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THE DETERMINATION OF GARNET CONTENT OF ROCKS BY DIFFERENT METHODS

(Fig. 1—5)

A b s t r a c t: The garnet content of eleven different rock specimens was established using stereological 3D planimetric analysis (performed on cleaved rock surfaces), point counting (on crushed and sieved specimens) and quantitative separation (in heavy liquids). After crushing, sieving, decantation and separation, the garnet content in the samples was found to be 6 to 7 times higher on the average than it is in the uncrushed specimens. The relationship between the results and the choice of optimal method for this type of measurement was investigated. Finally, recommendation for routine work are given.

Р е з ю м е: В одинадцати образцах горных пород установлено содержание граната следующими методами: стереологическим 3 R планиметрическим анализом (измерения проводились на больших плоскостях образцов обработанных молотком), точечным анализом (измерения проводились на дробленых и просеянных образцах) и количественной микросепарацией (в тяжелых жидкостях). После сепарации (в том числе дробления, просеивания и декантации), содержание граната в образцах повисилось в среднем на 6—7 раз по сравнению с содержанием в целостной породе. Авторы изучали взаимоотношения полученных данных и описали оптимальную методику для измерений этого рода.

Data concerning the content of accessory minerals in rocks are usually given in the literature without specifying the methods by which the data were obtained. In general, the assessment is done by estimation, some kind of modal analysis and less frequently by quantitative microseparation. The garnet content is an important petrological factor, so we made a test of the compatibility of the results obtained by the different methods used to establish it.

After the rock samples were selected (Tab. 1), planimetric modal analysis was done on cleaved, unpolished quasi-planar rock specimens by a method, which, then unknown to us, it had been elaborated somewhat earlier by E l-S o u d a n i (1975). Then point analysis was performed on disintegrated and sieved samples and, finally, weigh analysis was carried out by weighing the mineral fractions after quantitative micro-separation. Planimetric analysis was performed by manual planimetry, for point analysis the Eltinor IV (C Zeiss Jena) was used and the separtion was carried out in bromoform, Thoulet's solution and Clerici's solution. The point analysis and the separation were performed with 0,12—0,15 mm fraction (K. J a k a b s k á, 1975).

In point analysis the average number of the counted grains was 1000 ($\sim$ 0.004 g). The average total grain number in the analyzed population was 200.000 ($\sim$ 0.7 g). In case of weigh analysis of the separated fractions the garnet weighed 0.25 g on the average; the average weight of the sample before separation was $\sim$ 10.0 g. Thus, the purely statistical error should be less in the latter than in the former case. The oscillation in the data obtained by both types of

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Table 1. Results of the point, separation and planimetric analyses

No.	1	2	3	4	5	6	7	8	9	10	11
Locality	Zá-hrad-né	Bre-zina	Šiato-roš	Tiso-vec	V. Šariš	Bur-zovo	Pom-jaslo	Lesné	Beňa-tina	Kys-linky	Hnúš-ťa
Separa-ted from	andensite							rhyolite		rhyo-dacite	mica-schist
Separa-tion ana-lysis (A)	3,80	1,69	3,30	0,71	3,04	1,77	2,40	1,50	2,01	0,61	3,09
Point analysis (B)	2,20	1,60	5,80	1,40	1,30	1,10	2,20	1,10	3,70	1,80	2,70
Mean (A+B):2	3,00	1,65	4,55	1,10	–	1,44	2,30	1,30	2,86	1,20	–
Plani-metric analysis (C)	0,25	0,50	1,08	0,40	–	0,16	0,30	0,08	0,12	0,01	–
Surface analyzed planimet-rically (mm^2)	60 285	26 625	40 850	18 100	–	47 175	13 225	21 375	25 385	9 700	–

measurments (Tab. 1 and Fig 1), i. e., the point and separation analysis, follow an identical trend, but their values are not identical. In Figs. 2 and 3, the alternate data from Fig. 1 were arranged into a series with increasing percentual values; in Fig. 2 the point analysis –, and in Fig. 3 the weight analysis data were arrayed in such a manner. It can be seen that in both cases the" slave data" oscillate around the arrayed ones randomly. This would indicate that the differences in their nominal values are predominantly of statistical character. The graph of the relative displacement (Fig. 4) of the originally successive number after their re-arrangement in Figs. 2 and 3 shows however, that the trend of translocation is not wholely random. This reflects the non-statistical effects of the used methods upon the results. The detailed analysis of the data obtained by point and separation analyses showed that the differences originate from four sources: 1. imperfection of sampling, 2. inaccuracy of the measurements themselves, 3. the specificities of the applied type of measurments and 4. loss of material during separation (see below). As the above mentioned results showed persistently higher values than it could be expected from the analyzed rocks, the manual

planimetric analyses were performed again, on relatively large, cleaved rock specimens having an average surface of 26.300 mm^2. It was found (Tab. 1) that the garnet content in the integral rock is up to 10 times smaller than in the samples subjected to comminution and separation. We found that this

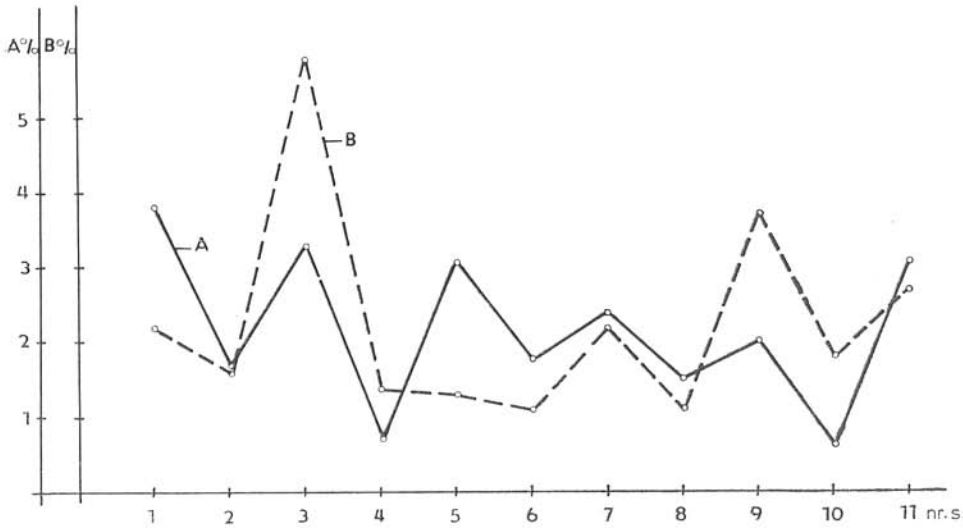

Fig. 1. Variation diagram of percentual values of point and separation analysis.

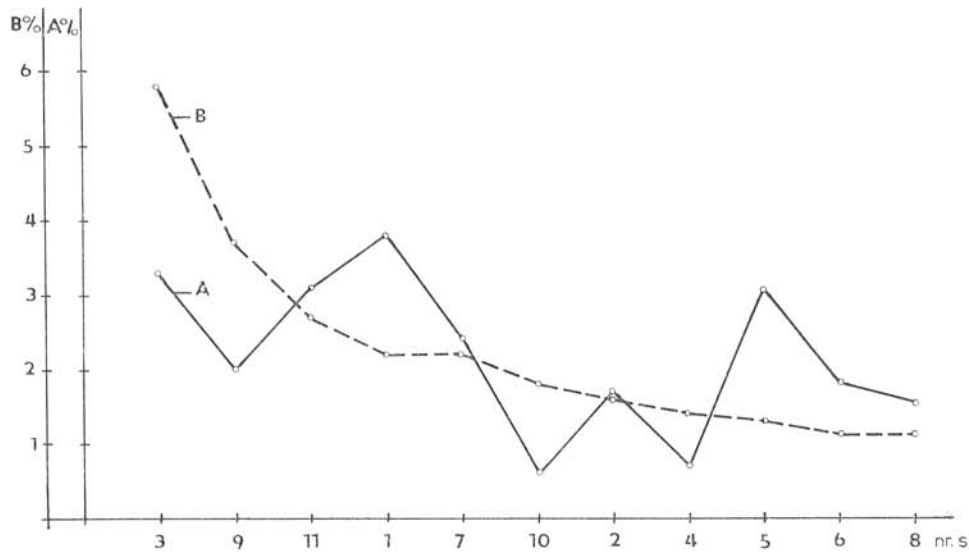

Fig. 2. Variation diagram of values obtained from point and separation analysis arranged by decreasing values of garnet content determined by point analysis.

enrichment was caused mainly by two factors, viz., that the constituent minerals of lower hardness were comminuted to less than 0.12 (a fraction smaller than can be analyzed) and that some minerals were solved and/or washed away during decantation. That these phenomena are of a systematic type may be seen

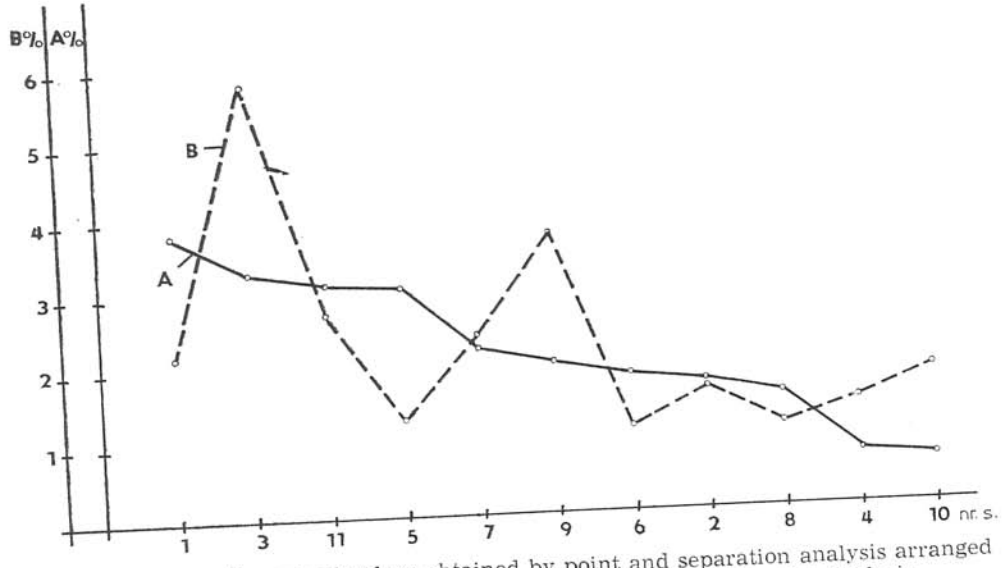

Fig. 3. Variation diagram of values obtained by point and separation analysis arranged by decreasing values of garnet content determined by separation analysis.

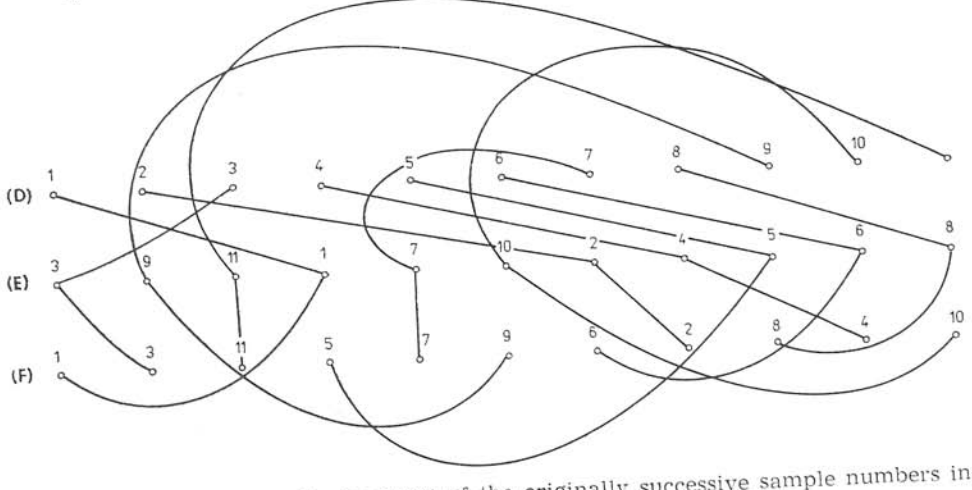

Fig. 4. Graph of relative displacement of the originally successive sample numbers in Figs. 1 to 3;
D – numerical order of samples
E – arrangement in Fig. 2
F – arrangement in Fig. 3

in Fig. 5, which shows the variation diagram of granet content obtained from disintegrated and integrated rock specimens. In Fig. 5, the mean of the individual pairs of data obtained by point and separation analyses was used in order

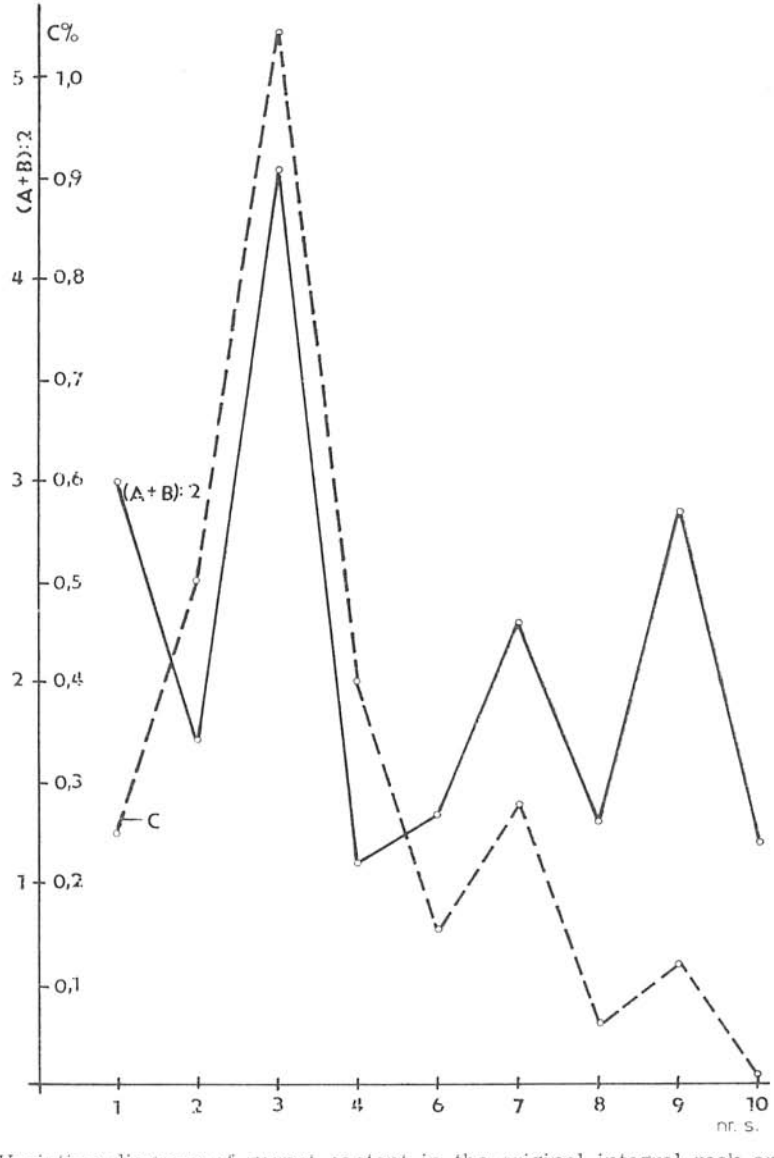

Fig. 5. Variation diagram of garnet content in the original integral rock and in the disintegrated and sived samples.
A — separation analysis
B — point analysis of comminuted sample
(A + B) : 2 — mean values
C — planimetric analysis.

to compensate for the statistical and other inherent errors in both methods. From Fig. 5 it is apparent that the oscillation of the frequency polygons – with the exception of two point pairs – have identical character. This shows that in spite of the individual biases of the employed methods, they can be correlated.

It can be concluded that the most straightforward and reliable results are obtained by stereological planar analysis performed on cleaved or polished rock sections (G. T i m č á k, 1975) on condition that the analyzed surface is sufficiently large (cf. Tab. 1). The objectivity of the point and quantitative microseparation analysis is distorted due to the differences in hardness and solubility of the constituent minerals and, subsequently, the already mentioned losses during the process of comminution and separation. The results may be tentatively corrected, however, if they are divided by a factor of 6 or 7, – the average degree of relative enrichment. The quantitative analysis by microseparation has to be used, however, in case of extremely low concentration of the accessory minerals, where stereological measurements would necessitate the use of unpracticably large rock specimens, though its results have to be always corrected.

As regards time consumption, the point and planimetric modal analysis is more favourable than the separation and weight analysis. While the process of separation of 10 g of rock takes 16 hours, the average time needed for a point or planimetric analysis (for garnets and three other minerals) is about 30 minutes.

It is evident from the above that information on the method used in determining the accessory content of rocks should be always quoted.

The differences between the discussed types of results may be less in case of rock-forming minerals, but much depends on their physical and chemical properties (cf. E. T h o m s o n, 1930). In case of indirect determinations (e. g., by selectione solving of disintegrated rock constituents) the expectable distortion are of identical character (G. T i m č á k, 1976).

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