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SPESSARTINE FROM SZKLARY, LOWER SILESIA, POLAND

Abstract. Yellow-orange garnet from the pegmatite found in the marginal zone of the serpentinite massif in Szklary near Zabkowice Śląskie was studied using the optical, chemical, X-ray and spectroscopic methods. The mineral represents a manganese garnet with the composition $\text{Sp}_{79}\text{Alm}_{16}\text{Gross}_3\text{Py}_1$, the unit cell $a = 11.6033 \text{ \AA}$, and the typical structure almost without any deficiency of aluminium or silica. It was formed probably in contact-metasomatic processes, during hybridization of an acid magma, intruding into an older, ultrabasic rock massif. The described garnet is the Mn-richest variety of this mineral found so far in the Lower Silesia area.

Key-words: spessartine, Szklary, chemistry, structure, Mössbauer spectrum, IR-spectrum.

INTRODUCTION

In the northernmost part of the abandoned open pit of the silicate nickel ores in Szklary near Zabkowice Śląskie, immediately beneath the weathering cover in the scarp, there crops out at the depth of ca. 2 m a rather thick (0.5 m) feldspar-quartz pegmatite vein with tourmaline. Originally, the vein must have stretched over at least 20 m, as at present it may be found in the northern part of the pit and some years ago it was also visible on its southeastern wall (this place is now covered with a serpentinite rubble). The accessible now part of the pegmatite contacts with a fine-crystalline leucocratic rock, described many times before in the German-language literature (*vide* Lis, Sylwestrzak 1986) as the so-called sacharite. Muszyński and Natkaniec-Nowak (1992) determined the rock in question as a plagioclasite (albitite-oligoclasite).

The pegmatite is characterized first of all by the distinct and, locally, very well expressed graphic texture. Besides feldspars and quartz, it also contains

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rather widespread micas: colourless muscovite, sometimes with a yellow-brownish tint, and always more or less altered biotite. Aggregates of a black tourmaline may locally occur (Pieczka 1987), and in the presently accessible part of the pegmatite another aggregates, of fine garnets, reaching sometimes some centimetres across, have been found.

METHODS

The garnets were hand-picked, crushed, and the fraction 0.09–0.20 mm was sieved. Then, this fraction was electromagnetically cleaned, traces of oxides were removed in the analytically pure 10% HCl on a water bath, eventually the sample was separated in tetrabromoethane C₂H₂Br₄ with the density 2.97 g/cm³. Such a separated out heavy fraction underwent further chemical, X-ray and spectroscopic analyses.

The chemical analyses involved determinations of SiO₂ and H₂O(+) by the weight method, of FeO and Al₂O₃ volumetrically, of TiO₂, MnO and P₂O₅ colorimetrically, and spectrophotometrical analyses of Na₂O, K₂O, CaO, MgO, Li₂O and ZnO using a PHILIPS PU 9100 X atomic absorption spectrometer and following experimental conditions recommended by the producer.

The X-ray analyses were carried out in the continuous recording mode using a TUR M-62 diffractometer with a HZG-4 goniometer coupled *on line* with an IBM PC class computer. The unit cell parameter was calculated on the basis of the position of the following reflections: (400), (420), (422), (431), (611), (532), (10.4.0) (10.4.2), recorded using the step technique ($\Delta 2\theta = 0.005^\circ$) with quartz as an internal standard. The computed a values were approximated using the Nelson-Riley equation to $2\theta = 180^\circ$.

The spectra in the fundamental infrared range were obtained with a FTIR BIO-RAD model FTS-165 spectrophotometer from a sample prepared in the form of discs with KBr.

The Mössbauer investigations were carried out at the Institute of Nuclear Physics in Cracow-Bronowice, using ⁵⁷Co (Cr) with the activity ca. 15 mCi as a γ source. The spectra were recorded and analyzed with an IBM PC class computer and calibrated against α -Fe.

DISCUSSION OF RESULTS

The individual garnet specimens are usually small, 2–3 mm, in places slightly bigger, reaching 1 mm. Mostly they display xenomorphic habits but sometimes crystallographic forms may be observed (combination of the dodecahedron and trapezohedron). The garnet is light, usually orange-reddish, with a variable colour saturation of individual grains. Its fine chips are transparent, brown-yellowish. The faces of garnet specimens are covered with brownish manganese compounds,

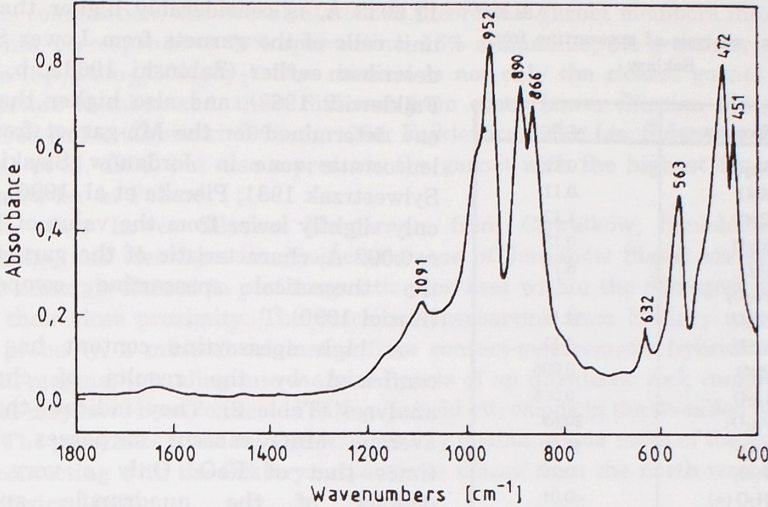


Fig. 1. Infrared spectrum of spessartine from Szklary

TABLE 1
X-ray powder data of the spessartine from Szklary

Spessartine Szklary		Spessartine JCPDS 2— 992		hkl
d _{hkl}	I	d _{hkl}	I	
2.902	65	2.899	50	400
2.595	100	2.597	100	420
2.476	13	2.481	5	332
2.368	44	2.370	20	422
2.276	24	2.278	20	431
2.119	19	2.119	20	521
2.050	10	2.049	5	440
1.882	39	1.890	50	611, 532
1.675	21	1.681	40	444
1.609	29	1.610	60	640
1.578	11	1.580	3	721, 633, 552
1.551	62	1.550	80	642
1.450	25	1.449	9	800
1.303	12	1.300	10	840
1.265	24	1.271	15	842
1.228	11	1.230	5	843
1.077	47	1.080	20	10.40
1.059	18	1.060	15	10.42
1.025	14	1.030	15	880

which form not far away smaller or bigger aggregates; some fracture planes of the pegmatite are lined with characteristic brownish Mn-dendrites. In a microscope picture, the garnets are mostly xenomorphic, sometimes contain numerous quartz inclusions and display a characteristic yellowish colour. Anisotropy has not been observed.

From the comparisons of the recorded infrared spectrum (Fig. 1) with the standard spectra of garnets (Moenke 1962; Moore et al. 1971; Hofmeister, Chopelas 1991; Lu et al. 1993), and of the calculated interplanar spacings d_{hkl} with JCPDS (1976) data, it has been ascertained that the garnet from Szklary represents a spessartine (Table 1). Its unit cell parameter *a*, equal to

TABLE 2
Chemical analysis of spessartine from
Szkłary

Component	wt. %
Na ₂ O	0.11
K ₂ O	0.12
CaO	1.12
MgO	0.18
FeO	6.75
Fe ₂ O ₃	—
MnO	34.15
TiO ₂	0.17
ZnO	0.006
Li ₂ O	0.018
Al ₂ O ₃	20.69
SiO ₂	36.38
P ₂ O ₅	0.26
H ₂ O (+)	<0.01
Σ	99.95

11.6033 Å, is considerably higher than the unit cells of the garnets from Lower Silesia described earlier (Żabiński 1963a, b, 1966; Fajkiewicz 1969), and also higher than the one determined for the Mn-garnet from the leucocratic zone in Jordanów Śląski (Lis, Sylwestrzak 1981; Pieczka et al. 1996), being only slightly lower from the value of 11.615 ± 0.002 Å, characteristic of the garnet with the theoretical spessartine composition (Kozioł 1990).

A high spessartine content has been confirmed by the results of chemical analyses (Table 2). They indicate that the average MnO content surpasses several times that of FeO. Only a very weak doublet of the quadrupole splitting attributable to Fe³⁺ was observed in the Mössbauer spectrum (Fig. 2). This doublet

contributes in about 2–3% to the whole spectrum, so the coordination of the Fe³⁺ (VI or IV) cannot be precisely determined. This suggests that the tetrahedral and octahedral positions are almost completely filled with their typical ions, i.e. Si⁴⁺ and Al³⁺ respectively. Considering all the said above, the following structural formula of the garnet from Szkłary has been inferred:

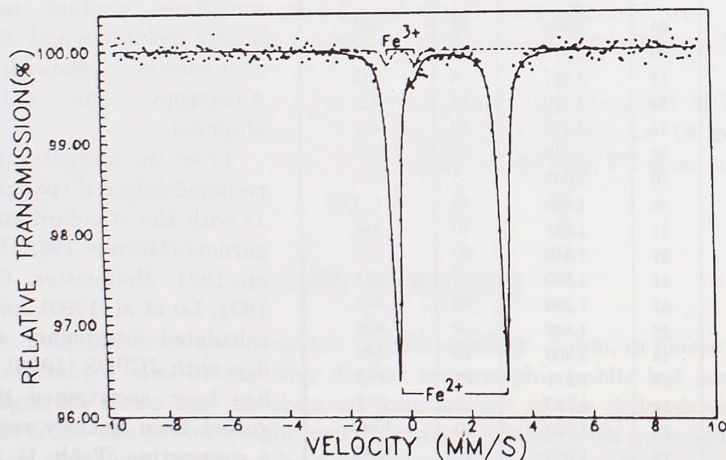
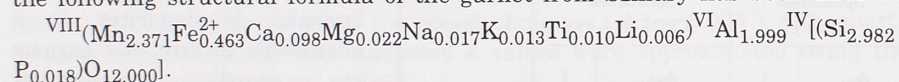


Fig. 2. Mössbauer spectrum of spessartine from Szkłary

This composition, after recalculation of theoretical garnet members into molar per cents, corresponds to 79% spessartine, 16% almandine, 3% grossular and 1% pyrope (Sp₇₉Alm₁₆Gros₃Py₁). The mineral is not only the richest garnet in the spessartine member and, thus, different from other Lower Silesian Mn-garnets described so far (Żabiński 1963a, b, 1966; Fajkiewicz 1969; Lis, Sylwestrzak 1981; Pieczka et al. 1996) but also represents the garnet with the highest Mn content known so far in Poland.

The other Lower Silesian Mn-garnets from Chwałków, Strzeblów, Gola Świdnicka, and also from the leucocratic zone of Jordanów Śląski are regarded as the minerals formed in post-magmatic processes within the Strzegom granites or in their close proximity. The described spessartine from Szkłary represents, most probably, a mineral originated from contact-metasomatic hybridization of an acid magma, intruding into marginal parts of an ultrabasic rock complex. The magma may have been connected with granitoid intrusions in the so-called Niemcza zone. The pegmatite itself belongs without any doubts to acid rocks of the granitoid type contacting with the Szkłary serpentinite massif from the north-western side (Niśkiewicz 1967).

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SPESSARTYN ZE SZKLAR, DOLNY ŚLĄSK, POLSKA

Streszczenie

Wykonano badania optyczne, chemiczne, rentgenowskie i spektroskopowe żółtopomarańczowego granatu z pegmatytu ze strefy brzeżnej masywu serpentynitowego Szklar koło Ząbkowic Śląskich. Stwierdzono, iż reprezentuje on typ granatu manganowego o składzie $\text{Sp}_{79}\text{Alm}_{16}\text{Gros}_3\text{Py}_1$ i stałej sieciowej $a = 11,6033 \text{ \AA}$, o typowej strukturze prawie nie wykazującej deficytu ani glinu, ani krzemu. Powstał on prawdopodobnie w procesach kontaktowo-metasomatycznych podczas hybrydyzacji kwaśnej, przesyconej resztkami magmy intrudującej w starszy, ultrazasadowy masyw skalny. Opisany granat jest najbardziej bogatą w mangan odmianą tego minerału stwierdzoną dotychczas na terenie Dolnego Śląska.