POLSKIE TOWARZYSTWO MINERALOGICZNE – PRACE SPECJALNE
MINERALOGICAL SOCIETY OF POLAND – SPECIAL PAPERS
Zeszyt 20, 2002; Volume 20, 2002

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POST-MAGMATIC RARE-EARTH-ELEMENT MINERALISATION IN THE GRANITOID STRZEGOM MASSIF, SW POLAND

The Variscan Strzegom granitoid massif (Majerowicz 1972, Puziewicz 1998) bears worldwide-known classic pegmatites (Lenkowski 1983, Janeczek 1985). Typical pegmatites are developed in the central part of the massif; the western part close to the contact, cropped out in the large quarry of Graniczna, contains mostly compact pegmatoid-type postmagmatic bodies. These mineral aggregations forming either vein-like streaks or zones indistinctly separated from the wall-rock, have been till present poorly recognised. The current investigations revealed interesting mineral assemblages. Quartz, feldspars, biotite (mostly chloritised), primary chlorite and epidote are the major minerals of the pegmatoids. Minor minerals comprise almandine-spessartine garnet, manganoan calcite, fluorite, wolframite, thorite, thortveitite, xenotime, uraninite, zircon, monazite, tysonite, gadolinite and two rare-earth unidentified minerals.

Chemical compositions of the minerals were analysed by means of the Cameca sx100 electron microprobe in the Inter-Institution Laboratory of Microanalysis of Minerals and Synthetic Substances at Faculty of Geology, Warsaw University, by the analysts: Dr. Piotr Dzierżanowski and Lidia Jeżak.

Garnet forms metasomatic grains 0.2–1 mm in size, bearing 49–50 mol. % spessartite, ca. 50 mol. % almandine, up to 1 mol. % grossular; occasionally up to 1.6 wt. % of Y_2O_3 has been found. **Calcite**, filling interstices between quartz, has the admixtures of $MnCO_3$ (ca. 13%) and $FeCO_3$ (ca. 2%). **Fluorite**, found with calcite, bears minor admixtures of yttrium (ca. 1 %). **Wolframite** is the middle member of the ferberite-huebnerite series. **Thorite** bears typically admixtures of phosphorus, aluminium and calcium. **Thortveitite** (scandium silicate) contains yttrium admixture (ca. 1 %) and minor ones of aluminium, manganese, ytterbium and erbium. **Xenotime** (yttrium phosphate) has minor amounts of calcium, aluminium, ytterbium, dysprosium, neodymium and iron (Table 1). **Uraninite** yielded analyses with admixtures of lead, thorium, silicon, aluminium and yttrium. **Zircon** typically contains up to wt. 7 % HfO_2, to 2 wt. % ThO_2, to 1.6 wt. % Y_2O_3, to 4 wt. % U_2O_3 and to 0.2 wt. % PbO. **Monazite** (cerium phosphate) has lanthanum, thorium and neodymium as major admixtures (Table 1). **Tysonite** (cerium lanthanum fluoride) bears thorium, calcium, neodymium, samarium and possibly praseodymium.

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Gadolinite (yttrium iron beryllium silicate with theoretical Be content, not determined here, but with oxygen content determined by the electron microprobe) contains a wide spectrum of the rare earth elements and calcium and manganese (Table 1); the typical crystallochemical formula is as follows: $Y_{1.15}Yb_{0.14}Er_{0.19}Dy_{0..35}Gd_{0.25}Eu_{0.02}Sm_{0.03}Nd_{0.11}Ce_{0.10}Fe_{0.84}Ca_{0.07}Mn_{0.02}[Be_2Si_{1.93}O_{9.65}]$. Two other rare earth minerals have been found, at present not identified. The

Table 1. Chemical composition of rare earth minerals from pegmatoids, Graniczna, wt. %.

Component	Xenotime	Monazite	Gadolinite*	Unknown 1	Unknown 2
P_2O_5	34.52	25.03	0.00	0.00	0.00
SiO_2	0.57	2.58	10.87	21.01	0.63
TiO_2	0.00	0.00	0.00	0.00	2.08
ThO_2	0.00	8.60	0.05	0.00	0.57
UO_2	0.00	0.66	0.00	0.00	4.51
Al_2O_3	0.14	0.00	0.00	4.17	5.51
Nb_2O_3	0.00	0.00	0.00	0.00	22.30
Ta_2O_3	0.00	0.00	0.00	0.00	18.90
FeO total	1.72	0.00	9.44	0.55	0.70
MnO	0.14	0.00	0.20	7.03	0.70
CaO	0.00	0.01	0.64	2.24	0.57
PbO	0.00	0.11	0.00	0.00	0.00
Na_2O	0.00	0.00	0.00	1.83	0.00
Y_2O_3	42.49	1.35	20.52	31.82	24.52
Yb_2O_3	7.38	0.00	2.43	5.77	3.93
Er_2O_3	4.39	0.00	3.43	0.00	2.61
Dy_2O_3	3.33	0.00	6.28	0.00	3.40
Gd_2O_3	0.56	4.17	4.42	0.00	1.22
Tb_2O_3	0.26	0.00	0.00	0.00	0.39
Ho_2O_3	0.97	0.00	0.00	0.00	0.73
Tm_2O_3	1.00	0.00	0.00	0.00	3.25
Lu_2O_3	1.41	0.00	0.00	0.94	0.92
La_2O_3	0.00	5.87	0.00	0.00	0.00
Ce_2O_3	0.00	25.03	1.74	0.00	0.00
Nd_2O_3	0.00	16.36	1.96	0.00	0.00
Pr_2O_3	0.00	3.71	0.00	0.00	0.00
Sm_2O_3	0.00	6.47	0.61	0.00	0.00
Eu_2O_3	0.00	0.00	0.37	0.00	0.00
O	n.d.	n.d.	31.01	n.d.	n.d.
Total	98.88	99.95	93.97	75.36	97.44

* elements; n.d. – not determined

unknown 1 is a strongly zoned, probably metamictised and water-bearing yttrium-ytterbium alumosilicate (Fig. 1), and the **unknown 2** – an yttrium-niobium-tantalum-titanium oxide with high contents of other rare earths, uranium and aluminium (Fig. 2 and Table 1). Titanium oxide content in the unknown 2 varies strongly, from 0.25 to 18.5 wt. % – maybe, there are two intergrown minerals.

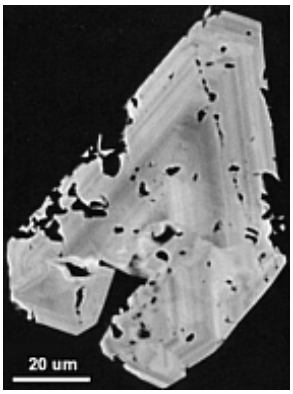

Fig. 1. The unknown mineral 1, BSE image.

Fig. 2. The unknown mineral 2, BSE image.

Fluid inclusions yielded the following temperatures of crystallisation (ºC): garnet 520–390, quartz 530–110, epidote 340–265, calcite 220–90, fluorite 250–130, cleavelandite 330–235. Pressure changed from 1.4 kbar to 0.9 kbar and the mineral-forming solutions were of the Na-Ca-Cl-CO_3^{2-} type with periodic increase of the potassium content; total concentrations of the solutions varied from 17 to 7 wt. (the data obtained by studies of 864 inclusions).

The study was financed by the grants of the Faculty of Geology of the Warsaw University No. BW1567/18 and BSt765/4.

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