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# PETROLOGICAL INTERPRETATION OF CRYSTALLIZATION PROCESSES IN BASALT ANDESITES OF THE ŠIBENIČNÝ VRCH HILL COMPLEX (FROM THE SOUTHERN PART OF THE KREMNICKÉ VRCHY MOUNTAINS)

*(Figs. 19, Tabs. 3)*

Abstract: The petrological study of rocks from the Šibeničný vrch hill complex (quarry Ladomer, near Bartošova Lehôtka and Šibeničný vrch hill) from the southern part of the Kremnické vrchy mountains has made possible to decipher the course of the crystallization process in individual silicate melts, the mechanism of the origin of individual bodies and has confirmed also their mutual genetic relationship.

Резюме: Петрологическое изучение пород комплекса Шибеничной горы (карьер Ладомер, карьер у с. Бартошова Легуотка и Шибеничная гора) южной части Кремницких гор представило возможность объяснить течение процесса кристаллизации в отдельных силикатных расплавах, механизм образования отдельных тел и оно подтвердило тоже их взаимную генетическую связь.

The Šibenický vrch complex (according to Konečný—Lexa—Planderová, 1983) is formed by dykes, penetrations, extrusions and flows of aphanitic basalt andesites, which are piercing or overlying the Jastrabá formation (sequence) in the southern part of the Kremnické vrchy moutains between the villages Bartošova Lehôtka, Jastrabá, Pitelová and town Žiar n/Hronom (Fig. 1). The mentioned authors (l. c.) assign to the complex also the lava flow and pyroclastics of the pyroxene andesites between Šášovské Podhradie and Žiar n/Hronom, which are of equal structural position and uncovered in the quarry of Ladomer.

The supposed age of rocks from the Šibeničný vrch complex, belonging to the lime-alkalic province, is Pannonian.

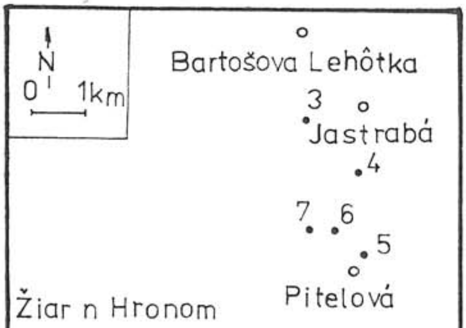


Fig. 1. Localization of volcanic bodies from the Šibeničný vrch hill complex. *Explanations:* 1 — quarry Ladomer; 2 — Šibeničný vrch hill; 3 — quarry and dykes in the cut of the railway near Bartošova Lehôtka; 4 — Ostrá hora; 5 — Strmý vŕšok; 6 — Chlebová; 7 — Klinčok.

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The crystallization processes were studied more in detail in the rocks of these localities: 1 — quarry of Ladomer, 2 — mount Šibeničný vrch hill, quarry near Bartošova Lehôtka. The conclusions of the study result from microscopic observation (with application of 5-axial Fiodorov's stage), from chemical analyses of minerals (by electron microanalyzer) and from chemical analyses of rocks,

## Quarry Ladomer

About 1 km northwest of Šášovské Podhradie a body (lava flow) formed by pyroxene andesite is exposed in the quarry. The rock has a porphyritic texture (Fig. 12) with hyalopilitic texture of the groundmass (with indications of fluidal structure). The maximum size of phenocrysts is up to 3 mm. The modal composition of rocks is as follows:

| | |
|---|---|
| groundmass | 78 % |
| plagioclases | 20 % |
| orthopyroxenes | 1.5 % |
| clinopyroxenes | 0.5 % |

a) Plagioclase is represented by zonal phenocrysts, the composition of which varies from bytownite (in the centre) to oligoclase (at the periphery of phenocrysts).

b) Orthopyroxenes form two groups:

1. allo — to hypidiomorphic phenocrysts of various size (0.3 to 1.0 mm) representing typical volcanic hypersthene with ratio $Fe/(Mg + Fe)$ in the interval 0.45—0.47 (Fig. 12).
2. hypidio — to idiomorphic phenocrysts of hypersthene of 0.6—0.7 mm size, which often contain larger phenocrysts of plagioclases and Fe-Ti oxides. The values of $Fe/(Mg + Fe)$ ratio in the frame of the individual phenocrysts are varying in the interval from 0.5 to 0.54 (Fig. 13). The value of the angle 2V in orthopyroxenes is also variable, in the interval of 56°—68°.

The phenocrysts of orthopyroxenes of the 1st and 2nd group have at their rim hems of variable thickness formed by pigeonite (Figs. 12, 13, 14).

c) Clinopyroxenes are represented by pigeonite, which on the one hand forms hems around phenocrysts of pyroxenes (Fig. 13) and also forms small needles ($< 0.1$ mm) in the groundmass and by Ca-rich clinopyroxenes, which form phenocrysts (diopside augite—ferroaugite, $Fe/(Mg + Fe) = 0.46$; Fig. 15) or are in the groundmass (ferroaugite, $Fe/(Mg + Fe) = 0.52$—0.53; Fig. 12).

In grains of clinopyroxenes in the groundmass intergrowths with Fe-Ti oxides and with pigeonite were observed (Fig. 14).

The groundmass contains microlites of plagioclases, grains of Fe-Ti oxides and accessory minerals (apatite, zircon) and volcanic glass (Fig. 12).

## Mount Šibeničný vrch hill

About 1 km east from Žiar n/Hronom is the mount Šibeničný vrch, representing an extrusive body - volcanic dome about 400 m in diameter. In direction to the north the body passes into a short lava flow. It is formed by basalt andesite. The rock is of a porphyritic texture (maximum size of phenocrysts-up to 3 mm) with coarsergrained pilotaxitic texture of the groundmass (Fig. 16). The rock has the following modal composition:

| | |
|---|---|
| groundmass | 67.4 % |
| plagioclases | 18.0 % |
| olivine | 8.7 % |
| clinopyroxenes | 5.9 % |

a) Plagioclase is represented by zonal phenocrysts, the composition of which varies from bytownite (in the middle) to oligoclase at the periphery of phenocrysts, (Fig. 16).

b) Olivine has normal zonal phenocrysts, i. e. in direction from the middle to the margin the content of magnesium decreases and on the contrary, the content of iron, manganese and calcium rises. A part of olivine phenocrysts (idio — to hypidiomorphic with content of $Fo^{x}_{63-48}$ and size from 0.3 to 0.6 mm) is affected by alteration into serpentine. This alteration is bound to joints and their close vicinity at the periphery of olivine phenocrysts (Fig. 17).

The second part of olivine phenocrysts forms allotriomorphic grains with $Fo^{xx}_{51-52}$ content, which, however, are not affected by alteration. Phenocrysts of olivine of $Fo^{xxx}_{80}$ composition were also determined optically, whilst phenocrysts, analysed by electron microanalyzer, attained maximum 63 % $Fo^{x}$ component.

c) Clinopyroxenes

1. Porphyric phenocrysts (up to 1.4 mm in size) are represented by diopside augite or ferroaugite with ratio $Fe/(Mg + Fe) = 0.39—0.53$.

2. In the groundmass clinopyroxenes are represented by ferroaugite ($Fe/(Mg + Fe) = 0.52$).

The optical parametres of clinopyroxene phenocrysts are as follows: $2V = 45°—55°$, $\gamma/c = 41°—50°$, $0_1/c = 12°—20°$.

The groundmass contains microlites of plagioclases, grains of olivine, Fe-Ti oxides and accessory minerals (apatite, zircon; Figs. 16, 17).

### Bartošova Lehôtka

About 2 km south of the village Bartošova Lehôtka is a quarry, situated in the studied body, which we can designate as a volcanic dome (with diameter around 400 m). Its rocks is formed by basalt andesite of porphyritic texture (maximum size of phenocrysts up to 3—4 mm) with pilotaxitic to trachytic texture of groundmass (Figs. 18, 19).

The modal composition of rock is as follows:

| | |
|---|---|
| groundmass | 75.2 % |
| plagioclases | 18.8 % |
| olivine | 4.9 % |
| clinopyroxene | 0.9 % |

a) Plagioclase is represented by zonal phenocrysts, the composition of which varies from bytownite (in the middle) to andesine (at the rim of phenocrysts).

b) O l i v i n e is represented by phenocrysts, which show an analogous zonality similar as in the rock from the locality Šibeničný vrch (Figs. 18, 19). Besides idio — to hypidiomorphic porphyric phenocrysts ($Fo^{x}_{59-70}$, of size approximately 1 mm) also olivines belonging to the groundmass (having hypidiomorphic shape, $Fo^{x}_{51-55}$), are affected by serpentinization. Unaltered olivine forms allotriomorphic grains in the groundmass. Phenocrysts of olivine with composition up to 85 % $Fo^{x}$ were determined optically whilst olivine analysed by electron microanalyzer contained maximum 70 % $Fo^{x}$ component.

c) C l i n o p y r o x e n e s

Porphyric phenocrysts (up to 1 mm large) are formed by d i o p s i d e a u g i t e to f e r r o a u g i t e ($Fe/(Mg + Fe) = 0.417—0.36$). The optical parameters of clinopyroxene phenocrysts are as follows: $2V = 44°—52°$, $\gamma/c = 45°—54°$, $0_1/c = 15°—20°$.

The groundmass contains microlites of plagioclases, grains of olivine, pyroxenes, Fe-Ti oxides and accessory minerals (apatite, zircon).

## *Petrological interpretation of crystallization processes in the studied rocks*

O l i v i n e:

(Chemical composition — Table 1, Figs. 2, 3).

$Fe/(Fe + Mg)$ ratio in the cores of olivines (which crystallized from the melt among the first phenocrysts of olivine) at the locality Šibeničný vrch as well as the locality Bartošova Lehôtka is almost equal and has a value around 0.4. The same ratio in composition of whole rocks from these localities is essentially in conformity with the foregoing mentioned value.

When we use the diagram showing the relation between the composition of crystallizing olivine and $Fe/(Fe + Mg)$ ratio in the melt in dependence on temperature (according to R o e d e r—E m s l i e, 1970) provided that the composition of the whole rock corresponds to the composition of the competent melt, in which crystallization was taking place (this precondition is fulfilled when olivine crystallized from the melt as first from Fe—Mg minerals), for crystallization of olivine the temperature around 1150 °C results.

P y r o x e n e s:

(Chemical composition — Tables 2, 3, Figs. 2, 3, 4).

Division of orthopyroxene phenocrysts in rocks from the quarry Ladomer into two groups together with the changes of $Fe/(Fe + Mg)$ ratio values during their growth, is in Fig. 5. The individual curves in this figure represent the dependence of the change of chemical composition in the frame of individual phenocrysts, given by $Fe/(Mg + Fe)$ ratio, from the centre to their margin. Arrangement of phenocrysts is not incidental but follows from the results of chemical analyses as ell as from mutual relations of the individual phenocrysts in the rock. On the horizontal axis are plotted the proportional sizes of phenocrysts, from the centre to their margin. From the figura is clearly to be seen what a different composition the phenocrysts of orthopyroxenes of the 1st and 2nd group have, how their chemical composition is changing during the growth and what is their relation to pigeonite.

Table 1

Point analyses of olivine phenocrysts from the locality Bartošova Lehôtka (points 1 to 9) and Šibeničný vrch hill (points 10 to 14)

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $SiO_2$ | 36.48 | 35.76 | 35.56 | 35.97 | 36.11 | 37.84 | 36.64 | 37.38 | 36.22 | 36.96 | 36.36 | 36.54 | 35.94 | 38.92 |
| $Al_2O_3$ | 0.01 | 0.01 | 0.03 | 0.02 | 0.02 | 0.01 | 0.00 | 0.03 | 0.02 | 0.01 | 0.02 | 0.01 | 0.02 | 0.02 |
| $Cr_2O_3$ | 0.03 | 0.00 | 0.00 | 0.01 | 0.01 | 0.02 | 0.00 | 0.00 | 0.02 | 0.00 | 0.00 | 0.01 | 0.00 | 0.01 |
| FeO | 33.53 | 36.36 | 35.78 | 33.58 | 34.32 | 25.52 | 30.66 | 26.89 | 33.43 | 31.38 | 34.44 | 32.39 | 33.08 | 20.93 |
| MnO | 0.66 | 0.67 | 0.70 | 0.66 | 0.70 | 0.49 | 0.63 | 0.48 | 0.62 | 0.61 | 0.66 | 0.73 | 0.68 | 0.36 |
| MgO | 29.79 | 27.23 | 27.48 | 29.12 | 28.61 | 36.47 | 31.29 | 34.92 | 30.31 | 31.78 | 28.88 | 29.56 | 28.82 | 39.75 |
| CaO | 0.26 | 0.27 | 0.29 | 0.26 | 0.27 | 0.17 | 0.16 | 0.18 | 0.24 | 0.22 | 0.25 | 0.27 | 0.29 | 0.14 |
| Sum | 100.76 | 100.30 | 99.84 | 99.62 | 100.04 | 100.52 | 99.38 | 99.88 | 100.86 | 100.63 | 100.61 | 99.51 | 98.83 | 100.13 |
| $Mg_2SiO_4$ (Fo) | 52.35 | 48.07 | 48.80 | 51.74 | 50.75 | 63.87 | 55.79 | 61.62 | 52.85 | 55.60 | 50.90 | 52.45 | 51.92 | 70.14 |
| $Fe_2SiO_4$ (Fa) | 47.64 | 51.92 | 51.29 | 48.25 | 49.24 | 36.12 | 44.20 | 38.37 | 47.14 | 44.40 | 49.09 | 47.54 | 48.07 | 29.85 |

Analysed by RNDr. J. Krištín, CSc. and RNDr. J. Határ, CSc. from OEMM GÚDŠ (Dionýz Štúr Institute of Geology), Bratislava.

The result of the study of the relation orthopyroxenes — clinopyroxene in the rock from this locality, basing on the works of K u n o (1950; 1968) and L i n d s l e y (1983), is the constructed curve (Fig. 6) showing the temperature of pyroxene crystallization in the magma from the given locality. The curve of Ladomer pyroxenes intersects the curve of inversion opx—cpx in the interval $En_{60}Fs_{40}$—$En_{55}Fs_{45}$, Its course essentially agrees with the course of the

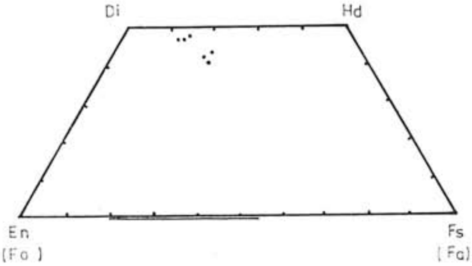


Fig. 2. Composition (molecule %) of olivine (—) and pyroxene (◯) in basalt andesite from the Šibeničný vrch hill locality.

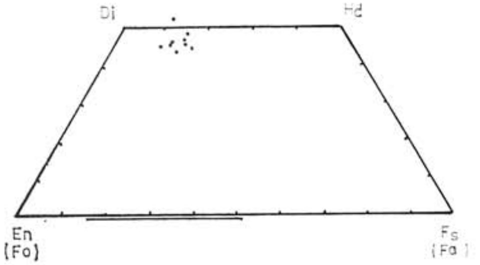


Fig. 3. Composition (molecule %) of olivine (—) and pyroxene (◯) in basalt andesite from the locality quarry near Bartošova Lehôtka.

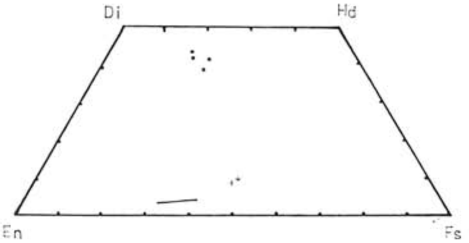


Fig. 4. Composition (molecule %) of orthopyroxene (—), pigeonite (+) and clinopyroxene (◯) in pyroxenic andesite from the locality quarry Ladomer.

curve constructed by S. T s u b o i in (K u n o, 1950) for the temperatures of crystallization of pyroxenes in natural magmas. On the basis of the graph of L i n d s l e y (Fig. 8 in L i n d s l e y, 1983), the temperature corresponding to this transition opx—cpx is around 880 °—980 °C, in dependence on pressure. The position of orthopyroxenes of the 1st and 2nd group on the mentioned curve is obvious from this figure (orthopyroxenes of the 2nd group represent minerals, which are found at the end of the curve showing their trend of crystallization in the magma close before this intersect the curve of the inverse transition opx—cpx).

In Fig. 7 is a part of the diagram enstatite—ferrosilite—diopside—hedenbergite containing the curve, which shows how the chemical composition of clinopyroxenes in the rocks from Ladomer, Šibeničný vrch and Bartošova Lehôtka was changing during the process of their crystallization from the magma. A common and distinct feature of the represented crystallization trends is sudden sinking in the right part of the curves, corresponding to decreasing calcium content in clinopyroxenes with termination (at Šibeničný vrch and

Table 2

Point analyses of phenocrysts of diopside augite to ferroaugite (the names of pyroxenes are according to classification of Carmichael — Turner — Verhoogen, 1974) from the locality Šibeničný vrch hill (points 1 to 5) and from the locality Bartošova Lehôtka) (points 6 to 8)

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| $SiO_2$ | 51.23 | 50.07 | 51.02 | 51.20 | 51.01 | 49.74 | 50.43 | 51.31 |
| $TiO_2$ | 0.44 | 0.69 | 0.58 | 0.56 | 0.76 | 0.77 | 0.31 | 0.25 |
| $Al_2O_3$ | 2.44 | 5.44 | 4.01 | 4.05 | 1.84 | 4.66 | 4.75 | 4.30 |
| FeO | 11.45 | 6.82 | 6.52 | 6.55 | 10.61 | 8.72 | 6.18 | 6.07 |
| MnO | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| MgO | 13.07 | 13.72 | 15.01 | 14.49 | 13.74 | 13.86 | 15.16 | 15.28 |
| CaO | 19.43 | 20.08 | 20.55 | 20.53 | 18.90 | 19.28 | 19.78 | 19.30 |
| $Na_2O$ | 0.40 | 0.34 | 0.35 | 0.31 | 0.31 | 0.51 | 0.43 | 0.43 |
| $K_2O$ | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 |
| Sum | 98.47 | 97.16 | 98.04 | 97.69 | 97.18 | 97.54 | 97.04 | 96.94 |
| $MgSiO_3$ | 34.80 | 38.82 | 40.77 | 40.67 | 36.96 | 38.26 | 42.01 | 42.77 |
| $FeSiO_3$ | 22.32 | 14.11 | 12.96 | 13.04 | 20.91 | 17.63 | 12.54 | 12.44 |
| $CaSiO_3$ | 42.86 | 47.05 | 46.26 | 46.28 | 42.12 | 44.10 | 45.43 | 44.78 |

Analysed by RNDr. J. Krištín, CSc. and RNDr. J. Határ, CSc., from OEMM GÚDŠ, Bratislava.

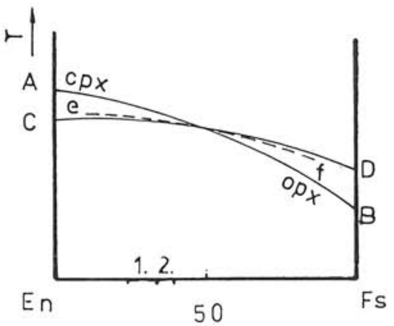


Fig. 6. Diagram showing areas of stability opx and cpx (according to S. Tsuboi in Kuno, 1950).

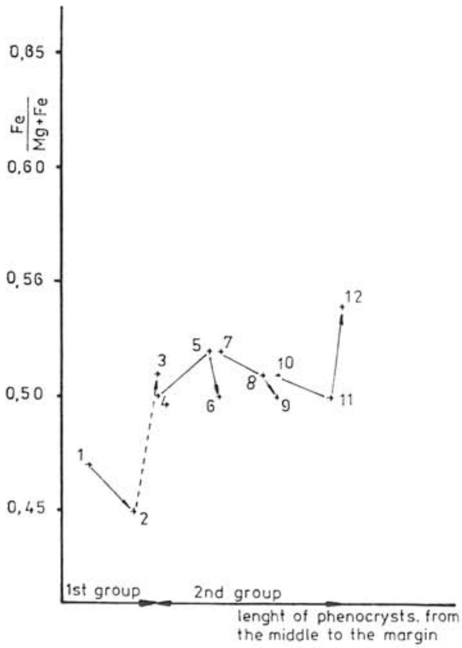


Fig. 5. (⟶) course of zonality of phenocrysts opx of the 1 and 2 group in pyroxenic andesite from the locality quarry Ladomer.

Ladomer), or before termination (at Bartošova Lehôtka) of their crystallization process in the melt.

Setting out from mutual relations between the individual minerals in the studied rocks, obtained by microscopic observation and electron microanalyzer, I compiled the following schemes of crystallization processes in melts, which resulted in formation of rocks from the localities Ladomer, Šibeničný vrch and Bartošova Lehôtka (Figs. 8, 9, 10).

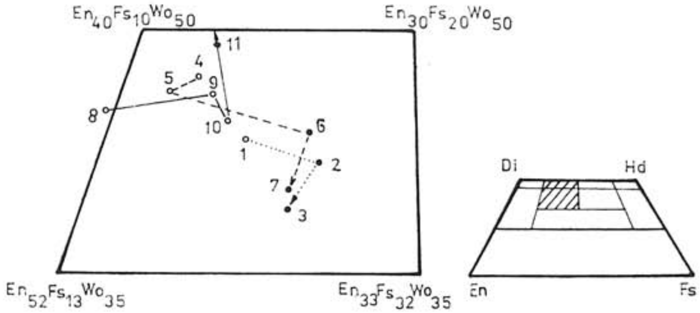


Fig. 7. Change of composition of pyroxenes durin gcrystallization of magma, ○ porphyric phenocryst, ● grain of groundmass.
*Explanations:* ——→ pyroxenes in basalt andesite from the quarry near Bartošová Lehôtka; – – –> pyroxenes in basalt andesite from Šibeničný vrch hill; . . . . > pyroxenes in pyroxene andesite from the quarry of Ladomer.

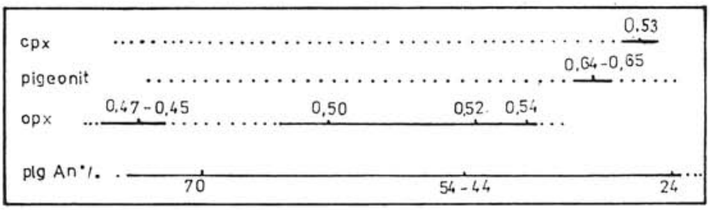


Fig. 8. Graphical representation of the crystallization process in pyroxene andesite from the quarry of Ladomer.
*Explanations:* The number at cpx pigeonite and opx mean the value of Fe/(Mg + Fe) ratio.
——— crystallization process confirmed by the results of observation;
. . . . . probable continuation of the crystallization process.

Now let us compare the crystallization processes, which were observed in rocks with possible courses of crystallization processes in the system $Mg_2SiO_4$—$CaMgSi_2O_6$—$SiO_2$.

Taking into consideration the fact that dark minerals in the rocks are represented by olivine and pyroxene (clinopyroxene and orthopyroxene), in the analysis of melt crystallization I am based on phase diagrams, the author of which is Kushiro (1964, in Шинкарев, 1970, 1969; in Yoder 1976, 1972; in Carmichael—Turner—Verhoogen, 1974). For representation of the crystallization process appears as most suitable the system at pressure

Table 3

Point analyses of pyroxene phenocrysts from the locality Ladomer. Points 1 to 13 – volcanic hypersthene, 14 – pigeonite (the names of pyroxenes are according to classification of Carmichael – Turner – Verhoogen, 1974)

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $SiO_2$ | 53.46 | 53.58 | 53.47 | 53.44 | 53.32 | 53.42 | 53.53 | 53.37 | 52.71 | 53.32 | 53.22 | 53.71 | 52.76 | 52.45 |
| $TiO_2$ | 0.28 | 0.36 | 0.40 | 0.36 | 0.32 | 0.30 | 0.33 | 0.19 | 0.45 | 0.28 | 0.25 | 0.18 | 0.23 | 0.44 |
| $Al_2O_3$ | 1.35 | 1.11 | 1.26 | 1.00 | 1.02 | 1.09 | 1.15 | 1.25 | 1.73 | 1.14 | 2.00 | 1.57 | 1.47 | 0.83 |
| FeO | 18.67 | 19.35 | 18.26 | 19.55 | 18.97 | 18.65 | 19.03 | 18.93 | 19.90 | 18.29 | 16.80 | 16.42 | 19.00 | 24.31 |
| MnO | 0.90 | 0.94 | 0.84 | 0.96 | 0.98 | 0.85 | 0.92 | 0.81 | 0.94 | 0.76 | 0.55 | 0.58 | 0.70 | 1.24 |
| MgO | 23.34 | 22.98 | 23.37 | 22.94 | 23.36 | 23.81 | 23.48 | 23.79 | 21.66 | 23.63 | 23.85 | 25.29 | 22.98 | 16.40 |
| CaO | 1.69 | 1.59 | 1.58 | 1.68 | 1.66 | 1.67 | 1.60 | 1.67 | 1.88 | 1.58 | 1.67 | 1.64 | 1.86 | 4.15 |
| $Na_2O$ | 0.40 | 0.31 | 0.15 | 0.47 | 0.24 | 0.16 | 0.11 | 0.37 | 0.13 | 0.23 | 0.57 | 0.04 | 0.59 | 0.76 |
| $K_2O$ | 0.00 | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 | 0.00 | 0.01 | 0.00 | 0.02 |
| Sum | 100.09 | 100.22 | 99.35 | 100.40 | 99.87 | 99.95 | 100.15 | 100.38 | 99.42 | 99.23 | 98.91 | 99.44 | 99.59 | 100.60 |
| $MgSiO_3$ | 60.72 | 59.73 | 61.43 | 59.36 | 60.48 | 61.27 | 60.59 | 60.94 | 57.30 | 61.64 | 63.54 | 65.39 | 59.78 | 43.57 |
| $FeSiO_3$ | 35.64 | 36.86 | 35.15 | 37.06 | 35.97 | 35.17 | 35.99 | 35.52 | 38.58 | 34.96 | 32.78 | 31.09 | 36.23 | 47.30 |
| $CaSiO_3$ | 3.62 | 3.40 | 3.40 | 3.57 | 3.54 | 3.55 | 3.40 | 3.53 | 4.10 | 3.38 | 3.67 | 3.50 | 3.97 | 9.12 |

Analysed by RNDr. J. Krištín, CSc. and RNDr. J. Határ, CSc., from OEMM GÚDŠ, Bratislava.

of 1 atm. (Fig. 11). In order to obtain such mineral associations by aid of this diagram, which not only in their composition, but also in mutual relations between the individual mineral phases would correspond to the associations of minerals observed in the studied rocks from Bartošova Lehôtka and Šibeničný vrch, we must set out from the composition of the melt (in which the own crystallization process began) situated in the area A in diagram — Fig. 11.

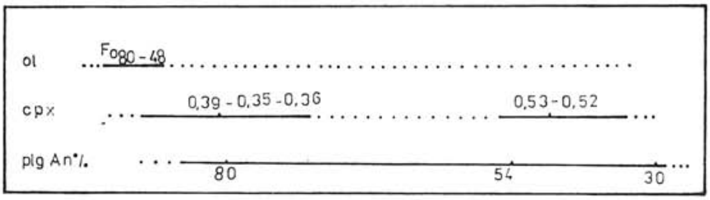


Fig. 9. Graphical representation of the crystallization process in basalt andesite from the Šibeničný vrch hill.
*Explanations* equal as in Fig. 8.

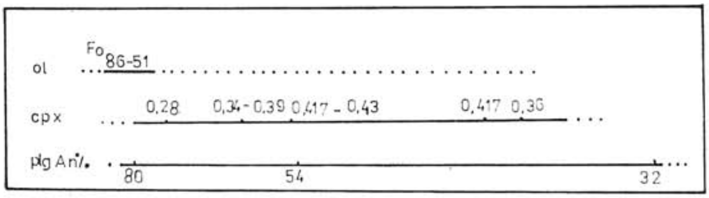


Fig. 10. Graphical representation of the crystallization process in basalt andesite from the quarry near Bartošova Lehôtka.
*Exlanations* equal as in Fig. 8.

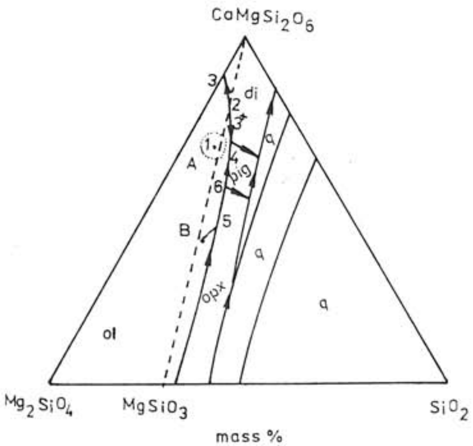


Fig. 11. System of $Mg_2SiO_4$—$CaMgSi_2O_6$—$SiO_2$ with pressure 1 atm (accordin to K u s h i r o, 1972).
*Explanations* in text.

When point 1 corresponds to composition of the melt (regarding to the content of normative quartz in rocks, which varies around zero value, point 1 must be situated near the connecting line $MgSiO_3$—$CaMgSi_2O_6$). With sinking temperature olivine begins to crystallize first in it (along line 1—2), which is impoverished by magnesium during the process of crystallization. Reaching point 2 on the cotectic line clinopyroxene begins from the melt to crystallize, whilst

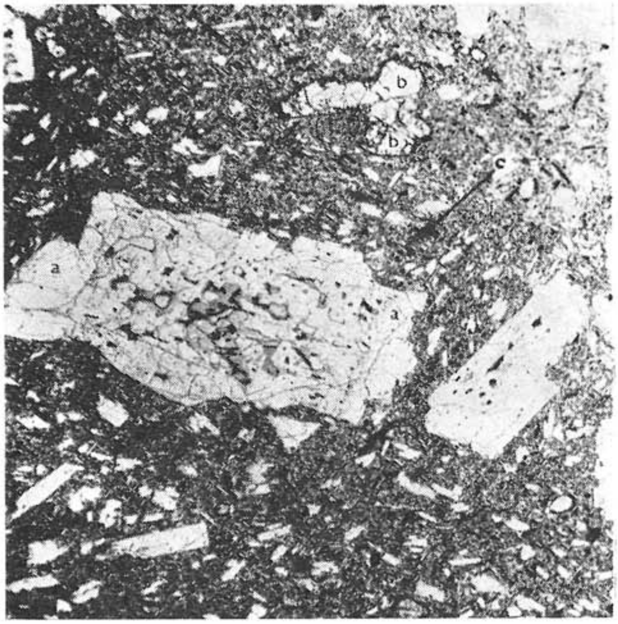


Fig. 12. Magnif. 19 x, ∥ nicols. Locality: quarry of Ladomer: a) phenocryst of plagioclase with enclosure; b) relict of phenocryst of volcanic hypersthene of the 1st group; c) ferroaugite phenocryst.

olivine begins to dissolve (dissolution results from the fact that the tangent to the cotectic line in point 2 intersects the side of $Mg_2SiO_4$—$SiO_2$ in the point, which is between $SiO_2$—$MgSiO_3$). In the interval 3—$3^+$ is somewhere the temperature maximum. It is probably lying in the area of point two (2). By such a position of the temperature maximum the changes in the contents of calcium and magnesium could be explained, which are observed in clinopyroxenes from Šibeničný vrch and Bartošova Lehôtka (points 4 — 5 — 6 and 8 — 9. in Fig. 7).

For Bartošova Lehôtka the process of crystallization probably continued in direction 2—3 with crystallization of clinopyroxene and dissolving of olivine at the cotectic line (the content of magnesium lowered and te the same time the content of calcium in clinopyroxenes increased) to exhaustion of melt. For Šibeničný vrch development in the melt continued to the right from the temperature maximum, also by crystallization of clinopyroxene with synchronous

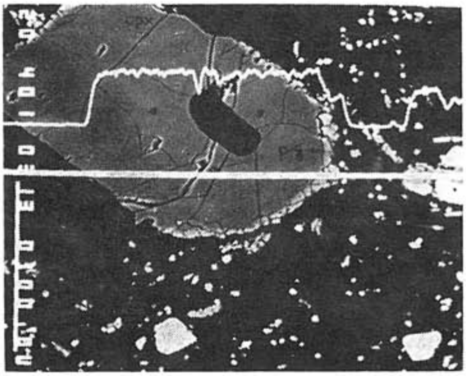

Fig. 13. Locality: quarry of Ladomer; orthopyroxene phenocryst with pigeonite hem; the line record correspond to Mg distribution.

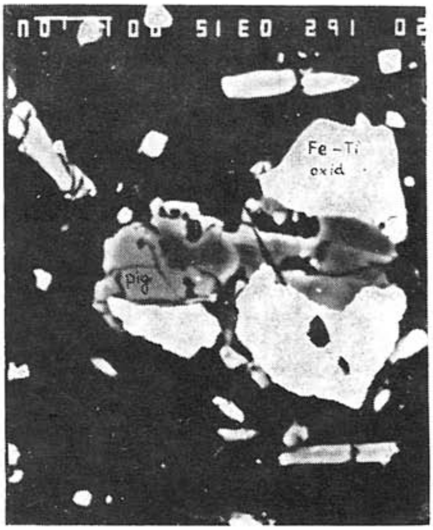


Fig. 14. Locality: quarry of Ladomer; relict of clinopyroxene grown over with Fe-Ti oxide and pigeonite (formation from the right part of Fig. 13).

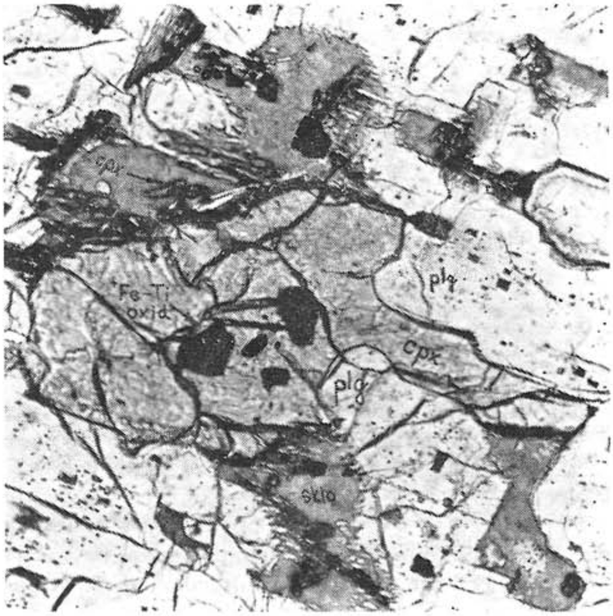


Fig. 15. Magnif. 300 x, ‖ nicols. Locality: quarry of Ladomer; detail of enclosure in plagioclase from Fig. 12.
*Explanations:* cpx — diopside augite — ferroaugite, Fe-Ti oxide, volcanic glass.

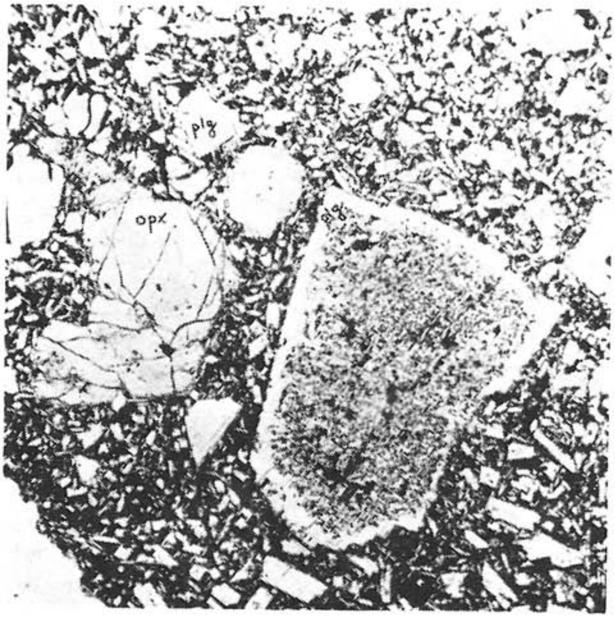


Fig. 16. Magnif. 19 x, ‖ nicols. Locality: Šibeničný vrch hill; porphyritic texture with coarser-grained pilotaxitic texture of groundmass.

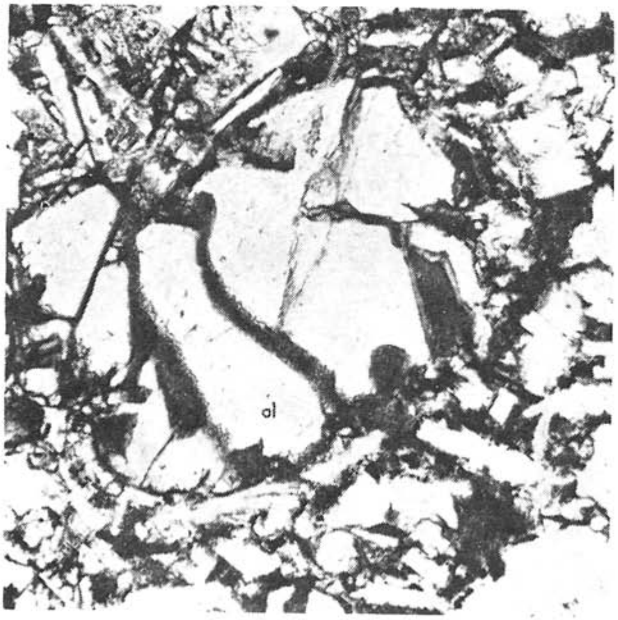


Fig. 17. Magnif. 120 x, ‖ nicols. Locality: Šibeničný vrch hill; olivine phenocryst affected by serpentinization.

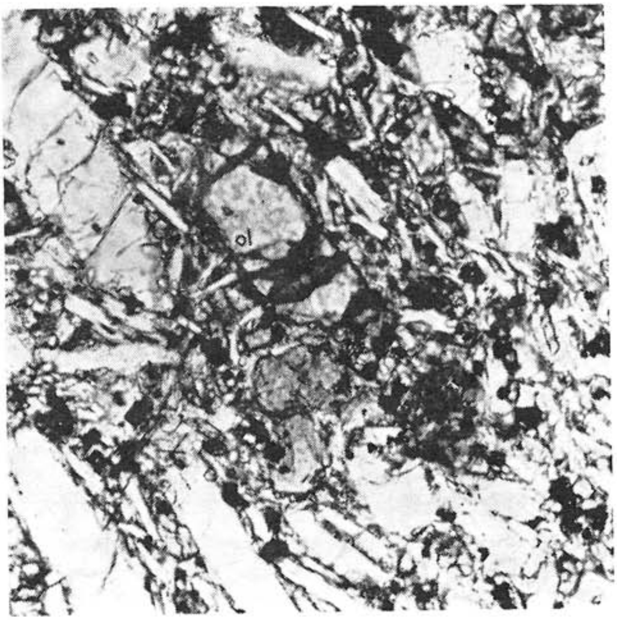


Fig. 18. Magnif. 120 x, ‖ nicols. Locality: quarry near Bartošova Lehôtka; olivine phenocryst affected by serpentinization.

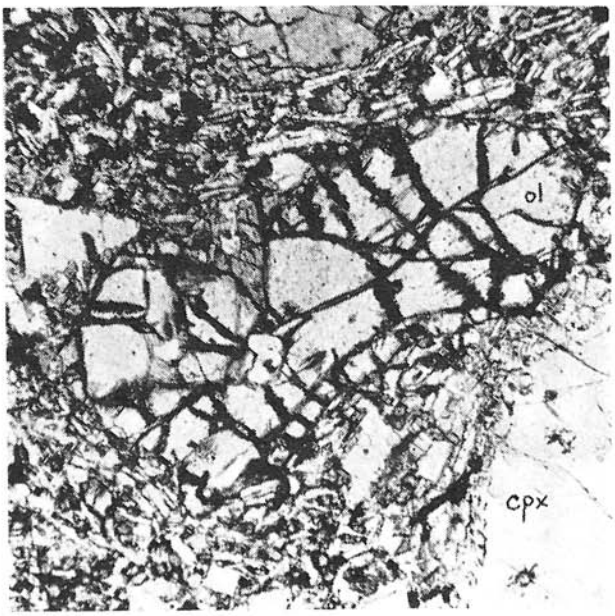


Fig. 19. Magnif. 60 x, ‖ nicols. Locality: quarry near Bartošova Lehôtka: olivine phenocryst affected by serpentinization.

dissolving of olivine. In direction 2—4, with the origin of clinopyroxenes, in which at the beginning the content of magnesium rises (points 4—5) in Fig. 7, but later (points 5—6) it decreases with continuous sinking of the calcium content in clinopyroxenes.

Not depending on the fact whether in crystallizing pyroxenes from Šibeničný vrch, Bartošova Lehôtka and Ladomer the content of calcium increases or lowers, with synchronously sinking magnesium content, the content of calcium suddenly decreases (Fig. 7). This lowering is obviously caused by rapid undercooling of the crystallizing melt as a consequence of reduction of pressure with magma ascending to the Earth surface.

The scheme of fractional crystallization of the melt, the surficial equivalent of which is the lava flow in the quarry of Ladomer, differs from both preceding crystallization schemes (for Bartošova Lehôtka as well as Šibeničný vrch). Crystallization began there near point B, which is situated already in the area of the triangle with peaks $MgSiO_3$—$CaMgSi_2O_6$—$SiO_2$ regarding to the fact that the rock contains normative quartz. From point B composition of the melt shifts to point 5, with olivine crystallizing only. Reaching point 5 on the cotectic line forsterite—protoenstatite, orthopyroxene begins to crystallize from the melt with contemporaneous dissolution of olivine. The crystallization process continues further from point 5 to peritectic point 6. Here (in point 6) together with orthopyroxene also pigeonite crystallizes (Fig. 13) and olivine phenocrysts are dissolving — when some of them are still preserved. From point 6 the melt composition shifts further in direction to point 4, pigeonite crystallizes from the melt only. In point 4 probably the crystallization process ends with common crystallization of pigeonite and solid solution of diopside.

Setting out from the character of the individual studied bodies, their geological structure and petrological study of rocks, we may say about their genesis: the magmas of Ladomer and Šibeničný vrch ascending to the Earth surface were cooling more rapidly (ascending into water environment or piercing aquiferous sediments) than the magma from Bartošova Lehôtka. After ascending to the Earth surface this magma was cooling slowly.

## *Conclusion*

The results of the petrological study of rocks from the Šibeničný vrch complex (quarry of Ladomer, quarry near Bartošova Lehôtka and Šibeničný vrch) from the southern part of the Kremnické vrchy Mts. have made possible to decipher the course of the crystallization process in of the individual bodies and have also confirmed their mutual genetic affinity.

I am indepted to RNDr. J. Lexa, CSc. for specialized guidance in the field works as well as in the study and processing of the obtained knowledge to RNDr. J. Krištín, CSc. and RNDr. J. Határ, CSc. for the chemical analyses by electron microanalyzer, to Academician B. Cambel and Doc. RNDr. D. Hovorka, CSc. for kind and critical reading of the text. According to latest investigations of RNDr. J. Lexa, CSc. (oral communication) the body formed by basalt andesite, which occurs at surface in the quarry near Bartošova Lehôtka represents a sill — or body, which was heat-insultated from the surrounding environment to some extent. This heat insulation regularly influenced the course of the own crystallization process in the melt (in its final stage), in agreement with this fact are also the results, which were achieved on the basis of petrological study of basaltoid andesite from the given locality.

Translated by J. Pevný

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