to tourmalines of sample 2/97 are slightly enriched in Fe (Fig. 3).

Tab. 1. Representative composition of tourmalines of the Kanina beds

No of sample	4/97	2/97	6/97
B	3.000	3.000	3.000
Si	6.083	6.096	6.011
Al_T	-	-	-
T Total	6.083	6.096	6.011
Al_Z	5.913	6.000	5.716
Fe_Z	0.087	-	0.284
Z Total	6.000	6.000	6.000
Al_Y	-	0.428	-
Ti	0.061	0.093	0.165
Fe	1.745	0.716	0.848
Mg	1.059	1.362	1.314
Cr	0.009	-	-
Mn	0.005		
V	-	-	0.011
Y Total	2.879	2.599	3.000
Ca	0.171	0.083	0.048
Na	0.438	0.596	0.614
K	0.018	-	0.006
Mg	-	-	0.043
X Total	0.627	0.679	0.711
Because of standard less analyses the precise amount of oxides cannot be determined			

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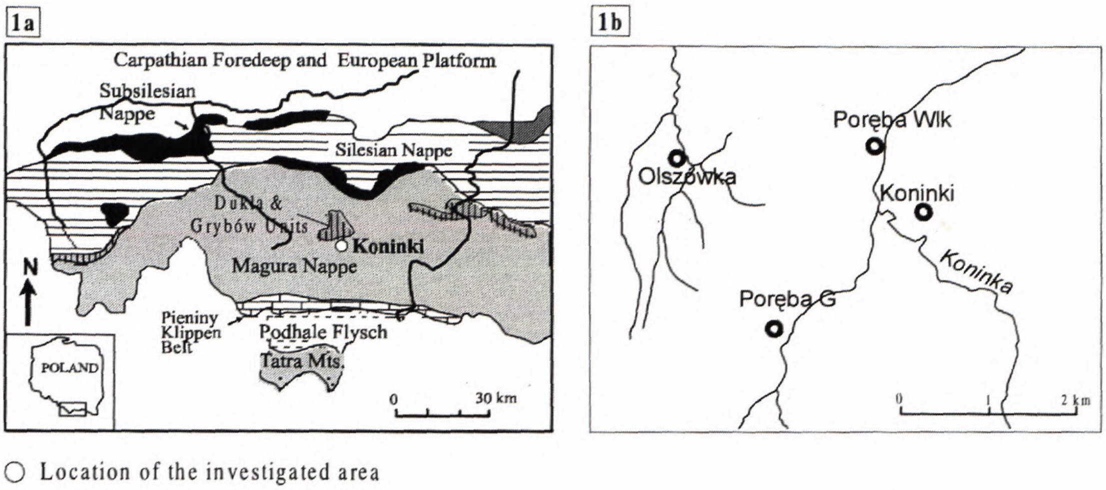

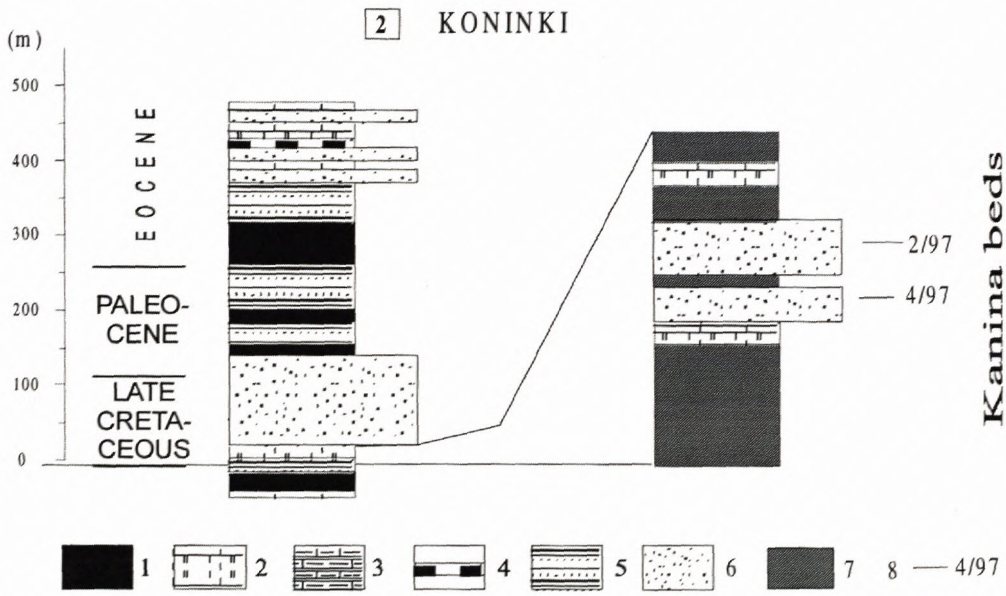

Fig. 1a, b Location of the investigated area.

Fig. 2 Lithological log of the Magura nappe in the Koninki Stream. 1. red shales, 2. turbidite limestones, 3. turbidite marls, 4. hornstones, 5. thin to medium turbidites, 6. sandstones, 7. greyish and greenish shales, 8. numbers of samples.

The tourmalines of samples: 2/97 and 4/97 display X- as well as Y-site vacancies. X-site vacancy value varies along the range of 0.20-0.50apfu (atom per formula unit) while the Y-site vacancy varies from 0.03 to 0.55apfu. In comparison to tourmalines from sample 2/97 the one from sample 4/97 have generally higher Fe amount. It is underlined by the Fe/Fe+Mg ratio which reveals: 0,34-0.45apfu in sample 2/97 and 0,38-0,76apfu in sample 4/97. Besides, Ti, Mn and locally Cr and K are also present.

In contrast to described above samples in the tourmalines from sample 6/97 the Y-vac. value is much lower and reveals 0-0.24apfu, while the X-vac. varies from 0.13 to 0.44apfu. The Fe/Fe+Mg ratio reaches 0.37-0.67apfu. In relation to samples: 2/97 and 4/97 they display generally lower Al amount (Tab. 1). Besides, Ti, Cr, K and V are also present.

The composition of tourmalines on the: Al-Fe(tot)-Mg and the Ca-Fe(tot)-Mg diagrams locate generally in fields describing different kinds of granitoids and metasediments (Fig. 4, Fig. 5).

Conclusions

The analyses of tourmaline grains indicate that they derive from different types of source rocks. Tourmalines from the Palaeocene sandstones (6/97) and tourmalines from the sample 2/97 (Campanian sandstones) seem to originate from various types of metasediments while tourmalines of the sample 4/97, which also was collected from the Campanian sandstones, seem to be of granitoidic as well as of metamorphic derivation.

The exotic pebbles granitoids, micropegmatites, gneisses, and various kinds of micaschists as well as sedimentary rocks which were found in sandstones and conglomerates occurring in the Magura Nappe (Unrug, 1968, Krysowska-Iwaszkiewicz & Unrug, 1967) seem to confirm the existence of source rocks determined on the basis of tourmaline composition.

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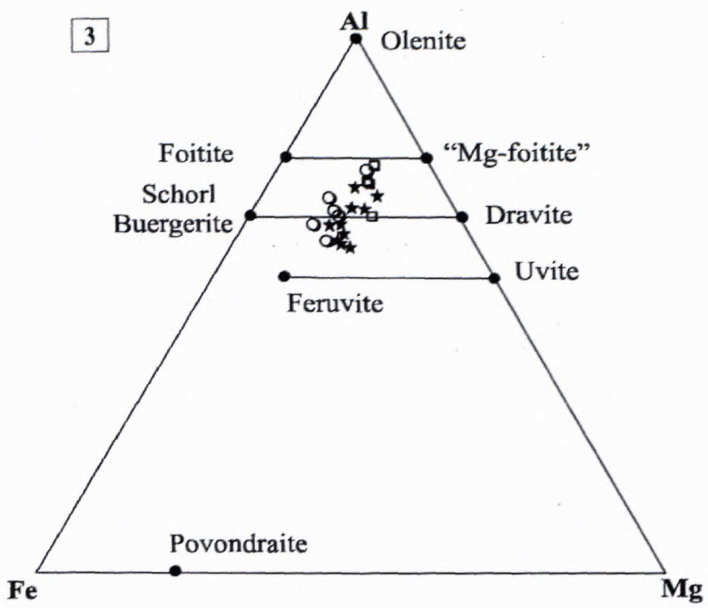

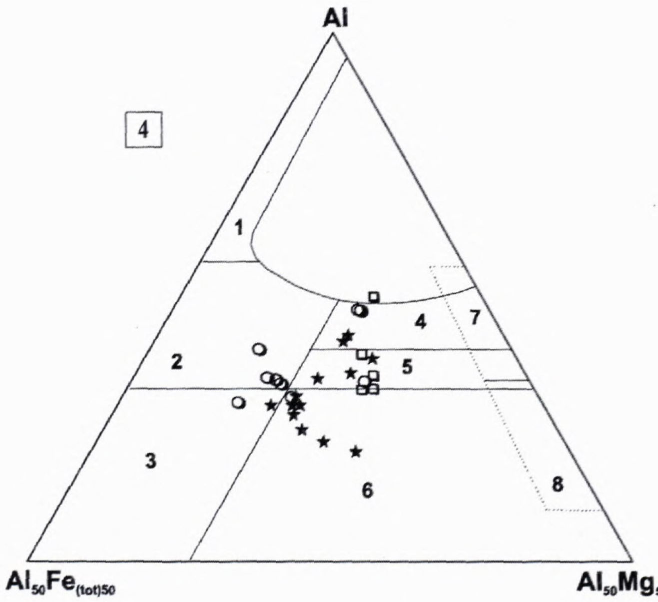

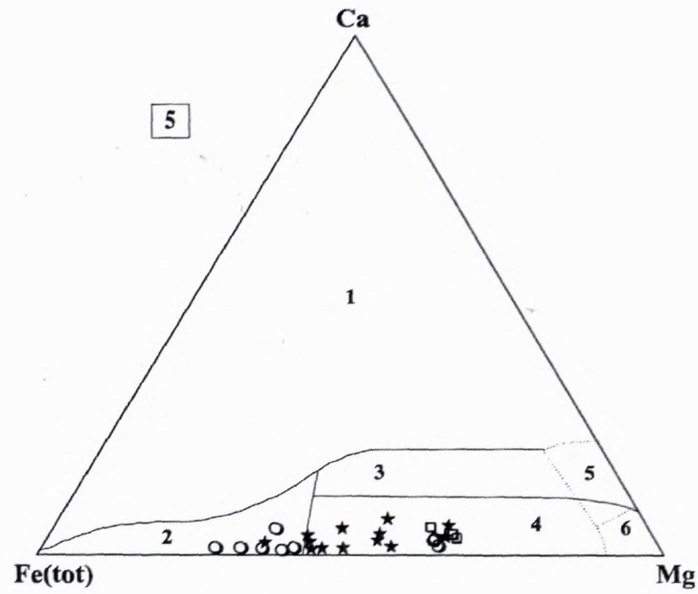

Fig. 3 The composition of tourmalines from the Kanina sandstones: 2/97 (□), 4/97 (○), 6/97 (□).

Fig. 4 Al-Fe(tot)-Mg diagram of points analysed in tourmalines (symbols of samples as in the Fig. 1): 1. Li-rich granitoid pegmatites and aplites, 2. Li-poor granitoids and associated pegmatites and aplites, 3. Fe^{+3}-rich quartz tourmaline rocks (hydrotermally altered granites), 4. Metapelites and metapsammites coexisting with an Al-saturating phase, 5. Metapelites and metapsammites not coexisting with an Al-saturating phase, 6. Fe^{+3}-rich quartz-tourmaline rocks, calc-silicate rocks, and metapelites, 7. Low-Ca metaultramafics and Cr, V-rich metasediments, 8. Metacarbonates and meta-pyroxenites (Henry & Guidotti, 1985).

Fig. 5 Ca-Fe(tot)-Mg diagram of analysed points (symbols of samples as in the Fig. 1): 1. Li-rich granitoid pegmatites and aplites, 2. Li-poor granitoids and associated pegmatites and aplites, 3. Ca-rich metapelites, metapsammites, and calc-silicate rocks, 4. Ca-poor metapelites, metapsammite and quartz-tourmaline rocks, 5. Metacarbonate, 6. Metaultramafics (Henry & Guidotti, 1985).

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