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The Kdyně massif, South-West Bohemia — a tectonically modified basic layered intrusion

Kdyňský masív v jihozápadních Čechách — tektonicky modifikovaná zvrstvená bazická intruze

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Abstract: A late Cadomian (Cambrian) layered intrusion, located in the metapelites and metabasites of the Domažlice crystalline complex and bordered by a marked contact aureole, consists of three stratiform zones: the lower — gabbroid, middle — diorite and upper — quartz diorite zones. Small tonalite and trondhjemite bodies are present as the products of a further intrusive phase. Differentiation of the products of the original tholeiite magma occurred along two trends differing in the Mg, Fe fractionation. The first, of the Skaergaard type, is represented by the olivine gabbro → fayalite ferrodiorite series. The second, characterized by low Mg, Fe fractionation, appears as diorite-tonalite-trondhjemite association. Variscan orogenesis led to local rock recrystallization, mostly accompanied by the formation of secondary amphiboles such as actinolite, tschermakite, cummingtonite, etc.

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Introduction

The Kdyně massif is one of the largest late Cadomian (Cambrian ?) intrusions of basic and intermediate rocks in the Bohemian Massif. It covers an area of about 200 km^2 on the present-day surface, of which about 1/4 lies in the FRG, where it is known as the Neukirchen massif (Fischer 1929). This intrusion is part of the Kdyně basic complex, which also includes a complicated set of regionally and contact-metamorphosed Upper Proterozoic rocks of volcanic-sedimentary origin, belonging to the central volcanic zone of the Barrandian area (Fiala 1977). As a regional geological unit of the second order, this complex forms the SE and E parts of the Domažlice crystalline area (Vejnar et al. 1984).

Research carried out so far in the massif dealt primarily with its geological position and especially with its relationship to surrounding amphibolites (Bergt 1905, Sokol 1924, Fischer 1929, Rädisch 1933). Exceptionally, the petrogenesis of some of its rocks was studied (Slavík 1922, Šmejkal 1958, Vejnar 1984). New research is based on geological mapping of the massif and its crystalline mantle at a scale of 1 : 50,000 (carried out in co-operation with J. Tonika), complemented by detailed field research at a scale of 1 : 10,000 (in cooperation with V. Miksa) and laboratory study of rock samples.

The region underlain by the massif is considerably covered with Quaternary deposits and affected by weathering, which complicates determination of the interrelationships among the individual rock types.

This study deals with the Czechoslovak part of the massif. I am greatly indebted to Dr. G. Stettner (Bayerisches geologisches Landesamt, München) for allowing comparison of field studies of the adjacent Bavarian parts and to Prof. Dr. Jung (Universität, Hamburg) for providing information on the present state of research on the petrogenesis of some rocks in this part of the massif.

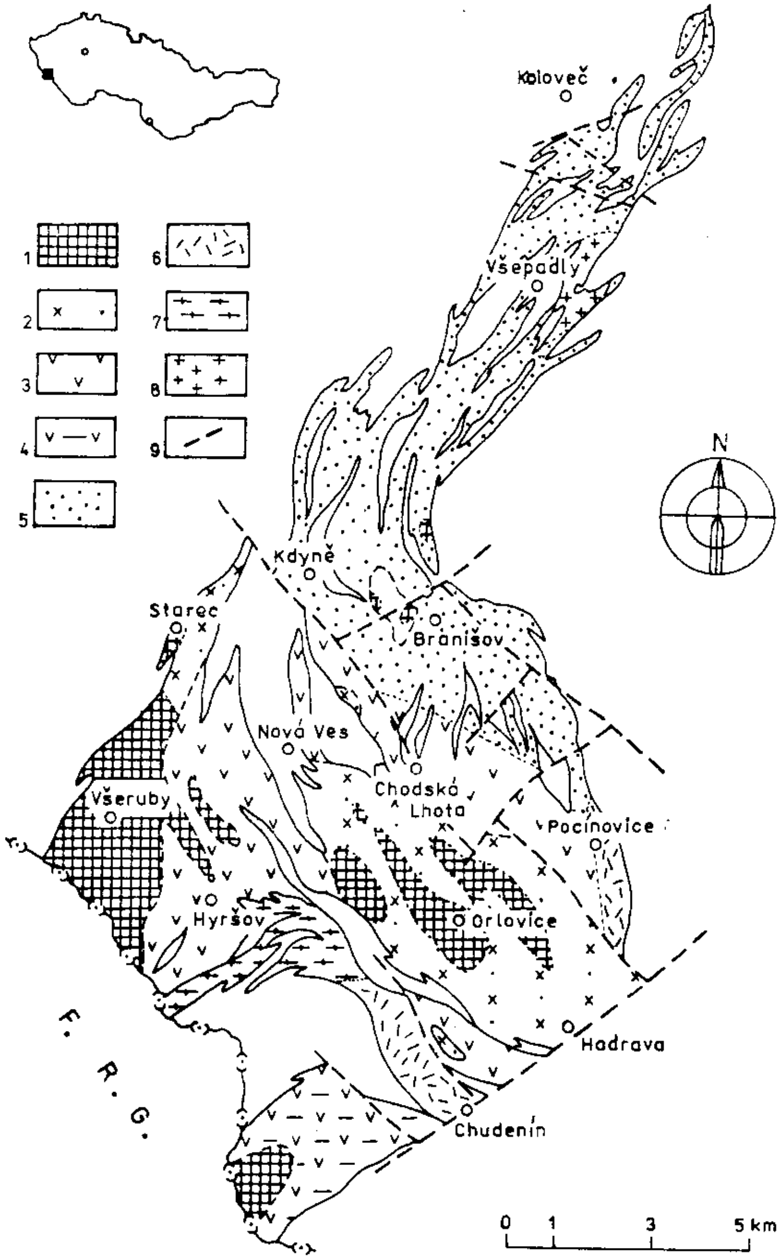
Basic geological characteristics of the massif

The Kdyně massif (fig. 1) in the present-day surface exposure represents a complicated variegated bottle-shaped intrusion elongated NE—SW. The intrusion follows a marked linear structure in this direction that in the SW is directed towards the intersection of the deep zone of the Bohemian Quartz Lode with a deep zone of the central Bohemian suture. In the NE this structure is accompanied by intrusion of the Stod massif (Tonika - Vejnar 1966).

The massif is emplaced more or less conformably with the general foliation of the neighbouring crystalline schists, formed during the Cadomian regional metamorphism of the Upper Proterozoic sedimentary and volcanic rocks. However, it is diagonally cut by metamorphic zones i. e. by the biotite zone in the NE and by the garnet zone in the SW.

Within the range of the contact effects of the massif, the crystalline schists of the biotite- and garnet zones are converted into contact schists and hornfelses. The contact aureole is developed to a greater extent along the NE part of the massif, where it is 2—4 km wide and narrows gradually to the SW. Small xenoliths and larger enclaves of the crystalline schists within the massif are also modified by contact metamorphism.

The shape of the massif is controlled in general by the above-mentioned NE—SW orientation of its intrusion zone. The characteristic bottle-shaped broadening of the central part (between Kdyně and Pocínovice) is apparently connected with the system of NW—SE faults, corresponding to the southernmost part of the Mariánské Lázně fault. The sharp boundary of the massif in the SE coincides with fracture zones representing a continuation of the central



1. Geological map of the Kdyně massif
1 — gabbro, gabbronorite and ferrodiorite; *2* — uralitized gabbro and gabbronorite; *3* — diorite; *4* — diorite with metabasite xenoliths, partly uralitized; *5* — quartz diorite; *6* — biotite-hornblende tonalite; *7* — biotite trondhjemite; *8* — biotite-hornblende granodiorite; *9* — faults

Bohemian suture towards the SW, accompanied in Bavaria by serpentinized peridotite bodies.

The intrusion can be most probably assigned to the lower Cambrian, since it produces contact metamorphism of the Upper Proterozoic rocks exhibiting Cadomian regional metamorphism, and since it is penetrated in the NE by granitoid rocks of the Stod massif, with radiometric ages ranging from 530 to 455 million years (Šmejkal - Vejnar 1965).

Rocks of the Kdyně massif also appear as xenoliths in the above-mentioned granitoid Stod massif.

The internal structure of the massif is very complex. Decoding of this structure was complicated by the great petrographic variability of the basic rocks, by the complicated morphology displayed by the many accompanying apophyses and by the presence of a large number of xenoliths and large enclaves of crystalline schists. The problem is further complicated by the process of secondary recrystallization-uralitization, primarily affecting the basic rocks of the central part of the massif. Similar to the nearby Poběžovice massif or Drahotín stock (Vejnar 1973 and 1980) this conversion led to partial or even complete decomposition of the original minerals and to modification of the rock structure accompanied by formation of secondary amphiboles, sodic plagioclase, biotite, chlorite and quartz.

On the basis of the regional distribution of the individual rock types, their spatial relationships and locally apparent very marked layering, caused by alternation of bands and laminae of various mineral compositions, the massif can be considered as a layered intrusion. Its original structure was deformed especially in the outer parts during emplacement into the crystalline mantle. The dominant, primarily gabbroid and dioritic rocks form a set resulting from differentiation of the original melt within a single intrusion phase. A further, locally present younger phase comprises the intrusions of differentiates of the tonalite-trondhjemite type. Other rocks present exhibit only a paragenetic relationship to the massif or are completely independent. These are primarily small bodies and dykes of leucogranite, aplite and pegmatite, that may represent metamorphic mobilizates and segregations derived by partial melting of enclaves of metapelitic rocks. Alternatively, they may represent the products of Variscan igneous activity, related to the nearby parts of the Central Bohemian pluton or of the West Bohemian pluton.

The variable group of spessartite, diorite porphyrite, trondhjemite porphyrite and granite porphyry dykes has a similar indirect relationship to the massif (Vejnar 1979).

Rocks of the older intrusive phases form three petrographically different zones in the framework of the stratiform structure of the massif. The lower zone, consisting of olivine gabbro, olivine gabbronorite and locally present ferrodiorite, appears at partial elevations of the given structure primarily in the SW and central parts of the massif. The middle zone consists of diorite and forms primarily the central part of the massif. The upper zone, exposed in the NE part of the massif, consists of quartz diorite.

The rocks of the lower zone appear at the present surface as isolated bodies. This is due to primary irregularities in the originally subhorizontal stratiform structure which forms local elevations (with possible rheomorphic penetration into higher zones) and to the extensive secondary recrystallization (uralitization). These bodies are most often surrounded by uralitized gabbroic rocks (primarily uralitized gabbronorite) and they occur near Orlovice, at Čertův kámen, near Všeruby and near Branišov.

The short-range, macroscopically visible stratification in the outcrops and the layering of the rock samples becomes less conspicuous towards the upper zones. Simultaneously, the frequency of xenoliths of crystalline schists increases and the intrusive rocks form an ever increasing number of small and larger apophyses, penetrating into the surroundings.

The uralitization is localized primarily along a poorly defined zone trending in the NW—SE direction diagonally across the massif. The zone is about 5 km wide and it roughly follows fracture zones corresponding to the SE spurs of the Mariánské Lázně fault.

Structural units of the massif and their rocks

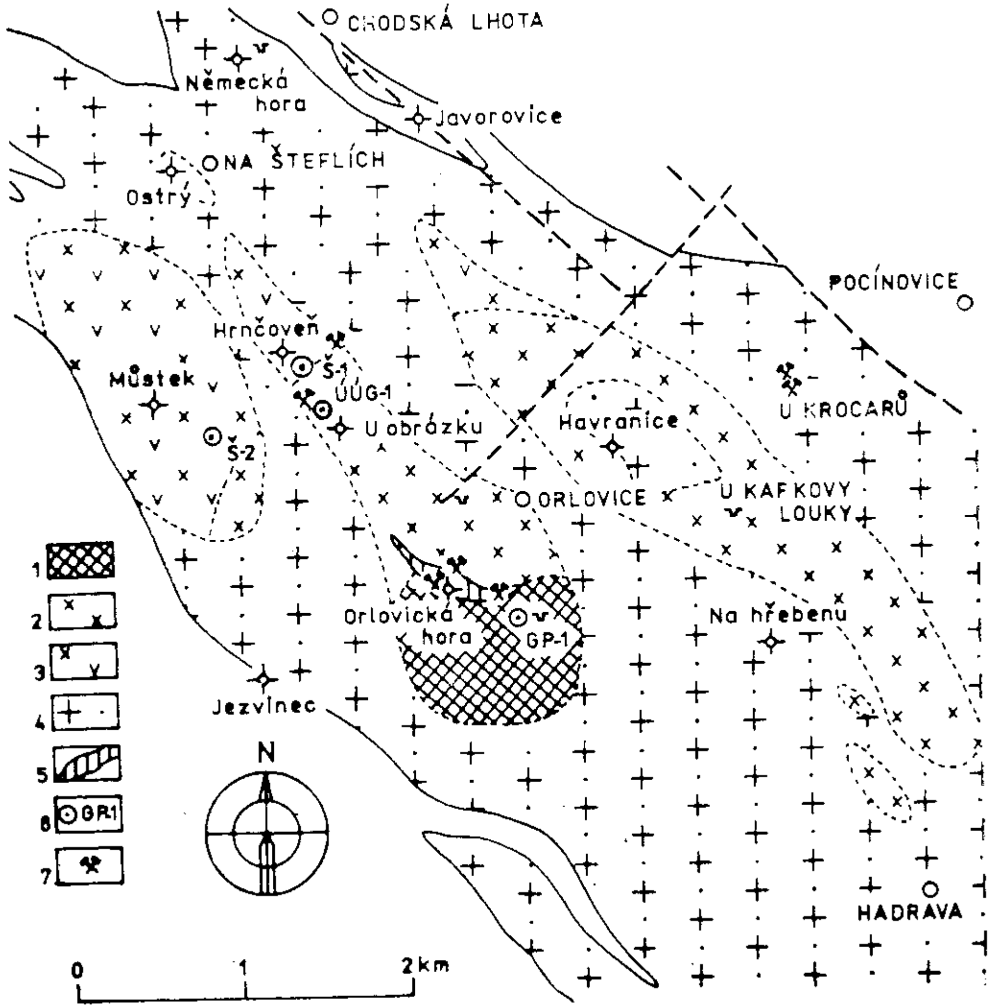
Units of the older intrusive phase

The lower zone of the massif

The lens-shaped bodies of primary gabbroid rocks accompanied by several small satellite bodies are found around Orlovice, a village lying about 7 km SW of Pocínovice; the most interesting of these is at the top of Ostrý Hill (594 m) near Štefle (3 km SW of Chodská Lhota). On the present-day surface, these bodies have the shape of irregular lenses, elongated in the NW—SE direction, about 2 km wide and 4—9 km long. These bodies are designated as the Můstek (564 m), Orlovická hora (719 m) and Havranice (666 m) bodies, depending on the name of the elevation that they form (fig. 2).

The bodies are surrounded by uralitized gabbronorite, and only the edge of the Můstek body lies along a hornblende-pyroxene hornfels band, accompanied by pyroxene-amphibole diorite. Exceptionally, these bodies contain enclaves of crystalline schists (primarily pyroxene-amphibole hornfels and olivine-pyroxene hornfels, locally enriched in pyrrhotite) and small intrusions of younger intrusive rocks, represented by tonalite, trondhjemite, leucogranite, spessartite, trondhjemite aplite and granite pegmatite.

The spatial relationships and clear continuity in the extent of the basic rock



2. Geological map of the region around Orlovice
1 — olivine gabbro; *2* — olivine gabbronorite; *3* — ferrodiorite; *4* — uralitized gabbronorite and ferrodiorite; *5* — olivine-pyroxene hornfels, sometimes with pyrrhotite; *6* — bore; *7* — old iron and titanium ore mines

types indicate that these localities represent relics of the original continuous body with a uniform stratiform structure. This structure is retained most completely in the Orlovická hora body and in the accompanying locality at Ostrý Hill.

The Orlovická hora body consists of three major types of rocks, belonging to various levels of the stratiform structure. The lowest horizon of this structure consists of olivine gabbro and appears on the surface in the southernmost part of the body S of Orlovická hora and Orlovice. The middle horizon of olivine gabbronorite outcrops further to the NW. The highest horizon, exposed extensively in the NW part of the body, consists of alternating layers of gabbronorite and olivine ferrodiorite with subsidiary interlayers of leucoferrodiorite, anorthosite and hortonolite rock. In the NW, i.e. higher in the stratiform sequence, the fraction of ferrodiorite increases, forming primarily the neighbouring Ostrý Hill locality.

The boundaries between the individual horizons are transitory, delimited by the step-wise appearance of bands, layers and schlieren of an individual rock or a particular mineral association and by the appearance of a second type of rock having a different mineral composition or containing minerals of different chemical composition. This alternation of bands of various rock types and varieties is least apparent in the lowest horizon, i.e. in the olivine gabbro. The central, gabbronorite level is mostly thick-layered. The individual rock varieties are present in layers dm to m in thickness. The thickness of the bands in the highest level varies from mm to cms. The margins of these relatively thin bands are poorly defined and the bands pass into schlieren and streaks.

Foliation planes corresponding to this layering are generally inclined at an angle of 30—50° to the NE or NNE. Outcrops on which these planes can be measured are very rare.

The Můstek body lying further west is very poorly visible on the present surface. It consists primarily of various varieties of ferrodiorite, with olivine gabbronorite in the S and E.

Olivine gabbronorite predominates in the Havranice body, almost everywhere weakly uralitized. Rocks inclining to ferrodiorite appear at the NW and NE edges.

Petrography of the bodies around Orlovice. *Olivine gabbro.* This rock consists of small to medium-grained aggregates of euhedral crystals of plagioclase with composition An_{58-64}, in which strongly corroded lobe-shaped anhedral olivines are dispersed (size 0.5 to 3 mm), exceptionally accompanied or bordered by subhedral bronzite. The dominant dark mineral is augite, present as 1—20 mm long poikilitic crystals enclosing the plagioclase grains. Optically, these crystals are mostly zonal. Their cores are pure, homogeneous and the edges are cloudy and full of tiny, dark-grey or brown microlitic inclusions, formed partly by augite inclining to diopside. The rock also contains a small amount (about 5 %) of dark-brown hornblende. Anhedral ilmenite and pyrrhotite appear as occasional accessory minerals.

The contact between the olivine and plagioclase is accompanied by a bizonal reaction rim, consisting of bronzite or augite and brown amphibole.

The primary stratification of the rock is not marked, and is given only by locally observed layers with various contents of poikilitic augite, or layers and schlieren differing in the crystal size of the rock-forming minerals.

The uralitization observed locally is bound to certain, several dm thick zones oriented parallel with the layering. Augite and the shape of the original olivine crystals possibly including bronzite, replaced by secondary amphiboles, are mostly retained in the thinner zones. The rock becomes light-coloured, spotted, grey-green with conspicuous whitish plagioclases. In the thicker zones, the original gabbro is mostly completely recrystallized and only ilmenite remains of the primary minerals.

Olivine gabbronorite. This rock occurs in several texturally and mineralogically different varieties, forming individual layers and bands. Šmejkal (1958) designated this rock as olivine gabbro in the sense of the classification system used at that time.

The most widespread variety of rocks is medium-grained and dark greenish-grey in colour. The texture is subhedral or gabbro ophitic, with local poikilitic augite. The mineral composition is 50–60 % plagioclase, 15–20 % olivine, 5–8 % bronzite and 15–20 % augite. Small amounts of a brown amphibole, ilmenite, apatite and pyrrhotite are also present.

In addition to aggregates of subhedral grains, plagioclase with composition An_{53-56} forms isolated, up to 10 mm long crystals, poikilitically enclosing along its margins olivine crystals. Olivine forms anhedral, lobate grains, whose contact with the plagioclase is lined by hypersthene + amphibole reaction rims. Abundant cracks in these olivine grains are decorated by very fine-grained magnetite or hematite.

The subhedral crystals of bronzite are mostly part of the complex olivine-augite aggregate, whose interstices are mostly filled with brown amphibole, occasionally accompanied by a small amount of pyrrhotite. Augite is also present as isolated poikilitic crystals up to 5 mm in size.

Ilmenite is usually surrounded by a narrow rim of brown amphibole. Pyrrhotite is present only occasionally as drop-shaped, grains; Šmejkal (1958) believes that the presence of these grains indicates a very high sulphur concentration in the original gabbroid magma. This mineral mostly forms a fill between Mg, Fe silicates. In some places these grains (up to 2 mm long), composed of mozaic aggregates of fine crystals, surround or enclose fine olivine.

Coarse-grained olivine gabbronorite, containing a somewhat smaller amount of olivine and more plagioclase and augite forms a texturally different variety of the described type. The content of accessory minerals is very low or zero.

A further variety of gabbronorite, characterized by an increased content of interstitial pyrrhotite, forms 5–50 mm wide fine-grained interlayers that are occasionally found between the thicker layers of the two above-described varieties of gabbronorite. The presence of pyrrhotite in amounts of up to cca 5 % is reflected by limonite coatings on weathered samples.

In regions of the transition between the middle and upper horizons (e.g. in the area around the "U obrázku" cross-roads), layers and bands of further rock types and varieties forming the upper, ferrodiorite horizon are gradually inserted into the layers and schlieren of the olivine gabbronorite. In this transitional region, olivine gabbronorite contains a distinctly larger fraction of orthopyroxene (10 % and more). which forms marked, broad overgrowths around the olivine crystals (up to 0.3 mm). Of the accessory minerals, apatite is present, in addition to ilmenite and pyrrhotite.

Olivine leucogabbronorite and anorthosite. These two rock types, which are frequently bounded by transitions, form poorly defined several cm to dm thick interlayers and schlieren with characteristic variation in the content of the mafic minerals. Their edges usually have 5—30 mm wide olivine-pyroxene melanocratic borders with a relatively high content of ilmenite (5—10 %) and apatite. Ilmenite is anhedral, irregularly lobe-shaped, ranging in size from 0.2 to 1 mm. The apatite characteristically is present in thin prismatic crystals with dimensions of about 0.1×0.7 mm.

Anorthosite is present in two limiting varieties given by the mineral assemblages

plagioclase + olivine ± augite ± amphibole

and

plagioclase + ilmenite + apatite ± amphibole.

In the first variety, anhedral olivine is accompanied by a small amount of interstitial augite and brown amphibole. There are practically no accessory minerals present. The second variety contains ilmenite as the main and often the only mafic mineral (5—10 %), forming irregular lobe-shaped anhedral, partly poikilitic grains (with a size of 0.5 to 1.5 mm), filling the spaces in the plagioclase aggregate and enclosing grains of apatite. Along the contacts with plagioclase a narrow rim of dark-brown amphibole is usually found. The apatite forms thin prismatic crystals (with a size of 0.1×1 mm), amounting to 1—3 %.

Hortonolite rock. This is a special rock type in the Kdyně massif discovered by Slavík in 1922; it occurs as scree in the weathered surface layer in the NW part of the Orlovická hora body, mainly between the forest road crossing at "U obrázku" (also "U Sv. Josefa") and the summit of the Hrčoveň elevation.

Hortonolite rock, also designated as ilmenite peridotite (Šmejkal 1958), forms several cm to dm thick layers in the area of the upper horizon of the Orlovická hora body, consisting primarily of olivine gabbronorite and olivine ferrodiorite with interlayers and schlieren of olivine leucoferrodiorite and anorthosite. This is a massive, smokey-black, limonitic weathered rock, primarily fine-grained, occasionally with macroscopical shiny ilmenite grains. It consists of an aggregate of anhedral olivine crystals, with spaces usually filled by ilmenite, apatite, brown amphibole, pyroxene and very sparcely also by plagioclase.

The content of the primary minerals in the rock varies within the following limits: 100—80 % olivine, 15—0.5 % ilmenite and 10—0 % pyroxene + amphibole + plagioclase. The variations in the modal composition were studied in detail in the hortonolite layer, at the "U obrázku" locality in the ÚÚG1 drill hole with an apparent thickness of 45 cm. The ilmenite content decreased in the order $15 \rightarrow 5 \rightarrow 2 \rightarrow 0.5$ % (measured at regular 15 cm intervals) from the top to the base of the layer. Simultaneously, the olivine content increased while the content of brown primary amphibole is constant (about 2 %).

Local uralitization first affects the brown amphibole, whose colour gradually changes to pale blue green. In the next stage, an aggregate of newly-formed acicular pale-green amphibole is formed, bordered by colourless actinolitic amphibole along contacts with olivine grains. As these alterations progress in irregular patches, olivine gradually decomposes to aggregates of acicular colourless actinolite, accompanied by abundant newly-formed magnetite, to be later replaced by hematite. This magnetite is accumulated in fine cracks and veins or forms marked secondary borders around former olivine grains.

These hematitized hortonolite portions and weathered outcrops subjected to limonitization were once mined as iron ore and, after the first and second world wars, were prospected as potential sources of titanium ore (together with schlieren and bands of ilmenite-rich leucogabbronorite).

Olivine ferrodiorite. This rock is similar to olivine leucogabbronorite with which it is connected by transitions. It differs from the latter by its content of a less calcic plagioclase (mostly An_{45}) and a higher content of olivine, ilmenite and apatite. The amount of orthopyroxene increases at the expense of clinopyroxene. S m e j k a l (1958) described this rock in the Můstek body and called it olivine diorite.

This rock is dark grey-green, mostly more or less markedly banded or streaky with gabbroic granular texture. The content of minerals in the individual bands varies considerably. The rock consists of plagioclase with a random orientation or parallel arrangement of subhedral grains, between which isolated crystals of dark minerals are dispersed.

The plagioclase is mostly zoned. Its composition ranges between An_{45} to An_{30}.

Olivine ferrodiorite from the summit of Ostrý often contains secondary, black-coloured hematitized olivine, accompanied by bluish-grey orthopyroxene, augite and dark-brown amphibole. The composition of the plagioclase varies around An_{35}.

Uralitization of this variety of ferrodiorite progresses along cracks and interfaces and gradually changes the individual crystals of Mg, Fe silicates and clusters of these crystals into pseudomorphs, which often have very marked zonal structure. The nuclei of these pseudomorphs, originally formed by pyroxenes, are gradually replaced by fine-grained aggregates of randomly oriented plates of light greenish or colourless amphibole (grünerite), mostly accompanied by a small amount of magnetite and titanite. The edges formed in the regions of the original borders of primary amphibole consist of radially arranged aggregates of dark blue-green amphibole (ferrotschermakite), partly also formed at the expense of the neighbouring plagioclase. Simultaneously, minute crystals of this secondary amphibole begin to appear in cracks of the plagioclase grains.

Decomposition of the olivine (fayalite) is accompanied by separation of a large fraction of magnetite later replaced by hematite.

The Můstek olivine ferrodiorite body is mostly streaky, with othopyroxene predominating over clinopyroxene. Rarely, melanocratic bands containing up to 5 % of ilmenite and 3 % of apatite appear. Their uralitized parts mostly contain fine-grained, radiating aggregates of colourless amphibole (cummingtonite), accompanied by large amounts of magnetite, mostly converted to hematite.

T h e Č e r t ů v k á m e n b o d y appears in the central part of the southern apophysis of the Kdyně massif, lying between Chudenín and the Czechoslovak border and extending further to the SW into the FRG. This apophysis is separated on the present-day surface from the main body of the massif by a band of crystalline schists, primarily represented by contact metamorphosed biotite paragneiss accompanied by hornblende-pyroxene hornfels.

The body is elliptical in shape and is surrounded by weakly uralitized pyroxene-amphibole diorite, which is the dominant rock in this apophysis. It is characterized by a high content of mafic xenoliths. This body showing characteristics of the stratiform structure (V e j n a r 1984) consists of olivine diorite with some domains and layers of olivine gabbronorite. Layers of pyroxene ferrodiorite and pyroxene leucoferrodiorite appear higher in the stratiform sequence.

T h e V š e r u b y b o d y is located at the W edge of the massif around Všeruby. Towards the SSW it continues into the FRG. It is elongated NNE—SSW and at the NNE end lies an isolated region of olivine gabbronorite at Starec, separated by a band of uralitized gabbronorite. In the W it approaches the crystalline rocks which are strongly thermally recrystallized. In the E, a number of outcrops and accompanying lens-shaped bodies (between Hájek and Hyršov) come into contact with pyroxene-amphibole diorite, which belongs to the central zone of the Kdyně massif. Along this contact, a marked convergence of the rocks of the two zones can be observed; gabbronorite of the

Všeruby body is relatively fine-grained, poorer in olivine and richer in amphibole. On the other hand, the diorite mostly contains isolated olivine and the composition of its plagioclase attains values as high as An_{52}.

The stratiform structure of the Všeruby body is poorly defined, and is interrupted by local xenoliths of pyroxene-amphibole hornfels and by the occurrence of rocks with diorite composition. In the immediate vicinity of Všeruby, i.e. in the central part of the body, medium to coarse-grained olivine gabbro is found, gradually passing into gabbronorite. This rock contains relatively abundant olivine (20—30 %) and up to 30 mm long poikilitic crystals of augite. Gabbronorite, characterized by a high content of orthopyroxene, becomes more fine-grained towards the margins of the body.

Gabbronorite from the locality around Starec contains about 25 % of dark red-brown amphibole, replacing the pyroxenes bordering the olivine crystals. The plagioclase is mostly plate-shaped and in some places clearly with a plane-parallel arrangement.

The gabbro and gabbronorite of the Všeruby body are locally weakly uralitized. At the N edge of this body (around Hájek) the degree of this alteration rapidly increases and the rock passes into uralitized gabbronorite.

Localities around Branišov. In the relatively extensive body of uralitized gabbronorite between Branišov and Kdyně, two small localities of olivine gabbronorite are preserved, with marked plane-parallel arrangement of tabular plagioclase. This rock, which is petrographically similar to the variety from the marginal parts of the Všeruby body, is fine-grained, more rarely medium-grained and contains only 3—5 % of olivine. On the other hand, the content of dark-brown amphibole attains values up to 25 %. The local uralitization has a similar character to that in the Všeruby body. It is occasionally accompanied by weak pyritization, primarily localized along fault zones.

The further small localities of gabbronorite in the broader region around Kdyně and Hluboká have a similar character.

Bodies and outcrops of uralitized gabbronorite. As mentioned above, the occurrences of uralitized gabbronorite are associated with a tectonically activated, about 4—5 km wide zone running acoross the central part of the Kdyně massif. The largest continuous body lies between Hadrava and Chodská Lhota, containing the above-described bodies of the primary gabbroid rocks of the Orlovická hora, Můstek and Havranice localities.

The uralitized gabbronorite is a grey-green rock with white spots that is texturally and mineralogically very variable; the grain size varies from coarse to fine and changes in the mineral composition reflect the variability of the original rock and the degree of recrystallization.

Considering the presence of relict olivine and pyroxene (and possibly their replacement by various types of secondary amphiboles) it is apparent that, in addition to the predominant varieties formed by uralitization of olivine gabbronorite, there are regions (e.g. around Štefle and Výrov), where they were derived from ferrodiorite and pyroxene diorite. The regional distribution of these varieties roughly corresponds to the distribution of the individual types of primary gabbroid rocks in the area.

In these sections, the rock has a relict gabbro granular or gabbro-ophitic texture, occasionally with coronite borders of secondary amphiboles around pseudomorphs after olivine or pyroxene. With increasing uralitization, a heterogranoblastic texture appears. The original dark minerals are gradually replaced by fine-grained, radiating aggregates of light-green, colourless or dark blue-green to black-green amphibole, most often corresponding to actinolite, cummingtonite and more rarely to ferrotschermakite and grünerite. Occasionally, these amphiboles are accompanied by a small amount of biotite and light-green chlorite.

The original plagioclase is mostly converted into andesine, and was occasionally recrystallized into oligoclase-andesine and/or oligoclase. It mostly encloses dirty grey clusters of microlites, apparently belonging to the minerals of the epidote group. The small content of quartz is mostly concentrated in fine veins that often also contain chlorite.

Hematitized olivine, bronzite, augite and rarely also brown amphibole are usually present as relict phases.

The middle zone of the massif

The dominant rock in this part of the massif, outcropping on the present surface S and SE of Kdyně (around Hyršov, Chodská Lhota and Fleky) is diorite, which appears in a number of textural and mineral varieties.

This rock is mostly fine-grained, occasionally medium-grained, massive, dark grey-green. It often contains small xenoliths, mostly of hornblende-pyroxene hornfels. The texture is usually gabbro-ophitic with poikilitic hornblende. It occasionally contains pyroxene and rarely biotite. In regions with high xenolith contents, this texture changes into anhedrally granular texture with poikilitic development of amphibole or pyroxene, similar to the structure of hornblende-pyroxene hornfels.

The mineral composition of diorite changes in dependence on the stratiform structure of the massif. The region next to the rocks of the lower zone, primarily gabbronorite, is formed by pyroxene-amphibole diorite and pyroxene diorite with plagioclase, varying in the range An_{47} to An_{53}. The higher parts of the sequence consist of pyroxene-amphibole diorite with biotite and amphibole-pyroxene diorite with plagioclase composition An_{40}—An_{45}. In these rocks, pyroxene is usually in the form of hypersthene and augite is present in smaller amounts. Biotite, present in amounts of up to 5 % is dark red-brown and mostly fills the interstices in the plagioclase-pyroxene-amphibole aggregate, or forms poikilitic skeletal crystals bearing tiny inclusions of pyroxene and plagioclase. A small amount of interstitial quartz occurs mostly in the variety containing biotite. The main accessory mineral is ilmenite, present in amounts up to 5—10 % in hypersthene diorite. It is locally accompanied by a small amount of pyrrhotite and pyrite.

To the S of Chodská Lhota and SE of Chalupy, diorite appears in the transitional region between the lower and middle zones of the massif, inclining to ferrodiorite, described in the region around Ostrý. Compared to the mafic variety of pyroxene-amphibole diorite, this rock clearly has a lower content of dark minerals (the colour index equals approx. 0.35), represented by ferrohypersthene, ferroaugite and ferrohornblende. The plagioclase corresponds to andesine with composition An_{34}—An_{40}.

All these varieties of diorite are locally weakly uralitized, showing decomposition of the dark minerals to actinolite or cummingtonite. The gradual decolouring of primary amphibole and its decomposition is accompanied by crystallization of titanite. The plagioclase is mostly sericitized.

The upper zone of the massif

This structural unit forms the NE part of the massif, lying between Kdyně and Koloveč. It consists of quartz diorite, mostly containing abundant xenoliths of crystalline schists (hornfelses). Around Branišov, E of Kdyně, this diorite contains a body of uralitized gabbronorite, apparently representing a local elevation of the lower zone of the massif, and also a body of pyroxene-amphibole diorite with biotite (around Dobříkov), corresponding to the middle zone.

The petrographic variability of quartz diorite apparently depends on the effects of local contamination. Its apophyses, penetrating into biotite-muscovite and biotite-cordierite hornfels, mostly consist of rather felsic, biotite- and quartz-rich varieties, locally inclining to tonalite. On the other hand, parts neighbouring with bodies of amphibole-pyroxene hornfels (or containing xenoliths of this rock) are richer in amphibole and occasionally contain monoclinic pyroxene. In addition to this local variability, a clear regional trend in the changes can be observed, seen as a gradual disappearance of pyroxene and a decrease in the content of amphibole from the SW (around Kdyně) to the NE (around Koloveč).

The mafic variety of quartz diorite, extensive, e.g., around Kdyně, is fine-grained and has a subhedral granular or markedly ophitic texture. It contains a large number of cm to dm inclusions of xenoliths of hornfelses. It consists of reddish-brown amphibole, a small amount of biotite (2—5 %), zonal plagioclase with composition An_{30} to An_{40} and quartz, which fills the intergranular spaces in the plagioclase-amphibole aggregates and is present as poikilitic skeletal crystals. Monoclinic pyroxene appears very rarely. Of the accessory minerals, zircon, apatite, ilmenite, titanite and epidote were found.

The medium-grained variety of quartz diorite mostly contains a smaller amount of amphibole and somewhat more biotite (5—15 %) and quartz. Occasionally it passes into tonalite. The amphibole is green or light green. Allanite is a characteristic accessory mineral. This rock is found most extensively in the eastern part of the massif around Pocínovice. It differs from the biotite-amphibole tonalite of the younger intrusive phase in having a less pronounced parallel fabric.

To the E of Koloveč, a variety of quartz diorite containing hypersthene (around Zichov) participates in the structure of the local apophysis of the massif, emplaced in the amphibole-pyroxene hornfels. In this variety, biotite is bright red brown, developed as macroscopically visible, 3—5 mm poikilitic flakes, carrying inclusions of bluish-grey hypersthene, dark-brown amphibole and plagioclase An_{42}—An_{50}. Quartz is present along interfaces. Local uralitization appears as decomposition of the hypersthene into cummingtonite.

Rocks of the younger intrusive phase

The lens-shaped bodies of rocks of the younger intrusive phase appear primarily in the central and S parts of the massif, mostly in crystalline schists of the mantle relics around Chudenín and Pláně. They are represented by tonalite and trondhjemite. In some bodies, these two rocks are apparently closely related, but mutual contacts have not been observed.

Tonalite is a medium-grained, light-grey, often clearly foliated rock. Its texture is subhedrally granular, occasionally cataclastic. It consists of roughly equal amounts of greenish-brown amphibole and reddish brown biotite, zoned plagioclase with composition An_{26} to An_{35} and quartz. Accessory minerals include zircon, apatite, allanite, ilmenite and titanite.

In contrast to tonalite, trondhjemite is finer-grained, whitish grey in colour and the dark minerals are mostly represented by biotite alone (ca. 5—8 %), occasionally accompanied by isolated crystals of blue-green amphibole. The plagioclase composition varies from An_{20} to An_{28}. Its cores occasionally contain secondary muscovite.

The younger intrusive phase also contains an elliptical body of biotite-amphibole granodiorite from Všepadly, located in quartz diorite. The rock contains occasional tiny phenocrysts of potassium feldspar. Petrographically and in its chemical composition, it is similar to the granitoids of the Stod massif (Tonika - Vejnar 1966).

The group of bodies of the younger intrusive phase can probably also be considered to include the small lens-shaped body of coarse-grained amphibole diorite, which penetrates through the relic of the crystalline mantle of the massif at the summit of St. Bernhard chapel 7 km WNW of Chudenín. The rock is coarse to very coarse-grained, consisting of a prismatic dark-brown amphibole and plagioclase An_{34}. Small amounts of biotite are present, along with quartz and rarely also with potassium feldspar. In some places, the rock contains almost monomineral, nest-like accumulations of large amphibole crystals, occasionally strongly uralitized.

Intrusive rocks genetically unrelated to the Kdyně massif

These rocks appear in the massif and in its mantle as occasional dykes, sometimes trending NW—SE along the faults. In the plutonic rocks of the massif, they are mostly only several dm to m thick; in the crystalline rocks of the mantle, this thickness increases up to several tens of metres. Petrographically, they comprise granite, spessartite, diorite- and trondhjemite-porphyrite (Vejnar 1979), pegmatite and granite- and trondhjemite-aplite.

Leucogranite is present primarily in the SE part of the massif, where is penetrates through the uralitized gabbronorite and contact-metamorphosed rocks of the mantle as several hundred metres long and 10 to 100 m thick dykes. The leucogranite is mostly fine- to medium-grained, clearly foliated, occasionally with small phenocrysts of potassium feldspar. It contains 3—8 % of muscovite biotite, An_{20} plagioclase, microcline and quartz. In the thin, mostly several cm to dm thick dykes, it is fine-grained, similar to aplite.

Spessartite appears as occasional thin dykes throughout the massif. It was studied in greater detail around Orlovice, where it occurs as fine-grained and medium-grained uralitized varieties.

The rock has relict ophitic texture. The original pyroxenes and partly the primary brown amphibole are converted into an aggregate of light-green secondary amphibole, formed partly at the expense of the original plagioclase. The high ilmenite content (ca. 5—8 %) is characteristic; it is present as marked skeletal or plate-like crystals.

Minerals and their chemical composition

The variability in the chemical compositions of olivine, pyroxenes, amphibole and biotite, present in the individual types and varieties of rocks of the older and younger intrusive phases of the massif, was studied on the basis of analyses carried out by V. Miksa in cooperation with J. Jilemnická and Ing. Z. Kotrba on an ARL-EMX type microanalyzer, in the laboratories of the Geological Survey, Prague (headed by Ing. J. Rybka).

Olivine. Olivine is present in the rocks of the lower zone of the massif primarily as anhedral, lobe-shaped corroded crystals, whose contact with plagioclase is accompanied by simple (orthopyroxene) or bizonal (orthopyroxene-augite, orthopyroxene-amphibole) reaction rims. Depending on the iron content, polished surfaces of the olivine are colourless, light ochre-grey or yellow-ochre in colour. The high-iron olivine present in ferrodiorite is mostly grey-black in colour as a result of partial decomposition, accompanied by crystallization of magnetite.

The chemical composition of the olivine (tables 1 and 2) varies primarily in the Fe/Mg ratio: olivine gabbro contains chrysolite, whose iron content X_{Fe} [expressed as the ratio (Fe+Mn)/(Fe+Mn+Mg)] varies in the range 0.22—0.33. In gabbronorite, olivine is present as hyalosiderite (X_{Fe} = 0.34—0.50), in leucogabbronorite, anorthosite and hortonolite rock as hortonolite (X_{Fe} = 0.60—.62) and in ferrodiorite as ferrohortonolite or fayalite (X_{Fe} = 0.78—0.91).

As the iron content increases in olivine, the content of manganese also increases from about 0.3 to 1.5 % MnO. The aluminium content, and, as indicated by a single determination, also the calcium content, are mostly very low, at the detection limit of the analytical method employed. Al_2O_3 contents up to several tenths of a percent mostly appear in olivine of gabbroid rocks rich in plagioclase.

Orthopyroxene. This mineral appears as subhedral or euhedral crystals of the cumulate type. It is most widespread in the rocks of the transitional region between the lower and middle zone of the massif, i.e. in ferrodiorite and pyroxene or pyroxene-amphibole diorite.

In the rocks of the lower zone of the massif, the composition of the pyroxene varies in agreement with changes in the iron content of the coexisting olivine. These changes were studied in detail on pyroxenes from rocks of the Orlovice bodies (table 3), where their fractional spectrum in the rock sequence olivine gabbro → ferrodiorite extends from bronzite to eulite (X_{Fe} varies from 0.20 to 0.83). The determined extend of the Fe-Mg substitution is much greater than that so far known for the Bushveld complex (Atkins 1969) or the Skaergaard intrusion (Wager - Brown 1968, Nwe 1976) and corresponds roughly to the variability of orthopyroxene from the rocks of the Harzburg massif (Vinkx 1982).

The diorite of the middle zone contains light-grey or blue-grey orthopyroxene in prismatic euhedral or subhedral crystals. Its composition (table 5) corresponds primarily to hypersthene and occasionally to ferrohypersthene.

Table 1

Microprobe analyses

Analysis	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*
Sample	843	846	847	850	915	888	899	825	777	V 27	896
Mother rock	olivine gabbro							olivine gabbronorite			
SiO_2	37.48	36.81	38.60	36.90	36.94	36.64	37.31	35.19	37.84	36.00	35.05
Al_2O_3	0.22	0.05	0.07	0.06	0.02	0,04	—	0.07	0.10	0.03	0.32
FeO tot.	24.77	25.30	24.94	29.25	27.37	20.43	28.00	30.96	29.18	31.43	40.44
MnO	0.44	0.41	0.35	0.46	0.34	0.22	0.28	0.48	0.50	0.47	0.60
MgO	36.93	37.55	36.51	32.92	35.72	41.38	34.68	33.39	32.38	31.88	24.22
Total	99.84	100.12	100.47	99.59	100.39	98.71	100.27	100.09	100.00	99.81	100.63
Formulas calculated											
Si	0.99	0.97	1.01	1.00	0.98	0.96	0.99	0.96	1.02	1.09	0.99
Al	0.01										0.01
Fe	0.55	0.56	0.55	0.66	0.61	0.45	0.62	0.70	0.66	1.15	0.96
Mn	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01
Mg	1.40	1.48	1.42	1.33	1.41	1.62	1.38	1.36	1.30	0.65	1.02
	2.03	2.05	1.98	2.00	2.03	2.08	2.01	2.07	1.97	1.82	2.00
$\frac{Fe+Mn}{Fe+Mn+Mg}$	0.28	0.27	0.28	0.33	0.30	0.22	0.31	0.34	0.34		0.48

Localities of samples given in tables 1—15:

138 — ÚÚG1 bore, 48.0 m, located close to point 560 ("U obrázku"), 1.2 km NW of Orlovice; 140 — GP1 bore located near the wood road from Orlovice to Jezvinec, 0.1 km S of point 622; 522 — ÚÚG1 bore, 12.5 m, located close to point 560, 1.2 km NW of Orlovice; 567 — abandoned quarry 0.75 km NE of Všepadly; 619 — boulders in the woods 1.1 km SSW of Prapořiště; 622 — abandoned quarry 0.75 NE of Všepadly; 627 — abandoned quarry in the woods 0.7 km SSW of Starec; 629 — boulders at the edge of the woods, 0.3 km W of point 568, ESE of Kdyně. Ilmenite-rich rock; 630 — boulders next to the field road leading to point 516 (Svatá Anna) from the Kdyně—Všeruby highway, 1.1 km SE of Brůdek; 632 — boulders at point 516 (Svatá Anna) 0.8 km SE of Hájek; 634 — abandoned sand pit at the NW edge of Všeruby; 635 — abandoned quarry in the fields 0.6 km NW of Hyršov. The rock contains amphibole-pyroxene hornfels; 638 — locality as 635; 640 — abandoned quarry on the NNE side of Mt. Bezný (659) 1 km WSW of Brnířov; 642 — locality as 635; 647 — sand pit 2 km NW of Chudenín next to the highway to Všeruby; 650 — rock outcrop close to point 446 at the edge of Hájek; 678 — abandoned quarry 0.5 km W of Branišov; 680 — abandoned sand pit in the saddle between Koráb (773 m) and Suchá hora (760 m) next to the road from Kdyně to Mezholezy; 681 — hole left after sand quarrying 0.5 km NW of Branišov; 685 — abandoned quarry in the fields, 0.8 km NW of Chodská Lhota; 687 — rock outcrops on the N ridge of Bezný (659 m), 1.1 km WSW of Brnířov; 689 — abandoned sand pit in the saddle between Bezný (659 m) and Čepice (642 m), 1 km NW of Nová Ves; 750 — boulders at the edge of the woods on the NE side of Ostrý (594 m), 2 km SW of Chodská Lhota; 752 — abandoned quarry NW of Branišov; 753 — top of Ostrý (594 m) 1.8 km WSW of Chodská Lhota; 761 — boulders at the edge of the woods on the right bank of Kouba

Table 1

of olivine. Orlovice bodies

12	13	14	15	16	17	18	19
522	138	778	V 26	903	761	782	753
anorthosite	leucogabbro norite	hortonolite rock		ferrodiorite			
32.49	32.76	35.14	34.14	32.42	31.83	33.57	34.02
0.24	0.38	—	0.02	—	0.32	0.15	0.41
48.24	49.09	47.58	47.69	58.57	62.86	61.44	62.01
0.85	0.96	0.69	0.85	1.10	1.36	1.32	1.46
17.88	17.37	17.39	17.10	9.20	3.91	3.32	0.72
99.70	100.56	100.80	99.80	101.29	100.28	99.80	98.62
on the basis of 4(O)							
0.97	0.97	1.03	1.02	1.01	1.03	1.07	1.08
0.01	0.01				0.01	0.01	0.01
1.21	1.22	1.16	1.18	1.52	1.70	1.64	1.70
0.02	0.02	0.02	0.02	0.03	0.04	0.04	0.04
0.80	0.77	0.76	0.76	0.43	0.19	0.16	0.03
2.04	2.02	1.94	1.96	1.98	1.94	1.85	1.78
0.61	0.62	0.60	0.61	0.78	0.88	0.91	0.98

1.5 km NE of Calupy; 762 — locality as 753; 766 — rocky outcrop behind the shop in Zíchov, W of Koloveč; 777 — abandoned quarry 0.4 km WSW of the gamekeeper's lodge in Orlovice. Band of gabbronorite with increased pyrrhotite content; 778 — old mine slag heap close to point 50 ("U obrázku"), 1.2 km NW of Orlovice; 782 — abandouned sand pit at the edge of the woods on the SW side of Ostrý (594 m), 1.9 km WSW of Chodská Lhota; 825 — abandoned quarry 0.4 km WSW of the gamekeeper's lodge in Orlovice; 843 — abandoned quarry in the woods 0.1 km E of point 622 at the E edge of Orlovice; 846, 847 — locality as 843; 850 — rocky outcrop on the S side of Orlovická hora (719 m); 852 — locality as 843; 857 — abandoned quarry at the SE edge of Srbice; 858 — abandoned sand pit 1.0 km SE of Srbice; 883 — rocky outcrops on the hill 0.6 km SE of point 527 (Na hřebeni) 1.2 km NW of Hadrava; 888 — debris at the edge of the Kameniště (541 m), 1.3 km ESE of Chalupy; 893 — outcrops next to the wood road 4.0 km N of Hyršov, 1.5 km ESE of Hájek; 896 — abandoned quarry near Kafkova louka next to the road from Orlovice to Pocínovice; 899 — debris in the woods on the E sides of point 629, 1.5 km W of Hadrava; 900 — debris in the woods road 0.5 km NE of Orlovice on the S side of Havranice (666 m); 903 — old iron mine close to the house "U Kroearů", 1.5 km SW of Pocinovice; 904 — locality as 888; 905 — debris on the SE side of Jezvinec (739 m), 0.3 km from the top; 909 — edge of the woods W of Přední Fleky; 910 — debris in the woods at point 475, 1 km NW of Sruby; 915 — locality as 843; 917 — cut in the road in the woods at the E side at the foot of Můstek (564 m), 1 km E of Chalupy; 940, 942 — boulders at the E side of Hadrava; 944 — cut in the wood road 0.2 km E of point 537 in the saddle between Můstek (564 m) and Orlovická hora (719 m); 945 — debris next to the wood road 0.25 km S of the top of Můstek (564 m), 1.5 km from Chalupy; 951 — locality as 888; 955 — boulders at the edge of the woods at point 531, 1 km E of Chalupy; 960 — boulders in the woods at the top of the hill 1.6 km E of Všeruby, 0.5 km WNW of point 556; 975 — abandoned quarry 1.3 km S of Chodská Lhota on the NNE side of Javorovice (587 m); 979 — debris at the edge of the woods 0.2 km NW of Branišov; 1018 — debris on the slope at the WNW side of point 641, 1 km from Jezvinec (739 m); V26 — ÚÚG1 bore, 21.5 m, located close to point 560 ("U obrázku"), 1.2 km NW of Orlovice; V27 — abandoned quarry 0.4 km WNW of the gamekeeper's lodge in Orlovice. Band of gabbronorite with increased pyrrhotite content.

Table 2

Microprobe analyses of olivine, Všeruby (*1—4*) and Branišov (*5, 6*) bodies

Analysis	*1*	*2*	*3*	*4*	*5*	*6*
Sample	634	627	979	703	629	681
Mother rock	olivine gabbro		olivine gabbronorite			
SiO_2	37.39	35.92	31.96	34.45	34.22	33.96
Al_2O_3	—	0.05	0.07	0.32	0.03	0.23
FeO tot.	28.23	26.92	38.48	40.36	41.25	46.50
MnO	0.43	0.42	0.53	0.79	0.61	0.83
MgO	32.98	37.26	28.99	22.63	23.99	18.14
Total	99.03	100.57	100.03	98.55	100.10	99.66
Formulas calculated on the basis of 4(0)						
Si	1.00	0.95	0.91	1.00	0.98	1.00
Al	—			0.01	—	0.01
Fe	0.63	0.60	0.92	0.98	0.99	1.15
Mn	0.01	0.01	0.01	0.02	0.02	0.02
Mg	1.32	1.48	1.23	0.98	1.03	0.80
	1.97	2.09	2.16	1.98	2.04	1.98
$\frac{Fe+Mn}{Fe+Mn+Mn}$	0.32	0.28	0.43	0.50	0.49	0.63

The manganese content in orthopyroxene increases, similarly as in olivine, with increasing iron content of the mineral from ca. 0.35 to 1.90 % MnO. The aluminium content is low and varies from 0.20 to 2.00 % Al_2O_3, in dependence on the Fe-Mg substitution: orthopyroxene (bronzite) of the olivine gabbro contains the most, ferrodiorite eulite, the least aluminium.

Calcic pyroxene. In olivine gabbro and partly also in gabbronorite, this mineral primarily forms poikilitic euhedral or subhedral crystals of accumulate and intercumulate character. It appears in ferrodiorite, diorite and quartz diorite as subhedral or anhedral grains, often surrounded or replaced by primary, dark-brown amphibole.

Table 3

Microprobe analyses of orthopyroxene, Orlovice bodies

Analysis	1	2	3	4	5	6	7	8	9	10	11	12
Sample	843	847	888	825	825	V 27	896	917	945	761	782	762
Mother rock	olivine gabbro			olivine gabbronorite				ferrodiorite				
SiO_2	52.62	54.58	52.68	52.46	53.52	52.29	54.24	48.62	49.78	47.72	47.29	50.55
TiO_2	0.30	0.34	0.23	0.34	0.21	0.96	0.03	0.12	0.14	0.09	0.12	0.01
Al_2O_3	1.67	2.03	1.95	1.51	1.53	1.28	1.38	0.40	0.36	0.39	0.32	0.26
FeO	15.30	15.44	12.66	18.66	16.83	19.31	20.21	36.36	37.81	43.08	43.17	41.60
MnO	0.43	0.35	0.78	0.45	0.52	0.49	0.46	0.79	0.81	1.27	1.27	1.92
MgO	28.40	26.79	30.63	26.48	26.24	24.47	22.26	11.87	11.04	7.53	6.81	5.16
CaO	0.70	0.89	0.58	0.72	0.69	1.46	0.36	1.09	0.64	1.03	1.08	0.88
Na_2O	0.06	0.02	0.21	0.03	0.02	0.02	0.09	—	—	0.04	0.02	0.06
Total	99.48	100.44	99.72	100.65	99.56	100.28	99.00	99.25	100.58	101.15	100.08	100.44
Formulas calculated on the basis of 6(O)												
Si	1.91	1.96	1.89	1.88	1.95	1.93	2.02	1.97	1.99	1.95	1.97	2.06
Al	0.07	0.04	0.08	0.07	0.05	0.06	—	0.02	0.01	0.02	0.02	—
Al	—	0.05	—	—	0.02	—	0.06	—	0.01	—	—	—
Ti	0.01	0.01	0.01	0.01	0.01	0.02	—	—	—	—	—	0.01
Fe	0.47	0.47	0.38	0.56	0.51	0.60	0.62	1.24	1.27	1.50	1.51	1.42
Mn	0.01	0.01	0.02	0.01	0.01	0.02	0.01	0.03	0.03	0.05	0.04	0.07
Mg	1.54	1.43	1.64	1.42	1.43	1.34	1.21	0.71	0.67	0.47	0.42	0.31
Ca	0.03	0.03	0.02	0.03	0.03	0.03	0.01	0.05	0.03	0.05	0.05	0.04
Na	—	—	0.01	—	—	—	—	—		—	—	—
	2.06	2.00	2.08	2.03	2.01	2.01	1.91	2.03	2.01	2.07	2.02	1.85
$\frac{Fe+Mn}{Fe+Mn+Mg}$	0.24	0.25	0.20	0.29	0.27	0.32	0.33	0.63	0.66	0.77	0.79	0.83

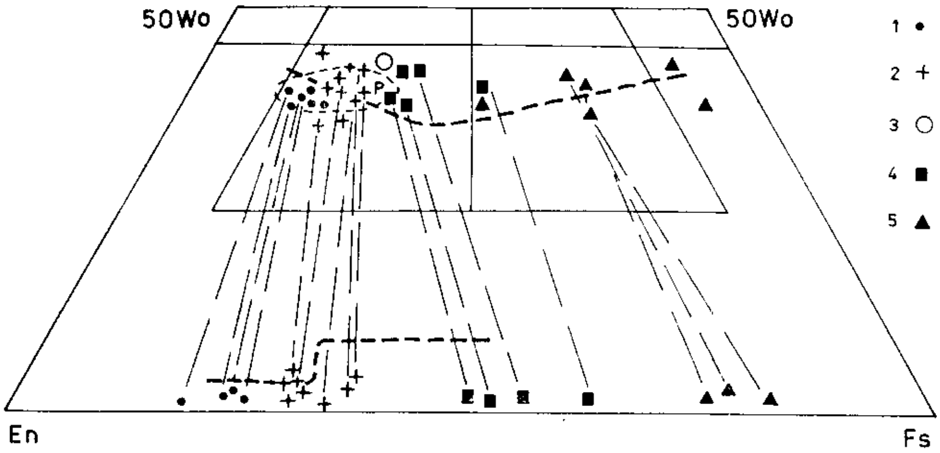
Table 4
Microprobe analyses of orthopyroxene, Všeruby (*1—4*) and Branišov (*5—7*) bodies

Analysis	*1*	*2*	*3*	*4*	*5*	*6*	*7*
Sample	627	703	960	893	629	681	680
Mother rock	olivine gabbronorite						
SiO_2	52.32	51.99	53.71	54.19	52.00	53.27	52.98
TiO_2	0.35	0.43	1.21	0.91	0.37	0.32	0.26
Al_2O_3	1.25	1.56	1.49	1.09	0.73	1.22	0.98
FeO	18.26	19.03	18.45	18.38	22.81	22.13	18.19
MnO	0.47	0.68	0.44	0.41	0.54	0.60	0.49
MgO	25.97	25.54	22.74	23.56	22.53	21.58	25.18
CaO	1.30	1.45	0.98	2.23	1.38	1.78	2.06
Na_2O	0.03	0.17	—	0.03	0.03	0.29	0.09
Total	99.95	100.85	99.02	100.80	100.39	101.19	100.23
	Formulas calculated on the basis of 6(O)						
Si	1.93	1.91	1.98	1.97	1.94	1.97	1.94
Al	0.05	0.07	0.02	0.03	0.03	0.03	0.04
Al	—	—	0.04	0.02	—	0.02	—
Ti	0.01	0.01	0.03	0.02	0.01	0.01	0.01
Fe	0.56	0.58	0.57	0.56	0.71	0.68	0.56
Mn	0.02	0.02	0.01	0.01	0.02	0.02	0.02
Mg	1.42	1.40	1.25	1.28	1.26	1.19	1.38
Ca	0.05	0.06	0.04	0.09	0.06	0.07	0.08
Na	—	0.01	—	—	—	0.02	0.01
	2.06	2.08	1.94	1.98	2.06	2.01	2.06
$\frac{Fe+Mn}{Fe+Mn+Mg}$	0.29	0.29	0.31	0.30	0.37	0.37	0.30

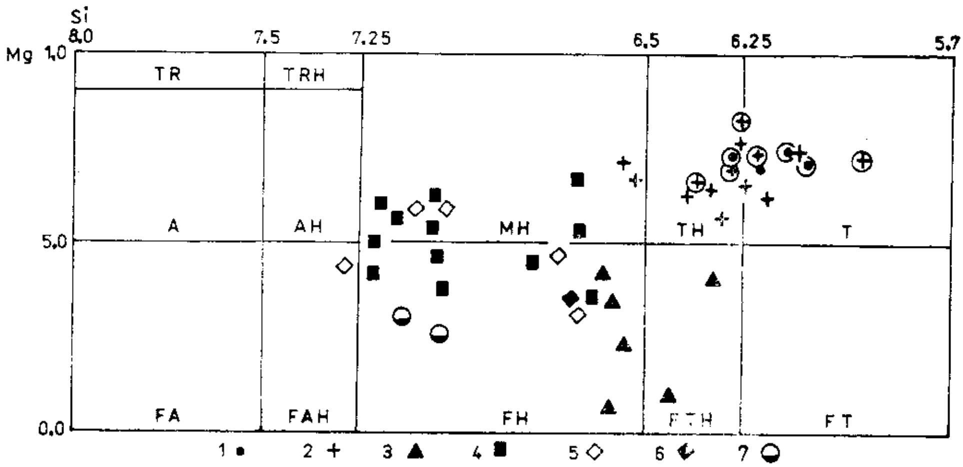
The chemical composition of the calcic pyroxene (tables 6—8) varies widely in the degree of Fe-Mg substitution, from very iron-poor augite to ferrohedenbergite. The range of this substitution is similar to that of calcic pyroxene of the Skaergaard intrusion (Brown 1957); however, the crystallization trend clearly differs from the latter in the relatively constant content of the wollastonite component (fig. 3).

The TiO_2 content is low and decreases with increasing iron content from 1.0 to 0.2 %. Simultaneously, the Al_2O_3 content also decreases from cca 3 to 1 %. The manganese content, on the other hand, increases in the range 0.2—0.6 % MnO.

The Mg-Fe distribution between coexisting orthopyroxene and calcic pyroxene was studied on the basis of the analytical data given in tabs. 3—5. Table 9



3. Orthopyroxenes and calcium pyroxenes of rocks of the Kdyně massif in the En (enstatite) — Fs (ferrosilite) — Wo (wollastonite) ternary diagram
Pyroxene mother rocks: *1* — olivine gabbro, *2* — olivine gabbronorite, *3* — hortonolite rock, *4* — diorite, *5* — ferrodiorite. Co-existing pyroxene pairs are linked by tie-lines. P — variation field of calcium pyroxenes of the rocks of the Poběžovice massif. The trends in crystallization of the pyroxenes of the Skaergaard intrusion are designated by *dashed lines*



4. Primary amphiboles of the rocks of the Kdyně massif in the B. E. Leake (1968) diagram for the hornblende group, where Ca+Na+K is less than 2.50 and Ti les than 0.50
The symbols *in circles* designate amphiboles, for which the Ca+Na+K value is greater than 2.50, and which belong to the group of pargasite and ferropargasite
Parent amphibole rocks: *1* — olivine gabbro, *2* — olivine gabbronorite, *3* — ferrodiorite, *4* — diorite, *5* — tonalite, *6* — ferrotonalite, *7* — granodiorite
Designation of the amphibole classification fields: TR — tremolite, TRH — tremolitic hornblende, A — actinolite, AH — actinolitic hornblende, MH — magnesiohornblende, TH — tschermakitic hornblende, T — tschermakite, FA — ferroactinolite, FAH — ferroactinolitic hornblende, FH — ferrohornblende, FTH — ferrotschermakitic hornblende, FT — ferrotschermakite

Table 5

Microprobe analyses

Analysis	1	2	3	4	5	6	7
Sample	766	857	857	857	857	650	632
SiO_2	49.04	52.53	53.12	53.78	51.76	55.12	51.69
TiO_2	0.21	0.14	0.06	0.48	0.41	0.33	0.22
Al_2O_3	0.45	0.97	0.70	1.58	0.97	0.96	0.58
FeO	38.20	34.15	32.04	25.45	24.25	25.45	29.19
MnO	0.69	0.79	0.72	0.57	0.48	0.56	0.65
MgO	10.51	10.43	11.90	15.32	20.62	18.08	17.38
CaO	1.25	1.23	0.86	2.35	1.73	1.09	0.96
Na_2O	0.01	0.13	0.10	0.24	0.03	0.02	0.03
Total	100.36	100.37	99.50	99.77	100.25	101.61	100.70
						Formulas calculated	
Si	1.98	2.06	2.07	2.03	1.95	2.04	1.98
Al	0.02	—	—	—	0.04	—	0.02
Al	—	0.04	0.03	0.07	—	0.04	0.01
Ti	0.01	—	—	0.01	0.01	0.01	0.01
Fe	1.29	1.12	1.05	0.80	0.76	0.79	0.93
Mn	0.02	0.03	0.02	0.02	0.02	0.02	0.02
Mg	0.63	0.61	0.67	0.86	1.16	0.99	0.99
Ca	0.05	0.05	0.04	0.09	0.07	0.04	0.04
Na	—	0.01	0.01	0.02	—	—	—
	2.00	1.86	1.83	1.87	2.02	1.89	2.00
$\frac{Fe+Mn}{Fe+Mn+Mg}$	0.66	0.64	0.60	0.48	0.39	0.44	0.48

gives the results of these calculations, carried out as described by Kretz (1963).

The marked variation in the values of the distribution coefficient $K_D{}^{opx-capx}_{Mg-Fe}$ in the olivine gabbro in the range 0.75—0.88 apparently reflects (material) nonequilibrium between the two pyroxenes, in agreement with the textural non-equilibrium. While pyroxene forms borders around olivine and accumulate crystals, calcic pyroxene — augite — appears primarily as intercumulative, poikilitic crystals. The distribution coefficients of pyroxene pairs from gabbro-norite and ferrodiorite also exhibit similar variability.

The data for pyroxene diorite are very different; here the roughly identical distribution coefficients for the studied pyroxene pairs, varying in the range 0.56—0.59, and textural evidence unambiguously indicate the equilibrium state.

Table 5

of orthopyroxene from diorites

8	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*
630	638	719	685	975	951	951	955	904
51.35	51.04	52.15	50.95	48.85	47.94	50.76	51.46	51.77
0.25	0.13	0.16	0.30	0.12	0.12	0.19	0.16	0.17
0.56	1.93	0.66	0.93	0.36	0.43	1.51	0.52	0.48
29.85	28.82	24.44	31.82	36.97	41.30	34.92	32.84	30.78
0.67	0.59	0.83	1.31	0.84	1.00	0.75	0.89	0.84
16.63	16.77	21.29	12.60	12.16	9.74	10.74	14.83	16.11
1.11	0.70	1.27	1.53	0.92	0.60	0.94	0.70	0.65
0.01	0.05	0.26	0.20	—	—	0.19	—	—
100.43	100.03	101.06	99.64	100.22	101.13	100.00	101.40	100.80
on the basis of 6(0)								
1.98	1.96	1.95	2.01	1.96	1.95	2.01	1.99	1.99
0.02	0.04	0.03	—	0.02	0.02	—	0.01	0.01
0.01	0.05	—	0.04	0.00	—	0.07	0.01	0.01
0.01	—	0.01	0.01	—	—	0.01	—	—
0.96	0.93	0.77	1.05	1.24	1.41	1.16	1.06	0.99
0.02	0.02	0.03	0.04	0.03	0.03	0.03	0.03	0.03
0.95	0.96	1.19	0.74	0.73	0.59	0.63	0.85	0.92
0.05	0.03	0.05	0.06	0.04	0.03	0.04	0.03	0.03
—	—	0.02	0.01	—	—	0.02	—	—
2.00	1.99	2.07	1.95	2.04	2.06	1.96	1.98	1.98
0.50	0.49	0.40	0.60	0.62	0.71	0.65	0.56	0.53

Primary amphiboles. These are the most widespread Fe, Mg silicates in the rocks of the Kdyně massif. On polished sections, they have adcumulate and intercumulate character. Their colour varies from reddish brown to brown green.

The chemical composition is characterized by high variability (fig. 4), primarily varying with the petrographic character of the mother rock. The composition is also affected by local uralitization processes, mostly leading to a decrease in the TiO_2 and alkali contents.

The primary amphibole of the olivine gabbro corresponds mostly to ferroan pargasite with a relatively high Ti content, approaching the critical classification value of 0.5 ions per structural formula, separating the hornblende group from Ti-amphiboles. The composition of the primary amphibole in olivine gabbronorite varies as a result of the gradually decreasing content of Ca + Na + K

Table 6

Microprobe analyses

Analysis	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
Sample	843	846	847	850	850	852	915	140	888
Mother rock	olivine gabbro								
SiO_2	52.03	52.22	53.05	52.54	51.11	52.03	52.71	49.73	52.02
TiO_2	0.98	0.94	1.14	0.51	1.14	0.91	1.23	0.87	0.79
Al_2O_3	3.29	3.12	3.01	2.58	2.58	3.07	3.05	3.66	3.09
FeO	7.27	7.80	7.99	8.63	9.38	7.52	7.64	8.05	6.78
MnO	0.22	0.22	0.23	0.19	0.30	0.24	0.21	0.26	0.28
MgO	17.03	16.89	15.90	16.37	15.95	17.28	16.33	16.96	18.26
CaO	18.33	19.35	18.64	18.85	19.66	19.09	17.98	21.06	19.54
Na_2O	0.42	0.32	0.34	0.28	0.36	0.40	0.31	0.45	0.33
Total	99.57	100.86	100.30	99.95	100.48	100.54	99.46	101.04	101.09
Formulas calculated									
Si	1.91	1.91	1.94	1.94	1.90	1.90	1.94	1.84	1.89
Al	0.09	0.09	0.06	0.06	0.10	0.10	0.06	0.16	0.11
Al	0.05	0.04	0.07	0.05	0.01	0.03	0.07	—	0.02
Ti	0.03	0.03	0.03	0.01	0.03	0.02	0.03	0.02	0.02
Fe	0.22	0.24	0.25	0.27	0.29	0.23	0.24	0.25	0.21
Mn	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Mg	0.93	0.92	0.87	0.90	0.88	0.94	0.89	0.93	0.99
Ca	0.72	0.76	0.73	0.74	0.76	0.75	0.71	0.83	0.76
Na	0.03	0.02	0.02	0.02	0.02	0.03	0.02	0.03	0.02
	1.99	2.02	1.98	2.00	2.00	2.01	1.97	2.07	2.02
$\frac{Fe+Mn}{Fe+Mn+Mg}$	0.20	0.21	0.12	0.20	0.25	0.20	0.22	0.23	0.19

from ferroan pargasite to tschermakite and tschermakitic hornblende. Diorite and tonalite contain hornblende with roughly equal Fe/Mg ratio and ferrodiorite contains ferrohornblende and ferrotschermakitic hornblende.

In agreement with the decrease in the mafic mineral content of the mother rock, the Si content in the structural formula increases in the given variation range of primary amphiboles, at simultaneous increase in the Fe/Mg ratio. Simultaneously, the Ti content decreases in the range of 0.5—0.15 atoms and the total Ca + Na + K in the range of ca. 2.8—1.9 atoms.

In the Na + K vs Al diagram (fig. 5), primary amphiboles are plotted in a clear variation order, in which Na + K and Al decrease in agreement with the content of mafic minerals in the rock. Amphiboles from the Všepadly granodiorite lie somewhat outside this variation order, as they have a relatively

Table 6

of clinopyroxene, Orlovice bodies

10	11	12	13	14	15	16	17	18	19	20
825	777	V 27	896	V 26	903	782	761	762	753	753
olivine gabbronorite				hortonolite rock	ferrodiorite					
51.49	52.21	53.10	51.64	53.36	51.57	48.73	47.34	50.84	48.50	47.34
0.99	2.19	1.15	0.71	0.33	0.42	0.32	0.26	0.26	0.26	0.34
2.42	2.36	2.61	2.55	1.60	1.50	0.85	0.98	1.14	0.85	1.00
9.52	10.15	9.72	11.13	11.33	17.86	23.80	25.14	24.56	28.65	31.41
0.30	0.63	0.28	0.35	0.36	0.50	0.64	0.60	0.53	0.63	0.61
16.01	15.83	15.91	14.48	12.67	9.95	6.44	6.15	6.06	2.11	1.80
19.01	17.33	18.26	18.10	20.32	18.20	19.30	19.26	16.87	19.49	17.27
0.36	0.30	0.40	0.29	0.34	0.34	0.24	0.24	0.28	0.26	0.23
100.10	101.00	101.43	99.25	100.31	100.34	100.32	99.97	100.54	100.75	100.00
on the basis of 6(O)										
1.91	1.92	1.93	1.94	1.99	1.98	1.94	1.91	2.00	1.97	1.95
0.09	0.08	0.07	0.06	0.01	0.02	0.04	0.05	—	0.03	0.05
0.02	0.02	0.04	0.05	0.06	0.05	—	—	0.01	0.01	—
0.03	0.06	0.04	0.02	0.01	0.01	0.01	0.01	0.05	0.01	0.01
0.30	0.31	0.27	0.35	0.35	0.57	0.79	0.85	0.81	0.97	1.09
0.01	0.02	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02
0.89	0.87	0.85	0.81	0.70	0.57	0.38	0.37	0.36	0.13	0.11
0.76	0.68	0.77	0.73	0.81	0.57	0.83	0.83	0.71	0.85	0.76
0.03	0.02	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
2.04	1.98	2.01	1.99	1.96	1.99	2.05	2.10	1.98	2.01	2.01
0.26	0.28	0.25	0.30	0.33	0.51	0.68	0.70	0.70	0.88	0.91

high alkali content and incline toward the amphiboles of granitoid rocks of the Stod massif.

Secondary amphiboles. These are products of secondary recrystallization — uralitization of rocks, locally affecting primarily gabbros, gabbronorites and partly also the diorites of the massif. They were formed by partial conversion of primary amphibole and by decomposition of pyroxene and olivine, or plagioclase. Their composition (tabs. 13, 14) varies widely, primarily in dependence on the character of the minerals from which they were formed.

Colourless, acicular anthophyllite (table 13, analysis *3*) is present in olivine gabbro, where it replaces the edges of bronzite crystals. This rock contains greater amounts of light ochre-coloured tschermakite and tschermakitic horn-

Table 7

Microprobe analyses of clinopyroxene, Všeruby (*1—5*) and Branišov (*6—8*) bodies

Analysis	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Sample	979	703	910	960	893	629	681	752
Mother rock	olivine gabbronorite							
SiO_2	52.13	49.96	53.66	53.74	54.05	52.75	50.91	51.22
TiO_2	0.62	0.74	0.92	0.88	0.52	0.49	0.82	0.12
Al_2O_3	1.45	2.52	3.12	2.35	1.60	1.28	1.46	1.34
FeO	10.09	9.29	5.37	6.64	6.95	11.52	9.75	10.68
MnO	0.31	0.42	0.15	0.27	0.22	0.31	0.45	0.28
MgO	17.76	16.41	17.03	14.31	15.66	14.83	15.47	14.93
CaO	17.61	20.05	18.92	21.61	21.78	18.70	21.00	20.93
Na_2O	0.21	0.54	0.30	0.29	0.24	0.25	0.36	0.14
Total	100.18	99.93	99.47	100.09	101.02	100.13	100.22	99.64
	Formulas calculated on the basis of 6(0)							
Si	1.93	1.87	1.95	1.97	1.97	1.97	1.91	1.93
Al	0.06	0.11	0.05	0.03	0.03	0.03	0.07	0.06
Al	—	—	0.08	0.07	0.04	0.03	—	—
Ti	0,02	0.02	0.02	0.02	0.01	0.01	0.02	—
Fe	0.31	0.29	0.16	0.20	0.21	0.36	0.31	0.34
Mn	0.01	0.01	—	0.01	0.01	0.01	0.01	0.01
Mg	0.98	0.92	0.92	0.78	0.85	0.82	0.86	0.84
Ca	0.70	0.81	0.74	0.85	0.85	0.75	0.84	0.85
Na	0.02	0.04	0.02	0.02	0.02	0.02	0.03	0.01
	2.04	2.09	1.94	1.95	1.99	2.00	2.07	2.05
$\frac{Fe+Mn}{Fe+Mn+Mg}$	0.25	0.24	0.14	0.20	0.20	0.31	0.27	0.29

blende (table 13, analyses *1, 2*), formed by partial conversion of primary pargasite in portions that were weakly uralitized. The conversion is accompanied by a decrease in the TiO_2 and alkali contents. Secondary, green-grey tschermakite (table 13, analyses *4, 5, 6*) was formed similarly in olivine gabbronorite.

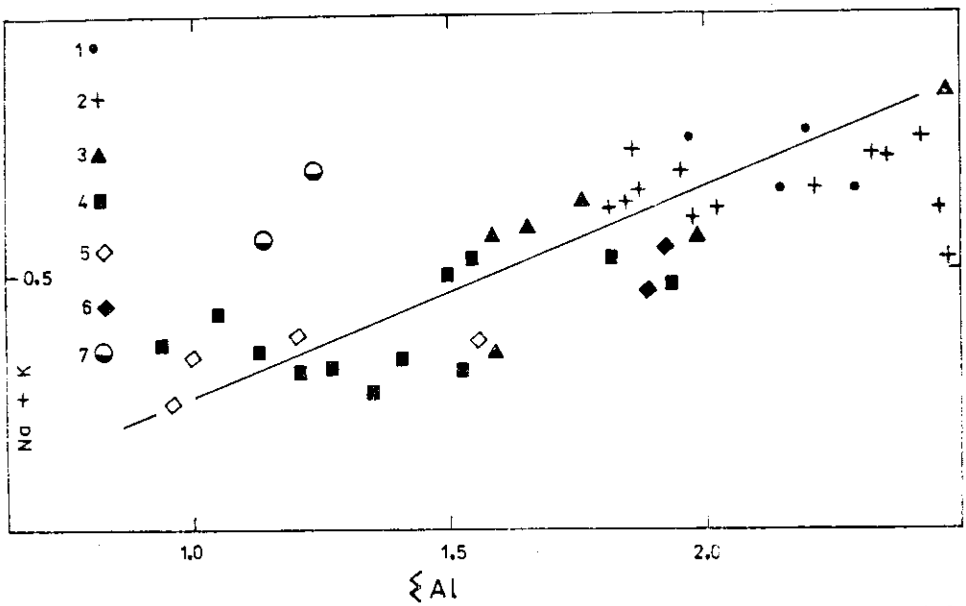
Intensely uralitized gabbro, in sites corresponding to the former hyperthene borders around the olivine crystals, contains grey, prismatic gedrite (table 13, analysis *8*), replaced at the edges of these borders by a grey or colourless, radiating aggregate of tschermakite crystals (table 13, analysis *7*).

Secondary amphiboles of the tschermakitic hornblende-actinolite series and, to a lesser degree, also polysynthetic lamellar cummingtonite (table 13, analysis *10*) also replace the original adcumulate or intercumulate pyroxene crystals in the uralitized gabbro and gabbronorite.

Table 8

Microprobe analyses of clinopyroxene from diorites

Analysis	1	2	3	4	5
Sample	638	975	955	955	904
SiO_2	52.78	53.12	54.95	53.93	53.66
TiO_2	0.27	0.15	0.17	0.28	0.21
Al_2O_3	1.23	0.89	0.96	1.23	0.84
FeO	13.58	17.26	12.41	12.98	14.02
MnO	0.33	0.46	0.41	0.40	0.36
MgO	13.77	9.85	11.95	11.57	12.68
CaO	19.22	17.67	19.59	19.20	17.93
Na_2O	0.16	0.22	0.22	0.24	0.17
Total	101.34	99.62	100.66	99.83	99.87
Formulas calculated on the basis of 6(0)					
Si	1.97	2.03	2.04	2.02	2.02
Al	0.03	—	—	—	—
Al	0.02	0.04	0.04	0.06	0.04
Ti	0.01	—	—	0.01	0.01
Fe	0.42	0.55	0.39	0.41	0.44
Mn	0.01	0.02	0.01	0.01	0.01
Mg	0.76	0.56	0.66	0.65	0.71
Ca	0.77	0.73	0.78	0.77	0.72
Na	0.01	0.02	0.02	0.02	0.01
	2.00	1.92	1.90	1.93	1.94
$\frac{Fe+Mn}{Fe+Mn+Mg}$	0.36	0.50	0.38	0.39	0.39



5. The ratio of the total aluminium to alkalies in primarily amphiboles of the rocks of the Kdyně massif. Symbols as in fig. 4

Table 9

Mg. Fe distribution coefficients of the pyroxene pairs

Mother rock	olivine gabbro			olivine gabbronorite			ferrodiorite			pyroxene diorite		
Sample	843	847	888	825	V27	896	761	782	762	638	975	904
$K_{D\,Mg-Fe}^{opx-capx}$	0.79	0.75	0.88	0.95	0.70	0.87	0.70	0.56	0.48	0.56	0.59	0.57

Table 10

Microprobe analyses

Analysis	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Sample	850	852	915	140	825	777	V 27	896
Mother rock	olivine gabbro				olivine gabbronorite			
SiO_2	42.49	41.83	42.66	41.59	43.31	45.15	43.49	42.43
TiO_2	3.68	4.06	4.29	3.94	1.65	1.85	4.50	2.82
Al_2O_3	11.44	12.75	13.33	12.39	13.83	11.57	10.95	13.62
FeO tot.	12.10	10.31	10.72	10.23	10.66	11.44	12.06	12.18
MnO	0.15	0.16	0.12	0.18	0.16	0.20	0.16	0.16
MgO	13.45	14.77	13.97	15.27	15.35	15.18	12.86	12.74
CaO	11.62	10.77	9.80	11.88	11.61	9.56	11.42	11.01
Na_2O	2.19	2.34	2.02	1.98	2.12	1.87	2.14	2.07
K_2O	0.69	0.58	0.54	0.54	0.74	0.37	0.64	0.63
Total	97.84	97.57	97.45	98.00	99.43	97.19	98.22	97.66

Formulas calculated

	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Si	6.27	6.12	6.21	6.08	6.21	6.56	6.36	6.24
Al	1.73	1.88	1.79	1.92	1.79	1.44	1.64	1.76
Al	0.25	0.32	0.50	0.22	0.55	0.54	0.24	0.60
Ti	0.41	0.45	0.47	0.43	0.18	0.20	0.50	0.31
Fe	1.49	1.26	1.30	1.25	1.27	1.39	1.46	1.49
Mn	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.02
Mg	2.96	3.22	3.03	3.33	3.28	3.29	2.80	2.79
Y	5.13	5.27	5.32	5.25	5.30	5.44	5.01	5.21
Ca	1.83	2.03	1.53	1.85	1.79	1.49	1.80	1.74
Na	0.63	0.66	0.57	0.56	0.59	0.53	0.61	0.60
K	0.13	0.11	0.10	0.10	0.13	0.07	0.11	0.12
X	2.59	2.80	2.20	2.51	2.51	2.09	2.52	2.46
$\frac{Fe+Mn}{Fe+Mn+Mg}$	0.28	0.26	0.30	0.28	0.28	0.30	0.34	0.35

In the uralitized gabbronorite, secondary amphiboles also form complicated zonal pseudomorphs after the original Fe-Mg silicates. The cores of these pseudomorphs are mostly composed of fine-grained aggregates of randomly oriented plates of light-green actinolite (table 13, analysis *13*) or light blue-green magnesiohornblende (table 13, analysis *17*). The bizonal border composed of radiating aggregates consists of light-green actinolitic hornblende (table 13, analysis *12*), gradually changing into tschermakitic hornblende to tschermakite (table 13, analysis *11*). Elsewhere, this border consists of blue-green actinolitic hornblende (table 13, analysis *15*), changing into dark blue-green tschermakite

Table 10

of primary amphiboles, Orlovice bodies

	9	*10*	*11*	*12*	*13*	*14*	*15*
	778	917	903	782	761	945	753
	hortonolite rock	ferrodiorite					
	41.82	42.58	41.38	40.98	40.15	42.95	40.74
	2.73	1.56	1.41	2.45	2.50	2.36	1.58
	11.01	8.61	13.83	8.38	8.65	10.91	8.72
	17.21	22.42	20.61	28.24	29.45	23.68	32.35
	0.11	0.25	0.23	0.36	0.40	0.26	0.35
	12.28	8.66	7.35	4.77	4.38	7.09	1.42
	9.78	11.63	9.38	9.94	9.95	8.05	10.30
	2.05	0.83	2.13	1,29	1.32	1.56	1.38
	0.48	0.53	1.05	0.81	0.83	0.58	1.02
	97.47	97.07	97.37	97.22	97.63	97.44	97.86
on the basis of 23(0)							
	6.30	6.61	6.32	6.55	6.44	6.60	6.60
	1.70	1.39	1.68	1.45	1.56	1.40	1.40
	0.25	0.19	0.81	0.13	0.08	0.58	0.37
	0.31	0.18	0.16	0.29	0.30	0.27	0.19
	2.17	2.91	2.63	3.77	3.95	3.03	4.39
	0.01	0.03	0.03	0.05	0.05	0.03	0.05
	2.75	2.00	1.67	1.14	1.05	1.62	0.35
	5.49	5.31	5.30	5.38	5.43	5.53	5.35
	1.58	1.93	1.56	1.70	1.71	1.32	1.79
	0.60	0.25	0.64	0.40	0.41	0.47	0.43
	0.09	0.11	0.20	0.17	0.17	0.12	0.21
	2.27	2.29	2.40	2.27	2.29	1.91	2.43
	0.44	0.59	0.61	0.77	0.79	0.65	0.93

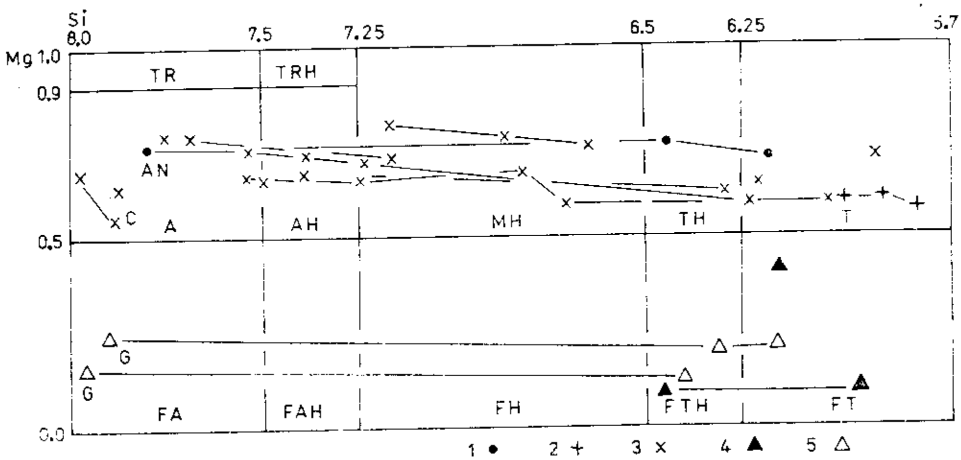
Table 11

Microprobe analyses of primary amphiboles, Všeruby (*1—6*) and Branišov (*7—9*) bodies

Analysis	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
Sample	634	627	703	703	619	619	629	752	680
Mother rock	olivine gabbronorite								
SiO_2	43.89	42.82	40.19	43.17	41.99	42.57	42.84	42.89	44.41
TiO_2	2.44	4.28	2.62	1.73	3.61	1.90	3.58	4.20	2.92
Al_2O_3	13.22	11.78	13.89	14.40	14.81	15.05	10.62	10.67	10.57
FeO tot.	6.71	11.03	10.66	10.80	8.99	11.00	13.85	13.25	11.95
MnO	0.14	0.20	0.23	0.28	0.14	0.21	0.18	0.16	0.29
MgO	17.08	14.13	15.56	13.73	14.75	15.81	12.54	13.58	13.42
CaO	12.27	11.21	11.22	10.83	10.42	8.90	10.98	10.59	11.40
Na_2O	2.00	1.91	2.31	2.00	1.66	1.45	1.78	1.92	1.71
K_2O	0.60	0.39	0.52	0.27	0.33	0.12	0.74	0.43	0.71
Total	98.35	97.75	97.20	97.21	96.70	97.01	97.11	97.69	97.38
	Formulas calculated on the basis of 23 (0)								
Si	6.25	6.25	5.93	6.29	6.10	6.18	6.39	6.33	6.53
Al	1.75	1.75	2.07	1.71	1.90	1.82	1.61	1.67	1.47
Al	0.47	0.28	0.35	0.77	0.64	0.71	0.26	0.18	0.36
Ti	0.26	0.47	0.29	0.19	0.40	0.20	0.40	0.47	0.32
Fe	0.80	1.35	1.32	1.32	1.09	1.33	1.73	1.63	1.47
Mn	0.02	0.03	0.03	0.04	0.02	0.02	0.02	0.02	0.04
Mg	3.63	3.07	3.42	2.98	3.19	3.42	2.78	2.99	2.94
Y	5.18	5.20	5.41	5.30	5.34	5.68	5.19	5.29	5.13
Ca	1.87	1.75	1.78	1.70	1.62	1.38	1.75	1.67	1.80
Na	0.55	0.54	0.66	0.57	0.47	0.41	0.51	0.55	0.49
K	0.11	0.07	0.10	0.05	0.06	0.02	0.14	0,18	0.13
Z	2.53	2.36	2.54	2.32	2.15	1.81	2.40	2.30	2.42
$\frac{Fe+Mn}{Fe+Mn+Mg}$	0.18	0.25	0.28	0.31	0.26	0.39	0.38	0.36	0.34

(table 13, analysis *14*), which is mostly accompanied by a small amount of paragonite.

7. Chemical composition of rocks of the Kdyně massif in the A (Na_2O+K_2O) — F (Fe_2O_3+FeO) — M (MgO) diagram, mass %
1 — olivine gabbro and uralitized gabbro; *2* — olivine gabbronorite and uralitized gabbronorite; *3* — hortonolite rock; *4* — diorite; *5* — ferrodiorite and uralitized ferrodiorite; *6* — coarse-grained amphibole diorite from St. Bernhard chapel; *7* — quartz diorite; *8* — tonalite; *9* — granodiorite; *10* — trondhjemite; *11* — granitoids of the Stod massif



6. Secondary amphiboles of the rocks of the Kdyně massif in the B. E. Leake (1968) diagram. Symbols and abbreviations as in fig. 4. Coexisting amphiboles are connected by tie-lines. The diagram contains projection points for coexisting anthophyllite (AN), cummingtonite (C) and grünerite (G)

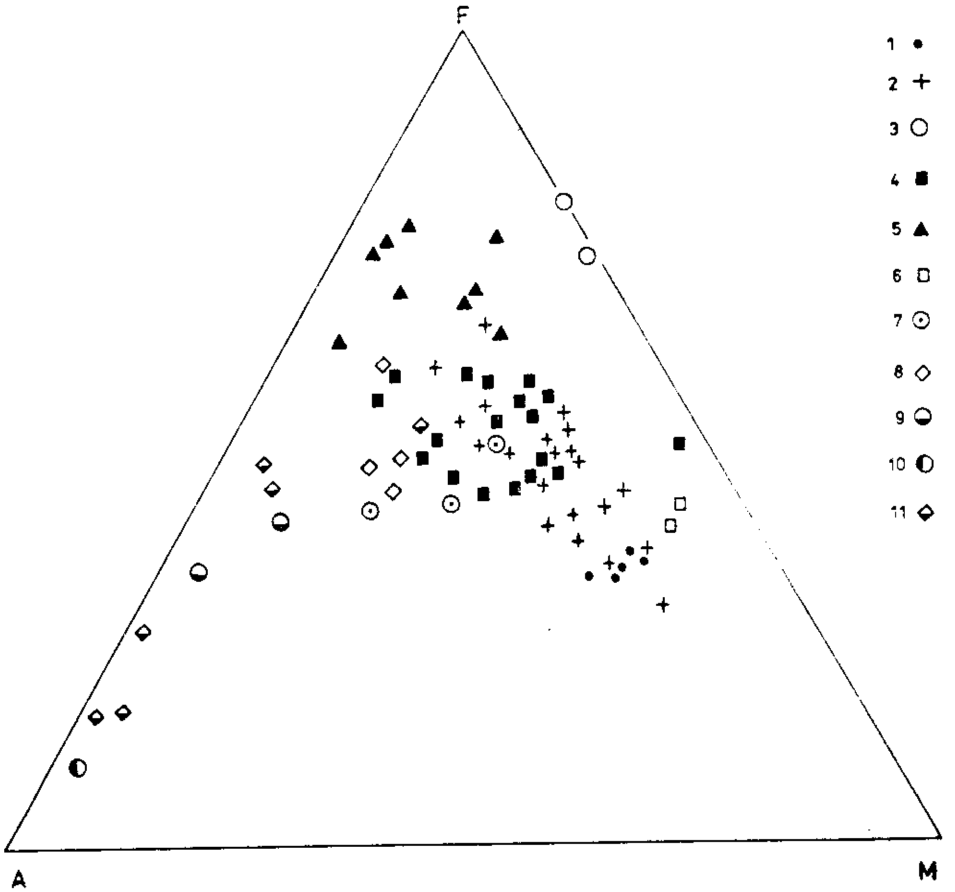


Table 12

Microprobe analyses of primary amphiboles from diorite (*1—12*),

Analysis	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
Sample	858	857	632	630	638	635	719	685	951
SiO_2	45.16	48.44	48.78	48.73	47.73	47.75	45.47	44.37	43.24
TiO_2	1.58	1.15	1.59	1.62	1.36	0.30	2.50	1.98	2.21
Al_2O_3	5.64	5.39	6.47	6.95	7.24	8.29	8.78	8.31	10.01
FeO tot.	25.12	23.20	16.26	16.51	15.74	18.64	12.48	19.75	23.85
MnO	0.36	0.34	0.21	0.22	0.20	0.28	0.23	0.45	0.30
MgO	7.96	8.73	12.99	12.29	13.09	12.34	14.06	8.96	7.29
CaO	9.81	9.91	9.43	10.49	10.61	9.21	11.72	11.05	8.97
Na_2O	1.01	0.98	0.73	0.65	0.65	0.69	1.34	1.15	1.38
K_2O	0.51	0.32	0.67	0.70	0.62	0.34	0.72	0.78	0.54
Total	97.15	98.46	97.13	98.16	97.24	97.84	97.30	96.80	97.79
								Formulas calculated	
Si	7.03	7.23	7.19	7.15	7.06	7.06	6.70	6.80	6.64
Al	0.97	0.77	0.81	0.85	0.94	0.94	1.30	1.20	1.36
Al	0.07	0.19	0.31	0.35	0.32	0.51	0.23	0.30	0.45
Ti	0.18	0.14	0.18	0.18	0.15	0.03	0.23	0.23	0.26
Fe	3.27	2.92	2.01	2.02	1.95	2.30	1.54	2.53	3.06
Mn	0.05	0.04	0.03	0.03	0.02	0.03	0.03	0.06	0.04
Mg	1.85	1.96	2.85	2.69	2.88	2.72	3.09	2.05	1.67
Y	5.42	5.25	5.38	5.27	5.32	5.59	5.12	5.17	5.48
Ca	1.64	1.60	1.53	1.65	1.68	1.46	1.85	1.81	1.48
Na	0.31	0.29	0.20	0.18	0.19	0.20	0.38	0.34	0.71
K	0.10	0.06	0.13	0.13	0.12	0.06	0.14	0.15	0.11
X	2.05	1.95	1.86	1.96	1.99	1.72	2.37	2.30	2.00
$\frac{Fe+Mn}{Fe+Mn+Mg}$	0.63	0.59	0.41	0.43	0.40	0.46	0.33	0.56	0.65

Secondary amphiboles, formed during partial or complete uralitization of ferrodiorite, represent a special group. Their chemical composition corresponds to ferrotschermakite and ferrotschermakitic hornblende. The rocks mostly also contain light-greenish or colourless grünerite (table 13, analyses *27*, *30*), present at aggregates of randomly oriented plates and forming the cores of pseudomorphs after the original orthopyroxene (ferrohypersthene or eulite). The radial radiating borders of these pseudomorphs, formed partly at the expense of the surrounding plagioclase, consist of dark blue-green, prismatic ferrotschermakitic hornblende (table 13, analyses *26*, *28*) or ferrotschermakite (table 13, analyses *25*, *29*).

Table 12

tonalite (*13—16*), ferrotonalite (*17—18*) and granodiorite (*19—20*)

10	*11*	*12*	*13*	*14*	*15*	*16*	*17*	*18*	*19*	*20*
955	955	904	640	687	689	647	909	1018	567	622
49.05	44.71	47.55	47.83	47.43	48.15	44.30	43.54	43.40	45.85	44.65
1.49	2.72	1.73	1.01	1.39	1.35	2.70	1.81	1.02	1.61	1.52
8.78	10.91	8.01	5.29	5.62	6.92	8.72	10.60	10.41	6.69	6.07
17.47	16.74	16.86	21.28	15.72	15.17	19.83	23.48	24.36	23.80	27.80
0.28	0.22	0.27	0.52	0.53	0.69	0.38	0.45	0.57	0.60	0.52
10.09	9.86	11.57	9.49	13.14	13.21	9.70	6.37	7.19	5.91	5.30
8.87	10.27	9.80	10.74	11.61	11.26	10.06	9.64	9.06	9.85	9.47
0.94	1.38	0.88	0.49	0.73	0.96	0.80	1.21	1.10	1.81	1.40
0.19	0.40	0.43	0.53	0.70	0.53	0.63	0.95	0.55	0.80	0.71
97.16	97.21	97.10	97.18	96.87	98.24	97.12	98.05	97.66	96.92	97.44
on the basis of 23 (0)										
7.22	6.67	7.05	7.28	7.10	7.06	6.73	6.67	6.68	7.13	7.04
0.78	1.33	0.95	0.72	0.90	0.94	1.27	1.33	1.32	0.87	0.96
0.74	0.59	0.45	0.23	0.09	0.26	0.29	0.59	0.57	0.36	0.17
0.17	0.31	0.19	0.11	0.16	0.15	0.31	0.21	0.12	0.19	0.18
2.15	2.09	2.09	2.70	1.97	1.86	2.52	3.01	3.14	3.09	3.66
0.03	0.03	0.03	0.07	0.07	0.09	0.05	0.06	0.07	0.08	0.07
2.21	2.19	2.56	2.15	2.93	2.89	2.19	1.45	1.65	1.37	1.25
5.30	5.21	5.32	5.26	5.22	5.25	5.36	5.32	5.55	5.09	5.33
1.40	1.64	1.54	1.75	1.86	1.77	1.64	1.58	1.50	1.64	1.60
0.27	0.40	0.25	0.14	0.21	0.27	0.24	0.36	0.33	0.54	0.43
0.03	0.08	0.08	0.10	0.13	0.10	0.12	0.18	0.11	0.16	0.14
1.70	2.12	1.87	1.99	2.20	2.14	2.07	2.12	1.94	2.34	2.17
0.50	0.49	0.54	0.56	0.41	0.40	0.53	0.68	0.66	0.70	0.75

Biotite. Biotite is present in diorites as interstitial crystals red-brown in colour. In tonalite, trondhjemite and granodiorite it forms brown subhedral flakes that are isolated or intergrown by amphibole.

The chemical composition (table 15) varies in dependence on the type of mother rock. Primarily the TiO_2 content (from 6 to 3 %) and the Fe/Mg ratio (X_{Fe} varies from 0.4 to 0.9) change. These rocks contain mainly Fe-biotite; Mg-biotite is present only in pyroxene diorite with very low amphibole content (table 15, analyses *4*, *5*). In the granodiorite from Všepadly its composition approaches that of lepidomelane (X_{Fe} varies from 0.81 to 0.91).

A characteristic of biotite in rocks of the Kdyně massif is the relatively high

Table 13

Microprobe analyses of secondary amphiboles, Orlovice bodies

Analysis	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Sample	850	915	915	896	896	896	899	899	944	944	942	942	942	940	940
Mother rock	olivine gabbro			olivine gabbronorite			uralitized gabbro and uralitized gabbronorite								
SiO_2	44.47	42.44	55.59	39.99	39.03	40.37	41.34	41.17	56.07	54.07	42.20	51.34	53.34	40.11	49.81
TiO_2	0.47	0.14	0.03	—	0.03	0.08	0.25	—	0.01	0.00	0.38	0.38	0.03	0.10	0.63
Al_2O_3	12.41	17.12	1.09	19.13	19.70	18.28	19.77	20.88	0.35	0.46	16.03	6.08	4.81	15.35	5.53
FeO	9.62	11.27	14.58	17.94	16.51	14.38	10.28	14.90	15.21	24.33	13.47	10.17	9.70	15.73	13.58
MnO	0.21	0.14	0.32	0.46	0.33	0.24	0.15	0.24	0.38	0.83	0.26	0.25	0.23	0.28	0.36
MgO	16.59	14.16	25.45	15.10	12.15	11.62	14.97	17.54	18.27	18.22	11.11	15.94	17.41	12.76	15.26
CaO	11.01	9.09	0.21	1.69	6.74	9.29	8.88	0.44	6.68	0.38	11.14	11.45	11.50	10.51	11.36
Na_2O	1.64	2.09	0.09	2.61	2.24	2.20	2.34	2.62	0.07	0.01	2.13	1.01	0.78	1.69	0.71
K_2O	0.62	0.17	—	0.40	0.21	0.23	0.14	—	—	—	0.27	0.12	0.10	0.34	0.10
Total	97.04	96.62	97.36	97.32	96.94	96.69	98.12	97.79	97.04	98.30	96.99	96.74	97.60	96.87	97.34
Formulas calculated on the basis of 23 (0)															
Si	6.46	6.18	7.80	5.89	5.80	5.99	5.91	5.88	8.00	7.89	6.24	7.39	7.56	6.03	7.26
Al	1.54	1.82	0.18	2.11	2.20	2.01	2.09	2.12	—	0.08	1.76	0.61	0.44	1.97	0.74
Al	0.59	1.12	—	1.12	1.25	1.19	1.24	1.40	0.06	—	1.03	0.42	0.37	0.75	0.21
Ti	0.05	0.01	—	—	—	0.01	0.03	—	—	—	0.04	0.04	—	0.01	0.07
Fe	1.17	1.37	1.71	2.21	2.05	1.76	1.23	1.78	1.82	2.97	1.67	1.22	1.15	1.98	1.66
Mn	0.03	0.02	0.04	0.06	0.04	0.03	0.02	0.03	0.05	0.10	0.03	0.03	0.03	0.03	0.04
Mg	3.59	3.07	5.33	3.32	2.69	2.57	3.19	3.73	3.91	3.96	2.45	3.42	3.61	2.86	3.31
Y	5.43	5.59	7.08	6.71	6.03	5.56	5.71	6.94	5.84	7.03	5.22	5.13	5.16	5.63	5.29
Ca	1.71	1.41	0.02	0.27	1.07	1.48	1.36	0.07	1.03	0.06	1.77	1.77	1.75	1.69	1.78
Na	0.46	0.59	0.02	0.74	0.65	0.63	0.65	0.73	0.02	—	0.61	0.28	0.22	0.49	0.20
K	0.11	0.03	—	0.01	0.04	0.05	0.03	—	—	—	0.05	0.02	0.02	0.07	0.02
X	2.29	2.03	0.04	1.02	1.76	2.16	2.04	0.80	1.05	0.06	2.43	2.07	1.99	2.25	2.00
$\frac{Fe+Mn}{Fe+Mn+Mg}$	0.24	0.31	0.25	0.40	0.43	0.41	0.28	0.32	0.32	0.44	0.41	0.27	0.25	0.41	0.34

Table 13 *(continued)*

Analysis	*16*	*17*	*18*	*19*	*20*	*21*	*22*	*23*	*24*	*25*	*26*	*27*	*28*	*29*	*30*
Sample	940	940	940	883	883	884	884	903	750	750	762	762	905	905	905
Mother rock	uralitized gabbro and uralitized gabbronorite							ferrodiorite			uralitized ferrodiorite				
SiO_2	45.05	46.42	51.69	43.14	50.33	49.41	53.79	39.94	41.30	36.91	40.49	50.30	40.44	39.31	50.47
TiO_2	0.14	0.17	0.37	0.08	0.03	0.38	0.08	0.02	0.11	0.02	0.40	0.04	0.62	0.79	0.08
Al_2O_3	10.77	9.34	3.08	17.21	8.57	6.68	1.83	15.55	15.63	17.38	12.44	0.63	15.59	16.05	1.15
FeO	13.90	12.27	12.77	13.10	13.25	11.17	10.04	24.42	26.74	27.60	29.02	39.72	25.47	26.27	36.62
MnO	0.30	0.32	0.36	0.18	0.31	0.22	0.24	0.45	0.29	0.35	0.45	1.46	0.37	0.40	0.89
MgO	12.28	14.77	15.60	12.04	15.89	15.92	18.50	9.85	1.39	1.17	2.46	4.73	3.51	3.71	7.93
CaO	12.23	11.90	12.63	8.77	7.10	12.39	12.53	2.64	8.52	10.15	9.96	0.91	8.67	8.05	0.35
Na_2O	1.57	1.52	0.47	2.22	1.12	0.70	0.27	1.75	2.70	1.45	1.57	0.11	1.65	1.70	0.12
K_2O	0.24	0.18	0.10	0.15	0.07	0.28	0.06	2.79	0.72	0.98	0.74	—	1.55	0.51	—
Total	96.48	96.89	97.07	96.89	96.67	97.15	97.34	97.41	97.40	96.01	97.53	98.02	97.87	96.79	97.61
Formulas calculated on the basis of 23 (0)															
Si	6.71	6.84	7.54	6.30	7.25	7.16	7.69	6.16	6.45	5.96	6.44	8.02	6.34	6.17	7.91
Al	1.29	1.16	0.46	1.70	0.75	0.84	0.31	1.84	1.55	2.04	1.56	—	1.66	1.83	0.09
Al	0.61	0.46	0.07	1.26	0.71	0.30	—	0.99	1.33	1.26	0.77	0.12	1.21	1.14	0.12
Ti	0.02	0.02	0.04	0.01	—	0.04	0.01	—	0.01	—	0.05	—	0.07	0.09	0.01
Fe	1.73	1.51	1.56	1.60	1.60	1.36	1.19	3.14	3.49	3.72	3.86	5.29	3.23	3.45	4.80
Mn	0.04	0.04	0.05	0.02	0.04	0.03	0.03	0.06	0.04	0.05	0.06	0.20	0.05	0.05	0.12
Mg	2.73	3.24	3.39	2.62	3.41	3.44	3.95	2.26	0.32	0.28	0.58	1.12	0.82	0.87	1.48
Y	5.13	5.27	5.11	5.51	5.76	5.17	5.18	6.45	5.19	5.31	5.32	6.73	5.38	5.60	6.53
Ca	1.95	1.87	1.97	1.37	1.09	1.93	1.92	0.43	1.43	1.75	1.70	0.15	1.45	1.35	0.06
Na	0.46	0.43	0.13	0.63	0.32	0.20	0.07	0.52	0.82	0.45	0.48	0.02	0.50	0.52	0.03
K	0.05	0.03	0.02	0.03	0.01	0.05	0.01	0.55	0.14	0.20	0.19	—	0.11	0.10	—
X	2.46	2.33	2.12	2.03	1.42	2.18	2.00	1.50	2.39	2.40	2.37	0.17	2.06	1.97	0.09
$\frac{Fe+Mn}{Fe+Mn+Mg}$	0.39	0.32	0.32	0.38	0.32	0.28	0.23	0.59	0.93	0.93	0.87	0.83	0.79	0.79	0.75

Table 14

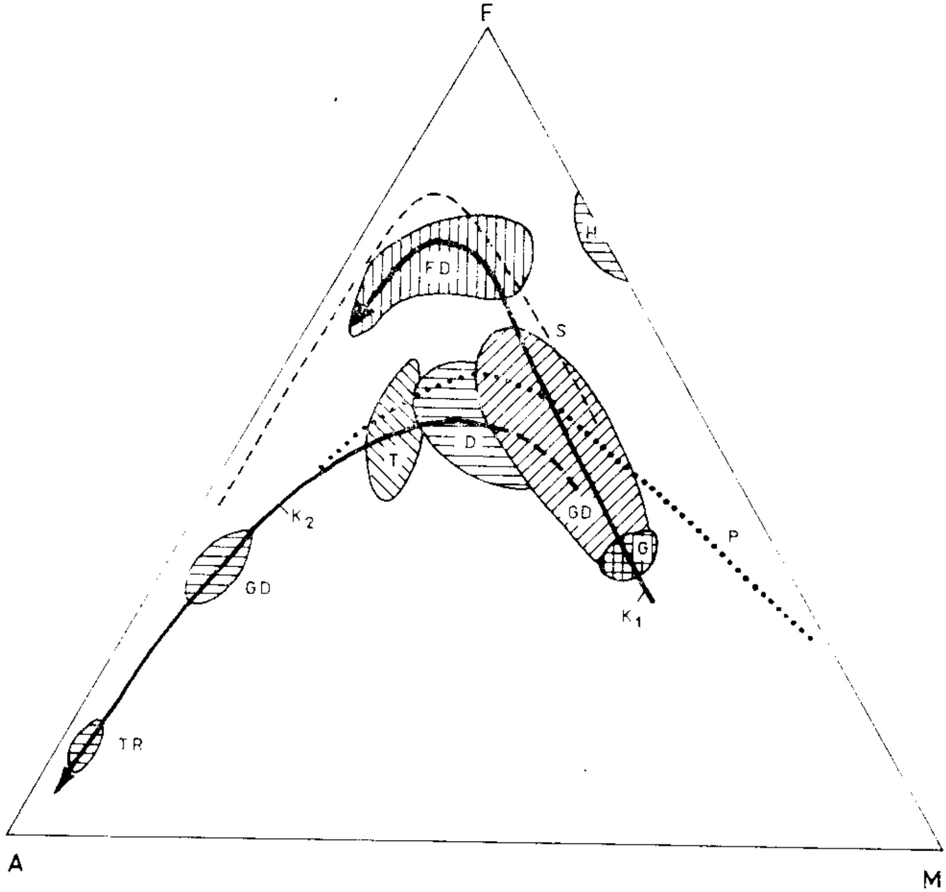
Microprobe analyses of secondary amphiboles, **Všeruby** *(1—4)* and Branišov *(5—9)* bodies

Analysis	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
Sample	619	619	619	979	681	752	752	678	678
Mother rock	uralitized gabbronorite								
SiO_2	46.43	48.00	50.41	55.13	42.33	49.96	51.82	50.69	54.54
TiO_2	0.74	0.30	0.12	0.04	0.07	0.10	0.09	0.97	0.06
Al_2O_3	13.17	10.77	6.71	1.17	15.66	6.00	4.09	4.35	1.73
FeO	9.84	9.06	9.17	10.99	12.66	13.15	14.61	12.59	14.64
MnO	0.15	0.16	0.17	0.16	0.22	0.19	0.15	0.18	0.16
MgO	15.12	16.73	20.26	19.79	13.00	16.73	16.73	15.27	14.95
CaO	10.12	10.57	10.04	11.03	10.96	10.09	9.81	9.96	11.41
Na_2O	1.55	1.28	0.24	0.08	2.23	0.83	0.06	0.52	0.09
K_2O	0.09	0.12	0.02	0.03	0.24	0.25	0.04	0.28	0.03
Total	97.21	96.90	97.14	98.42	97.37	97.30	97.40	94.81	97.61
	Formulas calculated on the basis of 23 (0)								
Si	6.65	6.86	7.17	7.77	6.21	7.24	7.50	7.40	7.88
Al	1.35	1.14	0.83	0.20	1.79	0.76	0.50	0.60	0.12
Al	0.87	0.68	0.29	—	0.92	0.27	0.20	0.18	0.17
Ti	0.08	0.03	0.01	—	0.01	0.01	0.01	0.01	—
Fe	1.18	1.08	1.09	1.29	1.56	1.60	1.77	1.60	1.77
Mn	0.02	0.02	0.02	0.02	0.03	0.02	0.02	0.02	0.01
Mg	3.23	3.56	4.29	4.16	2.85	3.62	3.61	3.46	3.22
Y	5.38	5.37	5.70	5.47	5.37	5.52	5.61	5.37	5.17
Ca	1.55	1.62	1.53	1.67	1.72	1.57	1.52	1.62	1.77
Na	0.43	0.36	0.07	0.02	0.64	0.23	0.02	0.15	0.02
K	0.02	0.02	—	—	0.04	0.04	0.01	0.05	—
X	2.00	2.00	1.60	1.69	2.40	1.84	1.55	1.82	1.79
$\frac{Fe+Mn}{Fe+Mn+Mg}$	0.26	0.24	0.20	0.24	0.36	0.31	0.33	0.32	0.36

content of TiO_2 and total iron, which clearly distinguish this mica from the biotite in similar rocks of the nearby Drahotín stock (V e j n a r 1980).

The chemical composition of the rocks

The petrographic and mineralogical variability of the rocks of the Kdyně massif is reflected in the wide range of their chemical compositions, apparent from the analyses given in table 16. Their two basic petrochemical variation trends are depicted in the A, F, M diagram in figs. 6 and 7. The first, including



8. Scheme of the differentiation trends of the Kdyně massif (K_1, K_2) in the A—F—M diagram and their relationship to the Poběžovice (P) and Skaergaard (S) trends
The variation field of the Kdyně massif; G — olivine gabbro, GD — olivine gabbronorite and uralitized gabbronorite, FD — ferrodiorite, H — hortonolite, D — diorite, T — tonalite, GD — granodiorite, TR — trondhjemite

rocks of the lower zone of the massif, is represented by the series olivine gabbro → olivine gabbronorite → ferrodiorite. The second, appearing in the central and upper zones of the massif appears as diorite-tonalite association.

In this diagram, olivine gabbro occupies a relatively narrow field characterized by the lowest iron content [$X_{Fe} = FeO_{tot.}/(FeO_{tot.} + MgO)$, expressed as mass percent] varying from 0.40 to 0.43. From the point of view of the Fe, Mg fractionation, this rock represents the magnesium-richest member of the given variation series.

The much greater range of the variation field of olivine gabbronorite corresponds to its greater structural variability, expressed by the banded struc-

Table 15

Microprobe analyses of biotite from diorite (*1—12*), tonalite (*13—16*),

Analysis	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
Sample	858	766	857	650	632	630	638	642	719	685
SiO_2	35.24	35.90	36.07	39.79	36.74	37.02	36.24	35.77	37.96	35.60
TiO_2	5.40	5.68	5.08	5.13	5.40	4.51	3.04	3.39	6.03	5.10
Al_2O_3	13.20	13.16	14.15	14.45	14.08	14.12	15.53	14.88	14.71	15.08
FeO tot.	26.46	27.06	24.93	16.38	19.03	20.76	22.94	25.75	15.43	22.92
MnO	0.19	0.11	0.11	0.09	0.10	0.07	0.07	0.08	0.12	0.20
MgO	6.84	6.53	7.60	12.01	11.77	10.51	10.24	10.48	11.79	7.00
CaO	—	0.01	—	0.02	0.01	0.09	0.41	0.19	0.71	0.51
Na_2O	0.10	0.16	0.13	0.06	0.05	0.15	0.12	0.04	0.32	0.24
K_2O	8.55	9.28	7.86	8.27	10.41	10.02	7.52	5.44	9.11	8.76
Total	95.98	97.89	95.93	96.20	97.59	97.25	96.11	96.02	96.18	95.41
								Formulas calculated		
Si	5.52	5.56	5.58	5.84	5.51	5.60	5.52	5.47	5.63	5.53
Al	2.48	2.44	2.42	2.16	2.49	2.40	2.48	2.53	2.37	2.47
Al	—	—	0.16	0.34	—	0.12	0.31	0.15	0.20	0.29
Ti	0.64	0.66	0.59	0.57	0.61	0.51	0.35	0.39	0.67	0.60
Fe	3.55	3.50	3.22	2.01	2.39	2.63	2.92	3.29	1.91	2.93
Mn	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.02	0.03
Mg	1.60	1.50	1.75	2.63	2.63	2.36	2.33	2.39	2.60	1.62
Y	5.81	5.68	5.74	5.56	5.64	5.63	5.92	6.23	5.40	5.52
Ca	—	—	—	—	—	0.01	0.06	0.03	0.11	0.08
Na	0.03		0.04	0.01	0.01	0.04	0.04	0.01	0.09	0.07
K	1.71		1.58	1.55	1.99	1.93	1.46	1.06	1.72	1.74
X	1.74	1.88	1.62	1.56	2.00	1.98	1.56	1.10	1.92	1.89
$\frac{Fe+Mn}{Fe+Mn+Mg}$	0.69	0.87	0.65	0.43	0.48	0.53	0.56	0.58	0.43	0.65

ture of the rock. There is considerable variation in the iron content, from 0.42 to 0.65, expressed as X_{Fe}, with an exceptional maximum of 0.78, found for an extreme banded variety(table 17, analysis *10*). Samples of hortonolite rock exhibit similarly high iron contents with $X_{Fe} = 0.72$ and 0.79.

The ferrodiorite field is characterized by the highest degree of Fe, Mg fractionation with X_{Fe} varying from 0.80 to 0.96.

The diorite-tonalite variation series follows from the diorite field, overlapping partially with the region of olivine gabbronorite and gradually passing into the quartz diorite + tonalite field. In this series, which also includes the granodiorite and trondhjemite group, the main variability factor is the changing

Table 15

ferrotonalite (*17—18*) and granodiorite (*19—21*)

11	*12*	*13*	*14*	*15*	*16*	*17*	*18*	*19*	*20*	*21*
975	951	640	687	689	647	909	1018	567	567	622
36.48	34.95	36.84	38.06	38.32	36.40	36.20	34.20	34.31	33.72	35.92
4.71	4.37	1.91	2.80	2.35	4.10	5.60	3.54	3.23	2.73	3.90
15.48	16.51	16.67	16.73	17.08	15.44	15.12	16.63	13.70	14.71	12.22
22.98	26.42	23.34	19.49	19.09	21.50	26.34	27.46	35.73	33.63	31.28
0.08	0.09	0.32	0.31	0.41	0.19	0.19	0.22	0.34	0.40	0.30
9.39	6.89	8.56	9.03	9.43	9.80	6.44	6.71	2.05	4.50	3.87
0.02	—	0.02	0.43	0.32	—	—	—	0.38	0.44	—
0.04	0.06	0.05	0.15	0.17	0.12	0.08	0.11	0.20	0.16	0.03
7.25	7.18	9.50	9.73	9.51	9.34	7.96	8.81	7.09	7.09	9.10
96.43	96.47	97.21	96.73	96.68	96.89	97.93	97.68	97.03	97.38	96.62
on the basis of 22(O)										
5.52	5.39	5.60	5.71	5.72	5.52	5.51	5.30	5.55	5.38	5.75
2.48	2.61	2.40	2.29	2.28	2.48	2.49	2.70	2.45	2.62	2.25
0.28	0.39	0.59	0.67	0.73	0.28	0.22	0.34	0.16	0.15	0.06
0.54	0.51	0.22	0.32	0.27	0.47	0.64	0.41	0.39	0.33	0.47
2.91	3.41	2.97	2.44	2.38	2.72	3.35	3.56	4.83	4.50	4.19
0.01	0.01	0.04	0.04	0.05	0.04	0.02	0.03	0.05	0.05	0.04
2.12	1.58	1.93	2.02	2.10	2.20	1.46	1.55	0.49	1.07	0.92
5.86	5.90	5.75	5.49	5.53	5.71	5.69	5.89	5.92	6.10	5.68
—	—	—	0.07	0.05	—	—	—	0.07	0.08	—
0.01	0.02	0.02	0.05	0.05	0.04	0.02	0.03	0.07	0.05	0.01
1.40	1.41	1.84	1.86	1.81	1.80	1.54	1.74	1.46	1.44	1.86
1.41	1.43	1.86	1.98	1.91	1.84	1.56	1.77	1.60	1.57	1.87
0.38	0.68	0.61	0.55	0.54	0.55	0.70	0.70	0.91	0.81	0.82

alkali content. The Fe, Mg ratio in this series varies in a narrower range (X_{Fe} = 0.50—0.80).

The coarse-grained amphibole diorite from St. Bernhard chapel (table 16, analyses *59* and *60*) occupies a special position in the A, F, M diagram, close to olivine gabbro; the only dark mineral in this rock is tschermakitic hornblende. In this rock, the iron content expressed as the X_{Fe} index, attains a value of 0.43.

In addition to the described variability in the Fe/Mg ratio, the distribution of titanium, manganese and phosphorus and the sulphur content are also interesting.

Table 16

Analysis	1	2	3	4	5	6	7	8	9	10
Sample	40	159	269	359	785	779	808	775	807	357
Rock type	olivine gabbro					olivine gabbronorite				
SiO_2	48.88	47.38	49.62	47.21	48.41	47.64	49.30	48.90	50.26	48.34
TiO_2	0.51	0.17	0.75	0.83	0.38	4.46	2.84	0.64	0.88	2.23
Al_2O_3	18.76	19.62	16.19	14.20	20.75	16.14	19.18	20.69	16.99	18.23
Fe_2O_3	0.87	0.45	0.91	1.34	0.64	0.96	0.40	0.66	0.82	0.80
FeO	5.41	6.53	5.67	8.19	6.37	10.36	7.73	4.62	7.36	11.34
MnO	0.12	0.08	0.14	0.18	0.19	0.16	0.15	0.09	0.14	0.18
MgO	9.00	9.98	9.47	12.44	10.09	6.17	4.48	7.23	6.90	3.36
CaO	11.65	10.96	12.05	9.96	8.31	9.14	9.66	12.60	9.82	8.20
Na_2O	3.38	2.64	2.96	2.15	2.92	2.73	3.79	2.60	3.26	4.61
K_2O	0.66	0.16	0.22	0.23	0.11	0.13	0.25	0.10	0.43	0.31
P_2O_5	0.04	0.14	0.07	0.06	0.04	0.04	0.06	0.07	0.17	1.08
CO_2	0.20	0.27	0.44	0.30	0.11	0.09	0.23	0.08	0.13	—
H_2O^+	0.67	0.58	0.46	2.01	0.80	0.96	0.94	0.96	2.20	0.44
S	0.04	0.10	0.07	0.10	0.08	0.22	0.07	0.09	0.28	0.08
H_2O^-	0.18	0.01	0.15	0.04	0.21	0.18	0.19	0.19	0.26	0.09
Total	100.37	99.07	99.17	99.24	100.02	99.38	99.27	99.52	99.90	99.29

Table 16 *(continued)*

Analysis	22	23	24	25	26	27	28	29
Sample	880	842	839	841	877	85	83	360
Rock type	ferrodiorite							uralitized gabbro
SiO_2	49.30	48.69	50.33	53.07	45.42	35.57	46.41	47.06
TiO_2	1.44	2.43	1.18	1.27	2.88	8.00	3.65	0.15
Al_2O_3	14.51	14.29	15.65	18.34	15.60	8.66	12.62	19.08
Fe_2O_3	5.62	3.42	2.05	1.40	0.50	6.85	1.94	1.06
FeO	12.23	14.45	13.35	10.75	16.71	13.69	14.07	5.58
MnO	0.39	0.33	0.33	0.24	0.28	0.47	0.30	0.15
MgO	0.79	1.43	2.15	1.08	3.96	4.20	4.16	10.11
CaO	7.50	7.75	7.47	6.27	7.50	12.45	10.22	8.20
Na_2O	4.80	3.77	4.91	6.09	3.61	2.45	3.73	2.60
K_2O	0.58	0.40	0.30	0.38	0.24	0.09	0.39	1.00
P_2O_5	0.47	0.82	0.80	0.15	1.60	5.12	0.84	0.02
CO_2	—	0.02	0.03	0.02	0.03	—	—	—
H_2O^+	1.03	1.25	0.51	0.49	0.67	1.96	0.72	4.48
S	—	0.02	0.09	—	0.11	0.58	0.23	0.01
H_2O^-	0.07	0.22	0.14	0.14	0.29	0.70	0.01	0.15
Total	98.73	99.29	99.29	99.69	99.40	100.79	99.89	99.65

of rocks of the Kdyně massif

Table 16

11	*12*	*13*	*14*	*15*	*16*	*17*	*18*	*19*	*20*	*21*
136	137	Š1	K2	852	K4	216	Š2	K3	Š6	324
olivine gabbronorite									hortonolite rock	
48.92	50.58	49.52	50.17	48.26	48.21	49.13	49.36	49.99	28.33	34.05
0.64	0.89	0.36	0.38	1.75	1.69	0.47	0.88	0.97	8.53	0.24
13.06	18.98	18.74	19.94	15.88	15.82	18.04	16.39	17.43	0.81	0.69
3.36	0.86	1.16	0.42	1.04	1.20	1.39	1.17	0.70	6.90	6.53
6.98	5.81	7.20	6.18	9.60	10.51	9.47	9.20	9.03	38.20	38.51
0.15	0.13	0.25	0.11	0.22	0.21	0.15	0.17	0.17	0.67	0.72
10.93	6.85	8.95	7.84	7.40	7.66	8.16	7.12	7.19	11.90	17.20
12.14	11.36	9.88	9.98	10.37	10.19	9.52	10.98	9.61	2.78	0.67
2.76	3.54	3.02	3.40	2.88	2.75	3.16	3.40	3.35	0.13	0.42
0.20	0.22	0.11	0.12	0.12	0.15	0.22	0.13	0.15	0.06	0.17
0.03	0.03	0.06	0.05	0.04	0.07	0.04	0.09	0.05	0.15	0.08
0.27	0.20	—	—	0.19	—	—	—	—	—	—
0.53	0.57	0.90	0.79	1.27	1.27	0.75	1.38	1.12	1.28	0.29
0.69	0.17	0.05	—	0.11	—	0.10	0.22	—	—	—
0.06	0.05	0.06	0.14	0.07	0.11	0.11	0.08	0.13	0.40	0.16
100.72	100.24	100.26	99.52	99.20	99.84	100.71	100.57	99.89	100.14	99.73

Table 16 *(continued)*

30	*31*	*32*	*33*	*34*	*35*	*36*	*37*	*38*	*39*	*40*
776	K155	K156	806	830	782	942	323	325	838	Š4
uralitized gabbronorite									uralitized ferrodiorite	
50.43	53.20	49.54	50.63	46.58	50.71	51.56	43.94	51.47	49.52	44.47
3.44	2.73	0.91	0.96	0.62	0.30	0.37	3.34	1.67	1.56	4.88
16.79	16.82	20.51	15.49	18.38	19.69	16.87	15.30	21.61	15.96	12.08
0.59	0.64	1.16	1.04	1.12	0.36	0.90	2.82	0.93	3.55	1.28
8.81	7.90	6.57	7.94	6.20	3.77	6.14	13.13	3.81	13.27	13.70
0.16	0.14	0.12	0.15	0.11	0.09	0.15	0.26	0.08	0.37	0.23
4.45	3.80	4.74	7.35	10.40	7.92	7.26	4.85	1.21	1.03	5.24
8.81	7.74	9.33	11.04	9.37	12.43	11.91	8.09	9.66	6.55	10.65
3.11	3.32	3.09	2.56	2.36	1.75	3.08	3.77	4.64	4.74	2.88
0.53	0.71	0.49	0.21	0.40	0.38	0.25	0.28	1.41	0.56	0.64
0.25	0.26	0.15	0.06	0.15	0.05	0.02	1.94	0.12	0.28	0.29
0.14	0.16	0.19	0.03	0.05	0.07	0.05	—	0.23	0.01	—
1.46	1.71	2.36	1.93	3.20	1.95	1.44	1.70	2.48	1.50	3.06
0.12	0.06	0.14	0.24	0.04	0.03	0.04	0.12	—	—	0.30
0.19	0.11	0.08	0.24	0.36	0.26	0.24	0.15	0.19	0.26	0.05
99.28	99.30	99.38	99.87	99.34	99.76	100.28	99.69	99.51	99.16	99.75

Table 16 *(continued)*

Analysis	*41*	*42*	*43*	*44*	*45*	*46*	*47*	*48*	*49*
Sample	943	944	786	K5	882	834	835	890	781
Rock type	pyroxene-amphibole diorite								
SiO_2	50.43	53.84	49.24	49.59	48.76	50.92	54.34	48.51	51.49
TiO_2	1.78	1.81	3.25	2.84	2.84	0.84	1.56	4.71	2.39
Al_2O_3	16.92	19.30	14.42	15.03	16.25	19.87	15.02	3.41	15.07
Fe_2O_3	0.82	1.02	0.42	2.63	1.83	0.53	0.10	1.87	0.75
FeO	10.78	8.23	11.42	9.05	10.47	7.08	9.27	12.38	10.09
MnO	0.20	0.17	0.21	0.22	0.22	0.12	0.16	0.32	0.18
MgO	4.24	2.26	6.31	6.37	5.08	5.81	7.02	14.26	5.92
CaO	8.58	6.93	8.92	9.16	8.62	9.65	6.97	11.36	8.75
Na_2O	3.98	5.13	2.81	2.85	3.73	3.85	2.78	0.59	2.99
K_2O	0.25	0.27	0.19	0.18	0.34	0.16	0.77	0.27	0.42
P_2O_5	0.60	0.34	0.49	0.48	0.66	0.05	0.11	0.14	0.35
CO_2	0.07	0.02	0.37	—	—	0.09	0.16	—	0.39
H_2O^+	0.96	0.79	0.97	0.92	0.15	0.76	0.85	0.21	0.90
S	0.10	0.05	0.15	—	0.07	0.08	0.30	0.25	0.11
H_2O^-	0.15	0.19	0.21	0.09	0.03	0.10	0.12	0.05	0.23
Total	99.86	100.35	99.38	99.41	99.05	99.91	99.53	98.33	100.03

Table 16 *(continued)*

Analysis	*61*	*62*	*63*	*64*	*65*	*66*	*67*	*68*
Sample	816	817	804	813	814	253	802	833
Rock type	quartz diorite			tonalite				granodiorite
SiO_2	61.67	53.59	55.36	54.17	62.22	59.00	57.25	69.90
TiO_2	0.78	2.92	1.14	1.95	1.20	1.28	1.56	0.33
Al_2O_3	16.91	16.37	16.47	16.65	15.31	15.99	15.88	14.09
Fe_2O_3	1.32	1.19	0.91	2.29	1.78	1.05	1.22	0.39
FeO	4.20	7.20	5.76	8.50	5.25	5.93	6.83	3.51
MnO	0.09	0.14	0.14	0.18	0.10	0.12	0.13	0.06
MgO	2.52	4.91	4.41	2.21	2.44	3.18	3.11	0.42
CaO	5.91	7.67	8.73	6.50	4.39	6.08	5.80	2.25
Na_2O	3.72	3.22	3.77	4.46	3.78	4.08	3.67	4.84
K_2O	1.58	0.67	1.18	0.89	1.72	1.57	1.83	2.25
P_2O_5	0.20	0.14	0.08	0.58	0.27	0.26	0.35	0.18
CO_2	0.03	0.13	0.07	0.02	0.03	—	0.03	0.17
H_2O^+	1.07	1.78	1.75	1.53	1.32	1.25	1.45	0.73
S	0.01	0.02	0.01	0.01	0.01	0.02	0.02	0.02
H_2O^-	0.32	0.28	0.30	0.26	0.37	0.19	0.26	0.28
Total	100.33	100.23	100.08	100.20	100.19	100.00	99.39	99.42

Table 16 *(continued)*

50	51	52	53	54	55	56	57	58	59	60
832	39	K153	K154	K111	K112	812	780	831	884	887
pyroxene-amphibole diorite								amphibole diorite		
50.05	54.05	52.92	51.24	53.24	54.13	54.39	50.82	54.25	49.83	49.59
1.46	1.38	1.88	1.99	1.84	1.83	2.04	2.39	1.18	1.44	1.40
16.33	16.06	15.67	16.78	17.51	17.33	16.70	15.77	16.45	9.40	8.50
1.02	1.18	0.48	0.35	1.15	0.54	1.64	0.19	0.57	2.49	2.99
7.22	7.53	9.01	8.08	7.41	7.64	8.95	10.84	6.90	7.95	8.14
0.14	0.18	0.19	0.17	0.16	0.16	0.16	0.21	0.13	0.16	0.18
6.51	4.95	4.87	6.43	3.91	3.84	2.53	6.45	5.24	13.76	14.06
8.81	7.68	8.39	9.35	7.35	7.37	6.52	8.33	8.08	9.25	9.42
3.18	4.12	3.23	2.95	4.30	4.47	4.23	3.23	4.04	1.66	1.38
0.45	1.37	0.58	0.36	0.72	0.66	0.87	0.28	0.73	0.85	0.57
0.26	0.25	0.27	0.07	0.39	0.47	0.54	0.44	0.24	0.17	0.19
1.34	0.17	0.35	0.22	0.02	0.02	0.02	0.37	0.14	—	—
2.80	1.08	1.36	1.23	1.19	1.01	1.08	0.81	1.85	2.08	1.87
0.01	0.05	0.10	0.09	0.07	0.19	0.18	0.11	0.05	0.02	0.01
0.36	0.14	0.09	0.10	0.12	0.18	0.23	0.22	0.31	0.07	0.06
99.94	100.19	99.39	99.41	99.38	99.84	100.08	100.46	100.16	99.13	98.36

69	70	71	72
878	879	809	A21
spessartite			trondhjemite
45.25	44.72	44.32	75.79
3.91	3.89	4.42	0.09
13.31	13.21	12.61	14.03
2.41	2.16	3.21	0.22
12.43	12.57	12.03	0.53
0.25	0.25	0.25	0.02
6.00	6.04	5.80	0.25
9.56	9.42	9.56	1.23
2.92	2.82	2.73	5.84
0.44	0.58	0.51	0.92
0.68	0.67	0.79	0.05
0.17	0.60	0.27	—
1.54	2.05	2.35	0.51
0.15	0.17	0.29	—
0.22	0.21	0.24	0.15
99.24	99.36	99.38	99.63

Locality: 1 — holes left from stone quarrying 0.5 km W of Pláně, next to the highway to Všeruby; 2—3 — abandoned quarry in the woods 0.1 km E of elevation point 622 at the S edge of Orlovice; 4 — drill hole GP1 next to the woods road from Orlovice to Jezvinec, 0.01 km S of elevation point 622; weakly uralitized rock; 5 — weathered boulders in an abandoned sand quarry near the NW edge of Všeruby; 6 — boulders at the edges of the woods 0.3 km W of elevation point 562, ESE of Kdyně; variety with increased ilmenite content; 7 — weathered boulders in an abandoned sand quarry 0.3 km W of Branišov; 8 — abandoned quarry in the woods 0.7 km SSW of Starec; slightly uralitized rock; 9 — weathered boulders in the sand quarry at the saddle point between

Koráb (773 m) near the highway from Kdyně to Mezholezy; 10 — UÚG drill hole 1 48.0 m. close to elevation point 560 ("U obrázku"). 1.2 km NW of Orlovice; 11 — abandoned quarry 0.4 km WSW of the Orlovice gamekepeer's lodge. Gabbronorite location with increased pyrrhotite content; 12, 13, 14 — locality as in no. 11. Medium to coarse-grained variety of olivine gabbronorite; 15, 16 — abandoned quarry on the NE side of Havranice (66 m). 0.3 km SW of the farm "U Havelků", 2 km W of Pocinovice; 17, 18 — abandoned quarry near Kafkova louka meadow near the road from Orlovice to Pocinovice (close to elevation point 606); 19 — locality as in no. 17. Weakly uralitized rock; 20 — pit near elevation point 560 ("U obrázku"). 1.2 km NW of Orlovice. Rock variety with high ilmenite content; 21 — UÚG drill hole 1, 21.5 m. close to elevation point 560 ("U obrázku"), 1.2 km NW of Orlovice. Rock variety with occasional ilmenite; 22 — boulders near the sand quarry on the S side of Ostrý (594 m), 1.5 km SW of Chodská Lhota; 23 — debris on the top of Ostrý (594 m), 1.5 km SW of Chodská Lhota; 24 — boulders on the SW edge of elevation point 568 m, 2.2 km SW of Chodská Lhota; 25 — boulders at the S edge of elevation point 568 m in the Kouba valley, 2.2 km SW of Chodská Lhota; 26 — drill hole Š-1 located close to elevation point 551 m (Hrčoveň), 1.5 km NW of Orlovice; 27 — mining shaft for ilmenite at the site called "V obci" on the NE side of elevation point 551 m (Hrčoveň). Ilmenite-rich variety of ferrodiorite; 28 — drill hole Š-2 located close to elevation point 537 SE of the top of Můstek (564 m), 2.1 km WNW of Orlovice; 29 — drill hole GP1 located on the woods road from Orlovice to Jezvinec, 0.1 km S of elevation point 622; 30, 31, 32 — abandoned quarry 1.5 km ESE of Kdyně; 33 — abandoned quarry in the woods 0.5 km WSW of Branišov; 34 — boulders in the woods 1.1 km SSW of Prapořiště; 35 — boulders on the ridge 0.5 km W of Brůdek; 36 — boulders at the E edge of Hadrava; 37 — UÚG drill hole 1. 19.0 m. located near elevation point 560 m ("U obrázku"). 1.2 km NW of Orlovice; 38 — locality as in no. 37. rock with tiny prehnite veins; 39 — debris at elevation point 567 m on the SW outcrop of Ostrý (594 m), 1.5 km SW of Chodská Lhota; 40 — drill hole Š-2 situated close to elevation point 537 SE of the top of Můstek (564 m), 2.1 km WNW of Orlovice; 41 — boulder outcrops on the NW part of the Čertův kámen ridge (651 m), 2.5 km W of Svatá Kateřina. The diorite contains occasional olivine; 42 — boulder outcrops on Čertův kámen (651 m) 2.5 km W of Svatá Kateřina. The rock is inclined to the leucocratic variety of ferrodiorite; 43. 44 — abandoned quarry in the fields 0.6 km NW of Hyršov. The rock contains occasional xenoliths of amphibole-pyroxene hornfels; 45 — rocky outcrop in the Kouba valley 0.3 km NW of Pláně. Diorite with many more or less assimilated xenoliths of pyroxene-amphibole hornfels; 46 — boulders near the road in the fields 0.3 km N of Hájek; 47 — boulder outcrops close to elevation point 446. N edge of Hájek; 48 — boulders on the SW part of elevation point 535 (Na skalici), 2.2 km WNW of Chodská Lhota. Melanocratic variety of diorite rich in ilmenite; 49 — boulders at elevation point 516 (St. Anna) 0.8 km NE of Hájek; 50 — abandoned quarry near the highway 1.7 km NE of Němčice; 51, 52, 53 — quarry still in use at the N edge of Smržovice; 54, 55 — abandoned quarry at the edge of the woods on the SW side of Dobrá hora (641 m), NW of Chodská Lhota; 56 — abandoned quarry in the fields 0.8 km NW of Chodská Lhota; 57 — boulders near the field road leading to elevation point 516 (St. Anna) from the Kdyně—Všeruby highway, 1.1 km SE of Brůdek; 58 — abandoned quarry near the highway 1.7 km NE of Němčice; 59 — boulder outcrops 0.15 km SSE of the St. Bernhard chapel, 1 km E of Liščí. Very coarse-grained amphibole diorite; 60 — boulders in the field at elevation point 567 near the highway from Liščí to Nýrsko; 61 — abandoned sand quarry on the saddle point between Bezný (659 m) and Čepice (642 m), 1 km NW of Nová Ves; 62 — abandoned quarry 0.6 km SSW of Dobříkov near the field road from Hluboká; 63 — abandoned quarry in the woods 0.5 km WSW from Branišov. Uralitized rock; 64 —

abandoned quarry on the NNW side of Bezný (659 m) 1 km WSW of Brnířov. Foliated rock variety; 65 — boulder outcrops on the N ridge of Bezný (659 m) 1.1 km WSW of Brnířov. Foliated rock variety; 66 — ÚÚG drill hole 0.5 km S of the farm "U Cihlářů", 2 km SSE of Pocínovice; 67 — boulders in the sand quarry 2 km NW of Chudenín near the highway to Všeruby; 68 — abandoned quarry 0.75 km NE of Všepadly; 69, 70 — drill hole Š-1 near elevation point 551 (Hrčoveň) 1.5 km NW of Orlovice. Fine-grained and small-grained varieties of spessartite; 71 — abandoned quarry on Německá hora (644 m), 0.5 km WSW of Chodská Lhota; 72 — boulders in the sand quarry located at the edge of the woods on the E side of Hlasný vrch 1 km ENE of Pláně, close to the highway to Chudenín.

The analyses were performed by the staff of the chemical laboratory of the Geological Survey Prague under the guidance of Z. Šulcek and M. Huka with exception of samples S1—S6 taken from V. Šmejkal (1958).

The TiO_2 content, primarily bound in ilmenite, varies widely, more or less independently of the degree of differentiation expressed as the Fe/Mg ratio. Large differences have been found in the content of this metal even within a single rock type. Examples are analyses of hortonolite rock, where the TiO_2 content varies from 0.2 to 8.5 %, or ferrodiorite, with variations from 1.3 to 8.0 % TiO_2. These variations are dependent on local differentiation, leading to separation of the individual mineral phases or certain mineral assemblages into separate bands and schlieren. Extreme differences appear in the most markedly banded rock portions.

The manganese distribution considerably depends on the iron content of the rock. The maximal contents of this metal appear in ferrodiorite, where it varies from 0.3 to 0.5 % MnO. The distribution of phosphorus is similar, with a content increasing in the rock series olivine gabbro → olivine gabbronorite → ferrodiorite from ca. 0.1 to 0.8 % P_2O_5. Extremely high values of 1.0—5.0 % P_2O_5 are connected with rocks containing ilmenite and appatite-rich layers, appearing in the transition zone between gabbronorite and ferrodiorite or in ferrodiorite.

The sulphur content is low everywhere and mostly varies from 0.05 to 0.20 % S. Higher contents appear only exceptionally in pyrrhotite-rich bands of olivine gabbronorite (table 16, analysis *11* — 0.69 % S), or ferrodiorite (table 16, analysis *27* — 0.58 % S), occasionally present in the Orlovická hora body. On the basis of the increased contents of sulphur at this locality and considering the presence of drop-shaped grains of pyrrhotite in the gabbronorite Šmejkal (1958) concluded that there had been a very high concentration of sulphur in the original basaltoid magma, which could eventually have led to the liquidation of a separate sulphidic melt.

Table 16 shows that uralitization leads to only slight changes in the original composition of the rocks. It is reflected only in an increased content of K_2O and chemically bonded water and is also accompanied by oxidation of iron.

Of the trace elements, only chromium and nickel have so far been studied. In addition to the degree of differentiation, the contents of these elements are markedly dependent on the mafic mineral contents and the appearance of ilmenite and pyrrhotite in the analyzed samples.

The chromium contents in the olivine gabbro and olivine gabbronorite vary from 90 to 150 ppm, in the ferrodiorite and diorite they are below 100 ppm. The ilmenite-rich variety of pyroxene diorite (table 16, analysis *48*) has an exeptional content of 170 ppm Cr.

The nickel distribution is similar: its contents vary in the olivine gabbro and olivine gabbronorite from 20 to 40 ppm and in the ferrodiorite and diorite from 10 to 20 ppm. The maximum content — 110 ppm — was found in the ilmenite-rich pyroxene diorite (table 16, analysis *48*).

The petrochemical relationship of the Kdyně massif to the Poběžovice massif in the W part of the Domažlice crystalline region (V e j n a r 1973) is depicted in the A,F,M diagram in fig. 8. Magnesium-rich types, including peridotite, troctolite and pyroxenite, occur in the Poběžovice massif. Similar rocks were not found in the Kdyně massif. From the point of view of the Fe, Mg fractionation, the variation trend of the rocks in the Poběžovice massif occupies a central position between the two above trends for the Kdyně massif, of which the first exhibits a very sharp shape of the Skaergaard type and the second has a flat shape similar to the main variation trend of the Central Bohemian Pluton (V e j n a r 1973).

Conclusions

The Kdyně massif is a very complicated intrusion of late Cadomian (Cambrian ?) age. It is located on a NE—SW oriented fault zone, appearing in the SW at the intersection of the deep fault zone of the Bohemian Quartz Lode with the Central Bohemian deep fault.

The well-developed contact zone, the presence of a high content of xenoliths of the surrounding crystalline mantle rocks, and the chemical composition of the rocks and their minerals phases indicate that a shallow level of the massif is exposed on the present surface.

The rock association has bimodal character: in addition to basic gabbroid and diorite rocks, representing the older intrusive phase, acidic rocks of the tonalite to trondhjemite type, corresponding to the younger intrusive phase, are present. The spatial arrangement of the basic types and varieties of rocks of the older intrusive phase, especially for the gabbroic members, reflect a more or less marked stratiform structure of the massif, with local magmatic layering.

The chemical composition of the gabbroic rocks is characterized by a relatively high content of Al_2O_3 (17.6 %), and a very low content of K_2O (0.2 %) approaching the chemical composition of Al-rich tholeiites. CIPW calculations indicate that these rocks are of the olivine normative type. The relatively high Fe/Mg ratio in the most basic rocks in the massif and in their Fe,Mg silicates, together with the low contents of chromium (ca. 120 ppm) and nickel (ca.

30 ppm) show that these rocks represent advanced differentiates of the original magma, lying higher in the stratiform structure. Residual, magnesium-, chromium- and nickel-enriched rocks of the peridotite or pyroxenite type have not been found in the exposed part of the massif. They can, however, be assumed at depth as a complementary differentiation component. In this connection it should be noted that the local occurrence of hortonolite rock cannot be assigned to residual rock types because of the composition of its olivine, characterized by a high iron content, and because this rock belongs to the primarily magmatic layering of gabbronorite in the region of transition to ferrodiorite.

Differentiation of the original magma, in which crystallization of illmenite played a characteristic role, follows two completely different trends from the point of view of the Fe,Mg fractionation. The first, represented by rocks of the olivine gabbro → olivine gabbronorite → ferrodiorite series, has a very sharp trend of the Skaergaard type that has not yet been observed for the region of the Bohemian Massif. The second, including the rock series pyroxene diorite → tonalite → trondhjemite, is relatively flat compared to the trend of the nearby Poběžovice massif (V e j n a r 1973) and is thus similar to the variation trend of mafic rocks in the Central Bohemian Pluton (V e j n a r 1973).

The thermal conditions for crystallization of the most mafic rocks of the massif, i.e. gabbro and gabbronorite, can be estimated to correspond to cca 1200—1050 °C on the basis of the Fe,Mg distribution in the coexisting pyroxene pairs. The very low content of aluminium and titanium in the pyroxenes of these rocks indicates that the crystallization occurred at quite low pressures.

Local secondary conversion of the rocks of the massif, apparently produced by processes of Variscan orogenesis and metamorphism, has uralitization character: the original minerals, primarily Fe,Mg silicates were gradually replaced by secondary amphiboles accompanied by a small amount of chlorite. The original plagioclase underwent decalcification or recrystallization, accompanied by the formation of a small amount of quartz. Secondary minerals formed included illmenite (illmenite II) and magnetite, mostly replacing the primary, iron-rich olivine.

From the point of view of metallogenesis, differentiation of the rocks of the Kdyně massif is accompanied by the formation of small accumulations of ilmenite, mostly accompanied by relatively high amount of apatite. These accumulations are connected with cca 1—5 mm thick layers and streaks and occur primarily in the strongly banded variety of olivine gabbronorite of the transition zone between olivine gabbronorite and ferrodiorite. They are accompanied by 5—30 cm thick layers of hortonolite rock, sometimes also containing more ilmenite. The role of sulphur is limited to very exceptional occurrences of pyrrhotite in this layers in the olivine gabbronorite or segregations cm to dm in size, most often present in the neighbourhood of pyrrhotite-bearing xenoliths of crystalline schists, enclosed in diorite and in gabbroid rocks.

The discussion of the geological position, internal structure, petrochemical characteristics and the significant role of the Fe/Mg fractionation in the differentiation permits interpretation of the Kdyně massif as a tectonically modified layered intrusion, with characteristics similar to the Harzburg gabbro massif. On the present surface, the upper part of the intrusion, characterized by the presence of rocks with medium to very high Fe/Mg ratios, is exposed.

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Kdyňský masív v jihozápadních Čechách — tektonicky modifikovaná zvrstvená bazická intruze

(Résumé anglického textu)

Zdeněk Vejnar

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Kdyňský masív, zaujímající na dnešním povrchu plochu ca 200 km^2, z čehož asi 1/4 leží na území NSR, představuje morfologicky i látkově velmi složitou bazickou intruzi pozdně kadomského (kambrického ?) stáří. Je situován na poruchové zóně sv. směru, vycházející na JZ z oblasti, kde se protíná hlubinný zlom českého křemenného valu se středočeským hlubinným zlomem (středočeským švem). Masív je součástí domažlického krystalinika a v jeho sv. pokračování leží prevariská granitoidní intruze stodského masívu (Šmejkal - Vejnar 1965).

Výrazně vyvinutý kontaktní dvůr a přítomnost vysokého podílu xenolitů okolních krystalických břidlic ukazuje, spolu s chemickým složením hornin i jejich minerálních fází, že na dnešním povrchu je odkryta svrchní, původně patrně mělce intruzívní část masívu.

Masív má velmi komplikovanou vnitřní stavbu stratiformního charakteru, v které lze rozlišit tři základní jednotky: spodní zónu, tvořenou olivinickým gabrem, olivinickým gabronoritem a fayalitickým ferodioritem, dále střední dioritovou zónu a svrchní zónu, budovanou křemenným dioritem. Kromě tohoto horninového souboru, představujícího starší intruzívní fázi, jsou v masívu přítomny horniny tonalitového až trondhjemitového typu, patřící mladší intruzívní fázi. Jako cizí element se v masívu dále vyskytují drobná čočkovitá a žilná tělesa leukokratní žuly, spessartitu, dioritového porfyritu, žulového porfyru, aplitu a pegmatitu.

Chemické složení gabroidních hornin masívu je charakterizováno relativně vysokým obsahem Al_2O_3 (ca 17,6 %) při velmi nízkém podílu K_2O (ca 0,2 %), čímž se blíží chemickému složení Al-bohatých tholeiitů. Z hlediska CIPW kalkulace jsou tyto horniny olivín-normativního typu.

Relativně vysoký Fe-Mg poměr v nejbazičtějších členech horninové suity masívu (X_{Fe} = 0,40) i v jejich Fe, Mg silikátech spolu s nízkými obsahy chromu (ca 120 ppm) a niklu (ca 30 ppm) ukazuje, že tyto horniny představují pokročilé, z hlediska stratiformní stavby masívu výše ležící diferenciáty původního magmatu. Výskyt reziduálních, hořčíkem, chromem a niklem obohacených hornin typu peridotitu nebo pyroxenitu není v dnes obnažené části masívu znám, lze jej však jako komplementární složku diferenciace předpokládat v hloubce. Známé lokální výskyty hortonolitovce (S l a v í k 1922) nelze za horninu tohoto reziduálního typu považovat vzhledem k složení jejího olivínu, charakterizovanému vysokou železnatostí ($X_{Fe} = 0.60$).

Diferenciace původního magmatu, při které významnou roli hrála krystalizace ilmenitu, sledovala z hlediska Fe-Mg frakcionace dva zcela odlišné trendy. Prvý, reprezentovaný horninovou řadou olivinické gabro → olivinický gabronorit → ferodiorit, má velmi strmý průběh skaergaardského typu. Druhý, zahrnující horninovou řadu pyroxenický diorit → amfibol-pyroxenický diorit → tonalit → trondhjemit je naopak relativně plochý, plošší než trend petrochemicky blízkého poběžovického masívu (V e j n a r 1973a). Je podobný základnímu variačnímu trendu hornin středočeského plutonu (V e j n a r 1973b).

Teplotní podmínky krystalizace nejbazičtějších hornin masívu, tj. gabra a gabronoritu, lze na základě Fe-Mg distribuce v koexistujících pyroxenových párech odhadnout na ca 1200—1050 °C. Velmi malý obsah aluminia a titanu v pyroxenech těchto hornin pak naznačuje, že krystalizace probíhala za relativně nízkých tlaků.

Lokální druhotná přeměna hornin masívu, patrně vyvolaná pochody variské orogeneze a metamorfózy, má charakter uralitizace: původní minerály, především Fe, Mg silikáty, byly postupně nahrazovány sekundárními amfiboly, v malé míře provázenými chloritem. Původní plagioklas podlehl dekalcifikaci, popř. rekrystalizaci, provázené vznikem malého množství křemene. Jako druhotný minerál vznikal — kromě titanitu — také ilmenit (ilmenit II) a magnetit, převážně nahrazující primární vysoce železnatý olivín. Tento magnetit bývá dále zcela změněn v hematit.

Z hlediska metalogeneze je diferenciace hornin kdyňského masívu provázena vznikem drobných akumulací ilmenitu, obvykle provázeného apatitem. Tyto akumulace jsou vázány na ca 1—5 mm mocné laminy a šlíry a vyskytují se především ve výrazně páskované varietě olivinického gabronoritu přechodního horizontu mezi gabronoritem a ferodioritem. Jsou provázeny 5—30 cm mocnými polohami hortonolitovce, někdy obsahujícího zvýšený podíl ilmenitu. Role síry se omezuje jen na zcela výjimečné drobné výskyty pyrhotinu, vázaného na vzácně se vyskytující tenké laminy v olivinickém gabronoritu, nebo na segregace centimetrových až decimetrových rozměrů, nejčastěji přítomné v sousedství xenolitů pyrhotin obsahujících krystalických břidlic.

Diskutovaná geologická pozice, vnitřní stavba, petrochemické rysy i výrazná role Fe-Mg frakcionace při diferenciaci dovolují interpretovat kdyňský masív jako tektonicky modifikovanou zvrstvenou intruzi, která je svými vlastnostmi blízká harzburgskému gabrovému masívu. Na dnešní povrch vystupuje tato intruze svou svrchní částí, charakterizovanou přítomností hornin se středním až velmi vysokým Fe-Mg poměrem.

Vysvětlivky k tabulkám

Tabulka 1. Chemické složení olivínu z těles v okolí Orlovice.

Tabulka 2. Chemické složení olivínu z všerubského (*1—4*) a branišovského (*5—6*) tělesa.

Tabulka 3. Chemické složení ortopyroxenu z těles v okolí Orlovice.

Tabulka 4. Chemické složení ortopyroxenu z všerubského (*1—4*) a branišovského (*5—7*) tělesa.

Tabulka 5. Chemické složení ortopyroxenů z dioritů.

Tabulka 6. Chemické složení klinopyroxenu z těles v okolí Orlovice.

Tabulka 7. Chemické složení klinopyroxenu z všerubského (*1—5*) a branišovského (*6—8*) tělesa.

Tabulka 8. Chemické složení klinopyroxenu z dioritů.

Tabulka 9. Distribuční koeficienty pyroxenových párů.

Tabulka 10. Chemické složení primárních amfibolů z těles v okolí Orlovice.

Tabulka 11. Chemické složení primárních amfibolů z všerubského (*1—6*) a branišovského (*7—9*) tělesa.

Tabulka 12. Chemické složení primárních amfibolů z dioritů (*1—12*), tonalitu (*13—16*), ferotonalitu (*17—18*) a granodioritu (*19—20*).

Tabulka 13. Chemické složení sekundárních amfibolů z těles v okolí Orlovice.

Tabulka 14. Chemické složení sekundárních amfibolů z všerubského (*1—4*) a branišovského (*5—9*) tělesa.

Tabulka 15. Chemické složení biotitu z dioritů (*1—12*), tonalitu (*13—16*), ferotonalitu (*17—18*) a granodioritu (*19—21*).

Tabulka 16. Chemické složení hornin kdyňského masívu.

Lokality vzorků uvedených v tabulkách 1—15:
138 — vrt ÚÚG1, 47,0 m, situovaný poblíž kóty 560 („U obrázku"), 1,2 km sz. od Orlovice; 140 — vrt GP1 situovaný při lesní cestě z Orlovice na Jezvinec, 0,1 km j. od kóty 622; 522 — vrt ÚÚG1, 12,5 m, situovaný poblíž kóty 560, 1,2 km sz. od Orlovice; 567 — opuštěný lom 0,75 km sv. od Všepadel; 619 — balvany v lesíku 1,1 km jjz. od Prapořiště; 622 — opuštěný lom 0,75 km sv. od Všepadel; 627 — opuštěný lom v lesíku 0,7 km jjz. od Starce; 629 — balvany při okraji lesíka 0,3 km z. od kóty 568, vjv. od Kdyně. Hornina bohatá ilmenitem; 630 — balvany u polní cesty směřující na kótu 516 (Svatá Anna) ze silnice Kdyně—Všeruby, 1,1 km jv. od Brůdku; 632 — balvany na kótě 516 (Svatá Anna) 0,8 km sv. od Hájku; 634 — opuštěná pískovna při sz. okraji Všerub; 635 — opuštěný lom v polích 0,6 km sz. od Hyršova. Hornina obsahuje xenolity amfibol-pyroxenického rohovce; 638 — lokalita jako 635; 640 — opuštěný lom v ssv. svahu Bezného (659 m) 1 km zjz. od Brnířova; 642 — lokalita jako 635; 647 — pískovna 2 km sz. od Chudenína při silnici do Všerub; 650 — balvanitý výchoz poblíž kóty 446 při s. okraji Hájku; 678 — opuštěný lom 0,5 km z. od Branišova; 680 — opuštěná pískovna v sedle mezi Korábem (773 m) a Suchou horou (760 m) při silnici z Kdyně do Mezholez; 681 — jáma po těžbě písku 0,5 km sz. od Branišova; 685 — opuštěný lom v polích, 0,8 km sz. od Chodské Lhoty; 687 — balvanité výchozy na s. hřbetu Bezného (659 m) 1,1 km zjz. od Brnířova; 689 — opuštěná pískovna v sedle mezi Bezným (659 m) a Čepicí (642 m) 1 km sz. od Nové Vsi; 703 — balvany u polní cesty 0,3 km s. od Hájku; 715 — opuštěná pískovna j. od Nové Vsi; 750 — balvany při okraji lesa na sv. svahu Ostrého (594 m), 2 km jz. od Chodské Lhoty; 752 — opuštěný lom sz. od Branišova; 753 — vrchol Ostrého (594 m) 1,8 km zjz. od Chodské Lhoty; 761 — balvany při okraji lesa na pravém břehu Kouby 1,5 km sv. od Chalup; 762 — lokalita jako 753; 766 — balvanitý výchoz za obchodem v Zichově, z. od Kolovče; 777 — opuštěný lom 0,4 km zjz. od

hájovny v Orlovici. Pásek gabronoritu se zvýšeným podílem pyrhotinu; 778 — halda staré kutací práce poblíž kóty 560 („U obrázku"), 1,2 km sz. od Orlovice; 782 — opuštěná pískovna při okraji lesa na jz. svahu Ostrého (594 m), 1,9 km zjz. od Chodské Lhoty; 825 — opuštěný lom 0,4 km zjz. od hájovny v Orlovici; 843 — opuštěný lom v lese 0,1 km v. od kóty 622 při j. okraji Orlovice; 846, 847 — lokalita jako 843; 850 — balvanité výchozy na j. svahu Orlovické hory (719 m); 852 — lokalita jako 843; 857 — opuštěný lom při jv. okraji Srbic: 858 — opuštěná pískovna 1,0 km jv. od Srbic; 883 — skalní výchozy na návrší ležícím 0,6 km jv. od kóty 527 (Na hřebeni) 1,2 km sz. od Hadravy; 888 — skelet při okraji lesa 0,4 km v. od Kameniště (541 m), 1.3 km vjv. od Chalup; 893 — výchoz u lesní cesty 4,0 km s. od Hyršova, 1.5 km vjv. od Hájku; 896 — opuštěný lom u Kafkovy louky při cestě z Orlovice do Pocínovic; 899 — skelet v lese na v. svazích kóty 629 1,5 km z. od Hadravy; 900 — výchozy v lesní cestě 0,5 km sv. od Orlovice na j. svahu Havranice (666 m); 903 — staré kutací práce na železnou rudu poblíž samoty „U Krocarů" 1,5 km jz. od Pocínovic; 904 — lokalita jako 888; 905 — skelet na jv. svahu Jezvince (739 m) 0,3 km od vrcholu; 909 — okraj lesa z. od Předních Fleků; 910 — skelet v lese u kóty 475 1 km sz. od Srubů; 915 — lokalita jako 843; 917 — zářez lesní cesty na v. úpatí Můstku (564 m) 1 km v. od Chalup; 940, 942 — balvany při v. okraji Hadravy: 944 — zářez lesní cesty 0,2 km v. od kóty 537 ležící v sedle mezi Můstkem (564 m) a Orlovickou horou (719 m); 945 — skelet u lesní cesty 0,25 km j. od vrcholu Můstku (564 m), 1.5 km v. od Chalup: 951 — jako lokalita 888; 955 — balvany na okraji lesa u kóty 531 1 km v. od od Chalup; 960 — balvany v lese na návrší 1,6 km v. od Všerub, 0,5 km zsz. od kóty 556; 975 — opuštěný lom 1.3 km j. od Chodské Lhoty na ssv. svahu Javorovice (587 m); 979 — skelet při okraji lesa 0,2 km sz. od Branišova; 1018 — skelet na svahu při zsz. úpatí kóty 641 1 km jv. od Jezvince (739 m); V26 — vrt ÚÚG1, 21.5 m, situovaný poblíž kóty 560 („U obrázku"), 1,2 km sz. od Orlovice; V27 — opuštěný lom 0.4 km zjz. od hájovny v Orlovici. Pásek gabronoritu se zvýšeným podílem pyrhotinu.

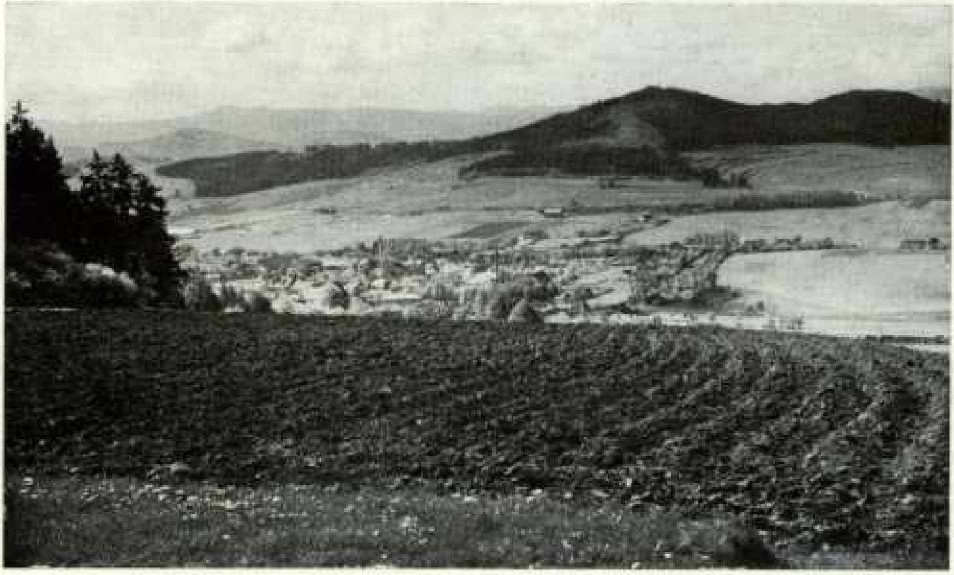
Lokality vzorků uvedených v tabulce 16:

1 — jámy po těžbě kamene 0,5 km z. od Plání při silnici do Všerub: 2, 3 — opuštěný lom v lese 0.1 km v. od kóty 622 při j. okraji Orlovice; 4 — vrt GP1 při lesní cestě z Orlovice na Jezvinec, 0,1 km j. od kóty 622. Hornina slabě uralitizována; 5 — navětralé balvany v opuštěné pískovně při sz. okraji Všerub; 6 — balvany při okraji lesíka 0.3 km z. od kóty 532, vjv. od Kdyně. Varieta se zvýšeným podílem ilmenitu: 7 — vyvětralé balvany v opuštěné pískovně 0,3 km z. od Branišova; 8 — opuštěný lom v lesíku 0.7 km jjz. od Starce. Hornina slabě uralitizována; 9 — vyvětralé balvany v pískovně ležící v sedle mezi Korábem (773 m) při silnici z Kdyně do Mezholez; 10 — vrt ÚUG1, 47,0 m, poblíž kóty 560 („U obrázku"), 1,2 km sz. od Orlovice; 11 — opuštěný lom 0,4 km zjz. od orlovické hájovny. Poloha gabronoritu se zvýšeným podílem pyrhotinu; 12, 13, 14 — lokalita jako č. 11. Středně až hrubě zrnitá varieta olivinického gabronoritu: 15. 16 — opuštěný lom na sv. svahu Havranice (666 m), 0.3 km jz. od samoty „U Havelků", 2 km z. od Pocinovic: 17, 18 — opuštěný lom u Kafkovy louky při cestě z Orlovice do Pocinovic (poblíž kóty 606); 19 — lokality jako č. 17. Hornina slabě uralitizována: 20 — halda staré kutací práce poblíž kóty 560 („U obrázku"), 1,2 km sz. od Orlovice. Varieta horniny s hojným ilmenitem; 21 — vrt ÚÚG1. 21.5 m, poblíž kót 560 („U obrázku"), 1,2 km sz. od Orlovice. Varieta horniny se zcela ojedinělým ilmenitem: 22 — balvany u pískovny na j. svahu Ostrého (594 m). 1.5 km jz. od Chodské Lhoty; 23 — skelet na vrcholu Ostrého (594 m) 1.5 km jz. od Chodské Lhoty: 24 — balvany na jz. úpatí kóty 568 m. 2.2 km jz. od Chodské Lhoty; 25 — balvany na j. úpatí kóty 568 m v údolí Kouby, 2,2 km jz. od Chodské Lhoty: 26 — vrt Š-1 situovaný poblíž kóty 551 m (Hrčoveň). 1.5 km sz. od Orlovice; 27 — kutací šachtice na ilmenit v místě zvaném „V obci" na sv. svahu kóty

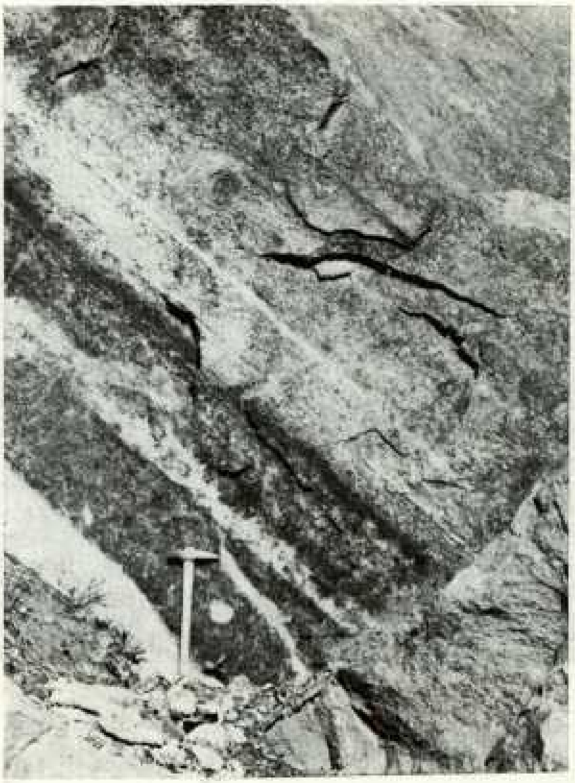
551 m (Hrčoveň). Ilmenitem bohatá varieta ferodioritu; 28 — vrt Š-2 situovaný poblíž kóty 537 jv. od vrcholu Můstku (564 m), 2,1 km zsz. od Orlovice; 29 — vrt GP1 situovaný na lesní cestě z Orlovice směrem na Jezvinec, 0,1 km j. od kóty 622; 30, 31, 32 — opuštěný lom 1,5 km vjv. od Kdyně; 33 — opuštěný lom v lesíku 0,5 km zjz. od Branišova; 34 — balvany v lesíku 1,1 km jjz. od Prapořiště; 35 — balvany na hřbetu 0,5 km z. od Brůdku; 36 — balvany při v. okraji Hadravy; 37 — vrt ÚÚG1, 19,0 m situovaný u kóty 560 m („U obrázku"), 1,2 km sz. od Orlovice; 39 — lokalita jako č. 37. Hornina s drobnými žilkami prehnitu; 39 — skelet na kótě 567 m na jz. výběžku Ostrého (594 m), 1,5 km jz. od Chodské Lhoty; 40 — vrt Š-2 situovaný poblíž kóty 537 jv. od vrcholu Můstku (654 m), 2,1 km zsz. od Orlovice; 41 — balvanité výchozy na sz. části hřebenu Čertova kamene (651) 2,5 km z. od Svaté Kateřiny. Diorit obsahuje ojedinělý olivín; 42 — balvanité výchozy na Čertově kameni (651 m) 2,5 km z. od Svaté Kateřiny. Hornina inklinuje k leukokratní varietě ferodioritu; 43, 44 — opuštěný lom v polích 0,6 km sz. od Hyršova. Hornina obsahuje ojedinělé xenolity amfibol-pyroxenického rohovce; 45 — skalní výchoz v údolí Kouby 0,3 km sz. od Plání. Diorit s četnými víceméně asimilovanými xenolity pyroxen-amfibolického rohovce; 46 — balvany u polní cesty 0,3 km s. od Hájku; 47 — balvanitý výchoz poblíž kóty 446, s. okraj Hájku; 48 — balvany na jz. části kóty 535 (Na skalici) 2,2 km zjz. od Chodské Lhoty. Melanokratní varieta dioritu bohatá ilmenitem; 49 — balvany na kótě 516 (Svatá Anna) 0,8 km sv. od Hájku; 50 — opuštěný lom u silnice 1,7 km sv. od Němčic; 51, 52, 53 — lom v provozu při s. okraji Smržovic; 54, 55 — opuštěný lom při okraji lesa na jz. svahu Dobré vody (641 m) sz. od Chodské Lhoty; 56 — opuštěný lom v polích 0,8 km sz. od Chodské Lhoty; 57 — balvany u polní cesty směřující na kótu 516 (Svatá Anna) ze silnice Kdyně—Všeruby, 1,1 km jv. od Brůdku; 58 — opuštěný lom u silnice 1,7 km sv. od Němčic; 59 — balvanité výchozy 0,15 km jjv. od kaple sv. Bernharda, 1 km v. od Liščí. Velmi hrubozrnný amfibolický diorit; 60 — balvany v poli na kótě 567 u silnice z Liščí do Nýrska; 61 — opuštěná pískovna v sedle mezi Bezným (659 m) a Čepicí (642 m), 1 km sz. od Nové Vsi; 62 — opuštěný lom 0,6 km jjz. od Dobříkova při polní cestě do Hluboké; 63 — opuštěný lom v lesíku 0,5 km zjz. od Branišova. Hornina uralitizována; 64 — opuštěný lom v ssz. svahu Bezného (659 m) 1 km zjz. od Brnířova. Hornina usměrněna; 65 — balvanité výchozy na s. hřbetu Bezného (659 m) 1,1 km zjz. od Brnířova. Hornina usměrněna; 66 — vrt ÚÚG 0,5 km j. od samoty „U Cihlářů", 2 km jjv. od Pocinovic; 67 — balvany v pískovně 2 km sz. od Chudenína při silnici do Všerub; 68 — opuštěný lom 0,75 km sv. od Všepadel; 69, 70 — vrt Š-1 u kóty 551 (Hrčoveň) 1,5 km sz. od Orlovice. Jemnozrnná a drobnozrnná varieta spessartitu; 71 — opuštěný lom na Německé hoře (644 m) 0,5 km zjz. od Chodské Lhoty; 72 — balvany v pískovně situované při okraji lesa na v. svahu Hlasného vrchu 1 km vsv. od Plání, poblíž silnice do Chudenína.

Vysvětlivky k obrázkům

1. Geologická mapa kdyňského masívu.
   1 — gabro, gabronorit a ferodiorit; *2* — uralitizované gabro a gabronorit; *3* — diorit; *4* — diorit s xenolity metabazitů, zčásti uralitizovaný; *5* — křemenný diorit; *6* — biotit-amfibolický tonalit; *7* — biotitický trondhjemit; *8* — biotit-amfibolický granodiorit; *9* — zlomy.
2. Geologická mapa okolí Orlovice.
   1 — olivinické gabro; *2* — olivinický gabronorit; *3* — ferodiorit; *4* — uralitizovaný gabronorit a ferodiorit; *5* — olivín-pyroxenický rohovec, místy s pyrhotinem; *6* — vrt; *7* — staré důlní práce na železné a titanové zrudnění.



1. View of the central part of the Kdyně massif from the NW. Kdyně is in the foreground, in the background, on the horizon, the mountain ridge of Královský hvozd with Ostrý Hill



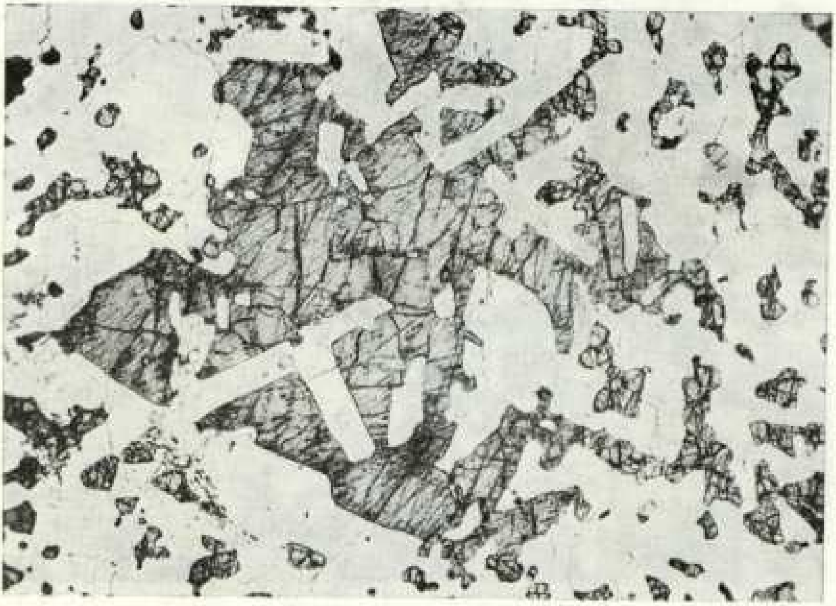
2. Coarsely banded structure (layering) in olivine gabbronorite. Abandoned quarry close to the gamekeeper's lodge in Orlovice

Photographs by Z. Vejnar

1. Rocky outcrop of layered olivine gabbro on the S side of Orlovická hora Hill

2. Weakly uralitized pyroxene-amphibole diorite with basic xenolith. Disintegrated outcrop NW of Chudenín. ×1.2

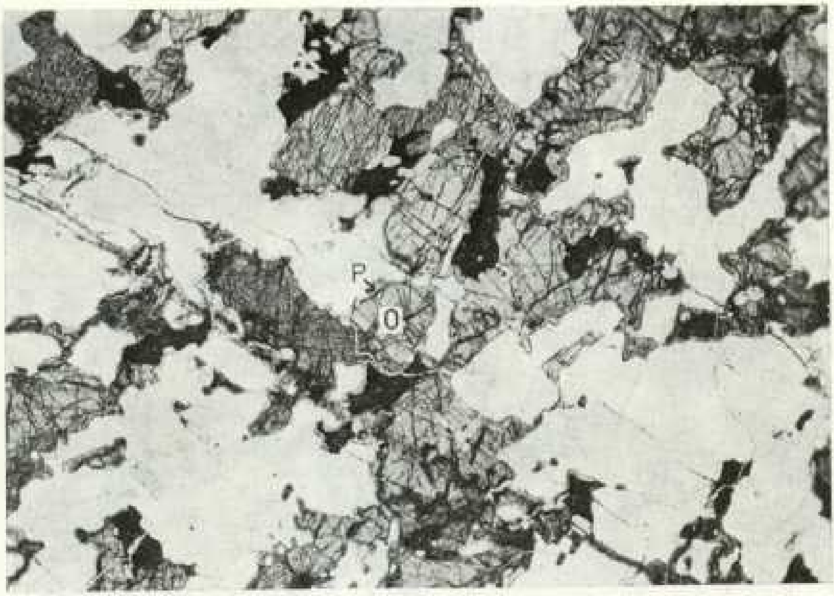
Photographs by Z. Vejnar



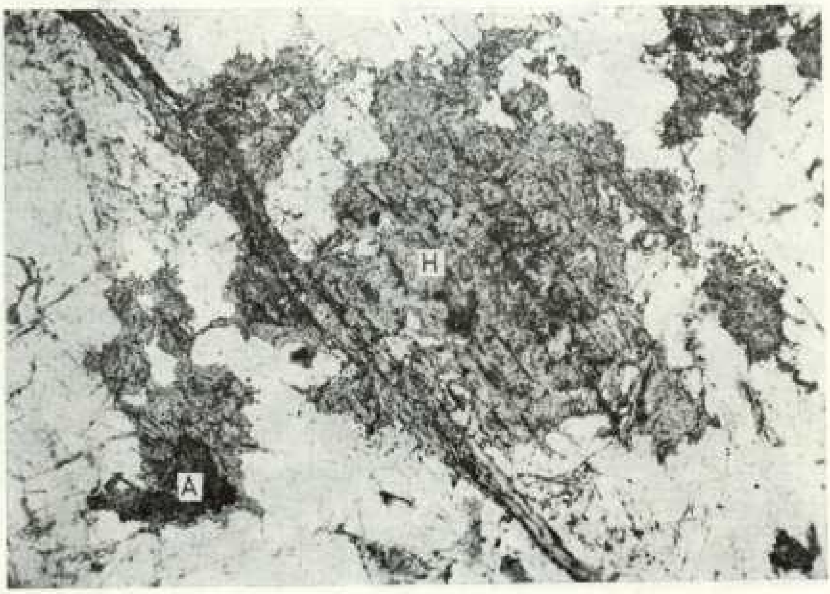
1. Olivine gabbro with poikilitic crystal augite enclosing fine tabular plagioclase. Orlovice. ×11.5, nicols //

2. Zonal poikilitic augite from olivine gabbro with light-grey core and dark-grey border. Orlovice. ×11.5, nicols //

Photographs by ÚÚG — K. Navrátilová

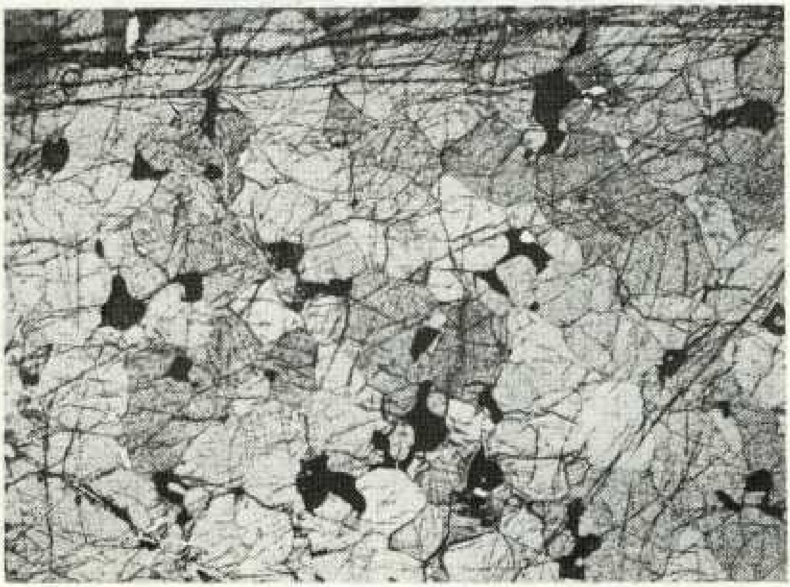


1. Olivine gabbronorite rich in ilmenite (black). Olivine (O) is accompanied by a narrow border of rhombic pyroxene (P) at the point of contact with plagioclase. Orlovice. ×11.5, nicols //



2. Uralitized gabbronorite with aggregates of secondary amphibole (H), with occasional augite (A) relicts and filling fine veins. ×12, nicols //

Photographs by ÚÚG — K. Navrátilová

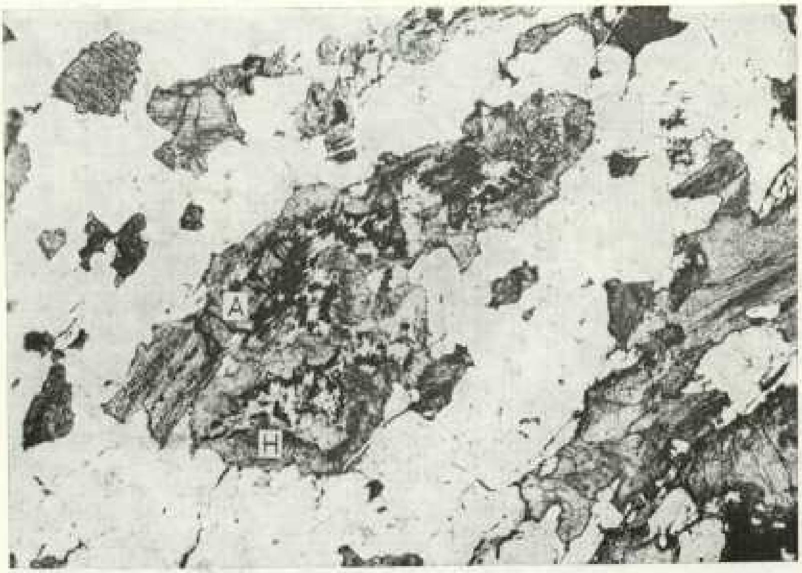


1. Hortonolite rock with accessory ilmenite (black). Hematitized magnetite is collected in fine cracks. Orlovice. ×14, nicols //

2. Partially uralitized hortonolite rock (variety without ilmenite) with hematitized magnetite concentrated at the edges of the olivine crystals and in fine veins. The magnetite is accompanied by secondary actinolitic hornblende. Orlovice. ×11,5, nicols //

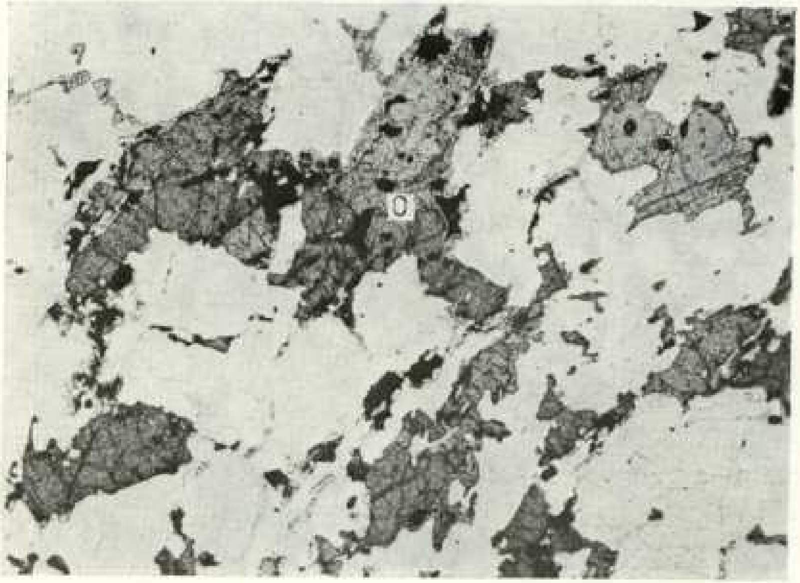
Photographs by ÚÚG — K. Navrátilová

1. Partially uralitized gabbronorite with pseudomorphs after pyroxenes formed of cummingtonite (C) and bordered by partly bleached primary amphibole. ×11.5 nicols //



2. Uralitized gabbronorite. Actinolite pseudomorphs after olivine containing hematite are bordered by dirty grey-green secondary amphibole (H), formed at the expense of primary amphibole and suppressing the surrounding plagioclase. Primary augite is retained in the rock. ×11.5. nicols //

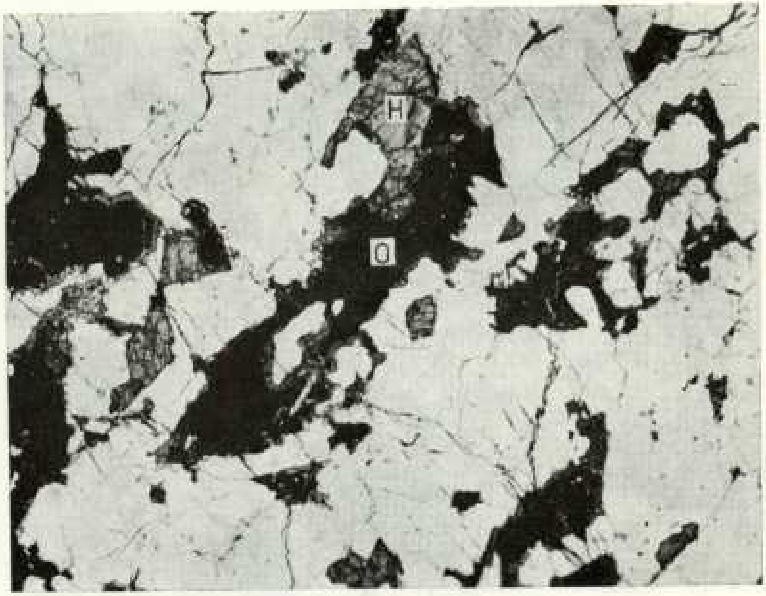
Photographs by ÚÚG — K. Navrátilová



1. Leucocratic variety of ferrodiorite with olivine (O), ilmenite (black) and rich in apatite. ×13, nicols //

2. Uralitized ferrodiorite. Actinolite-hematite pseudomorphs after fayalite (F) with narrow borders of cummingtonite (C) and radial acicular blue-green ferrotschermakite (T). Ferrotschermakite also forms fine veins and fills the cracks in the plagioclase. Ostrý Hill, ×14, nicols //

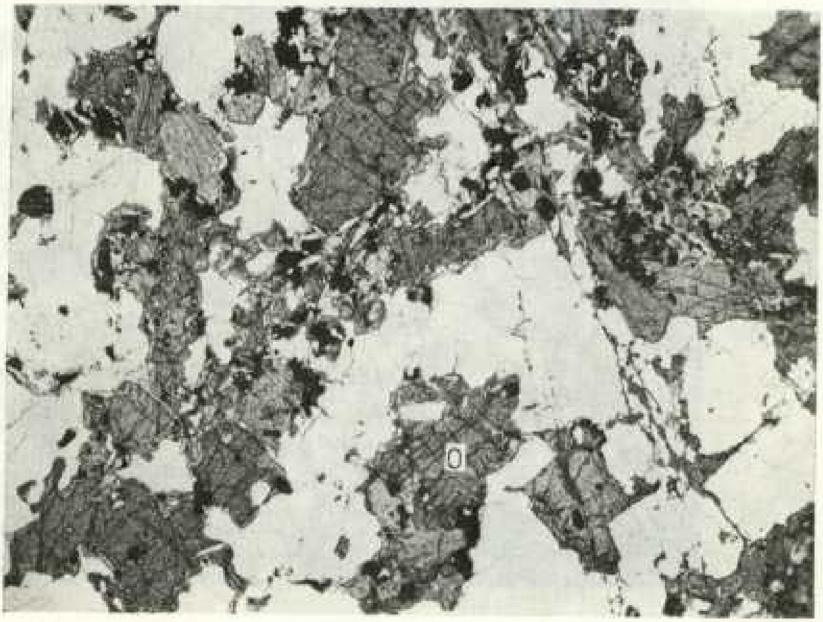
Photographs by ÚÚG — K. Navrátilová



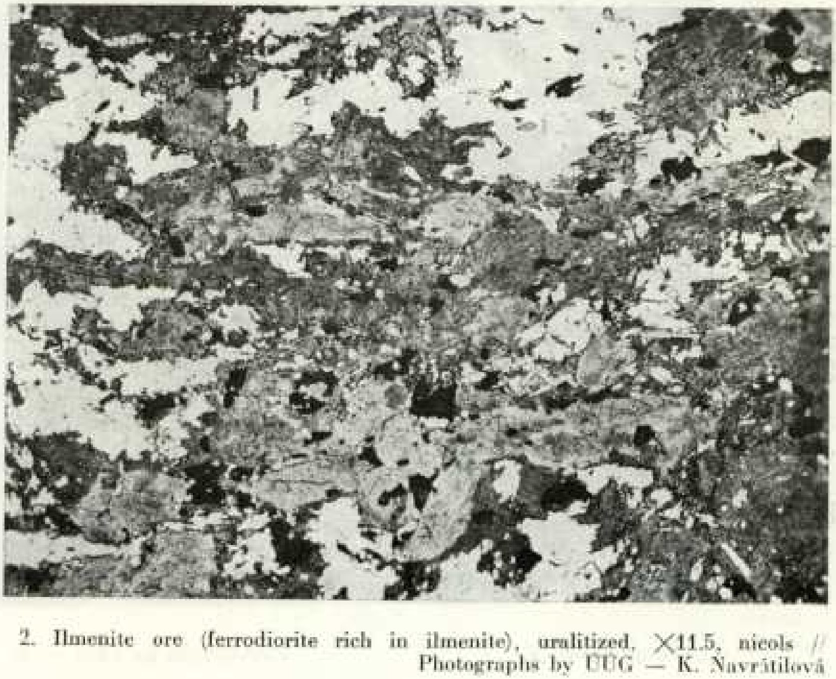
1. Leucocratic variety of ferrodiorite with hematitized olivine (O) and ferrohedenbergite (H). Ostrý Hill. ×11.5, nicols //

2. Uralitized ferrodiorite with hematitized olivine (O), bordered by cummingtonite (C) and blue-green ferrotschermakite (T). Primary augite (A) is retained in the rock. Orlovice. ×14, nicols //

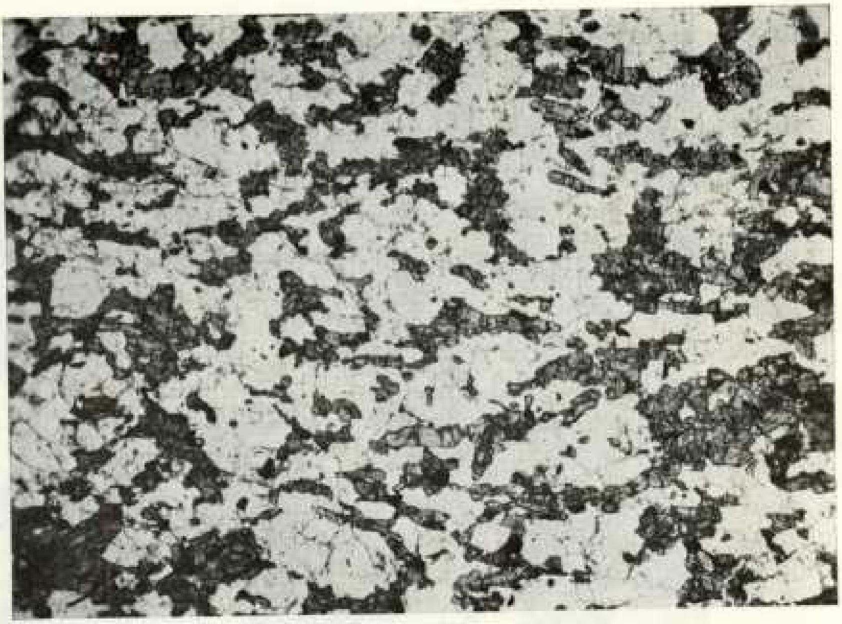
Photographs by ÚÚG — K. Navrátilová



1. Ilmenite ore, formed of ferrodiorite with ferrohortonolite (O), ilmenite and apatite. Orlovice, ×11.5, nicols //



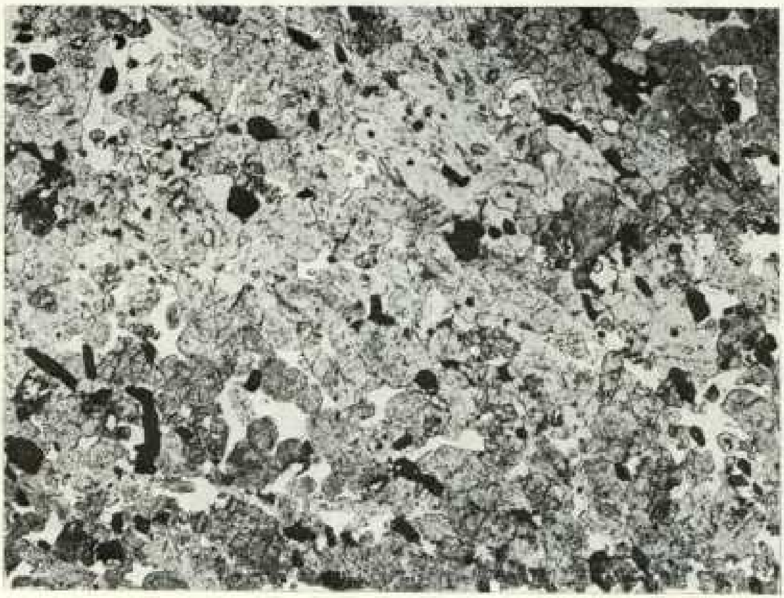
2. Ilmenite ore (ferrodiorite rich in ilmenite), uralitized, ×11.5, nicols //
Photographs by ÚÚG — K. Navrátilová



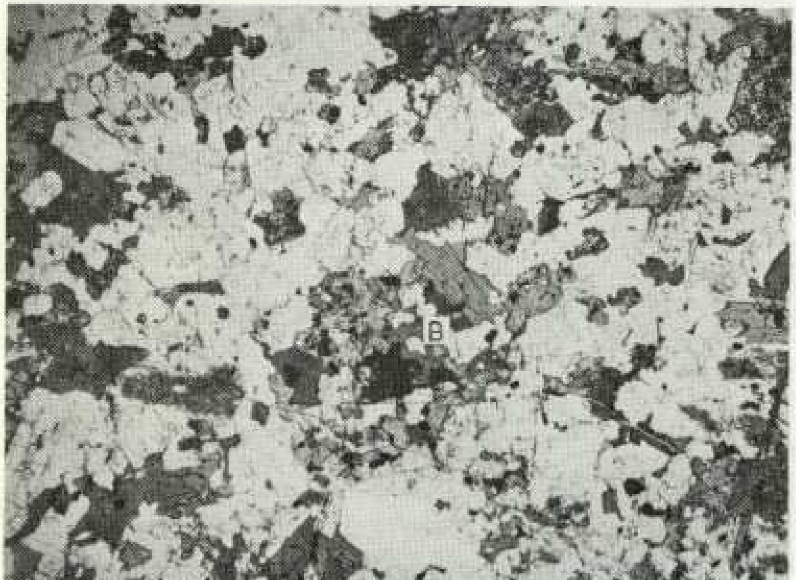
1. Fine-grained pyroxene diorite with tabular, planeparallel arrangement of plagioclase crystals. Nová Ves. ×13, nicols //

2. Ditto. Nicols ×

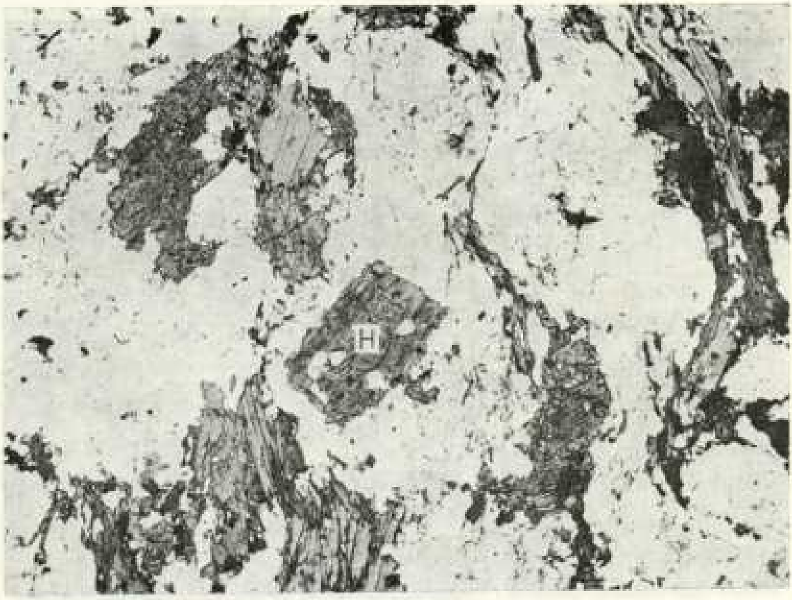
Photographs by ÚÚG — K. Navrátilová



1. Melanocratic variety of pyroxene diorite rich in ilmenite. Skalice Hill near Chodská Lhota, ×14, nicols //



2. Amphibole-pyroxene diorite with biotite (B) and isolated quarts from the transition zone between diorite and quartz diorite. Chodská Lhota, ×11.5, nicols // Photographs by ÚÚG — K. Navrátilová



1. Biotite-amphibole tonalite. Amphibole (H) forms poikilitic crystals enclosing plagioclase. Počanovice. ×11.5, nicols //

2. Biotite trondhjemite. Pláně. ×14, nicols //

Photographs by ÚÚG — K. Navrátilová

3. Ortopyroxeny a kalciové pyroxeny hornin kdyňského masívu v ternárním diagramu En (enstatit) — Fs (ferosilit) — Wo (wolastonit).
Mateřské horniny pyroxenů: *1* — olivinické gabro; *2* — olivinický gabronorit; *3* — hortonolitovec; *4* — diorit; *5* — ferodiorit.
Koexistující pyroxenové páry jsou spojeny čarami. P — variační pole kalciových pyroxenů hornin poběžovického masívu. *Čárkovaně* jsou vyznačeny trendy krystalizace pyroxenů skaergaardské intruze.
4. Primární amfiboly hornin kdyňského masívu v B. E. Leakově (1968) diagramu pro skupinu amfibolů, kde Ca+Na+K je menší než 2,50 a Ti než 0,50.
Symboly v *kroužku* označují amfiboly, u kterých je hodnota Ca+Na+K vyšší než 2,50, a které náležejí ke skupině pargasitu a feropargasitu.
Mateřské horniny amfibolů: *1* — olivinické gabro; *2* — olivinický gabronorit; *3* — ferodiorit; *4* — diorit; *5* — tonalit; *6* — ferotonalit; *7* — granodiorit.
Označení klasifikačních polí amfibolů: TR — tremolit; THR — tremolitický obecný amfibol; A — aktinolit; AH — aktinolitický obecný amfibol; MH — hořečnatý obecný amfibol; TH — tschermakitický obecný amfibol; T — tschermakit; FA — feroaktinolit; FAH — feroaktinolitický obecný amfibol; FH — železnatý obecný amfibol; FTH — ferotschermakitický obecný amfibol; FT — ferotschermakit.
5. Poměr celkového aluminia k alkáliím v primárních amfibolech hornin kdyňského masívu. Vysvětlivky značek jsou uvedeny u obrázku 4.
6. Sekundární amfiboly hornin kdyňského masívu v B. E. Leakově (1968) diagramu. Vysvětlivky značek a zkratek jsou uvedeny u obrázku 4. Koexistující amfiboly jsou spojeny čarami. V diagramu jsou zaneseny průměrné body koexistujícího antofylitu (AN), cummingtonitu (C) a grüneritu (G).
7. Chemické složení hornin kdyňského masívu v A (Na_2O+K_2O) — F (Fe_2O_3+FeO) — M (MgO) diagramu, hmotnostní %.
1 — olivinické gabro a uralitizované gabro; *2* — olivinický gabronorit a uralitizovaný gabronorit; *3* — hortonolitovec; *4* — diorit; *5* — ferodiorit a uralitizovaný ferodiorit; *6* — hrubozrnný amfibolický diorit od sv. Bernharda; *7* — křemenný diorit; *8* — tonalit; *9* — granodiorit; *10* — trondhjemit; *11* — granitoidy stodského masívu.
8. Schéma diferenciačních trendů kdyňského masívu (K_1, K_2) v A—F—M diagramu a jejich vztah k poběžovickému (P) a skaergaardskému (E) trendu.
Variační pole hornin kdyňského masívu: G — olivinické gabro; GD — olivinický gabronorit a uralitizovaný gabronorit; FD — ferodiorit; H — hortonolitovec; D — diorit; T — tonalit; GD — granodiorit; TR — trondhjemit.

Vysvětlivky k přílohám

Příl. I

1. Pohled na centrální část kdyňského masívu od SZ. V popředí Kdyně, v pozadí na obzoru je patrný horský hřeben Královského hvozdu s Ostrým.
2. Hrubě páskovaná textura (zvrstvení) olivinického gabronoritu. Opuštěný lom poblíž hájovny v Orlovici. Foto Z. Vejnar

Příl. II

1. Skalní výchoz zvrstveného olivinického gabra na j. svahu Orlovické hory.
2. Slabě uralitizovaný pyroxen-amfibolický diorit s bazickou uzavřeninou. Rozpadlý výchoz sz. od Chudenína, zvětšeno 1,2×. Foto Z. Vejnar

Příl. III

1. Olivinické gabro s poikilitickým krystalem augitu uzavírajícím drobný tabulkovitý plagioklas; Orlovice. Zvětšeno 11,5×, nikoly //
2. Zonální poikilitický augit z olivinického gabra se světlešedým jádrem a tmavošedými okraji; Orlovice. Zvětšeno 11,5×, nikoly // Foto ÚÚG — K. Navrátilová

Příl. IV

1. Olivinický gabronorit bohatý ilmenitem (černý). Olivín (O) je na styku s plagioklasem provázen úzkým lemem rombického pyroxenu (P); Orlovice. Zvětšeno 11,5×, nikoly //
2. Uralitizovaný gabronorit s agregáty sekundárního amfibolu (H), místy uzavírajícího relikty augitu (A) a vyplňujícího drobné žilky; Orlovice. Zvětšeno 12×, nikoly // Foto ÚÚG — K. Navrátilová

Příl. V

1. Hortonolitovec s akcesorickým ilmenitem (černý). V drobných trhlinkách je nahromaděn hematitizovaný magnetit; Orlovice. Zvětšeno 14×, nikoly //
2. Částečně uralitizovaný hortonolitovec (varieta bez ilmenitu) s hematitizovaným magnetitem, nahromaděným na okrajích olivínových krystalů a v drobných žilkách. Magnetit je provázen sekundárním aktinolitickým obecným amfibolem; Orlovice. Zvětšeno 11,5×, nikoly // Foto ÚÚG — K. Navrátilová

Příl. VI

1. Částečně uralitizovaný gabronorit s pseudomorfózami po pyroxenech, tvořenými cummingtonitem (C) a lemovanými částečně odbarveným primárním amfibolem. Zvětšeno 11,5×, nikoly //
2. Uralitizovaný gabronorit. Aktinolitové pseudomorfózy po olivínu obsahující hematit jsou lemovány špinavě šedozeleným sekundárním amfibolem (H), vzniklým na úkor primárního amfibolu a zatlačujícím okolní plagioklas. Primární augit (A) je v hornině zachován. Zvětšeno 11,5×, nikoly // Foto ÚÚG — K. Navrátilová

Příl. VII

1. Leukokratní varieta ferodioritu s olivínem (O), ilmenitem (černý) a hojným apatitem. Zvětšeno 13×, nikoly //
2. Uralitizovaný ferodiorit. Aktinolit-hematitové pseudomorfózy po fayalitu (F) s úzkými lemy cummingtonitu (C) a radiálně paprsčitého modrozeleného ferotschermakitu (T). Ferotschermakit dále tvoří drobné žilky a zaplňuje trhliny v plagioklasu; Ostrý vrch. Zvětšeno 14×, nikoly // Foto ÚÚG — K. Navrátilová

Příl. VIII

1. Leukokratní varieta ferodioritu s hematitizovaným olivínem (O) a ferohedenbergitem (H); Ostrý vrch. Zvětšeno 11,5×, nikoly //
2. Uralitizovaný ferodiorit s hematitizovaným olivínem (O), lemovaným cummingtonitem (C) a modrozeleným ferotschermakitem (T). Primární augit (A) je v hornině zachován; Orlovice. Zvětšeno 14×, nikoly // Foto ÚÚG — K. Navrátilová

Příl. IX

1. Tzv. ilmenitová ruda, tvořená ferodioritem s ferohortonolitem (O), ilmenitem a apatitem; Orlovice. Zvětšeno 11,5× nikoly //
2. Tzv. ilmenitová ruda (ferodiorit bohatý ilmenitem), postižená uralitizací. Zvětšeno 11,5×, nikoly // Foto ÚÚG — K. Navrátilová

Příl. X

1. Drobnozrnný pyroxenický diorit s tabulkovitými, planparalelně uspořádanými krystaly plagioklasu; Nová Ves. Zvětšeno 14×, nikoly //
2. Dto. Nikoly × Foto ÚÚG — K. Navrátilová

Příl. XI

1. Melanokratní varieta pyroxenického dioritu bohatá ilmenitem; Skalice (u Chodské Lhoty). Zvětšeno 14×, nikoly //
2. Amfibol-pyroxenický diorit s biotitem (B) a ojedinělým křemenem z přechodní zóny mezi dioritem a křemenným dioritem; Chodská Lhota. Zvětšeno 11,5×, nikoly //

Foto ÚÚG — K. Navrátilová

Příl. XII

1. Biotit-amfibolický tonalit. Amfibol (H) tvoří poikilitické krystaly uzavírající plagioklas; Pocinovice. Zvětšeno 11,5×, nikoly //
2. Biotitický trondhjemit; Pláně. Zvětšeno 14×, nikoly // Foto ÚÚG — K. Navrátilová

Кдыньский массив в ю.-з. Чехии — тектонически модифицированная пластовая интрузия основного состава

Позднекадомская (кембрийская?) пластовая интрузия, внедренная в метапелиты и метабазиты Домажлицкого кристаллиникума и окаймленная выразительным контактовым ореолом, сложена тремя стратиформными зонами, именно нижней — габброидной, средней — диоритовой и верхней — кварцдиоритовой. В результате дальнейшей фазы внедрения массива присутствуют мелкие тела тоналита и трондьемита. Дифференциация первичной толеитовой магмы произошла по двум направлениям, отличающимся друг от друга степенью фракционирования Mg, Fe. Первое, скергардского типа, представляется рядом: оливиновое габбро—фаялитовый ферродиорит; второе, характеризованное низкой степенью фракционирования Mg, Fe, представлено рядом: диорит—тоналит—трондьемит. Вследствие варисского орогенеза местами произошла рекристаллизация пород, сопровождаемая, прежде всего, образованием вторичных амфиболов, как напр. актинолита, чермакита, куммингтонита и др.

Přeložil A. Kříž