GEOLOGICKÝ ZBORNÍK — GEOLOGICA CARPATHICA 31, 1—2, BRATISLAVA, JUNE 1980, PP 185—199

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COMPOSITION OF THE MAIN MORPHOLOGICAL TYPES OF GARNETS FROM PEGMATITES OF THE MALÉ KARPATY, MTS. (THE WEST CARPATHIANS)

(Figs. 5, Tab. 1)

Abstract: The chemical composition of the main morphological types of garnets from the pegmatites of the Malé Karpaty mts. analysed by electron microprobe indicates the range of percentual contents of end members. The content of the almandine member varies in the range from 50,59 % to 73,10 %, the spessartite member 22,90 % — 46,55 % the pyrope member 1,39 % — 5,62 % and of the grossularite member from 1,04 to 2,20 %. It is possible to presume from the character of isomorphous exchange Fe^{2+} and Mn^{2+}, resp. from the blending of the almandine and spessartite members the uniform that means the primary way of origin and duration of the interval of probably continuous crystallization of the different morphological garnet types. The garnet morphology had been changed in a relative temporal sequence of garnet crystallization from tetragonal trisoctahedron with less developed rhombododecahedral form to almost perfect rhombododecahedral form.

Резюме: Электроновым микроанализатором анализированный химический состав главных морфологических типов гранатов из пегматитов Малых Карпат показывает пределы процентных содержаний конечных членов. Содержание альмадинового компонента колебается в пределах 50.59 %—73,10 %, спессартинового 22,90 %—46,55 % пиропового 1,39 %—5,62 % и гроссулярового 1,04—2,20 %. По характеру изоморфной замены Fe^{2+} и Mn^{2+}, илиже по смешиваемости альмандиновой и спессартинсвой составных частей возможно предполагать единый, а именно первичный способ возникновения и длину интервала вероятно непрерывной кристаллизации разных морфологических типов гранатов. В относительной последовательности времени кристаллизации граната его морфология изменялась от тетрагонтриоктаэдрической с менее развитой ромбической додекаэдрической формой в направлении к почти совершенно ромбической додекаэдрической форме.

Introduction

The presence of accessory garnets in granitoids, pegmatites and aplites continuously is the cause of an interest and effort to solve the question of their origin in these rocks, in the first place where they are not typical components of their mineral associations in contrast to metamorphic rocks. However, not only typomorphic associations but also typomorphic properties of minerals can approach us to solve the complex genetic problems.

One of the properties which reflects the character of the chemical composition of the environment what a certain mineral had crystallized from, is its morphology. A different crystal morphology of certain mineral is determined by differences of geochemical processes during the mineral origination. This results in the importance of knowing these bilateral dependences.

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But the processes of the origin and the growth of crystalls are so complicated as regards mineral crystallization laws that it is not possible to explain them completely only from one point of view (J. Babčan, 1974).

Relationship between morphology of garnets and rock types

Many authors refer to characteristic morphological garnet forms from different rock types, however, there exists a remarkable difference in genetic interpretations of garnets with different morphology and its dependence on their chemical composition. A. E. Fersman (1940), a pioneer of the theory of mineral typomorphism, mentions the typical morphological forms of garnets originated in different geophases of pegmatitic process. B. Hejtman (1956) considers a characteristic form of garnets (211) in ingneous rocks, especially in pegmatites, or connections of forms (211) and (110), on the contrary the garnets of the same composition (with prevalent almandine member) are the most frequently in metamorphic rocks in the form (110) and sometimes also in connection form (110) and (211). F. Slavík et al. (1974) describes the garnet morphology in pegmatites in accordance with the previous author. I. Kostov (1971) considers the change of relationship between bivalent and trivalent cations as a cause of prevalence of rhombododecahedral form for calcareous order and of tetragonal trisoctahedral form for aluminium order of garnets. Š. S. Gendelev (1963) observes direct dependence between melt enrichment in trivalent iron and prevalence of tetragonal trisoctahedral form. A. A. Jaroševskij (1956, 1959 in V. V. Ljachovič, 1973) considers tetragonal trisoctahedral form of garnets as characteristic one for rocks enriched in Al and rhombododecahedral form for rocks enriched in Ca, Fe and Mg and so the presence of garnets with the form (110) in pegmatites interprets as relics of absorbed gneissic rocks. V. V. Ljachovič (1968), on the basis of statistical study of garnet forms, concluded that the prevalent form for biotite-amphibolic and biotite granites is rhomobododecahedron, sometimes in combination with tetragonal trisoctahedron — this form is typical for pegmatites and aplites; in those cases when rhombododecahedral garnet crystals are found in pegmatites, they are considered to be xenocrysts or it is possible to put them in connection with hybridism. V. Arnaudov — S. Petrusenko (1973) examined during research of primary accessory mineralization in pegmatite of Viščerica (Western Rhodops. mts.) an inscreasingly distinct spessaritite character of garnets and simultaneously acquiting rhombododecahedral form in direction to inner parts of pegmatite veins.

The author (R. Nováček, 1931) of a quite detailed work about garnets of Czechoslovak pegmatites pays attention also to morphological forms where there is rather clear the tendency of morphology change in the order from spessartite through almandine — spessartite and spessartite — almandine to almandine garnets. The morphology of garnets is changed in the mentioned order from tetragonal trisoctahedron (211) to rhomododecahedron (110), namely over combination of both forms. Only rare ones were stated forms (100) and (111). The mentioned author (R. Nováček, l. c.) is a supporter of primary origin of almandine — spessarite garnets in pegmatites and aplites.

Garnets of pegmatites of the Malé Karpaty mts.

Garnet is a characteristic often quantitatively predominant accessory mineral in vein's derivatives — in pegmatites and aplites of granitoid intrusion of the Malé Karpaty mts. (J. Valach, 1954, B. Cambel — J. Valach, 1956; Š. Dávidová, 1968, J. Veselský — J. Gbelský, 1978). In the scope of detailed mineralogical — petrographical study of pegmatites of the Malé Karpaty mts., Š. Dávidová (1968) investigated also physical properties and chemical composition of garnets from two regions of pegmatite occurrences (Briežky and Železná Studnička, quarry I.). Because the results of the quoted work were the impulse to this detailed study of chemical composition of main morphological types of garnets it is necessary to cite the main results of that work:

Š. Dávidová divided in pegmatites two basic morphological types of garnets with very close physical properties and chemical composition. Garnet I with prevalent form (110) in combination with less developed form (211) reaching the magnitude maximally 1 mm occurs mainly in aplitoid zone of pegmatites where it is often corroded by quartz and it had been probably crystallized from the melt owing to cleaning from dark components or it can be resorbtion product that means, the product of crystallization of resorbed — contaminating material. Garnet II with dimension from 1 mm to 3 cm has its prevalent form (211) in combination with less developed from (110), occurs often together with muscovite which corrodes it and that is in block microline zone forming a component of albite veinlets. It had been originated in later stages of pegmatite origination as garnet I and it can be considered as metasomatic. The examined garnets belong to the group of pyralspites to almandine — spessartite order with prevalent almandine component. On the basis of results of classical silicate analysis and the study of physical properties, the author established the range of almandine component from 54.12 % to 59.89 % and spessartite component from 27.60 % to 34.23 %, where there were found very close physical properties and the chemical composition of both garnet types. The refractive indices, according to the author, should have higher values regarding the Fe^{3+} content.

Thanks to the possibility of using the electron microprobe the chemical composition of individual crystals of above mentioned distinguished basic morphological and in the given case also genetic types of garnets were investigated now. There were analysed garnets separated from granite pegmatites of the locality Železná Studnička, quarry I (in agreement with locality of Š. Dávidová, l. c.) and the locality Jur near Bratislava where there are pegmatites found in hybrid granites and migmatites.

The methods of study

During separation of accessory heavy minerals „the method of heavy fractions from crushed rock" was used according to J. Veselský — M. Žabka (1976). Garnets were separated from the obtained concentrate by electromagnetic separator fy. Cook and Sons Ltd. in the range from 0.25 to 0.6A, mainly, however, at 0.4. A of electric current intensity using 20° of anterior-posterior and 11° of lateral slope. At 0, 4 A there were selected from magnetic fraction 3 idiomorphic crystals each of the most frequent morphological types of garnets in pegmatites of studied localities : nearly ideal rhombic dodecahedron (110) — Fig. 1. and tetragonal trisoctahedron in combination with less developed form of rhombododecahedron (211) > (110) — Fig. 2. from the

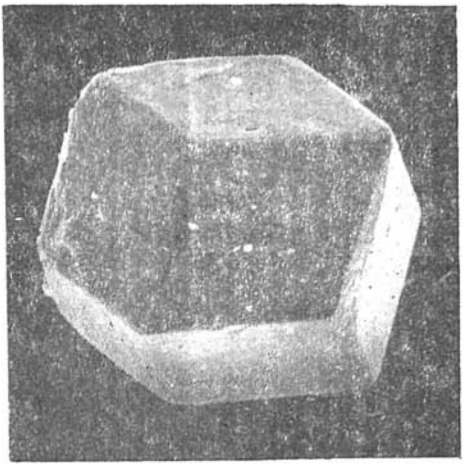

Fig. 1. Rhombododecahedral garnet form (110). SEM, magn. 300 x.

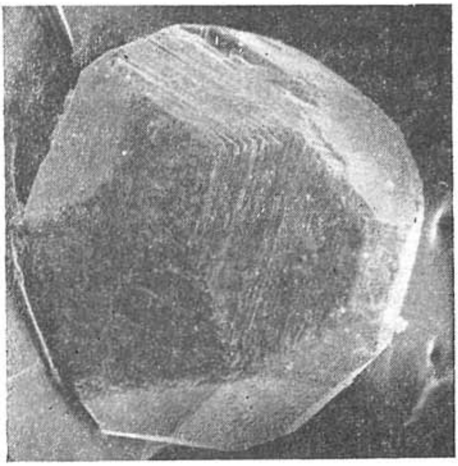

Fig. 2. Tetragonal trisoctahedral form of garnet in combination with relatively less developed rhombic dodecahedron form (211) > (110) with striation mainly on surfaces (211). SEM, magn. 200 x.

locality Železná Studnička; rhombic dodecahedron in combination with less developed tetragonal trisoctahedron (110) > (211) and tetragonal trisoctahedron in combination with less developed form of rhombic dodecahedron (211) > (110) from the locality Jur near Bratislava. The scanning microscope JSM—— U3, fy. Jeol. was used for the research of morphological types and peculiarities of morphological development and crystal surfaces. The homogeneity of chemical composition was controlled by the electron microanalyzer JXA——50A, fy. Jeol. by recording of composition and planar distribution of the main garnet elements. There were also followed relative changes of their concentrations in line profiles from the edge to the edge of crystals. Garnet macroelements were in three points (at the edges and in the centre) of line recordings quantitatively analysed by the use of following standards : synthetical hematite, Mn_3O_4, MgO, TiO_2, Al_2O_3, SiO_2 and natural diopside. The accelerating voltage was 15 kV, abs. current 3.4—3.6 . 10^{-8} A. For calculation of corrections the method ZAF was used.

At recalculation of chemical analyses to the individual garnet end members the summary Fe was considered as Fe^{2+} according to following reasons : the calculation of andradite member from physical garnet properties was not possible because of not successful separation of insufficient amount of garnets with undoubtful basic morphological types for determination of density and lattice parameters. The possibility of using a theoretical way for determination of Fe^{3+} cations' number as it was used e.g. by H. Szimazaki (1977) when $Al + Fe^{3+} = 2$ (on the basis of the total number of 12 oxygens) was excluded because the number of Al^{3+} atoms practically reached over the introduced value refering to theoretical total of both cations in all cases. Therefore the total number of Ca atoms was used for recalculation of grossularite component.

Results

By the study of composition and planar distribution of the macroelements the homogeneity of chemical composition was found in the searched garnets. But control line recordings of relative changes of macroelement manganese concentrations in garnets owing to conditions' change of the apparatus sensitiveness, marked zonal decomposition of manganese (Fig. 3) during its examination. The quantitative differencies in the individual macroelement concentration at all searched garnets are mentioned in Table 1, in the order according to sinking average content of the spessartite component in the individual morphological types of crystals.

Garnets from examined pegmatites of the Malé Karpaty mts. belong to pyralspite group to the almandine — spessartite order with prevalent almandine component. But the found out range of the individual end members of garnets is quite wide. The average content of almandine member in the individual crystals varies from 50.59 % to 73.10 %. spessartite component in the range 22.90 % — 46.55 %, pyrope component 1.39 % — 5.62 % and the grossularite component in the range 1.04 % — 2.20 %.

There are besides the evident intensive blending of almandine and spessartite components from the positions of searched garnets in the cut of the triangle pyrope + grossularite — spessarite — almandine (Fig. 4) evident some different trends of chemical composition changes of morphological types of garnets from pegmatites of the individual localities. Intensive blending of almandine and spessartite components is illustrated also at Fig. 5 as follows nearly linear dependance in compensation, or isomorphic exchange of bivalent cations of Fe and Mn. Regressive straight lines illustrate the different position of garnets from pegmatites of two searched localities. For correlative coeficients' calculation were used percentual values of FeO and MnO contents from the centre of analysed crystals. From the graph follows an important knowledge about different position of individual searched basic morphological types al-

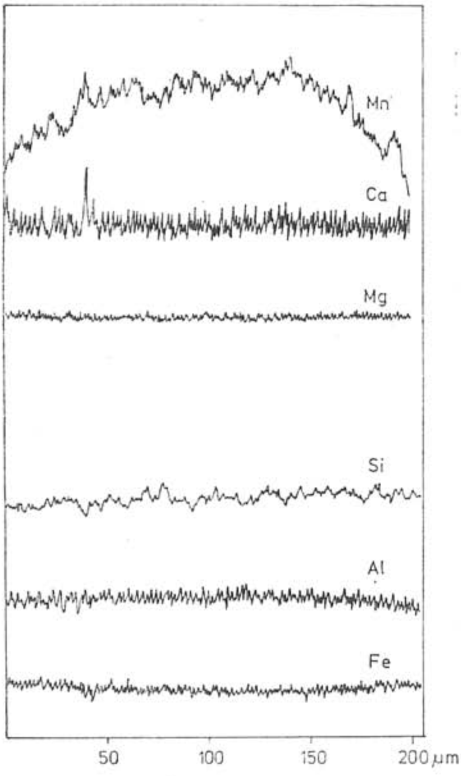

Fig. 3. Line recordings of garnet macroelements (110), grain 2 from the locality Železná Studnička, quarry I. Magnifying of apparatus sensitiveness at Mn recording indicates zonality in garnet composition.

Table 1

Electron Microprobe Analyses of Garnets

Locality	ŽELEZNÁ STUDNIČKA, guarry I								
Type	(110)								
Grain	1			2			3		
Point of anal.	edge	centre	edge	edge	centre	edge	edge	centre	edge
SiO_2	36.33	35.00	37.48	36.55	36.80	36.59	36.03	36.28	36.23
TiO_2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Al_2O_3	20.69	20.22	21.61	20.85	21.33	21.31	19.50	20.79	20.87
FeO^*	21.37	20.63	21.78	21.73	20.28	21.80	22.72	22.89	23.23
MnO	19.42	19.88	18.67	18.88	20.09	18.47	17.05	17.21	16.64
MgO	0.35	0.35	0.39	0.35	0.31	0.36	0.33	0.36	0.38
CaO	0.45	0.49	0.49	0.43	0.44	0.44	0.38	0.38	0.39
Total	98.60	96.57	100.40	98.78	99.26	98.98	96.01	97.92	97.73
Numbers of cations on the basis of 12 oxygens									
Si	3.02	2.98	3.04	3.03	3.02	3.02	3.07	3.02	3.02
Al	2.02	2.03	2.06	2.03	2.06	2.07	1.96	2.04	2.05
Fe^{2+}	1.48	1.47	1.47	1.50	1.39	1.50	1.62	1.60	1.62
Mn	1.36	1.43	1,28	1.32	1.39	1.29	1.23	1.21	1.18
Mg	0.04	0.04	0.05	0.04	0.04	0.04	0.04	0.04	0.05
Ca	0.04	0.04	0.04	0.04	0.04	0.04	0.03	0.03	0.03
Mol. % of end members									
Pyrope	1.37	1.34	1.76	1,38	1.40	1.39	1.37	1.39	1.74
aver.		1.49.			1.39			1.50	
Almandine	50.68	49.33	51.76	51.72	48.60	52.26	55.48	55.56	56.25
aver.		50.59			50.86			55.76	
Spessartite	46.58	47.99	45.07	45.51	48.60	44.95	42.12	42.01	40.97
aver.		46.55			46.35			41.70	
Grossularite	1.37	1.34	1.41	1.38	1.40	1.39	1.03	1.04	1.04
aver.		1.37			1.39			1.04	
Type	(211) > (110)								
SiO_2	37.25	37.72	37.47	37.69	36.88	36.70	38.13	37.24	37.70
TiO_2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Al_2O_3	21.22	21.38	21.56	20.91	21.82	21.58	21.27	21.38	21.46
FeO^*	25.42	25.30	25.68	30.18	28.65	29.72	31.08	29.88	31.08
MnO	14.72	14.67	14.39	10.39	11.70	10.43	9.00	10.47	9.12
MgO	0.84	0.82	0.81	0.60	0.59	0.63	0.57	0.56	0.53
CaO	0.51	0.54	0.52	0.61	0.48	0.63	0.56	0.52	0.49
Total	99.96	100.43	100.44	100.38	99.54	99.70	100.61	100.05	100.37
Numbers of cations on the basis of 12 oxygens									
Si	3.03	3.05	3.03	3.06	3.02	3.00	3.08	3.03	3.05
Al	2.03	2.03	2.05	2.00	2.05	2.08	2.02	2.05	2.04
Fe^{2+}	1.72	1.70	1.73	2.04	1.96	2.03	2.09	2.03	2.10
Mn	1.01	1.00	0.98	0.71	0.81	0.71	0.61	0.72	0.62
Mg	0.10	0.10	0.10	0.07	0.07	0.08	0.07	0.07	0.06
Ca	0.04	0.05	0.05	0.05	0.04	0.06	0.05	0.05	0.04
Pyrope	3.48	3.51	3.50	2.44	2.43	2.78	2.48	2.44	2.13
aver.		3.50			2.55			2.35	
Almandine	59.93	59.65	60.49	71.08	68,06	70.49	74.11	70.73	74.47
aver.		60.02			69.88			73.10	
Spessartite	35.19	35.09	34.27	24.74	28.13	24.65	21.63	25.09	21.99
aver.		34.85			25.84			22.90	
Grossularite	1.39	1.75	1.75	1.74	1.39	2.08	1.77	1.74	1.42
aver.		1.63			1.74			1.64	

Locality	JUR PRI BRATISLAVE								
Type	(110) > (211)								
Grain	1			2			3		
Point of anal.	edge	centre	edge	edge	centre	edge	edge	centre	edge
SiO_2	36.24	36.77	35.54	36.62	36.53	36.83	37.50	37.42	36.92
TiO_2	0.05	0.04	0.05	0.05	0.07	0.06	0.03	0.03	0.04
Al_2O_3	21.88	21.65	20.71	22.37	22.66	22.62	21.39	21.46	20.76
FeO^{+}	24.93	24.66	24.50	24.82	25.02	25.23	25.34	25.51	25.59
MnO	13.45	13.54	13.41	12.87	13.32	13.25	12.31	12.47	12.51
MgO	0.75	0.75	0.69	0.84	0.85	0.82	1.11	1.10	1.01
CaO	0.65	0.51	0.65	0.70	0.71	0.64	0.76	0.69	0.73
Total	97.96	97.92	95.56	98.27	99.17	99.44	98.44	98.68	97.57
Mol. % of end members									
Si	3.00	3.03	3.02	3.00	2.98	2.99	3.07	3.06	3.06
Al	2.13	2.10	2.07	2.16	2,17	2.16	2.06	2.06	2.03
Fe^{2+}	1.72	1.70	1.74	1.70	1,70	1.71	1.73	1.74	1.77
Mn	0.94	0.49	0.96	0.89	0.92	0.91	0.85	0.86	0.88
Mg	0.09	0.09	0.09	0.10	0.10	0.10	0.14	0.13	0.13
Ca	0.06	0.05	0.06	0.06	0.06	0.06	0.07	0.05	0.06
Mol. % of end members									
Pyrope	3.20	3.24	3.16	3.64	3.60	3.60	5.02	4.68	4.58
aver.		3.20			3.61			4.76	
Almandine	61.21	61.15	61.05	61.82	61.15	61.61	62.00	62.59	62.32
aver.		61.14			61.49			62.30	
Spessartite	33.45	33.81	33.68	32.36	33.09	32.73	30.47	30.94	30.99
aver.		33.65			32.73			30.80	
Grossularite	2.14	1.80	2.11	2.18	2.16	2.16	2.51	1.80	2.11
aver.		2.02			2.17			2.14	
Type	(211) > (110)								
SiO_2	37.62	38.07	37.02	37.94	37.66	38.07	39.22	38.72	38.36
TiO_2	0.02	0.01	0.01	0.03	0.04	0.00	0.07	0.06	0.06
Al_2O_3	20.89	20.60	20.49	21.72	22.16	22.41	22.14	22.38	22.06
FeO^{+}	26.16	25.65	25.91	25.97	26.03	25.96	26.64	27.11	26.54
MnO	12.08	11.96	12.09	11.66	11.18	11.86	10.99	11.12	11.18
MgO	0.76	0.85	0.73	1.14	1.23	1.05	1.30	1.36	1.23
CaO	0.60	0.52	0.62	0.59	0.66	0.44	0.69	0.72	0.71
Total	98.12	97.66	96.87	99.04	98.96	99,81	101.04	101.47	100.15
Numbers of cations on the basis of 12 oxygens									
Si	3.09	3.15	3.09	3.08	3.05	3.06	3.10	3.06	3.07
Al	2.02	2.00	2.01	2.07	2.11	2.12	2.06	2.08	2.08
Fe^{2+}	1.79	1.77	1.80	1.75	1,76	1.74	1.76	1.79	1.77
Mn	0.84	0.84	0.85	0.80	0.77	0.81	0.73	0.74	0.76
Mg	0.09	0.11	0.09	0.14	0.15	0.13	0.15	0.16	0.15
Ca	0.05	0.05	0.06	0.05	0.06	0.04	0.06	0.06	0.06
Mol. % of end members									
Pyrope	3.25	3.97	3.21	5.11	5.47	4.78	5.56	5.82	5.47
aver.		3.48			5.12			5.62	
Almandine	64.62	63.90	64.29	63.87	64.23	63.97	65.19	65.09	64.60
aver.		64.27						64.96	
Spessartite	30.32	30.32	30.36	29.20	28.10	29.78	27.04	26.91	27.74
Spessartite		30.33			29.03			27.23	
Grossularite	1.81			1.82	2.19	1.47	2.22	2.18	2.19
aver.		1.92			1.83			2.20	

mandine — spessartite garnets in dependence on MnO and FeO contents or the content of spessartite and almandine components.

Discussion and Conclusions

Isomorphic crystals with succesive continuous and regular changes of their composition cause successive continuous changes of atomic structure and physical properties, sometimes in consequence of what successive and continuous changes of external crystal form sometimes occurs (G. B. Bokij, 1975). From the principles of the theory about origination and growth of crystals (J. Babčan, 1974) follows that isomorphic admixtures in isomorphic crystals have the same effect to the rate of growth of all surfaces, so there occurs no change of habit.

From the results of study there is evident the coherence of systematic change of garnet morphology and the change of their chemical composition or changes of prevalent contents — isomorphically mutually substituting main components of investigated garnets. Probably the assertion about demonstration of strict dependence may be exaggerated also for the reason that by the study of chemical composition of morphological garnet types from different localities the different „borders" of transition of one morphological type to second one in connection with successive isomorphic exchange of prevalent garnet component were found. Isomorphic replacement of main components of isomorphic mineral need not be a primary cause of the morphological shape change. Isomorphic minerals with wide content range of their mutually substituting main components we can however consider as products of the environment with different chemical composition and different thermodynamic conditions and so the total character of crystallization environment influences the origination of crystal embryos and their further growth to macroscopic crystal with the morphology characteristic for certain mineral in different conditions of its growth from geochemical view. It is also necessary, besides geochemical aspect to consider mineral crystallization from the standpoint of theory of origin of ideal and real crystal for unambiguous conclusions.

The study results of chemical composition of individual garnet crystals of certain morphological shapes using the electron microprobe can contribute to what an extent is justified to ascribe them different genesis in one rock type and certain locality.

Nearly mutual linear dependence of main component contents' change (FeO and MnO, Fig. 5) in investigated garnets from pegmatites of individual localities is evidently the reflection of efficiency of mutual isomorphic replacement or blending of almandine and spessartite components. Interesting

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* Total Fe as FeO

Localities: Železná studnička, quarry I. — medium-grained two-mica pegmatite. Bratislava — Železná studnička, quarry on the left side of Bystrica brook valey; Jur pri Bratislave — medium, nearly coarse- 4rained pegmatite, near the road Jur pri Bratislave — Myslenice, SE under the Kominar hill.

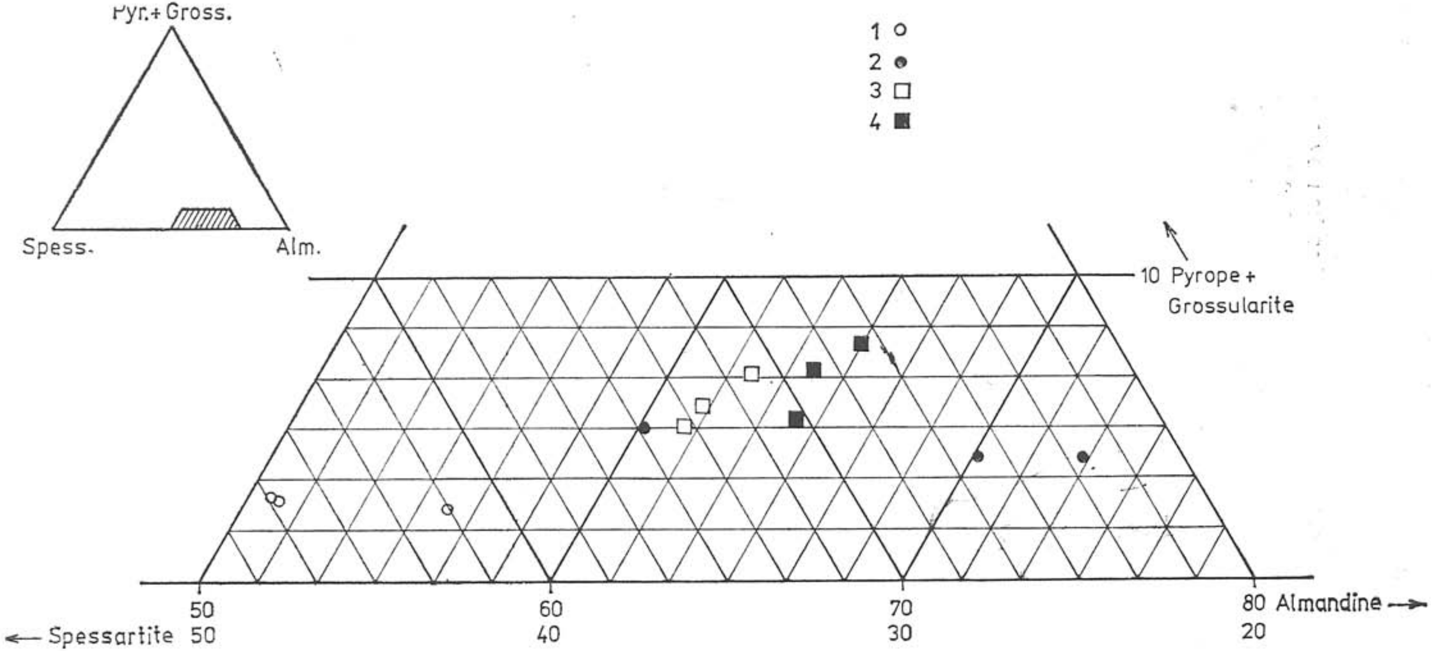


Fig. 4. Garnet composition of individual morphologic types: 1 — garnet (110) from the locality Železná Studnička, 2 — garnet (211) > (110) from the locality Železná Studnička. 3 — garnet (110) > (211) from the locality Jur near Bratislava. 4 — garnet (211) > (110) from the locality Jur near Bratislava.

is, however, the fact that total content of basic components of investigated garnets in different morphological types is constant but different for individual localities. It is not very probable that one morphological type would represent the product of primary crystallization (phenocryst) and the second type allogene material (xenocryst) absorbed by magma. If petrographic study results indicate a metasomatic origin of one from morphological garnet types (Š. Dávidová, 1968) it is more possible that in this case rather autometasomatism occurs. R. Nováček (1931) considers the high manganese content in pegmatites and aplites to be characteristic primary concentration

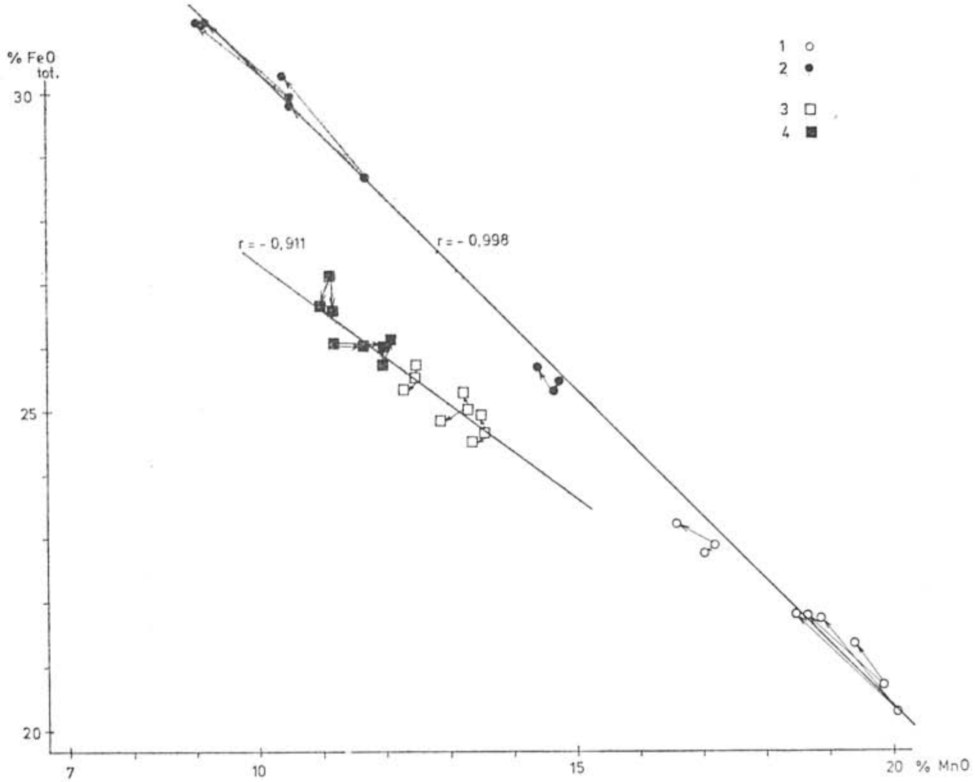
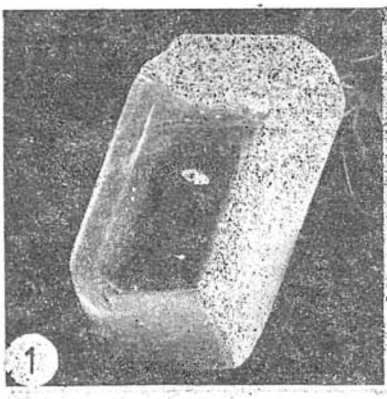


Fig. 5. The graph gives a description of mutual dependence FeO_{tot} and MnO contents of individual morphological types of garnet crystals. Symbols' explanations at Fig. 4. Arrow-heads ilustrate MnO and FeO contents changes from the centre to crystal's edges; r = correlative ratio FeO_{tot} / MnO.

Pl. 1. Morphological and surface peculiarites of garnet crystals characterized by scanning electron microscopy. Fig. 1 — irregularly developed rhombododecahedral garnet form, magn. 300 x; Fig. 2 — complicated form of irregularly developed garnet crystal, magn. 200 x; Figs, 3 — 6 garnets with marks of disturbed surface; mainly at the edges; and sometimes at crystal surfaces, magn. 400 — 4 000 X.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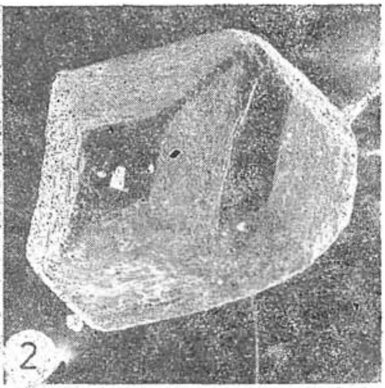
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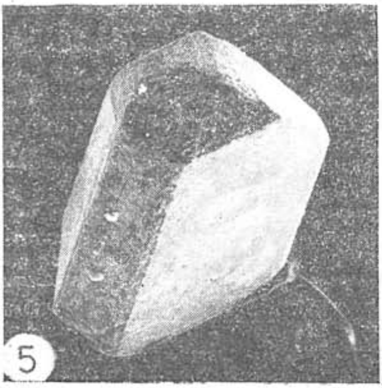
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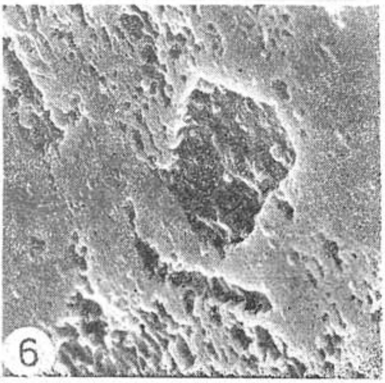
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which usually occurs in the most acid parts of rock where there are no conditions for origination of other coloured members so the garnet does not represent a product of „endogenic assimilation". W. R. Vennum (1979) genetically interprets idiomorphic garnet from pegmatites and aplites as phenocrysts where the low pyrope content even relatively less at crystal margins, „is consistent with ingneous zonation". B. E. Leake (1967) considers garnets of Galway granites and aplites to be products of magmatic crystallization. J. G. Fitton (1972) describes garnets of calc—alkaline Borrowdale volcanic group as phenocrysts. The development of granite melt proceeds to the end members with very low MgO content what is simultaneously the necessary condition for garnet crystallization instead of biotite (D. Hovorka, 1968). Investigated garnets from pegmatites of the Malé Karpaty mts. comply with the opinion of A. Miyashiro (1955) who characterizes pegmatite garnets joined with calc-alkaline rocks as phenocrysts of almandine — spessartite composition with imperceptible presence of pyrope component. Such garnets (V. V. Ljachovič, 1973) occur in granites which do not have any evident traces of assimilation or metasomatic processes. Finding a quite wide range of chemical garnet composition from pegmatites of the Malé Karpaty mts. on the basis of analysis of different morphological types, finding evidently regular trend in ratio changes of almadine and spessartite components and mainly their constant but — at individual localities — different total content is probably a reflection of the wide interval of their crystallization. It is needful to notice (Fig. 5) that wider range of FeO and MnO ratios or almandine and spessarite components is accompanied by higher morphologic variability. Concretely, pegmatite garnet at Železná Studnička locality has relatively the highest MnO, or spessartite component contents when it forms nearly perfect rhombic dodecahedron form (110). The mentioned results simultaneously indicate the common origin for all investigated morphological garnet types which the most probably were originated by primary crystallization during the cooling process of pegmatite melt. Pegmatite garnets from the Malé Karpaty mts. often have some marks of postmagmatic processes' influence (Pl. 1,2). Tectonically disrupted crystals are healed in joints with sericite, epidote, or quartz which simultaneously indicate some corrosion effects. F. K. Drescher — Kaden (1974) asserts though that solutions with corrosion ability can affect just originated silicates again, when in most cases silica products only are preserved at corrosion border, concretely, in contact with garnet. Pegmatite garnets from the Malé Karpaty mts. are also filled with quartz next to corrosion in joints originated

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Pl. 2. Microscopic garnet characteristics from pegmatites of the Malé Karpaty mts., locality Železná Studnička: Fig. 1 — idiomorphic garnets in contact with muscovite, quartz and feldspars, magn. 150 x, nicols X. Fig. 2 — idiomorphic garnets in plagioklase or in contact with quartz, magn. 160 x, nicols X. Fig. 3 corrosion garnet with cracks sěcondary healed with finegrained sericite aggregate which simultaneously fills up also tectonically disturbed plagioklas, magn. 150 x, nicols X. Locality Jur near Bratislava. Fig. 4 — garnet corroded and healed in cracks with quartz, magn. 150 x, nicols //. Figs. 5, 6 — corroded garnet twinning crystal, replaced by epidote where there are evident relics of primary isotropic garnet in not extinct parts of epidote, magn. 150 x, nicols X.


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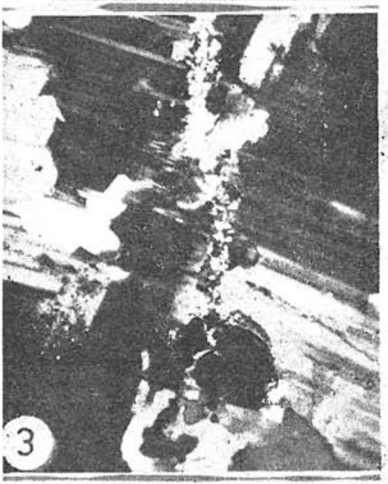
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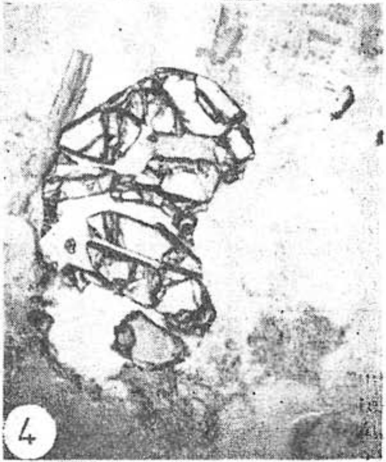
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by influence of later tectonical effects. Replacement of garnet by secondary epidote, too, and sporadic pseudomorphoses of biotite after garnet were found. Different positions of garnet suites from different localities (Figs. 4,5) are a reflection of the different character of medium where they had been originated. The relatively wider interval of garnet origination in pegmatites from Železná Studnička locality is possible put into connection with the character of pegmatite bodies investigated occurrences because here, on the contrary to the locality Jur near Bratislava pegmatites form perfectly differentiated zonal veins.

It is important to take into consideration geochemical changes in pegmatite process at reviewing garnets according to temporal consequence of the individual searched morphological types' crystallization. A tendency of decreasing Mg and Fe contents with simultaneously increasing Mn content in the time of cooling of pegmatite melt is also reflected in composition of investigated almandine spessartite garnets. From that follows (Fig. 4, 5) a relatively earlier origination of tetragonal trioctahedral garnets in comparison to rhombobododecahedral ones, where is evident that nearly an ideal rhombic dodecahedron crystal has relatively highest content of spessartite component and relatively lowest almandine and pyrope component contents.

The composition of main morphological garnet types from pegmatites of Malé Karpaty mts. indicates content range of end garnet members and simultaneously lenght of primary crystallization interval during consolidation process of pegmatite melt. But appearance alone of certain morphological garnet type in a certain rock type does not determine the way of its origin.

Acknowledgements: The author wishes to express his thanks for making possible this research to directorships of geological institutes of Slovak and Czechoslovak Academies of Sciences, personally to acad. B. Cambel and Ing. V. Heil, CSc. His exceptional thanks belong to Doc. RNDr. J. Veselský, CSc. and Doc. RNDr. Š. Dávidová, CSc. for cosultations and introducing in the field. He expresses his thanks to Ing. A. Langrová and M. Kozumplíková, Geological Institute of the Czechoslovak Academy of Sciences for doing analytical work; K. Šebor and M. Švec, workers of the Dionýz Štúr Institute of Geology for photographing by scanning microscope.

Translated by L. Halmová

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Review by B. CAMBEL

Manuscript received September 10, 1979