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REDAKTOR JIŘÍ KOUŘIMSKÝ

MARIE PALIVCOVÁ

IGNEOUS-LOOKING METASOMATIC HYDROTHERMAL ALBITITES

("SYENITE OF SMOLOTELY", CENTRAL BOHEMIAN PLUTON)

SUMMARY

The "Smolotely syenite", a coarse-grained miarolitic igneous-looking rock of brick-red colour, originally considered as a normal potash syenite, determined later by A. Dudek — F. Fediuk (1956 a, b) to be a miarolitic "albite-syenite", and more recently regarded as a result of the differentiation of the anorthosite magma (V. Steinocher 1964) *is not a magmatic rock. It is a product of hydrothermal metasomatic albitization,* a coarse-grained albitite. The miarolitic texture, considered to be a magmatic one, is a product of the same metasomatic alteration. Similar rocks originate from different types of granitoids, ranging from adamellites to tonalites, by joint alteration: they reflect the original structural and textural features of the pre-existing rocks and have fresh igneous appearance, although the final stage of alteration represents a complete reorganization of the primary mineral assemblage: amph + bi + plag (olig, and,) + potash feldspar + quartz —> albite + chlorite, haematite, sericite, epidote, calcite). Typical examples of hydrothermal albitization which is probably in close genetic connection with the metallogenic process, are described below.

INTRODUCTION

The "Smolotely syenite" drew the attention of all authors of the Central Bohemian Pluton*) by its almost monomineral feldspar composition, by the brick-red colour of the coarse-grained feldspars, the lack of quartz and a striking miarolitic texture. By these features it differs from the other normal granitic rocks of CBP associated with it, even if it is of plutonic appearance. The term is used according to the results of J. Vachtl's investigations (1932, 1935). Vachtl pointed out the abundant occurrence of this rock in the surroundings of Smolotely near Milín in the Příbram area. In literature (A Dudek — F. Fediuk 1956 a, b; B. Hejtman 1957, p. 121; V. Steinocher 1964) the rock was so far considered as deep-seated magmatic one.

The present paper deals with petrography and the problems of origin of the rocks of the "Smolotely syenite" type; the author found similar occurrences in many other parts of the CBP. She considers these rocks to be a typical example of a hydrothermal metasomatic alteration which has been termed as total albitization. Examples of such a gradual alteration will be described (see Fig. 1) : A) in the normal granitoids

*) further CBP only; summarizing papers about the complex see M. Palivcová 1965, Krystalinikum 3, 99—131; O. Kodym jun. 1966, pp. 49—99 in J. Svoboda et al., Regional geology of Czechoslovakia, Part. I., Prague.

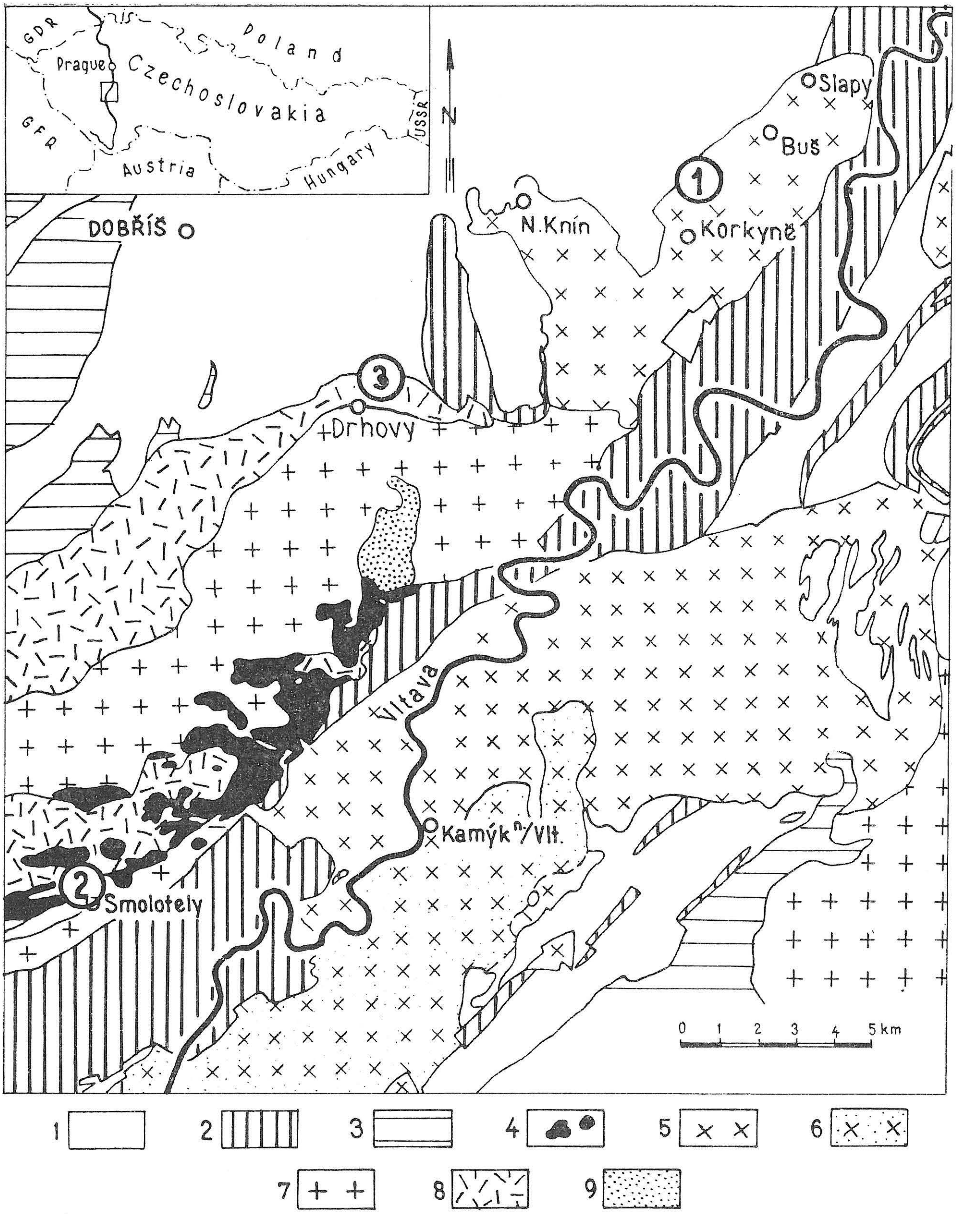

Fig. 1.

Localization of described albitites and a scheme of geology of referred area of the Central Bohemian Pluton. According to the Geological map of Czechoslovakia 1 : 200.000, the sheet Tábor, 1963.

Nr. **1** — Slapy - apophysis of the Central Bohemian Pluton, 30 km S of Prague (ad tab. 1, in text described sub A).

Nr. **2** — Environ of Smolotely, 10 km SEE of Příbram (ad tab. 2, in text described sub B).

Nr. **3** — Drhovy near Dobříš, 40 km SSW of Prague (ad tab. 3, in text described sub B). 1 — Upper proterozoic sediments; 2 — proterozoic spilite-keratophyre association; 3 — Lower palaeozoic; 4 — gabbroic rocks (mostly hornblende gabbros); 5 — normal biotite-hornblende granitoids (granodiorites and tonalites of the Sázava type); 6 — the same as 5, porphyritic; 7 — normal hornblende - bearing biotite granitoids (granodiorites of the Blatná type); 8 — coarse-grained porphyritic biotite (± hornblende) granodiorite (marginal facies); 9 — small - grained biotite granodiorite.

of the CBP (so-called Sázava type), B) in the coarse-grained porphyritic granitic rocks of the CBP (so-called marginal facies). Sub C) chemistry and modal composition are given. In conclusion, the genesis of the rocks is discussed.

DESCRIPTIVE PART

A) Hydrothermal metasomatic albitites in the granitoids of the "normal type"*

Geology

The hydrothermal metasomatic albitization is not so common in the normal types of the rocks of the CBP as it is frequent in the area of porphyritic coarse-grained granitoids (sub B). The hydrothermal character of the alteration is, however, in this first case quite evident and the relations to the surrounding unchanged granitic rocks are quite obvious. The alteration appears by a striking change of the normal grey colour to pink and red along joints. The character of alteration is analogous to the albitization process described by V. Zoubek (1931) from the granites of the Tatra Mts. the difference consisting just in that, that the change of colour in our case was caused probably by a more basic character of the original granitic rock. The ribbed bands of the albitized zones on the surface of rocks as they are typical for Tatra Mts. granites are not developped. The final product of the alteration in the CBP has the character of almost monomineral red albitite and its appearance strongly depends on the original texture of the rock. We can easily follow the albitization along joints e. g. in Podmráčí at Benešov (in quartz diorite of the Sázava type in the southern part of the quarry), in a bright mylonite zone at Bedrč north from Benešov, in the granodiorite of the Vltava type near Kamýk upon Vltava (old quarry of Velká), in the granodiorite of Něčín, in the quarries of Kozárovice (the old quarry); the alteration mentioned by A. Dudek and F. Fediuk (1960, p. 12) from the Blatná granodiorite also belongs here and even some of the alterations described by K. Urban (1937, p. 122) from the quartz diorite of Bohutín are most probably of the same type. According to F. Fediuk et al. (1960 p. 388) and V. Bouška — R. Pavlů (1964, p. 132) the occurrences of zeolites in the area of the pluton and its vinicity are interpreted as consequence of the albitization process.

The author had the opportunity to follow the distribution and character of the albitization in the area of the "Slapy granite" (part of the Sázava-type complex of the CBP) in details. R. Kettner (1929, unpubl.) was the first to observe the alteration of these rocks when choosing the place for the Slapy dam: just in the place suitable for the dam the rocks were affected by a "special hydrothermal alteration" manifesting by red or rust coloured feldspars while the appearance of the rock remained "strikingly fresh" and massive. Later, on a similar occasion, V. Zoubek (1933 unpubl.) determined the red feldspar as albite and emphasized the intensive secondary alteration of mafic minerals.

An analogous alteration in the Slapy-apophysis was observed by the

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* In Czech literature as granitoids of the "normal type" equigranular medium-grained grey granitoids of the central most extended zone of the CBP are designated; they range from hornblende-biotite and biotite-hornblende granodiorites to tonalites (the Sázava, Blatná, Vltava and relative types).

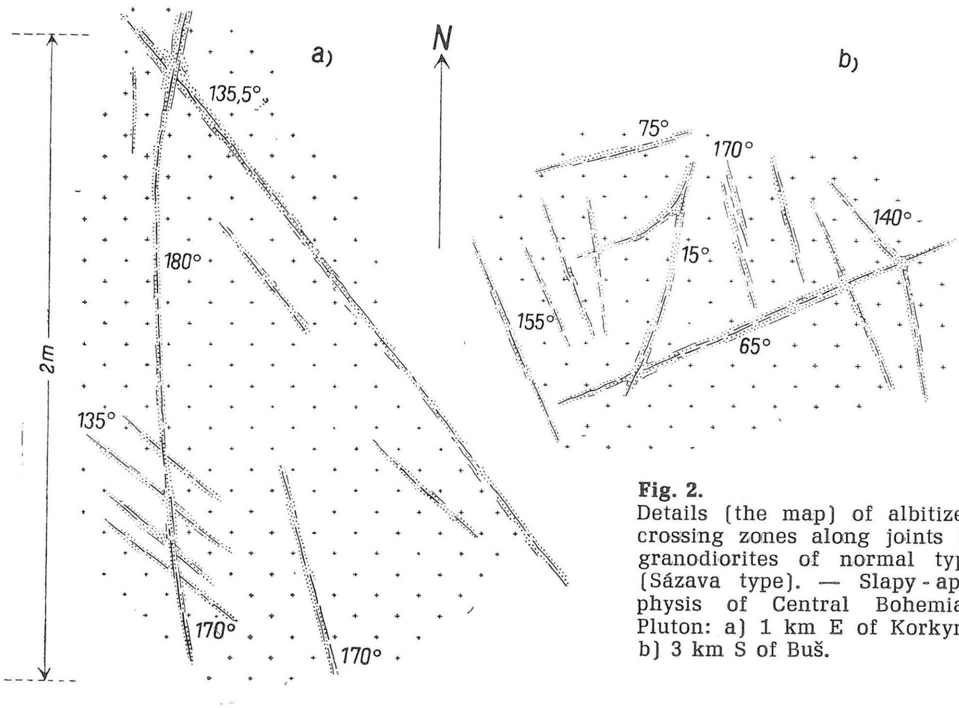

Fig. 2.
Details (the map) of albitized crossing zones along joints in granodiorites of normal type (Sázava type). — Slapy-apophysis of Central Bohemian Pluton: a) 1 km E of Korkyně b) 3 km S of Buš.

present author especially in the surroundings of Křížov, Korkyně, Záborná Lhota and Libčice. The network of joints (Fig. 2) in which albitization took place, is sometimes very dense; the albitization joints most frequently strike N—S, E—W and in diagonal direction, while the areas of such albitized rocks (max. up to 2 km^2) sometimes show a general E—W prolongation. Frequent examples of progressive alteration enable here to follow transitional stages of the process grading from the normal grey granodiorite through an albitized slightly pink granodiorite (with epidote, chlorite) to the final red monomineral massive and sometimes even cavernous albitite. Apparent "dikes" of albitite do not exceed a thickness of 0.5 — 1 m (Háje, 1 km NE from Korkyně; Želná 0.5 km to the S from Prostřední Lhota) and swell and thin out usually rapidly; where they can be traced for a long distance they may be regarded erroneously even as aplitic dike rocks. If the albitization process is accompanied by occurrence of vein quartz, the zonality of the following scheme (in the cm order) is usually developed: a thin quartz vein (usually milky), a chlorite-film, a thin zone of almost pure epidosite (or ± quartz-epidosite), a zone of red albitite, a slightly pink altered granodiorite grading to an unaltered grey one. The albitization is, however, associated with the quartz veins infrequently only. Quartz is more often missing and only the secondary minerals (epidote, chlorite, calcite, zeolites) appear as a filling or films on the walls of the joints. At the contact of granodiorite with basic rocks (gabbros, gabbrodiorites, lamprophyres) the alteration affects both kinds of rocks, but preferably the granodiorite. The alteration of the rocks from the surroundings of Korkyně at Slapy will be shown here as an example of progressive metasomatic albitization in normal, medium-grained granitoids.

Petrography

a) *The unaltered rock, the "Slapy granite"* (B. Hejtman et al. 1943, p. 61) most frequently corresponds to the type designated as a "light facies of the Sázava type" in the near quarries of Teletín, east bank of the river Vltava (A. Dudek — F. Fediuk 1958, p. 99). It is a medium-grained *hornblende-biotite to biotite-hornblende granodiorite,* described many times in Czech literature. The rock shortly characterized below derives from the locality Buš, 2 km SW from Slapy (mod. anal. 1, chem. anal. 1 on p. 138; Pl. II, fig. 1; Pl. IV, fig. 1).

Macroscopically, it is a common grey-blue granitoid of an apparent grain size of 3 mm and more, in reality around 0.5 — 1 mm, some micas and hornblendes even 5 mm; the apparent larger grain size is due to cumulation of feldspars on one side and mafic minerals on the other.

Rock composition:

mafic minerals: deep brown to black-brown biotite, common green hornblende
felsic minerals: plagioclases, potash feldspar, quartz
access. and second.: apatite, zircone, magnetite, sphene, orthite, epidote, chlorite, sericite.

The intermediate *plagioclase,* mostly euhedral, in some cases subhedral (cores mainly An_{49}, the inner zones about An_{56}, the rims up to An_{22}) is strongly zonal showing complex twinning (especially the triads kv + ab + pericline or acline*); it forms the framework of the rock. The euhedral shape of the plagioclase depends on the bulk composition of the rock, increasing in the portions enriched in potash feldspar, and even in quartz. The interstices in the fabric of the plagioclases are filled with quartz; more often "patches" of *interstitial quartz* are developped showing uniform extinction and a tendency to individualize into larger slight undulatory isometrical irregular grains. *Potash feldspar* has either the character of a poikilitic undulatory and polysynthetic twinned microcline or penetrates in amoeba-like manner along fine cracks and boundaries of the adjacent minerals, sometimes even quartz.

The poikilitic grains of potash feldspar are several times larger than the average grain size of the rock. The ghosts are so overfilled with the other minerals that they can hardly be discerned with the naked eye. The strongly coloured dark brown *biotite* (straw-yellow parallel to X, dark-brown nearly black-brown to Y and Z) is always less euhedral than it appears macroscopically; against hornblende and plagioclase it is usually anhedral. Its flakes are not fresh and are resorbed along their borders. The common strongly green *hornblende* changes its shape against adjacent minerals. Against plagioclases it is anhedral (Z/c most often 16°, $2V = 64°_{\alpha} \pm 2$), but against potash feldspar and also often against quartz it is euhedral. It is characterized by pronounced pleochroism which has been described many times as a common type in the whole area of the Sázava-granitoids (X straw-yellow, Y brown green, Z grass to emerald green). Changing its shape it changes its tint too and with column-like euhedral habit it becomes lighter and more blue-green along Z; at the same time twinning becomes more frequent. On the contrary, the darker is the hornblende, the more subhedral up to anhedral shape it can have showing a slight tendency to form large poikilitic grains. Accessories occur mostly in mafic minerals which enclose small crystals of *magnetite,* rare minute *zircon* grains and greater needles and grains of *apatite. Sphene* and *orthite* crystals often appear associated especially with column-like euhedral hornblende. Secondary *chlorite* and *epidote* are bound especially to biotite; *sericite* is rare in plagioclases indicating the cores and zones with higher An-content.

The rock is a typical example of subhedral equigranular "monzonitic" texture. In fig. IV/1 the texture of rock is shown which is characteristic of portions enriched in plagioclases.

b) *The transitional stage of alteration* (Háje, 1 km NE from Korkyně near Slapy), has the character of a *strongly sericitized, chloritized, epidotized and slightly albitized granodiorite.* The alteration of the rock is sudden, so that the boundary can be seen even in thin section. The thin

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* Optical data of minerals were determined by common methods on the U-stage of Fjodorov; the curves from the book of F. Fediuk, Fjodorovova universální metoda, NČSAV Praha 1961, were used.

section in Pl II, fig. 2 shows the initial stage of such an alteration along a fine crack. The alteration begins by an *intensive sericitization* of feldspars; it primarily affects plagioclases, later even potash-feldspars. At the same time mafic minerals decompose, biotite somewhat easier than hornblende. Both are gradually *chloritized.* The alteration is accompanied by the development of abundant *epidote*; the latter occurs either in pseudomorphs after mafic minerals, or it migrates later along the grain boundaries towards the fissure along which albitization takes place; the epidote accumulates in it as thin films (sometimes in nets of small perfect flat crystals) or as a massive granular epidosite. Simultaneously with the disintegration of the mafic minerals, feldspars become turbid by *haematite dispersion;* they change gradually their original slight grey colour through pink to deep red due to ferruginitization and clouding (J. R. Harpum 1954, p. 1085). The An-content in strongly sericitized and ferruginitized plagioclases cannot be determined at all. At this transitional stage of alteration, the *quartz (± potash feldspar)* remains in the rock, being more resistent than mafites and plagioclases. The alteration can stop at this stage preserving the quartz. However, the gradational sericitization, ferruginitization and feldspar clouding is most often accompanied simultaneously by *initial stages of albitization.* During sericitization plagioclases lost their striking twinning which became indistinct; but patches of *new fresh albite lamellae* begin to appear progressively in the place of the earlier lamellae. These lamellae grow through the whole grains of felspar and roughly follow the relict traces of twinning of pre-existing plagioclases. The new lamellae, being first dusty and unsharp later become marked, broader and simplier than those in the original plagioclase. Together with the beginning of alteration, even the earlier zoning of feldspars has disappeared. On the other hand a *new specific zonal structure* appears, so that narrow rims of clean and clear conformably twinned albite grow around the pre-existing sericitized individual (Pl III, fig. 1). An-content is the same in both parts of plagioclase, in patches in turbid cores, as well as in the clean rims; the composition is almost pure albite (An_{03}—An_{06}), i. e. the same as in the "Smolotely syenite" (A. Dudek — F. Fediuk 1956 a, b). The clear rim-albite can "resorb" the outline of the early "clouded" plagioclase (Fig. 3).

Simultaneously with the origin of the clear albite rims, desintegration and *decomposition of the original quartz* and *reconstruction of rare potash feldspar* into the same albite takes place (for details see sub B).

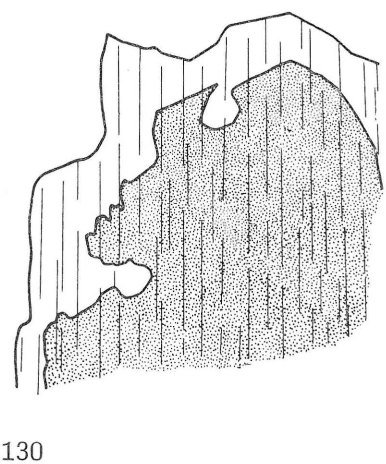


Fig. 3.
Resorption of pseudomorph after earlier plagioclase (dotted), mantled by clear albite; the original plagioclase (zonal andesine — now albite) sericitized and ferruginitized. Drawn from the thin section, × 50. Albitite, Korkyně, Slapy-apophysis of the Central Bohemian Pluton

The interstitial quartz of the pre-existing rock becomes gradually more "granulated" and consumed by the growing clear albite. With the advancing albitization the pseudomorphs after the mafic minerals are also disintegrated, the original as well as the newly-formed secondary products (epidote, chlorite, apatite, sphene, haematite) migrate and recrystallize and a general reconstruction of the rock takes place, as it is shown below in the description of the final stage of alteration.

c) *The final product of alteration,* the medium-grained *red albitite* (Kořkyně near Slapy; chem. anal. 1, mod. anal. 1' on p. 138; Pl IV, fig. 2), is distinguished by macroscopically textural features of the pre-existing rock, reflecting its medium grain size (about 3 mm), the analogous spacing of the relics after mafic minerals, also reflecting the oriented or massive granular structure of the original rock.

Rock composition:

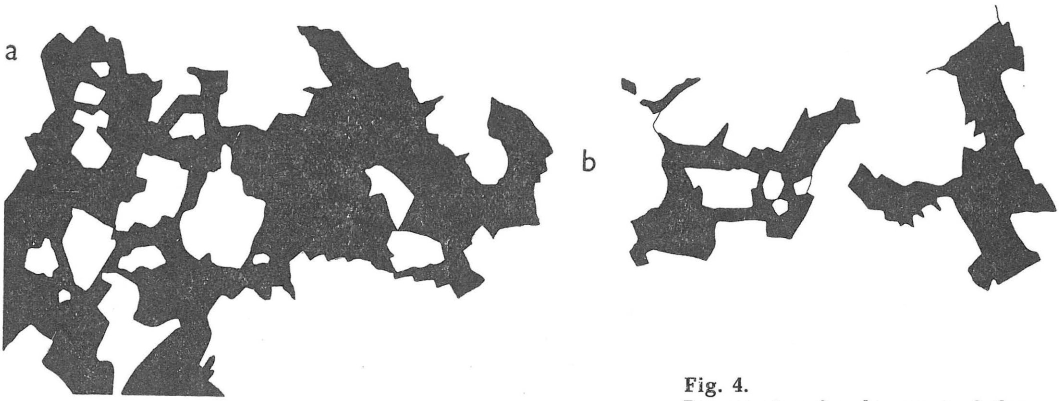
felsic minerals: albite: An_{03-06}, clouded, with clear rims

access. and second.: chlorite, epidote, sphene, magnetite, sericite; sporadically apatite, calcite.

Albites occur as euhedral individuals with intensely clouded cores and with strikingly clean rims. These can appear as continuous albitic "matrix", filling interestices of the framework of the pre-existing, now turbid, plagioclase shapes (Pl. IV, fig. 2). No other felsic mineral is present in the rock. The clear albite may considerably disturb the sericitised pseudomorphs, coloured pink by dusty haematite, and even may penetrate through them along cracks (Pl. VI, fig. 1). *Chlorite* is penninite of deep-green colour (X straw yellow) with intensively purple and violet anomal polarization colours (Ch_m—) in case that it forms fairly large flakes of pseudomorps after ferromagnesian minerals; at a more advanced stage, chloritization of the same pseudomorphs is repsesented by a fine spherulitic type of chlorite (D = ± zero, with brown polarization colours Ch_m = +). The great part of the amount of slightly brown *sphene,* of *magnetite,* viz. of *haematite* and *epidote* is associated with these chloritic pseudomorphs after mafic minerals. All these secondary minerals, especially magnetite (haematite), can be accumulated along the boundaries of feldspars. Haematite and chlorite migrate very easily and form the film and filling of miarolitic cavities which appear in interstices between euhedral albites (see below). *Sericitization* and *ferruginitization* occur in original shapes of plagioclases. Sporadic apatite needles, distinctly recrystallized, can be found in the rock.

The rock is "miarolitic" its matrix displaying automorph and hypautomorph granular texture (Pl. IV., fig. 2 — see further on). Dark clouded euhedral albites — pseudomorphs after pre-existing plagioclases — sometimes "swim" in the clear albite groundmas.

A progressive texture transformation resulting in *development of cavernous and typical finely miarolitic texture* can be well traced in the rock. This typical miarolitic texture appears to be a pseudomiarolitic one. One of the posibilities of its origin — quite different from commonly accepted primary interpretation — consists in gradual break — down of chloritic pseudomorphs after original mafites. As stated above, at the initial stages of the alteration chloritic pseudomorphs are often formed by chlorite (penninite) in which relics of mafics, mainly of biotite, are well visible. With advanced albitization disintegration of monopseudomorphs, however, takes place, namely in the cases, where the mafic minerals were poikilitic and contained plagioclase grains which are enclosed within them or project from their borders (Fig. 4a; Pl. V, fig. 1). This disintegration goes on by albite growing; the enclosed plagioclases slightly enlarge their volume, clear albite rims couting them. In this way poikilitic chloritic pseudomorphs change into "interstices" filling between plagioclases (Fig. 4b, c; Pl. V, fig. 2). The monocrysts of penninite can recrystallise into fine spherulitic chlorite aggre-



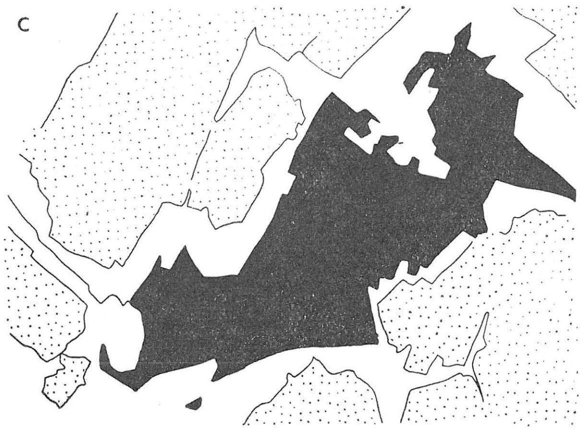


Fig. 4.
Progressive development of the miarolitic texture from chloritic pseudomorphs after mafic poikilitic minerals. Black — chlorite, white — clear albite, dotted — turbid shapes of original plagioclases coloured in red by haematite dispersion (compare Pl. V, fig. 1 ad a; pl. V. fig. 2 ad c): a) chloritized pseudomorphs after mafic mineral (biotite or hornblende) b) pseudomorphs divided by growing albite c) chloritic "pseudomiarole" into which perfect euhedral albites with ferruginitized cores (dotted) project by clear albitic rims. Drawn from the thin section, a, b × 12, c × 30. Albitite, Korkyně, Slapy-apophysis of the Central Bohemian Pluton.

gates of lighter grey-green colour (prochlorite after H. M. Huber 1943). The progressive growth of albite metacrysts in the whole rock results in migration of mafic desintegrated products: chlorite and haematite often form films along the boundaries of albite. All chlorite (± haematite) concentrated in the interstices between the albite grains; these may be erroneously regarded as cavity filling, i. e. miaroles. The chloritic filling can be even transported away and perfect "miarolitic" cavities arise; striking euhedral albite crystals coated by haematite project into them (fig. 4c). The texture seems to be a typical primary miarolitic one, but *it is secondary* and is *due to most advanced metasomatic albitization.* It should be called as "pseudomiarolitic" one.

The similar development of "miarolitic" texture emphasized by calcite filling can be traced in the Smolotely syenite (compare Pl. I. fig. 1, 2 in A. Dudek — F. Fediuk 1956a).

The described origin of the cavernous structure resulting from the disintegration of the mafites is only one of the possibilities which could be taken into consideration. The porosity may have other causes (falling out of quartz, the rock volume contraction etc.), too, and may represent even more then 15 — 20 vol. % of the rock.

In the albitized tectonically disturbed types with granulated quartz, the albitic pseudomorphs do not assume a perfect form; the fine quartz in the interstitial mass remain longer preserved in the rock; the plagioclases retain strong sericitization rather a long time, till the origin of new polysynthetic albite twinning.

B) Coarse-grained albitites from the porphyritic granitic rocks* of the Central Bohemian Pluton (so called "Smolotely syenite").

Geology

In coarse-grained porphyritic granitoids all alteration and replacement processes described above are much more conspicuous and to a greater extent then in normal types. On the other hand, the intensity of alteration often conceals the relation to the unaltered rocks and the rock presents itself *as an peculiar type of an igneous-looking rock.* The largest area affected by albitization exists in the surroundings of Smolotely and Rtišovice near Milín at Příbram; another area of the same type established by the present author is in the neighbourghood of Dobříš (loc. Drhovy, 8 km SE from Dobříš). Both areas mentioned occur near the contact with the Algonkian sediments and in the vicinity of the well-known ore deposit areas at Příbram and N. Knín.

J. Vachtl (1935, 14) considered originally the rock from the *surroundings of Smolotely* (mapping work) to be a hornblende potash-syenite composed of coarse-grained red potash feldspar and plagioclase, with "miaroles" filled with hornblende and quartz. A. Dudek — F. Fediuk (1956 a, b) found by petrographical studies in a newly opened quarry in Rtišovice near Smolotely a surprising composition: the rock is almost monomineral, composed of 90 vol% almost pure albite, the majority of the remaining 10 % of miaroles being filled by calcite, chlorite and specularite. The estimated body is about 5 km long. F. Kratochvíl (1943) noticed even before a peculiar albite composition of the feldspars in the rocks in near surroundings: the grey biotite up to hornblende granodiorite gradually changes into a strikingly pink rock which "springt ins Auge" containing phenocrysts of red albite in micropegmatic groundmass of albite and quartz (of mafites only chlorite is present). J. Kratochvíl and A. Orlov (1930, 203) also described red albites, namely in some dike rocks from the area.

The mutual relations of the red albitite (the "Smolotely syenite" and of the original unaltered rock — "marginal type" of the CBP) can be well observed in the above-mentioned quarry at Rtišovice. The geological setting in the quarry is rather complicated. At the first sight, the corridor-like form of the quarry (length about 25 m, unequal breadth, at the entrance about 2 m, in the front 7—10 m) is striking. The varying breadth reflects the form of the albitized zone. The quarry is founded at the contact of a variable fine-grained to aphanitic or also dioritic rock (belonging to small "gabbrodiorite" bodies of this areas — see fig. 1) with the granodiorite of "marginal type" of the CBP. The gabbroic rock builds the NE side of the quarry (situation well-seen in 1960); it is abundantly infiltrated with "schlieren", lenses and patches of light-coloured granodiorite. The abundance of granitic material grows towards the bottom, and in the same direction the colour of granitic rock gradually changes, being pink and reddish at the roof and slightly yellow to normal light grey at the bottom. The opposite side of the quarry shows the transition of the coarse-grained porphyritic granodiorite to an equigranular medium-grained one which intrudes a small basic

* so called "marginal type of the CBP."

outcrop at the bottom. The upper part of this wall shows the same alteration, the medium-grained granodiorite being strongly coloured in red by alteration. The coarse-grained brick-red "fresh" albitite is best developed in the front of the quarry across its prolongation. It contains frequent inclusions of the basic rocks mentioned and the feldspars visible in these inclusions also become pink. All transitional stages of slightly up to strongly altered rocks can be observed in the walls of the quarry. The prolongation of the quarry reflects the course of the albitized zone which has an unequal thickness swelling and dying out along the contact of the granitic rocks with the gabbroids.

The dike-like forms of the occurrences of the "Smolotely syenite" in the surroundings of Smolotely and Rtišovice are well-visible on the new map by J. Kudrnovský et al. (1965, unpublished) — in Fig. 5. The albi-

Fig. 5.
Scheme of distribution and mode of occurrence of hydrothermal albitites ("Smolotely syenite") in coarse-grained porphyritic granodiorite (marginal facies of Central Bohemian Pluton) in the NE surroundings of Smolotely, 10 km SE of Příbram. According to J. Kudrnovský et al. 1965, unpublished.

tization process is intensive here, the zones can be 60 m thick about. This can lead to the uncorrect conclusion that there occurs a continuous body of a special "magmatic diffferentiated rock".

The marginal (coarse-grained porphyritic) granodiorite being a rock very easily liable to albitization is nearly in the all described area slighty affected by initial alteration stages. This manifests itself by strong chloritization and more frequent occurrence of other secondary minerals (epidote, sericite, sometimes orthite). The zones of strong albitization can be partly very distinct, the transitions sudden; partly, on the contrary, it is not easy to detect the connection with tectonic or contact lines.

The rock of the "Smolotely syenite" type, hitherto unknown, also occurs in the surroundings *of Drhovy near Dobříš* (fig. 1). The albitization takes place in a 2 km long defilé along the stream of the Novodvorský potok, afluent of the Kocába brook near Dobříš, 2 km N of Drhovy. The defilé is transverse to the contact of the granodiorite with pelitic Algonkian sediments. The plane of contact strikes 115 ° and dips 65 °

plunging N under the plutonic rocks. Albitization can be established in several zones to be roughly subparalell with the contact at a distance of about 0,5 km from it. In the defilé the medium-grained normal grey biotite-hornblende-bearing granodiorite of the Knín-apophysis pass slowly into the coarse-grained porphyritic one (marginal facies). Basic rocks are not developed there but zones rich in inclusions appear. Albitization affects both granodiorites. In the first type of granodiorite the alteration is similar — in thin "veins" following joints — as described from the Slapy-apophysis. In the coarse grained marginal facies the metasomatic process becomes more intensive and transitional stages of transformation are here well-developed and preserved. They have the nature of quartz-albitites. The miarolitic cavernous albitite is well-developed similarly as in the area of Smolotely; the calcite filling of miaroles, however, occurs more sporadically. On the contrary, albitites of slightly yellow (not red) colour have been found here. There is no doubt that a gradual process of alteration of the original marginal facies of the CBP into albitites took place in zones along joints.

Petrography

The changes in composition from the environs of Smolotely are shown on the examples of the analysed rocks 2,2′, tab. 2 on p. 139. *The unaltered rock, a marginal facies of the CBP*, coarse-grained biotite granodiorite, derives from the locality Lešetice, 1,5 km NE of Milín, where fresh material occurs. In texture and structure it is the same granodiorite as that from Drhovy (see further on), and therefore will be not described here. Even at the same locality the variation in mode (in colour index, potash feldspar content) is considerable (comp. in Kodym O. jun. at al. 1963, 134, anal. 34, 35 from Lešetice).

The final product of alteration, the red Smolotely syenite from the original locality (chem. an. 2′, mod. an. 2′) has been thoroughly characterized petrographically by A. Dudek, F. Fediuk 1956 a, b. It corresponds to the further described albitite from Drhovy near Dobříš (in tab. 3 sub 3″). It has however a better and more markedly developed miarolitic texture and the miarolitic filling frequently consists of calcite (comp. pl. I, fig. 1, 2 in the paper of the above-mentioned authors). In contrast to these authors' opinion, the present author does not think the miarolitic texture to be a primary feature of the rock but — similarly as in the normal type of granodiorites — a secondary one due to albitization process. Nor the chlorite of the first type, with preserved relics of mafic minerals, can be held for a magmatic mineral — being product of disintegration of original mafites during the hydrothermal process. The difference between the two types of chlorite depends on the degree of alteration, recrystallisation and migration. Similarly to the albitites from Drhovy, the Smolotely syenite contains a small amount of epidote only as compared with more basic granodiorites or tonalites of the normal type. This dependence may be observed in Rtišovice quarry where both types of rocks, even hybrid rocks contaminated by basis inclusions occur. The content of epidote is suggested to depend on the colour index of the rock. Rather difficult is the explanation of the abundant calcite filling in miaroles, especially in relation to the porous types, in which calcite filling is missing. Ca may be liberated from the rock itself and/or may be imported in the form of later hydrothermal solutions (comp. discussion P. Láznička 1965, p. 99).

The alteration of coarse-grained porphyritic granitic rocks will be described in more details, using the rocks from the surrounding of Drhovy near Dobříš (Nr. 3 in the map of Fig. 1) for comparison with the rock from the original locality of Smolotely, described by A. Dudek, F. Fediuk 1956 a, b.

a) *The unaltered rock of the Drhovy section* (tab. 3, an. 3; pl. I, fig. 1) is a *coarse-grained porphyritic hornblende biotite granodiorite (adamellite).* The grain size of the groundmass is analogous to the normal medium-grained granodiorites (plagioclases and mafites about 2—3 mm); strinkingly rounded large transparent dark-grey quartzes, or sometimes brownish, about 0,5—1 cm^2 in size, are well visible in the rock. Very conspicuous constituents of the rock are large (2—3 cm long) skin coloured potash feldspars, macroscopically seeming to be euhedral. The real distribution of potashfeldspar in the rock is shown in fig. 6 (dyed rock sample)

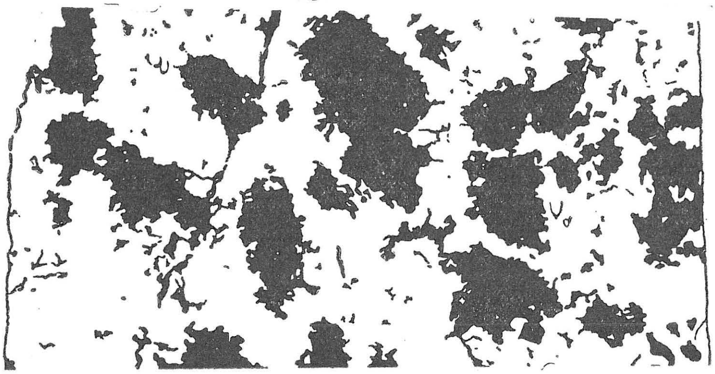


Fig. 6.
Distribution of potash feldspar in porphyritic hornblende biotite granodiorite. Drawn from a dyed sample; natural size. Drhovy near Dobříš (compare Pl. I, fig. 1).

Rock composition:
mafic minerals: biotite, ± hornblende
felsic minerals: plagioclase, potash feldspar, quartz
access. and second.: apatite, zircon, orthite, sphene, magnetite, sericite.

The *plagioclases* are thickly tabular and, in contrast to the plagioclases of normal granodiorites (tonalites) of Sázava type, show more simple and more regular but less distinct polysynthetic twinning and a less developed zoning. Albite twins are most abundant, more numerous than carlsbad, pericline and complex twins. An-content corresponds to An_{36} in average: the shape and composition of the plagioclases changes strikingly with the increasing content of hornblende in the rock. In the presence of hornblende their character approaches the complex twinned and zonal andesines characteristic of rocks of tonalite association. The *potash feldspar* is slightly clouded, perthitic, rather fresh. The nonzonal, seemingly euhedral shapes of the porphyritic individuals show microscopically anhedral outlines of the outer rims. The grain-size varies continuously — from larger porphyritic individuals to those of a medium-grained groundmass. Sometimes a fine microcline twinning appears in them. The potash feldspar encloses all rocks constituents and also *quartz grains.* The latter have a tendency to anhedral outlines, especially against potash feldspar. The large grains of quartz offen consist of one individual; granulation into several subindividuals and undulotory extinction are not very frequent. In addition to potash feldspar the quartzes also enclose all the other minerals. *Biotite* well-formed in basal pinacoids only, is often affected by initial *chloritization,* the secondary products *(magnetite, sphene)* being liberated during the alteration process. The original biotite was deep dark-brown in colour, typical of normal granitoids of CBP. The rare by occurring common deep-green hornblende is always more fresh and better outlined against biotite. The two mafic minerals with inclusions of normal accessories *(apatite, zircons)* are scattered in quartz as well as in potash feldspar. Here and there a more striking grain of zircon appears. Rather common is *orthite* in small turbid yellow and orange metamict individuals, also associated with mafic minerals.

The rock texture is typically *porphyritic* (with porphyritic potash feldspar, quartz) showing a *granitic, hypautomorphic to xenomorphic granular texture of the groundmass.* Transition from porphyritic to subporphyritic or equigranular texture is common.

b) *Quartz albitite* (chem. an. 3′ mod. an. 3′ in tab. 3, p. 139; Pl. I, fig. 2) is an unusual rock due to its macroscopic appearance, as well as the texture in thin section. Especially when weathering, strikingly white, milky, rounded quartz grains of the same shape as in the unaltered rocks (about 0,5—1 cm^2 in size) stand out in the brick-red albitite. The quartz albitite developes gradually from the coarse-grained porphyritic granodiorite facies.

Rock composition:

felsic minerals: albite An_{03-06}, quartz,

acces. and second.: magnetite, hematite, sericite, sphene, epidote; relics of biotite.

Albites form grains of variable dimensions reflecting the character of the original minerals. The reconstruction manifests itself on lamellae development in feldspars. A new twinning begins to appear in sericitized and decomposed feldspars, the new lamellae being thicker and more complex in earlier plagioclase grains, thinner and denser in earlier microcline grains. The growth of lamellae is hardly visible at initial stage, covered by feldspar clouding. Later, the lamellae lose the secondary turbid products and become clear. The *potash alteration* beginns often by a variously advanced "chessboard" patchy stage. At very advanced stage, the traces of original inner structure of feldspar are obliterated by total recrystallisation, and a new marked and sharp polysynthetic simple lamellae arise, different from that occurring in the normal granitoids (Pl. III fig. 2). *Quartz* is also affected by unusual decomposition. The larger rounded grains gradually break down into aggregates of crystals passing through an undulatory stage; the desintegration however, is not a usual granulation; the subindividuals in original quartz grains gain a shape similar to hydrothermal quartz (prismatically prolonged star-like or feather-like quartz). The decomposition is accompanied by regular rupturation along and across the subindividuals of the aggregate. The milky tint is due to abundant dusty porose pigment. The mafic minerals can remain preserved in all the stages of alteration, from a slightly to strongly *chloritized biotite* still with biotite relics up to *chlorite* pseudomorps or as redeposited and recrystalized accumulation of secondary relict products in the same rock. The most decomposed stages of mafite alteration are the ore skeletons of magnetite or haematite (specularite); the ores occur as metacrysts, or skeleton-like relics in which a considerable amount of recrystallized accesories (*apatite* needles, *zircon* grains, *epidote,* small *sphene* crystals) reveal and prove the presence of earlier mafic mineral. The secondary products, especially when enclosed in quartz fall often out and a fine porosity with small cavities coated by haematite film arises.

c) *The final product of the alteration,* the porose and *cavernous albitite* (chem. am. 3″, mod. an. 3″ in tab. 3; Pl I, fig. 3) is a deep brick-red monomineral rock formed by *albite* An_{03-06}, coarse grained (in grain size of 1 cm^2), quite similar to the "Smolotely syenite". The only difference is that the filling of cavities with calcite is not so frequent there.

The rock composition is identical with the previous rock, *quartz however is missing.* Partly it falls out similarly as the relics of the alteration products of mafic minerals, partly it is, most probably, consumed in the rock during albitization. Even in the advanced alteration stage it is possible to find *albites of two mentioned characters,* showing perfect albitic twinning when arisen from plagioclases and patchy and finer twinning when derived from microcline. The same double character of albite has been found in the Smolotely syenite, too. The mode of alteration is of striking significance for the common way of a replacement process: the old structure and texture of rock is reflected not only as a whole but also in the inner structure of singular grains. Similarly as in quartz albitite, some ore *skeletons* clearly indicate the origin from mafic minerals (Pl. VI, fig. 2). A great migration of these latest products *(haematite, magnetite),* however, most often takes place, which settle on the boundaries of grains, as film in cavities etc. (Pl. V, fig. 2).

The structure of rock is porose, *cavernous,* the texture being *pseudomiarolitic.* The *groundmass* is *hypautomorphic,* most often *xenomorphic granular,* due to the fabric of the pre-existing rock.

C) Chemistry and modal composition of albitized rocks.

The changes in chemical and modal composition are shown in tab. 1—3. The chemical variation is represented in diagram LQM (Fig. 7; Wolff values see tab. 1—3). From which it can be gathered that, in all

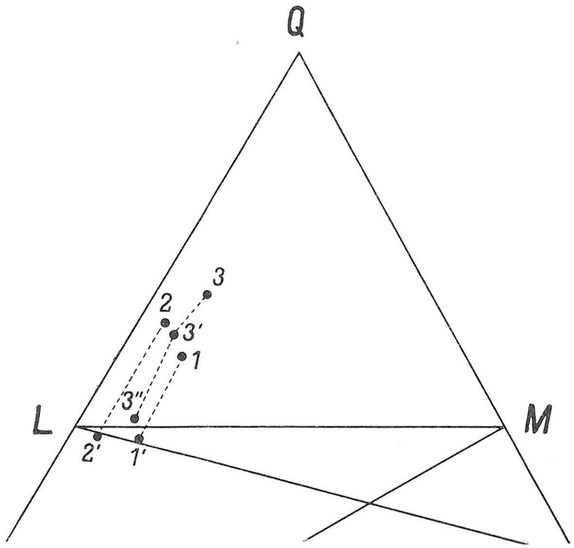


Fig. 7. Changes in composition of original granitoids during the albitization, shown in diagram LQM. 1, 2, 3 — original unaltered granitoids; 1′, 2′, 3″ — albitites (for details see tab. 1—3).

Tab. 1.

Modal and chemical composition of unaltered and albitized biotite hornblende granodiorites ("normal type" of granitoids of the Central Bohemian Pluton):

1. biotite hornblende granodiorite ("Slapy granite"); Buš near Slapy, Slapy-apophysis of the CBP

1′ albitite; Korkyně near Slapy, Slapy-apophysis of the CBP[1].

	1	1′
SiO_2	62,85 %	58,49 %
TiO_2	0,43	0,43
Al_2O_3	15,90	19,42
Fe_2O_3	2,58	2,62
FeO	3,12	2,55
MnO	0,10	0,08
MgO	2,31	1,98
CaO	5,65	3,01
Na_2O	2,78	8,69
K_2O	3,27	0,29
P_2O_5	0,20	0,20
H_2O^+	0,62	1,47
H_2O^-	0,06	0,10
CO_2	0,04	0,54
	9,91 %	100,04 %

	1	1′
plag	49,1 (An_{45})	82,2 (An_{05})
K-f	16,2	—
qz	18,2	—
amf	8,7	—
bi	7,4	—
ore	0,4 (magn)	1,5 (haem)
ep	—	3,5
ti	—	0,2
chl	—	12,1
	100,0 vol. %	100,0 vol. %
colour ind.	16,5	17,3
lenght of line	1215 mm	1180 mm

Wolff values:

	L	M	Q	A	C	K_2O	T
1	64,24	15,92	20,42	5,28	5,50	2,31	—
1′	90,44	13,12	2,89	9,81	2,91	0,21	0,32

Formulae of rocks (according to V. G. Bogolepov 1962; ad Fig. 8):

1	K_{11}	K_{14}	Ca_{16}	Mg_9	$Mn_{0,2}$	Fe_5^{+2}	Fe_7^{+3}	Al_{50}	$Ti_{0,8}$	C_0	Si_{168}	O_{465}	$(OH)_{11}$
1′	$K_{0,9}$	Na_{44}	Ca_8	Mg^8	$Mn_{0,2}$	Fe_{5+2}	Fe_5^{+3}	Al_{59}	$Ti_{0,8}$	C_2	Si_{152}	O_{441}	$(OH)_{2}$
	—10,1	+30	—8	—1	—	—	—1,5	+9	—	+2	—16	+24	+15

[1] chem. anal. 1, 1′ : L. Mráz 1960.

Tab. 2.

Modal and chemical composition of unaltered and albitized porphyritic hornblende biotite granodiorite of the Central Bohemian Pluton ("Smolotely-syenite" — Milín area)

2 porphyritic hornblende-bearing biotite granodiorite; Lešetice, 2 km NW of Milín.
2' albitite; Rtišovice, 2 km SSE from Milín ("Smolotely syenite")[1]

	2	2'
SiO_2	67,80 %	58,49 %
TiO_2	0,35	0,26
Al_2O_3	15,04	17,35
Fe_2O_3	2,58	1,64
FeO	1,87	0,46
MnO	0,09	0,08
MgO	1,17	1,11
CaO	2,85	5,45
Na_2O	3,28	10,13
K_2O	4,05	0,04
P_2O_5	0,58	0,35
H_2O+	0,37	0,08
CO_2	0,19	4,32
	100,26 %	99,76%

	2	2'
plag	43,0 (An_{27})	90,1 (An_{03})
K-f	20,0	—
qz	31,0	—
amf	1,0	—
bi	6,0	—
ore	—	1,2
chl	—	1,7
calc	—	6,2
	101,0 vol. %	99,2 vol. %
colour ind.	7,0	3,1 (calcite-free) 9,1 (with calcite)
lenght of line	814,85 mm	

Wolff values:

	L	M	Q	A	C	K_2O	T
2	64,8	7,4	+27,4	6,4	3,4	2,9	—
2'	96,6	5,36	— 2,12	12,03	—	0,03	0,6

Formulae of rocks:

2	K_{14}	Na_{17}	Ca_8	Mg_5	$Mn_{0,2}$	Fe_4^{+2}	Fe_3^{+3}	Al_{48}	$Ti_{0,6}$	C_1	Si_{183}	O_{481}	$(OH)_7$
2'	$K_{0,2}$	Na_{53}	Ca_{16}	Mg_5	$Mn_{0,2}$	Fe_1^{+2}	Fe_3^{+3}	Al_{55}	$Ti_{0,5}$	C_{16}	Si_{159}	O_{464}	$(OH)_2$
	—13,8	+36	+8	—	—	—3	—2	+7	—0,1	+15	—24	—17	—5

[1] chem. anal. 2: V. Veselý, mod. anal. V. Steinocher 1950, No. 20, chem. and mod. anal. 2': A. Dudek—F. Fediuk 1956 a), b).

Tab. 3.

Modal and chemical composition of unaltered and albitized porphyritic hornblende biotite granodiorite of the Central Bohemian Pluton (Dobříš area).

3 porphyritic hornblende biotite granodiorite (adamellite); Drhovy, 8 km SE of Dobříš[1].

3' quartz albitite; the same locality

3'' albitite; the same locality

	3	3'	3''
SiO_2	71,97 %	70,85 %	62,53 %
TiO_2	0,16	0,25	0,34
Al_2O_3	10,25	13,04	15,58
Fe_2O_3	4,05	2,49	6,23
FeO	2,11	2,88	1,77
MnO	0,07	0,01	0,01
CaO	2,66	0,53	0,48
Na_2O	3,46	7,26	9,91
K_2O	3,70	0,83	0,82
H_2O^+	0,22	0,54	0,93
H_2O^-	0,05	0,04	0,18
	99,51	99,87	99,57

	3	3'	3''
plag	36,14	63,53	81,63
K-f	32,37	—	—
qz	24,89	29,00	—
amf	1,77	—	—
bi	4,83	—	—
ore	—	0,15	2,90
ti	—	0,35	—
chl	—	6,97	—
cavities	—	—	15,48
	99,99 vol. %	100,0 vol. %	100,1 vol. %
An-content	$An_{(53-47)-36-(22)}$	An_{03}	An_{06}
colour ind.	6,6	7,4	2,9
lenght of line		2330 mm	2603 mm

Wolff values:

	L	M	Q	A	C	K_2O	T
3	51,48	12,28	+36,25	6,26	0,35	2,59	—
3′	66,20	9,88	+23,90	8,22	0,11	0,57	—
3″	84,24	13,76	+ 1,70	10,53	—	0,60	—

Formulae of rocks:

3	K_{13}	Na_{18}	Ca_8	Mg^4	Mn_0	Fe_5^{+2}	Fe_8^{+3}	Al_{32}	$Ti_{0,3}$	Si_{190}	O_{471}	$(OH)_4$
3′	K_3	Na_{38}	$Ca_{1,5}$	Mg_5	$Mn_{0,02}$	Fe_7^{+2}	Fe_5^{+3}	Al_{42}	$Ti_{0,5}$	Si_{194}	O_{493}	$(OH)_{10}$
3″	K_3	Na_{51}	$Ca_{1,4}$	Mg_3	$Mn_{0,02}$	Fe_4^{+2}	Fe_9^{+3}	Al_{49}	$Ti_{0,6}$	Si_{166}	O_{455}	$(OH)_{16}$
3 — 3′	—10	+20	—6,5	+1	—	+2	—3	+10	+0,2	+4	+22	+ 6
3′ — 3″	0	+13	—0,1	—2	—	—3	+4	+7	+0,1	—28	—38	+ 6
3 — 3″	—10	+33	—6,6	—1	—	—1	+1	+17	+0,3	—24	—26	+12

[1] chem. anal. 3, 3′, 3″: Chemical laboratory Obalsklo Teplice 1960.

[2] from the surface of a coloured sample 5149 mm^2 in area by means of net (porphyritic feldspars) and from modal analysis of a line 1264 mm long (groundmass).

these cases, the trend of transformation (from the original granitoids 1, 2, 3, primarely richer in Q component, to the albitites 1′, 2′, 3″, i. e. to the rocks grouped around the saturation line L — M) was the same. The diagram clearly shows, the value M (i. e. the content of mafic components) remaining well-preserved in the rock; the transitional character of the quartz albitite (3′) manifests itself in approaching the original rock in its chemical composition only, resembling albitite in its mineral composition and appearance.

It is possible to deduce from the column diagram of the transformation (Fig. 8) the tendency of the final product to attain in all cases approximately the same mineral composition whatever the original material may be. The diagram also shows the varying values of the calculated chemical analyses after V. G. Bogolepov 1962 (a modified calculation of Barth's standard cell; data given in tab. 1 — 3). In all cases in the final product the content of Na and Si is roughly the same the content of Ca being small (its higher value is due to the presence of calcite miaroles in the syenite of Smolotely and of epidote in the albitite from Korkyně). Besides the removal of potassium the losses of other oxydes are rather small; a constant higher amount of Al is visible in the final product as compared with the original rock; although the Al-ratio to other felsic oxides is higher in original (more basic) plagioclases of the unaltered rock, increase of Al is influenced by SiO_2 decrease, caused by the transport away of free quartz. This is evident from the complet series of analyses from Drhovy (3, 3′, 3″); the value of SiO_2 remain the same in the transitional type as well as in unaltered rock even if the albitization was very advanced (compare Na in 3 and 3′).

In the contrast to the mafic components the ratio of the original light mineral components may have considerably influenced the degree of alteration. If it was possible to draw the SiO_2 needed for the formation of albite from the decomposition of the other minerals (potash feldspars), the conditions for the preservation of quartz were favourable untill the later stages of albitization, although the process was considerably advanced; in the opposite case, the disintegration of quartz occured in the first place. It is possible to express the qualitative variations of the chemical composition as follows:

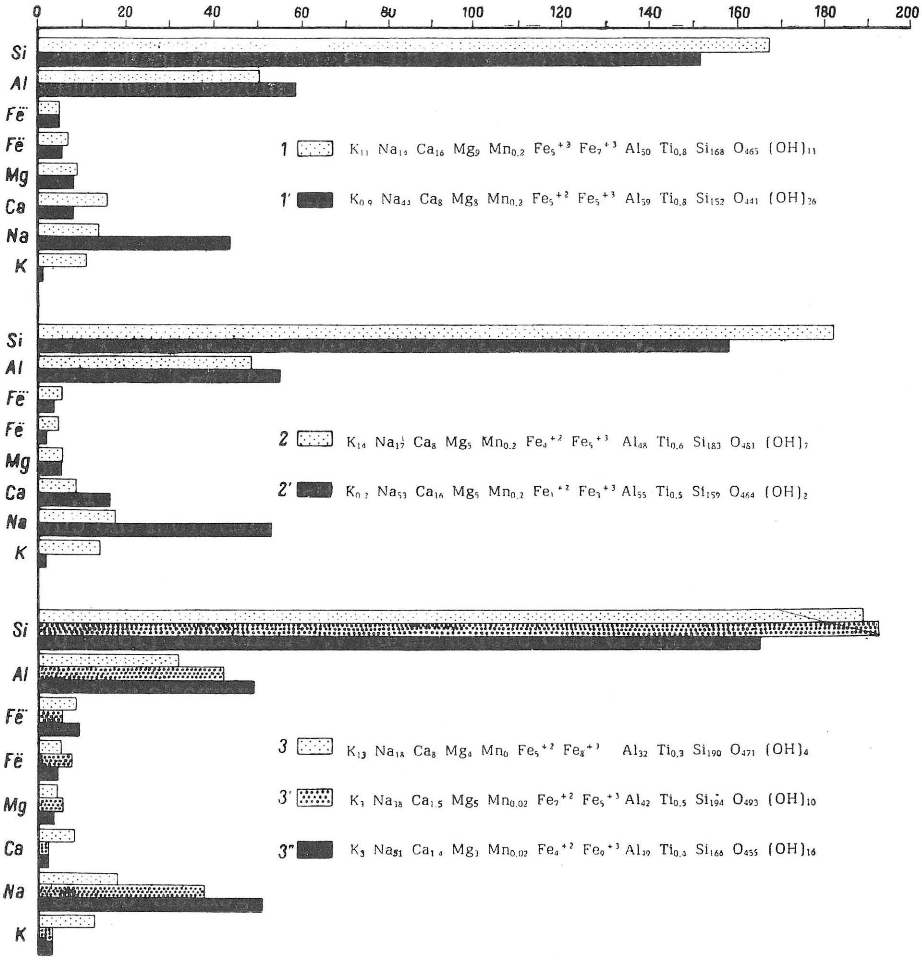


Fig. 8.
Column-diagram of quantitative changes of original granitoids (chem. anal. 1, 2, 3) and their albitized products (1′, 2′, 3″) according to V. G. Bogolepov 1962 (adapted Barth's method, calculated for a standard vol. 10.000 Å^3).

1 — biotite hornblende granodiorite, Buš near Slapy; 1' — albitite, Křížov near Slapy; 2 — porphyritic biotite granodiorite, Lešetice near Milín; 2′ — albitite, Smolotely near Milín; 3 — porphyritic hornblende biotite granodiorite, Drhovy near Dobříš; 3' — quartz albitite, Drhovy near Dobříš; 3″ — albitite, Drhovy near Dobříš. (C was omited in analyses).

I) the original granitic rock:	Si	Al	Fe^{+2}	Fe^{+3}	Mg	Ca*	Na	K
	↑	↓	|	|	|	↓↑	↓↓	↑↑
II) albitite:	Si	Al	Fe^{+2}	Fe^{+3}	Mg	Ca	Na	K

(↓ increase, ↑ decrease, | approximately the same amount, ↑ slight change ↑↑ great change — compared with original rock).

The mineral assemblage of the samples of the educt and the product vary within the following range:

I) plag An_{50-30} (49-36 %) + quartz (31-18 %) + potash feldspar (32-18%) + biotite (7-5 %) + hornblende (8-1 %) — (colour ind. 16-7 %)
II) albite An_{03-06} (82-90 %) (± sericite) + chlorite + hematite + epidote ± calcite — (colour ind. 17-3 %)

* in dependence on CO_2 - supply.

The hydrothermal solutions were above all alkali (Na) rich and were aggresive especially against K and Ca. Potassium being the most mobile constituent of the rock was totally removed from the light minerals as well as from the mafic ones.

THE GENESIS OF THE ROCKS OF THE "SMOLOTELY SYENITE" TYPE

A. Dudek and F. Fediuk (1956 a, p. 149) took the Smolotely syenite (designated by J. Vachtl 1935 as the syenite facies of marginal granite facies) for an unusual igneous rock. They discussed its position in the system of igneous rocks (leucosodaclas-tonalite according to A. Johannsen, alkali- or albite syenite according to P. Nigli and S. J. Shand). According to Dudek and Fediuk the miarolitic texture is a characteristic feature of this rock, although it is rare in the magmatic rocks of the Bohemian Massif. F. Šorf (1956, 12, unpubl.) also describes the rock as a product of magmatic (superficial) differentiation. Likewise. F. Kratochvíl (1943, 3 unpubl.), regards the red albite granites from the environs of Cetyně near Smolotely as a product of magmatic differentiation posterior to the surrounding grey facies. B. Hejtman (1957, 121) assigns this rock to alkali-syenites in his system of igneous rocks. The opinion of its magmatic origin is also supported by V. Steinocher (1963, p. 193) who considers the rock to be a product of crystallization from hydromagma. According to this author (1963, 193) hydromagmatic rocks should be referred to as end-members of the primary magmatic series forming the continuation of the Bowen's scheme of reaction series. Recently, V. Steinocher (1964, unpubl.) explains the origin of the rocks studied by crystallization of the anorthosite magma which "split up" into albitic component and primary calcite.

The examples described from the area of the Central Bohemian Pluton indicate that the magmatic interpretation of the genesis of the rock cannot be maintained any more. The rocks of the "Smolotely syenite" type represent the *product of metasomatic alteration.* They are *albitites arisen in the process of gradual hydrothermal metasomatic albitization.* The hydrothermal metasomatic origin of the rocks in question is based on:

1. geological setting — the rocks arise along joints, the thickness varies from cm-film up to regional-scale transformations in area of several km^2 in size; they develop in place of pre-existing granitic rock by its gradual alteration; the parent rocks consist of various types of granitoids (Figs. 2,5; Pl. II, fig. 1);

2. the petrographic investigation of the gradual change of rock textures during which essential features of the rock (grain size, distribution of mafic minerals etc. (Pl. I, fig. 1—3, Pl. IV, fig. 1—2) were preserved; the alteration is responsible for the origin of characteristic metasomatic structures and textures (cavernous, miarolitic, Pl. IV, fig. 2, Pl. V, fig. 2; Dudek - Fediuk 1956 a) fig. 1, 2 in Pl I);

3. the petrographic study of the alteration and recrystalization of individual mineral constituents — the transformation can be traced in various minerals and from the initial mineral composition of the educt through transitional stages (Pl. IV, fig. 1—2; Pl. V, fig. 1—2), up to the final product.

4. the compositional character of rocks — transitional types formed in place of original rock are perceptible not only in modal but also in chemical composition (Pl I, fig. 1—3, Fig. 7—8).

The process of albitization leading to formation of igneous-loking and related rocks ("apogranites" according to following russian authors) is best known from the papers dealing with the alaskite granites complexes connected with Sn—W mineralization. The metasomatic nature of the process and its dependence of the geological structures given (e. g. contacts, joints, faults etc) was pointed out in particular by A. A. Beus et al. (1962), E. A. Severov (1962) and in our country by M. Štemprok (1965 etc.). The albitization of this type closely related to ore mineralization is very common. The albitization leading to the formation of albitites of the "Smolotely syenite" type is a less usual, more basic analogon of the same process in another original material, i. e. in normal granodiorites to tonalites. In this case, from the geological point of view, the dependence on joints is more clearly visible. As to composition, the product of the transformation is analogous to the second type of the albitized granites according to the R. V. Masgutov's (1962) classification, i. e. non-orebearing albitized granites; neither ore mineralization nor accumulation of trace elements is associated with the albitization of this type, which is evidently of low-thermal character; it is mediated by sericitization, natrium being supplied up to 6.13 - 8.67% Na_2O according to the author mentioned. The same alteration product arising along joints is described in detail by H. M. Huber (1943, 533, 535) from granitic rocks in the Gotthard Massif. Two succesive phases of this process (leaching and impregnation) are distinguished by this author, the process being put into connection with the Alpine metamorphism. H. M. Huber (l. c.) finds this process reminiscent propylitization in the volcanic complexes of the Au/Ag formation (p. 500).

Thus the *rocks of "Smolotely syenite" type are products of a more progressive and wide-spread hydrothermal albitization* as compared with that of less advanced stage (white to pinkish granites only) described by Masgutov (c. l.) The process *can be perfectly compared with the alteration* markedly developed *along the joints in Huber's Alpine massifs* (c. l.). The analogy with this occurrence was more recently suggested by P. Láznička (1965, 99) during his study of mineral fillings in Czech granitoids. Thus, the rocks of the "Smolotely syenite" type *are neither an unusual igneous rock nor a product of the crystallization from hydromagma or anorthosite magma.*

The process of albitization discussed here involves a number of questions of general and regional character which at the present stage of investigation of the granite problem as well as endogenous hydrothermal process cannot be answered unequivocally. One of the questions is the problem of *source and origin of albitizing hydrothermal solutions* and their genetic connection with metallogenic process. Judging from examples under consideration, as well as from those given in the literature, similar transformation occurs in both types of the deposits of Au-formation and the deposits of radioactive raw materials associated with quartz and carbonate veins (Ch. E. B. Conybeare, Ch. E. B. Campbell 1951, J. Harpum 1954). In our country, the two most extensive examples of albitization occur in the Příbram and Nový Knín areas. On the other hand, the albitization is also found outside these metallogenic fields (see p. 127). The relation between albitization and ore veins is complicated — the process of albitization is found to be earlier and later also than these veins — and can be interpreted in connection with the study of these ore veins only. The final product, an almost pure albitite, bears evidence of a considerable natrium supply. Contrary to this, it may be supposed, as does M. Huber (1943) and consequently P. Láznička (1965), that at least a portion of the hydrothermal vein filling (calcite, epidote, zeolites) may be in connection with a great removal of calcium from the rock.

According to the present author the albitization process is more important *from the viewpoint of petrogenesis,* especially with regard to the *criteria of magmatic crystallization* based on the petrographic textures of the rock. As many other, A. Savolahti (1963) newly emphasized that these criteria — especially that of order of crystallization derived from crystal shape — should be used with caution and from a convergence point of view. In the present author's opinion, *these criteria appear to be quite doubtfull when applied to plutonic rocks and need reevaluation.* Thus, for instance, the miarolitic texture hitherto regarded as a magmatic texture of granitoids, is, in our case, a pseudomiarolitic one, although there is a typical example of development of "magmatic" miaroles. The hypautomorphic granular texture is rendered more marked during the same metasomatic process up to automorphic one which seems to be perfectly magmatic. Thereby *the best bounded grains* (recrystallized feldspars, those of apatite, sphene, orthite, epidote, haematite etc.) in rock studied *appear as the least reliable;* like in hydrothermal process *their euhedral shape is the result of growth of metacrysts.* Futher, albitization of granitoid rocks indicates the surprising capability of rock to *preserve the fundamental features of the original structure of the rock during metasomatism.* Details of texture and structure were preserved up to late stages of transformation, whereas complete chemical decomposition and reconstruction took place, similarly as pointed out by V. Hanuš (1963) for carbonate rocks. *Even the silicate system does not hinder such a copying of texture.*

In addition the albitization process in the Central Bohemian Pluton is connected with the petrogenetic problem of a wider regional significance, namely with the interpretation of *"red granites",* a frequent facies of the marginal type along the Algonkian contact. They have been known as early as from the papers by Austrian geologists (E. Klesczynski 1855, 260, N. V. Lipold 1860 etc.), and newly discussed by J. Vachtl in the Březnice area (1935, 13). The facies of "read granites" in the Central Bohemian Pluton was thought to be the "ore-bearing body" of the ore aureole of the pluton along the contact with the Barrandian area. The red colour, the ferruginization of feldspars is, though, not specific for the albitization process only (potash feldspars can also be red coloured in them). On the other hand it is to be noted, that albite occurs in a number of intensively coloured rocks containing red feldspars (e. g. Těchnice granite from the surroundings of Krásná Hora and Milešov, described by V. Steinocher 1958, 59). In this case it is necessary to establish the relations of albitization of hydrothermal and joint character to diffuse alteration of regional extent which are in more intimate connection with the crystallization proper of granitoid rocks.

Similarly according to the above-mentioned authors (Beus, Severov, Štemprok and others), the process of hydrothermal albitization in the Central Bohemian Pluton can be assigned to the *"postmagmatic stage"* of development of plutonic complexes — in so far this term is understood sufficiently broadly in non-genetic sense as "post-plutonic" one, saying nothing about the origin of the preceeding stages of development of rocks. The relation of the process of albitization to the genesis of parent plutonic rocks in which it takes place along joints offers similar problems as does the relation between hydrothermal metallogenic process to plutonogenesis. Analogously, but without direct proofs, the albitization in the Central Bohemian Pluton can be assumed to be of Variscan age.

CONCLUSIONS

1. The *red syenitic rocks* of CBP (of the "Smolotely syenite" type) are not magmatic rocks. They are albitites in composition and *originated by hydrothermal metasomatic albitization.* The alteration took place along joints and the gradual process of albitization is demonstrated by means of two different rock materials, normal granitoids (A) and the coarse-grained marginal facies (B) of the Central Bohemian Pluton. The structural features of the original rock remain well preserved in the final product.

2. The *miarolitic texture* as well as the typical hypautomorphic or automorphic granular "primary magmatic" rock texture distinguished by euhedral feldspars *is the product of metasomatic process and recrystallization* in rocks under consideration. The more progressive is the alteration, the more perfect can be the euhedral shape of minerals. The seemingly magmatic type of texture is obtained by pronounced recrystallization. Thus the *criteria of sequence of crystallization* based on crystallographic shapes and used hitherto in petrogenetic interpretations *are suggested* by present author *to be fully doubtfull in plutonic rocks.*

3. The transformation is evidenced by petrography, chemical composition and modal composition of rocks. *The final product,* an almost monomineral albitite, *tends to attain the similar mineral and chemical composition* in spite of the different starting material. The alteration is assumed to take place at two closely connected stages. The albitization process is preceded by intensive hydrothermal stage (sericitization, chloritization, epidotization). The final stage of alteration manifests itself by the break down of quartz and potash feldspar. From the chemical point of view, the alteration is characterized by the *complete removal of potassium and calcium* from the rock and by the addition of natrium.

Attention is drawn to the significance of the transformation in the solution of some problems of petrogenesis and metallogeny of the Central Bohemian Pluton.

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Geological Institute of Czechoslovak
Academy of Sciences, Prague
(Praha 1, Jilská 1)

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ČESKÉ RESUMÉ

Ve středočeském plutonu byl jako neobvyklá magmatická hornina označen tzv. „smolotelský syenit", *sytě cihlově červená hrubozrnná hornina s miarolitickou strukturou,* určená A. Dudkem — F. Fediukem jako *„albitický syenit"*, popř. „leukosodaclastonalit" v klasifikaci A. Johannsena. V. Steinocherem je hornina pokládána za produkt diferenciace v hydrotermálním pokračování Bowenových reakčních serií, tj. z neobvyklého magmatu bohatého vodou, „hydromagmatu", nověji za produkt rozštěpení anorthositového magmatu.

Autorka ukazuje na třech příkladech doložených chemickými a modálními analýzami, že obdobné horniny vznikají porůznu ve středočeském plutonu (i v jiných plutonických komplexech) v různých horninových typech jako *typické produkty puklinové hydrotermální metasomatické albitizace,* přestože si zachovávají vzhled a texturu plutonické masivní horniny. Chemické a modální analýzy, č. 1 a 1′ patří produktu a eduktu v horninách tonalitové asociace, tj. normálnímu biotiticko-amfibolickému granodioritu až křemennému dioritu, nejrozšířenější hornině středočeského plutonu. Počáteční stadium procesu po puklině zachycují tab. II/1. mikroskopicky tab. II/2. Výsledný produkt přeměny je sytě cihlově červený albitit téže textury a zrnitosti jako původní hornina tab. IV/1-2). V procesu přeměny uvedené horniny možno velmi dobře pozorovat *jeden z možných způsobů vzniku miarolitických dutin,* tj. vypadáváním produktů rozkladu tmavých minerálů z horniny tab. V/1—2). Zdánlivé chloritické výplně miarol jsou chloritické pseudomorfózy rozrušené nově přirůstajícími a posléze do „dutin" čnějícími albity. Albity se vyznačují zakalenými jádry na místě původních plagioklasů (ferruginitizací hematitovým pigmentem z rozkladu mafitů) a automorfními lemy čirého albitu (tab. IV/2, tab. V/2). Přeměna je shodná s procesem popsaným H. M. Huberem (1943) a R. V. Masgutovem (1960).

Chemická a modální analýza 2 a 2′ ukazuje týž proces ve smolotelském syenitu a okolních horninách. Výchozí horninou je hrubozrnný porfyrický biotitický granodiorit s malým obsahem amfibolu, výslednou horninou je albitit popsaný A. Dudkem — F. Fediukem (1956 b). Obě horniny mají shodné složení s horninami popsanými sub 3, 3″ z okrajového typu na Dobříšsku (lok. Drhovy). Zde možno pozorovat v defilé 2 km dlouhém postupné přechody od nezměněného porfyrického a křemenem bohatého granodioritu do kavernosního albititu přes přechodnou horninu o složení křemenného albititu (anal. 3′) tab. I/1—3). Je popsán způsob přeměny jednotlivých minerálů, který probíhá v prvých stadiích přes proces chloritizace mafitů (za vzniku druhotného epidotu, titanitu, magnetitu aj.) a přes proces sericitizace živců, v dalším stadiu vede k rozpadu chloritických pseudomorfóz, po nichž zbývají relikty magnetitu změněné v hematit (tab. VI/2) a k překrystalizování světlých minerálů v albit. Nově vznikající albity si mohou ponechat struktury původních metasomaticky přeměněných minerálů (albitické lamelování po plagioklasech, „šachovnicový" albit po mikroklinech).

Diagramy (obr. 7) podle F. Wolffa a sloupcové diagramy přepočtu chemických analýz (obr. 8) podle V. G. Bogolepova (upravená Barthova metoda) ukazují změny během procesu albitizace, která v konečném výsledku vede k hornině téhož složení z různých výchozích hornin — různě zrnitému (podle původní zrnitosti horniny) obvykle cihlově červenému albititu.

Zjištěný proces přeměny může mít význam *pro výklad tzv. „červených žul"* ve středočeském plutonu (tj. hornin pokládaných za rudodárný magmatický typ středočeského plutonu) a v neposlední řadě i pro proces metalogenetický, s nímž je obvykle spjat. Má dále význam *pro novou interpretaci některých „magmatických" struktur,* nejen diskutované *miarolitické,* ale i pro chybné *přeceňování významu automorfie minerálů,* dosud základního kritéria magmatické sukcese a krystalizace; automorfně omezené minerály jsou v našich horninách metakrysty, jejich *automorfie se zvyšuje s intenzitou metasomatických přeměn.* Proces albitizace poskytuje dále dobrou příležitost pro studium mechanismu metasomatického pochodu, zejména reliktních struktur a textur substrátu.

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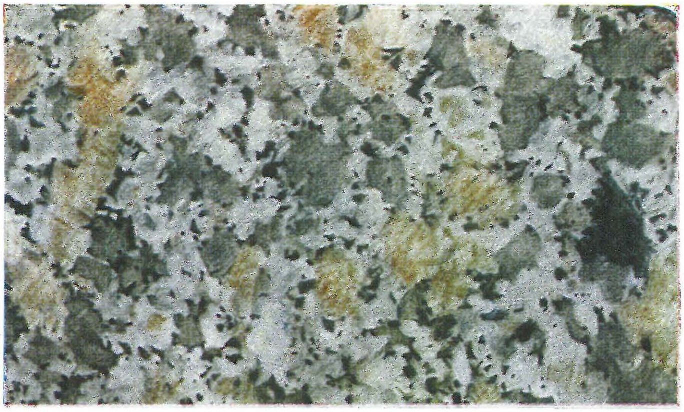
Pl. I, fig. 1—3



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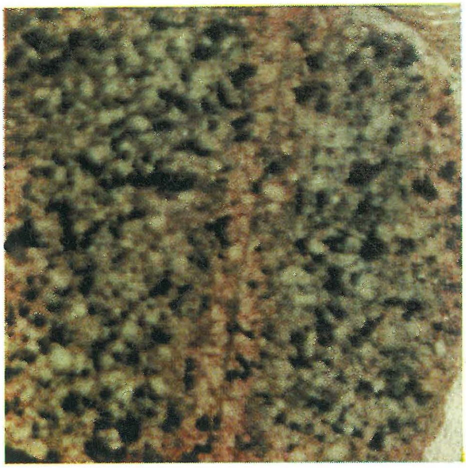
Pl. II, fig. 1, 2



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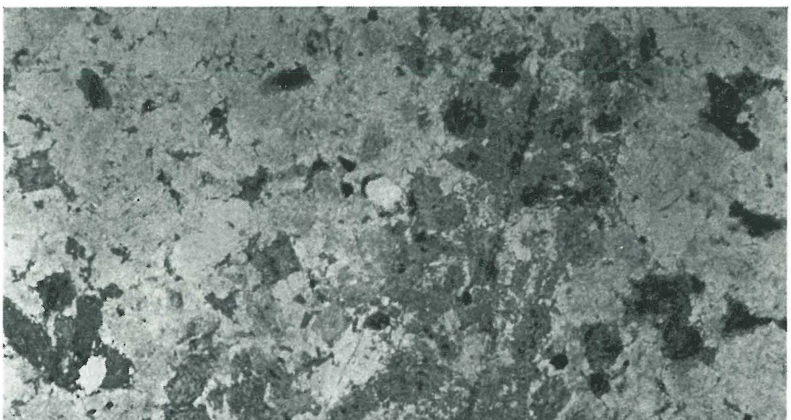
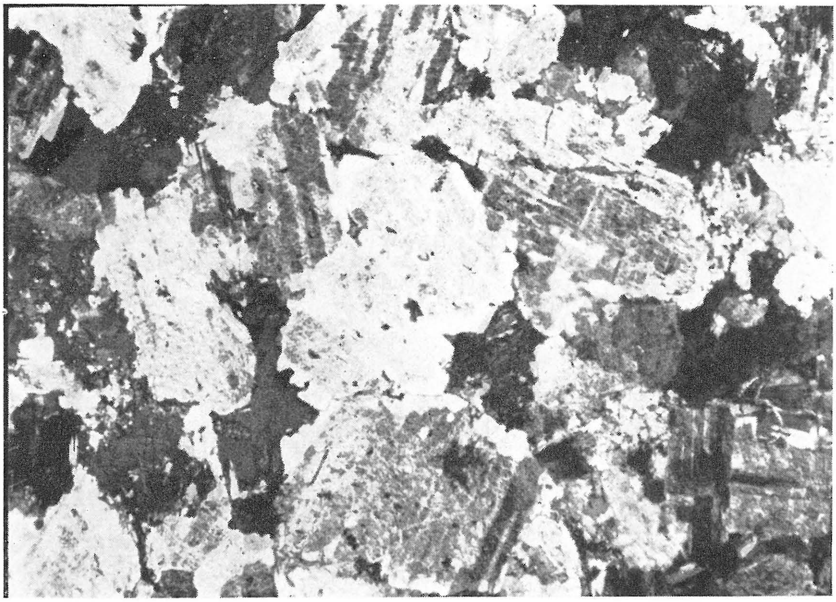


Pl. III, fig. 1, 2



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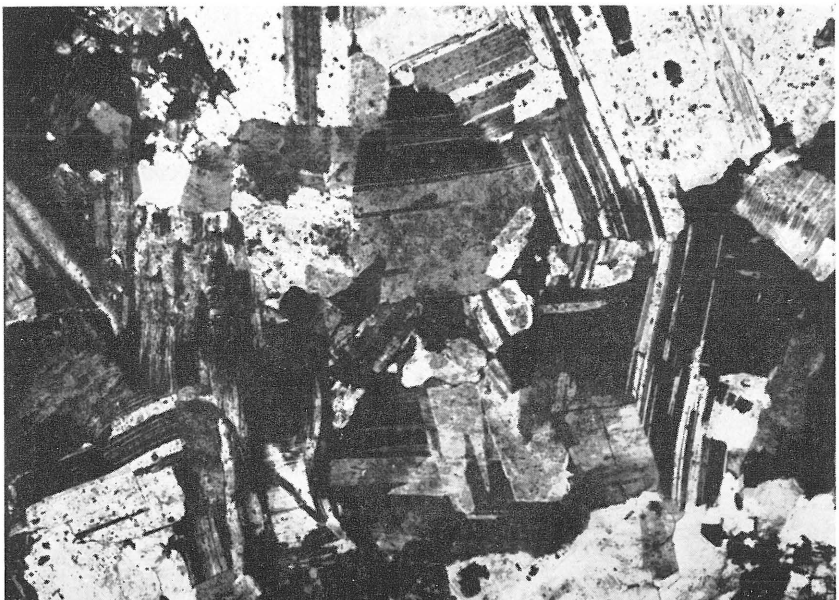

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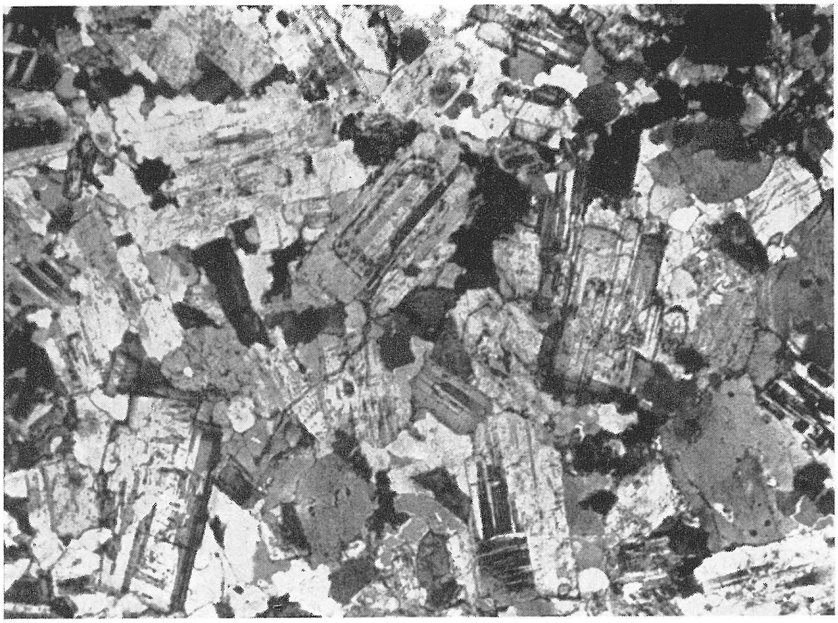
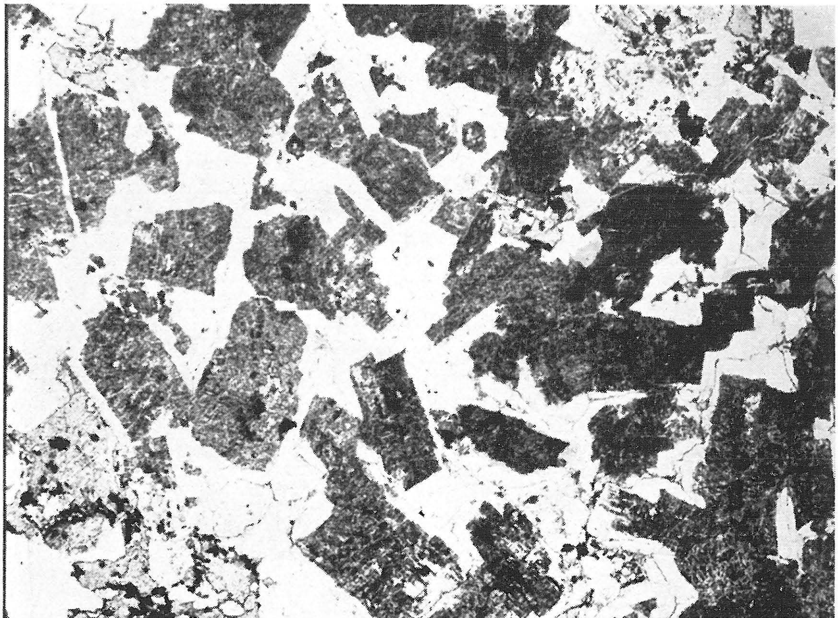
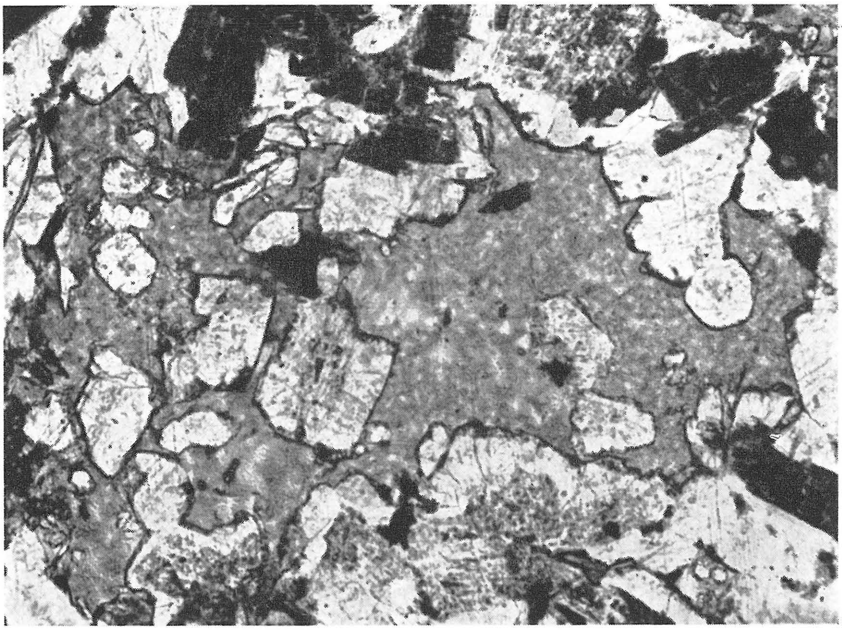
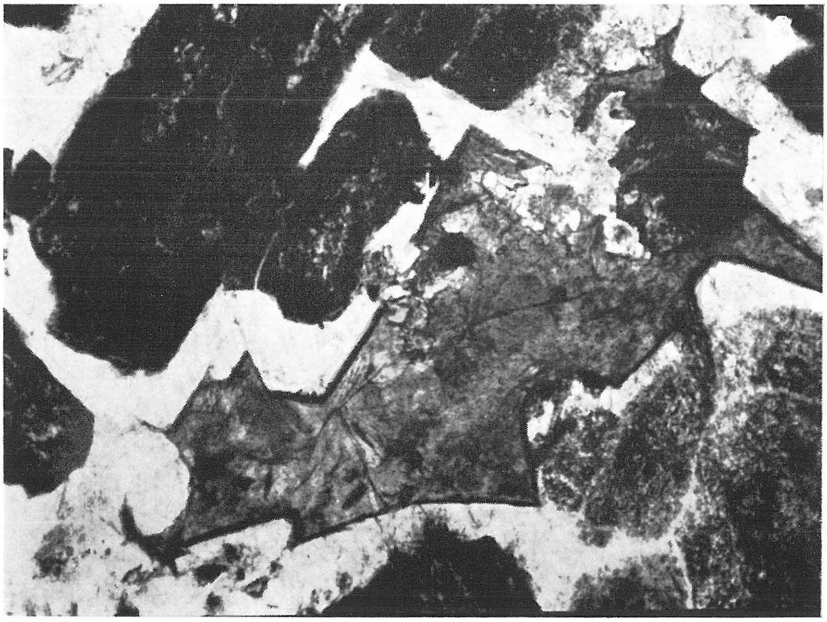
Pl. IV, fig. 1, 2



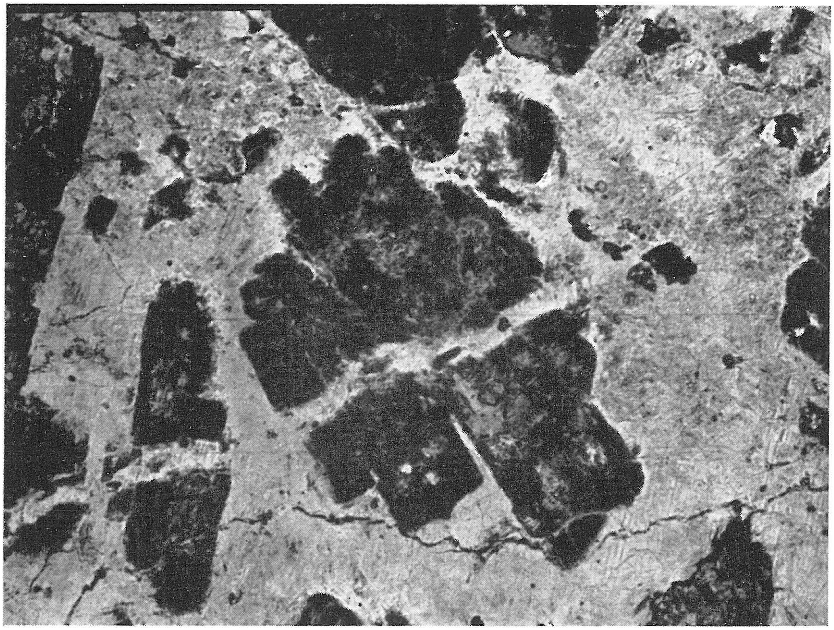


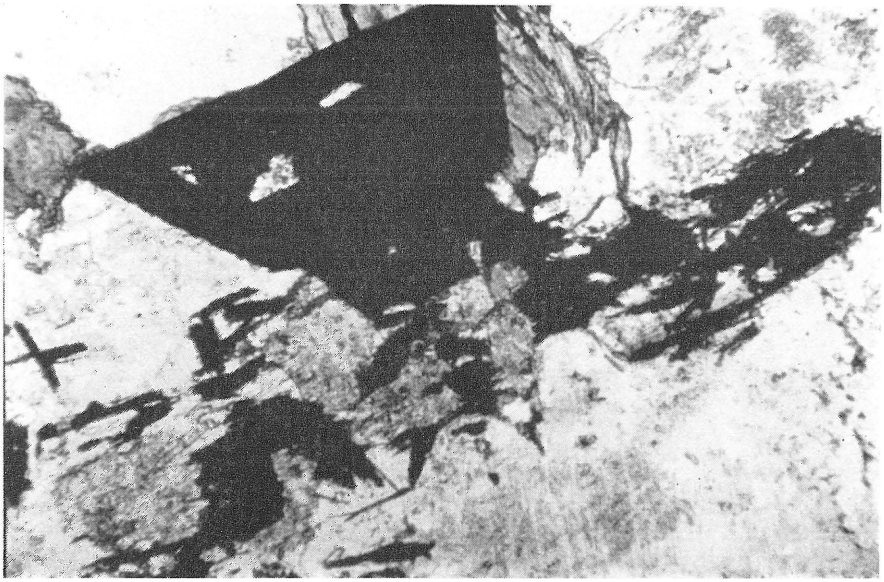
Pl. V, fig. 1, 2





Pl. VI, fig. 1, 2





EXPLANATION OF PLATES (PHOTOGRAPHS)

Pl. I, fig. 1—3.

Succesive albitization of porphyritic granodiorite. Drhovy near Dobříš, 40 km SSW of Prague.

1. Porphyritic hornblende biotite granodiorite; white plagioclases, pinkish potash feldspar, grey quartz (anal. 3, p. 139; see Fig. 6).
2. Quartz albitite produced by alteration of the preceeding granodiorite; milky-white quartz, pink albite (anal. 3′, p. 139).
3. Cavernous albitite, final product of albitization (anal. 3″, p. 139).

All figures drawn from rocks by J. Izera 1965, slightly diminished.

Pl. II, fig. 1.

Albitization along a crack in biotite-hornblende granodiorite ("Slapy granite"); Korkyně near Slapy.
Photograph in natural size (microphoto of the same crack see the fig. below).

Pl. II, fig. 2.

Albitization along a crack in biotite-hornblende granodiorite. Detail of the previous figure; the initial stage of alteration with sericitized plagioclases and chloritized mafic minerals. Epidote (darker line) concentrated in a crack along which albitization took place.
× 6, ordinary light, microphoto V. Mlýnek.

Pl. III, fig. 1.

Albitized granodiorite — initial stage of alteration. Softly sericitized plagioclases loose sharp twinning; newly formed albites grow on clear albite rims. Quartz disintegrates into minute grains. Korkyně near Slapy.
× 21, crossed nicols, microphoto V. Mlýnek.

Pl. III, fig. 2.

Polysynthetic twinning in albitite (final product of alteration). Of felsic minerals only albite An_{03-06} is present in the rock. Drhovy near Dobříš.
× 10, crossed nicols, microphoto J. Izera.

Pl. IV, fig. 1.

Microscopic texture of unaltered biotite hornblende-bearing granodiorite in a portion richer in plagioclases. Buš near Slapy (anal. 1) Compare the fig. below.
× 15, crossed nicols; microphoto.

Pl. IV, fig. 2.

Albitite. Final stage of alteration of granodiorite shown on preceeding figure. Turbid pseudomorphs after plagioclase are pink and mantled by clear albite; mafic minerals are quite chloritized. Korkyně near Slapy (tab. 1. an. 1′).
× 12, ordinary light, microphoto.

Pl. V, fig. 1.

Chlorite pseudomorphs after poikilitic mafites with enclosed albitized plagioclases. Initial stage of origin of "miarolitic" texture. Compare the following fig. and on page 132.
Albitite Korkyně near Slapy.
× 19, ordinary light, microphoto.

Pl. V, fig. 2.

"Miarole" filled with chlorite. Perfect euhedral albites coated by haematite project inwards; the former have strongly turbid (ferruginitized and sericitized) red cores after pre-existing plagioclases. The final stage of origin of "miarolitic" texture (compare preceding fig. and Fig 4c on page 132. Albitite Korkyně near Slapy.
× 42, ordinary light, microphoto V. Mlýnek.

Pl. VI, fig. 1.

Clear albite penetrating trough the pseudomorphs after pre-existing plagioclases; dark — original plagioclase shapes turbid by haematite red dispersion, white — clear albitic substance. Most advanced product of alteration. Albitite, Korkyně near Slapy.
× 30, ordinary light, microphoto.

Pl. VI, fig. 2.

Ore-metacrysts and ore-skeleton of haematitized magnetite after decomposed mafite. The original shape evidenced by the cleavage of pre-existing minerals (reflected by ore-skeleton). In ore-skeleton minute grains of recrystallized apatite are abundant. Quartz albitite, Drhovy near Dobříš.
× 100, ordinary light, microphoto.