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The Letovice dismembered metaophiolites in the framework of the Saxo-Thuringian zone of the Bohemian massif

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Разделённые метаофиолиты летовицкого кристалиника в строении саско-дуринской зоны Ческого масива

В кристалическом масиве района Летовице находятся нижние ультраосновные породы (тектониты), породы кумулативного комплекса, основные вулканиты и очень неравномерно породы жильного типа. Считаем их за метаморфованные члены разделенного класического офиолитового комплекса. Степень их региональной перемены переходит из фации зелёных сланцев до амфиболитовой фации. Геотектонические верхнепротерозойские летовицкие метаофиолиты являются частей саско-дуринской зоны среднеэвропейских герцинид (варисцид). Могут сравниваться с породами марианско-лазенского комплекса, с офиолитами центрального саского линеамента, с метабазитами и ультрабазитами староместского гнейсового пояса и с офиолитами на периферии Совиих гор. Указанные офиолитовые комплексы возникли в геотектонической среде окрайового моря саско-дуринской зоны особенно в местах глубинных разломов.

The Letovice dismembered metaophiolites in the framework of the Saxo-Thuringian zone of the Bohemian massif

New geological and geochemical data are presented for basic and ultrabasic rocks of the Letovice crystalline complex. Lower ultrabasic rocks, cumulate rocks, basic volcanics and local basic dykes represent a dismembered ophiolite suite metamorphosed under conditions of amphibolite and greenschists facies. The geochemical features and differentiation trend correspond with those of other ophiolite complexes (e. g. Pindos, Bay of Island, Troodos, Oman, Papua etc.). Geotectonically, the Upper Proterozoic Letovice metaophiolites are a part of the Upper Proterozoic structural level of the Saxo-Thuringian subzone of the Hercynian (Variscan) fold belt. They are comparable with the Mariánské Lázně basic complex, with the ophiolites along the Central Saxonian Lineament, with the Staré Město ophiolite belt and the ophiolite complex at the border of the Sowie Góry Mts. All these ophiolite complexes could be formed in a marginal sea environment, following internal rift depressions inside the Saxo-Thuringian zone. Considerable thinning of the Earth's crust, formation of a new ocean floor and deep faults are the most characteristic features of these depressions.

In the classical zoning of the Central European Hercynides, the Letovice crystalline complex belongs to the Saxo-Thuringian zone which is bordered by Moldanubian zone in the S and by Central German Crystalline Rise in the N (Fig. 1). All these three zones together with the Rheno-Hercynian zone are pinched together in the Moravian-Silesian fault zone (lineament) which may represent an important deep fault along the continental margin active in the Cadomian and Hercynian geotectonic cycles.

The tectonic development of the Saxo-Thuringian zone seems to be clearer from the time of the Hercynian than of the Cadomian geotectonic cycle. Paleozoic sediments unconformably cover the Proterozoic basement with geosynclinal sediments and volcanics (Barrandian basin). If metamorphosed they still differ quite distinctly from all Proterozoic sediments and volcanics in other parts of the Saxo-Thuringian zone (Erzgebirge). The Paleozoic formations do not contain any real ophiolites.

However, many metamorphosed basic and ultrabasic rocks can be found in the Pre-Hercynian structural level. Some of them are considered to be members of the classical ophiolite suite e. g. basic and ultrabasic rocks of the Mariánské Lázně complex, Letovice complex, Staré Město complex (Mísař et al., in press), other belong to the Upper Proterozoic volcano-sedimentary formation with spilites. Geosynclinal spilites together with graywackes and laminated shales, form a substantial part of the Central Bohemian Region (Fig. 1). The Upper Proterozoic age of some metamorphosed basic volcanics is documented by K/Ar isotope data in hornblende from the Mariánské Lázně complex (Gottstein, 1970). C. D. Werner (1981) mentions a transgression of Vendian conglomerates over metaophiolite in the area of the Saxonian granulite Mts.

During the past decade increased attention has been devoted to ophiolite complexes present in the continental crust. Classic ophiolites defined by G. Steinman (1927) commonly occur in alpine orogenic belts. Their age is mostly Jurassic to Cretaceous. Some older ophiolites were described in Hercynian belts e. g. the Ural or Tchien-Shan Mts., or in the Caledonian belts in Scotland, Norway, New Foundland, Mongolia etc. Pre-Cambrian ophiolites are relatively rare. There were described in the Panafrican orogenic belt by R. Black (1980) or in the Bajkal orogenic belt by N. L. Dobretsov (1982). The sequence of ultrabasic and basic metamorphosed rocks from the Cadomian basement of the Armoric massif could also be regarded as Pre-Cambrian metaophiolites.

Field relations of the Letovice crystalline complex

The Letovice crystalline complex is located at the most eastern part of the Saxo-Thuringian zone where this approaches the Moravian-Silesian fault zone. The complex consists of mica schists, gneisses, metaquartzites (metalydites), amphibolites, metagabbros and metamorphosed ultrabasic rocks. The basic and ultrabasic rocks of the Letovice complex

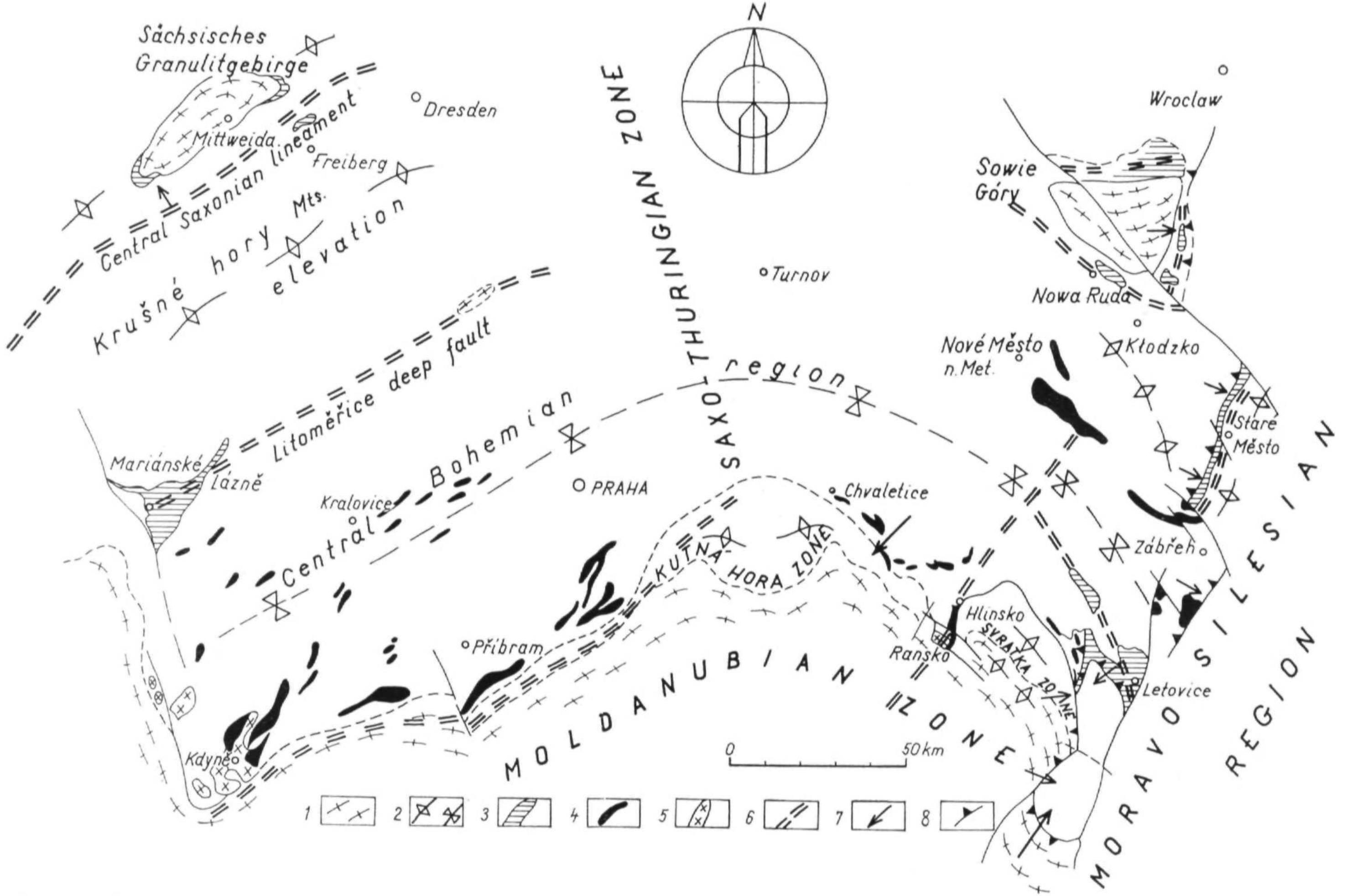

Fig. 1. Outline structural map with the distribution of Upper Proterozoic ophiolites and basic initialites in the Saxo-Thuringian zone of the Bohemian massif. 1 — Moldanubian region, 2 — axes of megastructures, 3 — Upper Proterozoic ophiolites, 4 — Upper Proterozoic basic volcanics and keratophyres, 5 — gabbro--periodite massifs, 6 — deep faults, 7 — direction of tectonic movements, 8 — Moravian-Silesian fracture zone

are a part of the Moravian-Silesian ophiolite belt (Mísař, 1979). Metasediments represent of about 30 per cent, amphibolites 30 per cent, metagabbros 30 per cent and ultramafic rocks about 10 per cent of the Letovice complex.

Z. Roth (1941) supposed the Letovice complex to be a large laccolith which had undergone gravity differentiation in situ. Diabases form the margin of the complex and ultramafic rocks the centre. J. Svoboda and V. Zoubek (1950) tried to compare the metabasite of the Letovice complex with the Upper Proterozoic spilites in the Barrandian area. The ultramafic bodies, amphibolites and mica schists have the same structural history.

Recently, D. R. Bowes et al. (1978, 1980) described the polyphase deformation of the Letovice amphibolites with dominant F_3 folds. Although the Letovice crystalline complex and the Moravian complex are in tectonic contact, they still have a comparable structural imprint for at least part of their history (Bowes et al., 1980).

Although the Letovice crystalline complex is overlain by a cover of Permian and Upper Cretaceous sediments, its amphibolites and ultrabasic rocks can be followed further to the NW to Svitavy using the gravimetry. Here, an ultrabasic body with dimension of about 10×0,5 km has been found by drilling.

The fundamental megastructures of the

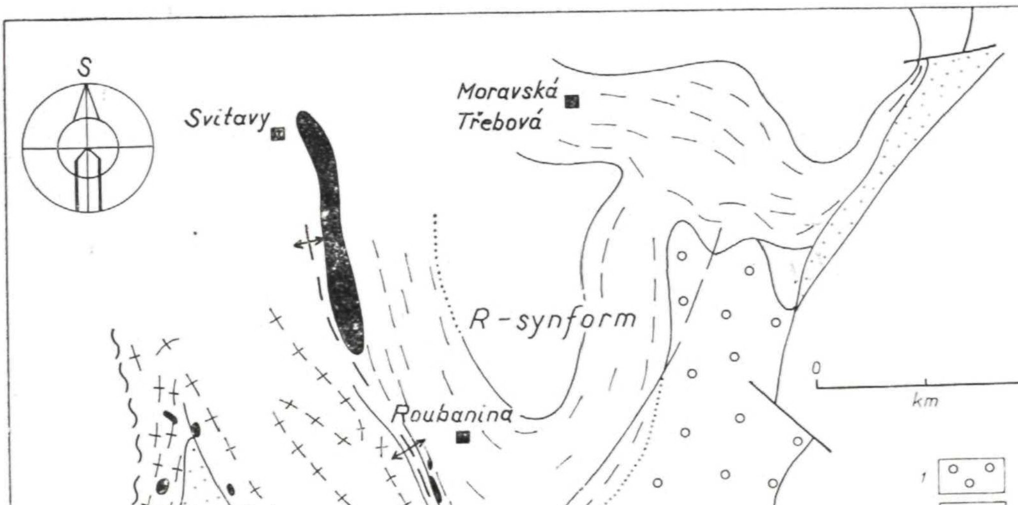

Fig. 2. Structural scheme of the Letovice crystalline complex. 1 — Permian sediments of the Boskovice furrow, 2 — Moravian metamorphic complex, 3 — mica schists and gneisses, 4 — amphibolites, 5 — ultrabasic rocks, 6 — megastructures as indicated by magnetic and gravity anomalies, 7 — mylonites

Letovice unit consists of two main synforms (Fig. 2): first is called the Letovice synform (= L-synform), the second, the Roubanina synform (= R-synform). The L-synform represents the leading megastructures of the Letovice complex exposed. To the west it joints the brachyanticlinal closure of the Moravian mica schist zone. The L-synform also closes near the deep fault zone of the Boskovice furrow. The internal dominating fold structures of the L-synform coincides perfectly with the corresponding dominating structures described in detail at the Bohuňov locality by D. R. Bowes et al. (1978).

The L-synform is separated from the R-synform by a narrow crest consisting of mica schists and quartzitic schists. Some NW—SE faults and mylonite belts also follow the boundary between both synforms.

The R-synform may be considered as a marginal structure of a large scale synform formed of Upper Proterozoic flysch-like sediments and basic volcanics (Fig. 2).

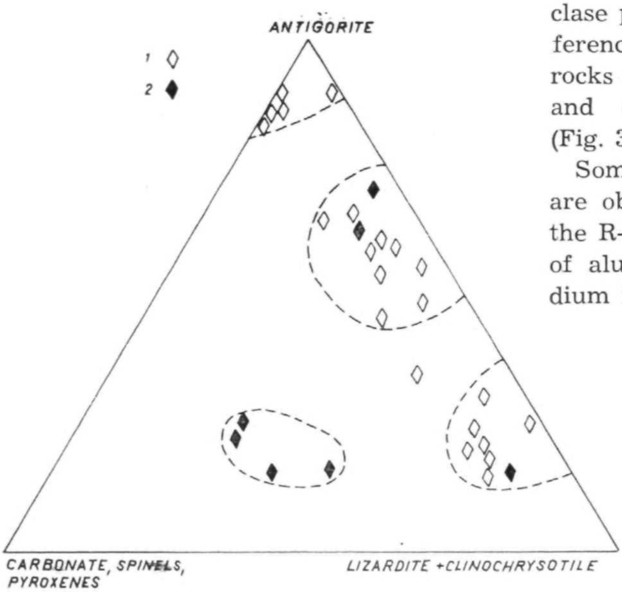

Fig. 3. Mineral content of Letovice ultrabasic rocks in a triangle antigorite — carbonate + spinel + pyroxene — lizardite + clinochrysotile. Mineral identification by differential thermal analyses-weight %. 1 — L-synform utrabasic rocks, 2 — R-synform ultrabasic rocks

Both rocks types, together with ultrabasic rocks and gabbros, are the main constituents of the R-synform.

Petrology of the Letovice crystalline complex

The petrological description of the rocks is mostly concerned with metamorphosed basic and ultrabasic rocks of the Letovice crystalline complex.

Ultrabasic rocks of several separated allochthonous bodies are situated at the boundaries between amphibolite and mica schists or are completely surrounded by amphibolites. The ultrabasic bodies are lenticular or slab-like with developed reaction zones at the contact with the country rocks. The largest exposed ultrabasic body is 1 km × 0,6 km in size.

There are some differences between the ultramafic rocks of the L- and R-synforms. The ultrabasic rocks of the L-synform are mostly serpentinites and strongly serpentinized peridotites, always with abundant spinel. The ultrabasic rocks of the R-synform are serpentinized peridotites, plagioclase peridotites and pyroxenites. The difference between two types of ultrabasic rocks may be also followed in the content and character of serpentine minerals (Fig. 3).

Some significant geochemical differences are observed between ultrabasic rocks of the R- and L-synforms. The concentration of alumina, calcium, titanium and vanadium is higher in the ultrabasic rocks of the R-synform. This is mostly due to the presence of olivine cumulates and of pyroxene crystals in these rocks. The FeO^{tot}/MgO ratio is also different for the two rock groups.

According to the petrological and chemical character of the ultrabasic rocks of the L-synform these rocks are very similar to the lower ultrabasic rocks of any classical ophiolite suite. On the other hand, the ultrabasic rocks of the R-synform are reminiscent of cumulate ultrabasic rocks.

Metagabbros can be found in both synforms of the Letovice crystalline complex. However, they are more common in the R-synform where separate gabbroic bands (differing in composition and structures) can be mapped inside a larger gabbro body. From the geological and petrological point of view, the gabbro complex of the R-synform is strongly resembled of the layered gabbro complex of a typical ophiolite suite.

In spite of strong deformation the hornblende gabbro of the R-synform, it still contains visible relics of primary texture with larger crystals of hornblende and plagioclase.

The lowest members of the layered gabbro complex may be correlated with some horizons of the layered ultrabasic zone of the classical ophiolite sequence. This is reflected in the presence of cumulate olivine gabbro, troctolite and plagioclase-bearing peridotite and/or bands of dunite that are extremely rich in magnesium. The cumulate texture of these rocks with oval olivine and interstitial plagioclase and pyroxene is further evidence for this assumption. A peculiar rock type of the layered gabbro complex of the R-synform is "vesicular" peridotite in which lenses or spheres in the serpentine matrix are filled with talc. Geologicaly "vesicular" peridotite alternates in bands with pyroxenite.

A thin dyke of fine-grained diabas was found at only one place in the R-synform.

Metagabbros also occur in the L-synform. Here, they are very strongly sheared and metamorphosed under amphibolite metamorphic facies. The primary rock was very coarse-grained hornblende gabbro. Unfortunately, the relationship of gabbro to massive amphibolite in the L-synform is not sufficiently clear. However, D. R. Bowes et al. (1980) have described a fine-grained, basic dyke in coarse-grained metagabbro with a relic texture indicative of a plutonic origin.

Major and trace element chemistry were discussed in detail in the paper by E. Jelínek et al. (1984). Generally, the chemical criteria help to distinguish the gabbros of the R-synform from the gabbro of the L-synform. The L-synform gabbro has higher contents of Si, Fe, Na + K, and Ti compared with all types of gabbros of the R-synform. The chemistry of olivine gabbro is closely related to the chemistry of ultrabasic rocks of the R-synform (Fig. 4), characterized by a lower content of alkalines and lower Fe/Mg ratio compared with hornblende metagabbros. The enrichment of the olivine gabbro in Ni and Cr corresponds to a high degree with the higher content of these elements in ultramafic rocks of the R-synform.

Amphibolites are the most typical rocks of the Letovice crystalline complex. They form a substantial part of the L-synform. The lithology of the amphibolite bands is rather complex. Massive, fine grained, laminated and banded amphibolites can be distinguished. The amphibolite also differ in mineral assemblage. The most common amphibolites contain green hornblende and plagioclase. Others are richer in quartz, garnet, zoisite or epidote. Well-banded amphibolites and garnet amphibolites represent good marker horizons in the north-western part of the L-synform.

The texture and metamorphic grade of amphibolites in both synforms seems to be different. Massive, fine-grained amphibolites and well-banded amphibolites and garnet amphibolites do not occur in the R-synform. Strongly sheared and metamorphosed gabbro with some relics of primary texture is also typical for the L-synform. Amphibolites of the R-synform are very fine-grained and finely laminated. Plagioclase and green hornblende classify these rocks as common amphibolites. The common amphibolites of both synforms seem generally to be identical. However, a small difference can be found in the magnesium content, which is higher in the amphibolites of the R-synform.

Garnet-epidote-zoisite amphibolites as a special variety of amphibolites of the L-synform are slightly enriched in Al, Ca and Mg and impoverished in alkalies, titanium and chromium.

B a s i c   d y k e s are not very common elements in the amphibolites of either synform. In the R-synform at only one

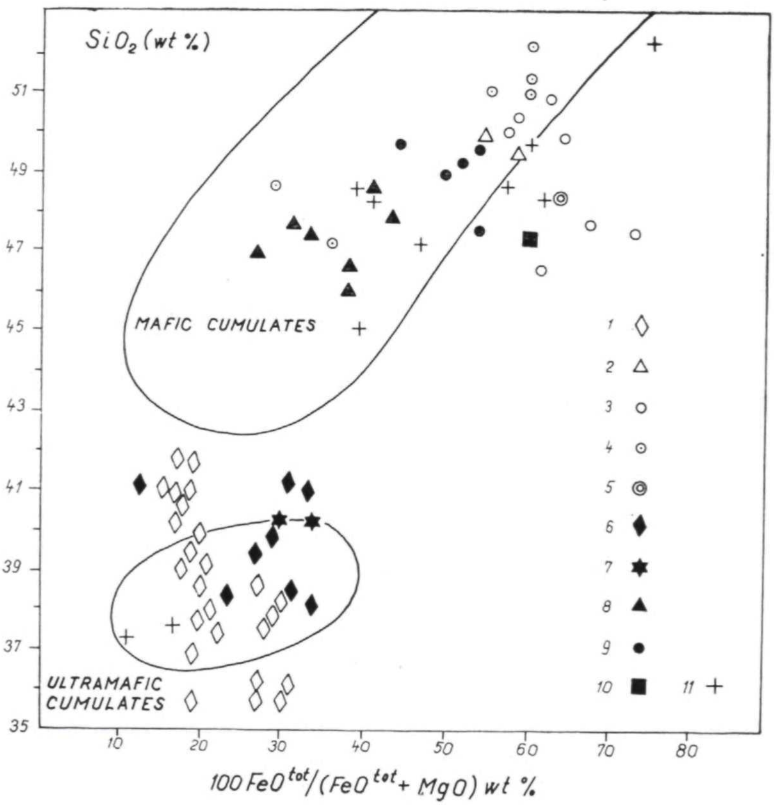

Fig. 4. Plot of SiO_2 versus 100 $FeO^{tot}/(FeO^{tot} + MgO)$ — Wt %. Rocks of the L-synform: 1 — ultramafic rock, 2 — gabbro, 3 — amphibolite, 4 — garnet (±zoisite) amphibolite, 5 — basic dyke. Rocks of the R-synform: 6 — ultramafic rock, 7 — olivine gabbro, 8 — hornblende gabbro, 9 — amphibolite, 10 — metadolerite. Others: 11 — ophiolite suite of Central Saxonian lineament according to C. D. Werner (1981). The field for ultramafic and mafic cumulates after R. C. Coleman (1977)

place, a small dyke has been found inside a layered metagabbro complex. The rock is fine to medium-grained with typical ophitic texture. Hornblende and plagioclase are the two main components. The chemistry of this rock (diabase) exhibits a marked contrast to all the gabbros and amphibolites described. The rock is extremely rich in Ti and Fe and very poor in Ni and Cr.

A thin basic dyke younger than the key fold structure F_3 was also found in metagabbros in the south-eastern part of the L-synform (Bowes et al., 1980). The dyke rock is black, very fine-grained and consists of hornblende and plagioclase. The preserved texture is microgabbroic.

Mostly monomineral rocks found at contacts between ultrabasic rocks and country rocks can be simply described as actinolitites, tremolitites, talc schists etc. A "band" found in the serpentine body at Letovice is rather strange and consists of chlorite and chlorite + vermiculite, probably replacing the primary mineral assemblage of pyroxenite.

Geochemistry

The results of geochemical research on basic and ultrabasic rocks of the Letovice crystalline unit may help to determine if these rocks are comparable with some members of the classical ophiolite sequence. In addition, the geochemical character of the rocks is a good base for discussion of the geotectonic environment in which these rocks originated. There are various methods and plots for expression of the chemical character of rocks. Some diaggrams generally used for ophiolites are discussed in this chapter.

The lower ultrabasic members of the classical ophiolite sequence are represented by the ultrabasic rocks of the L-synform. Their magnesium content is higher than in the ultrabasic rocks of the R-synform (Fig. 4). The cumulate phase of the ophiolite layered complex is represented by ultrabasic rocks and gabbro of the R-synform. The major element chemistry and abundance of trace elements (Ti, V, Ni, Cr) show a systematic variation with the degree of differentiation: the Ni and Cr contents decrease, whereas the Ti and V contents increase with increasing Fe/Mg ratio (Fig. 6). Similar differences between lower and cumulate ultrabasic rocks are clearly demonstrated by the AFM plot (Fig. 7).

The chemistry of the upper members of the ophiolite sequence yields more information than that of the lower ones. The SiO_2 versus FeO^{tot}/MgO plot and also the plot of SiO_2 versus Cr (Miyashiro, 1975) indicate that all the metabasic rocks (amphibolites and metagabbros) are tholeiitic (Fig. 5).

It seems to be more difficult to interpret the results of the chemistry of ophiolite complexes in terms of their tectonomagmatic and geotectonic position, especially when the type of volcanism is concerned. Most of the discrimination plots are constructed on the basis of data from recent volcanic regions. The reliability of these methods when applied to rocks regionally metamorphosed has, however, not been verified.

The chromium, nickel and vanadium contents and Fe/Mg ratio of metabasic rocks of the L- and R-synform correspond to the average contents of these components in ocean floor basalts (Fig. 6). The Cr and Ti content distinguishes fields of lower ultrabasic rocks of the L-synform (extremely depleted in Ti) and the field of the R-synform ultrabasic rocks belonging to the lower part of the cumulate complex. The metagabbros of the R-synform are very similar to cumulate types, whereas the gabbros of the L-synform differ from them in a much higher content of titanium.

Correlation of the Letovice basic and ultrabasic rocks with corresponding rocks of some classical ophiolite sequences (Pindos-Greece, Troodos-Cyprus, Bay of Island-New Foundland, or Sarmiento-Chile) reveals similar differentiation trends in the AFM diagram (Fig. 7). The position of the ultrabasic rocks of the L-synform in the diagram with that of the ultrabasic rocks from New Foundland, Oman and Papua. The gabbros of the L-synform (the cumulate type) are also in a good agreement with the gabbros of these ophiolite complexes. Gabbros of the L-synform may correspond to upper gabbros of the Pindos ophiolite suite or to volcanic rocks of the

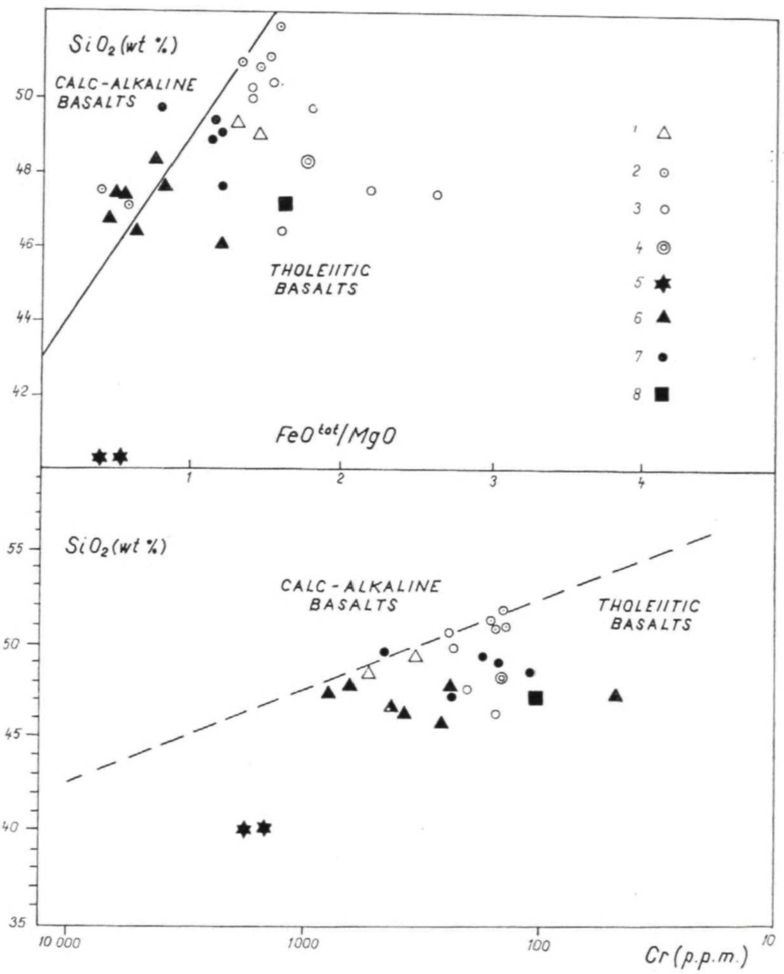

Fig. 5. The position of rocks of the Letovice complex in the diagrams of the L-synform: 1 — gabbro, 2 — amphibolite, 3 — garnet amphibolite, 4 — basic dyke. Rocks of the R-synform: 5 — olivine gabbro, 6 — hornblende gabbro, 7 — amphibolite, 8 — metadolerite

Papua and Oman ophiolites.

The general differentiation trend of the Letovice metaophiolites and of Pindos, Bay of Island and Sarmiento ophiolites expressed by relationship between the Solidification Index (SI) and the Ti/CrxNi ratio is shown in Fig. 8. Differentiation trends for the basic and ultrabasic rocks of the R-synform of the Letovice crystalline complex are comparable with the trends of the Pindos ophiolite suite. On the other hand, the gabbros as well as amphibolites of the L-synform follow the trend of Bay of Island and Sarmiento ophiolites.

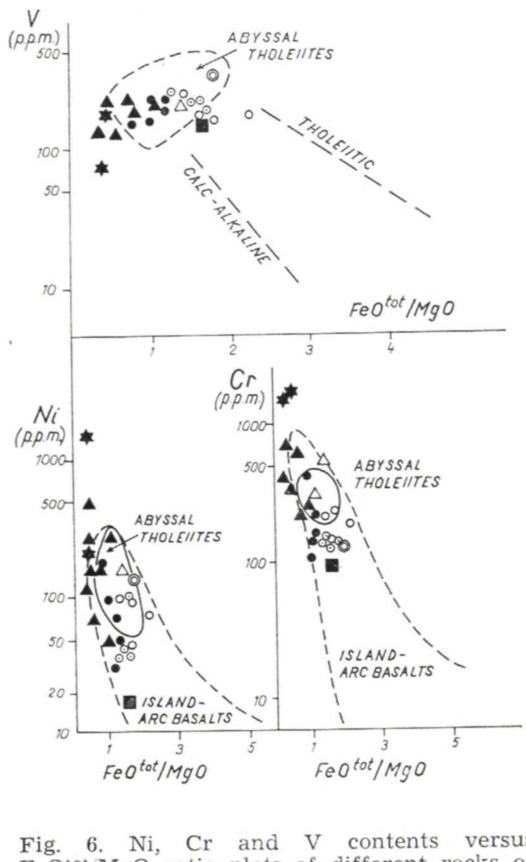

Fig. 6. Ni, Cr and V contents versus FeO^{tot}/MgO ratio plots of different rocks of the Letovice crystalline complex. Fields of abyssal tholeiites and island arc basalts as well as tholeiites and cacl-alkaline boundary after A. Miyashiro (1975). The symbols for the rocks of the L- and R-synforms as in Fig. 4

The geochemical data for the Letovice metaophiolites are identical with the corresponding data for the Pindos, Troodos, Bay of Island and Papua ophiolites. Some similarities have been found also between the Letovice metaophiolite and Sarmiento ophiolite complexes in which not all the members of the typical ocean lithosphere occur (ultrabasic members are missing — Saunders et al., 1979).

Although the major and trace elements of the Letovice metaophiolite do not unequivocally determine their geotectonic position, they support the idea of a marginal sea basin or ocean floor environment for the origin of the Letovice metaophiolites.

Regional geological aspects

The Letovice metaophiolite complex belongs to the Saxo-Thuringian zone of Central European Hercynides. In the Bohemian Massif, this zone is characterized by a thinner continental crust, as related to the Moldanubian zone and by the occurrence of Cadomian geosynclinal sediments and volcanics in larger, but narrow internal troughs. The Cambrium and, if it missing, the lower Ordovician sediments cover the folded Cadomian basement.

The morphological and structural subdivision of the Saxo-Thuringian zone and the deep fault zones strongly control the position of the metaophiolite complexes. The Letovice metaphiolite complex is located in the marginal area of the Central Bohemian region and closes at the Moravian-Silesian fault zone (Fig. 1).

Corresponding metaophiolite complex has been described by J. Tonika (1971) and in this sense also interpreted by Z. Mísař

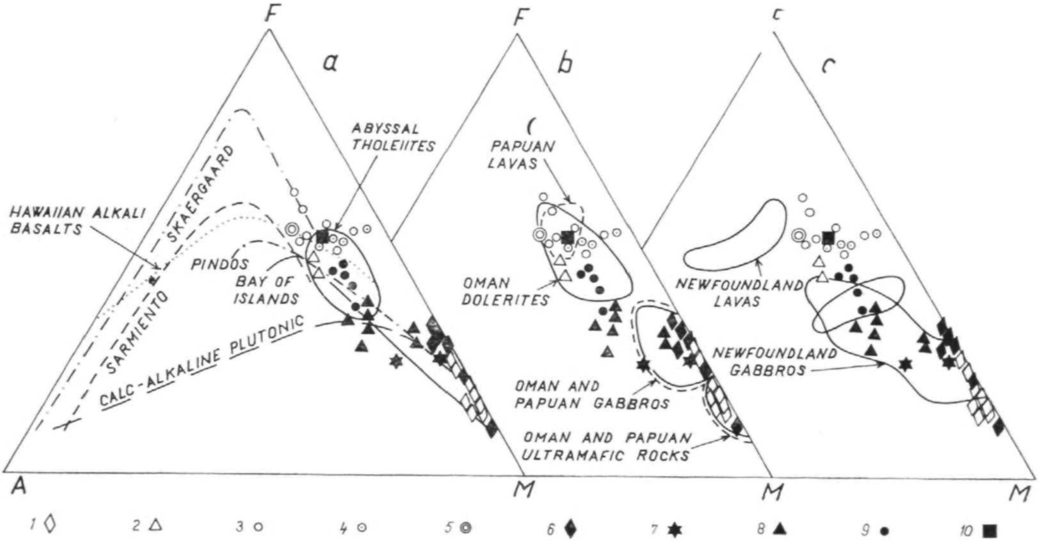

Fig. 7. Letovice metaophiolites in A-F-M plot as compared with trends of other ophiolite complexes [see corresponding data in Alleman and Peters (1972), Coleman (1977), Davis (1971), Montigny et al. (1973), Norman and Strong (1975), Saunders et al. (1979), and Suen et al. (1979)], Rocks of the L-synform: 1 — ultramafic rock, 2 — gabbro, 3 — amphibolite, 4 — garnet amphibolite, 5 — basic dyke. Rocks of the R-synform: 6 — ultramafic rock, 7 — olivine gabbro, 8 — hornblende gabbro, 9 — amphibolite, 10 — metadolerite

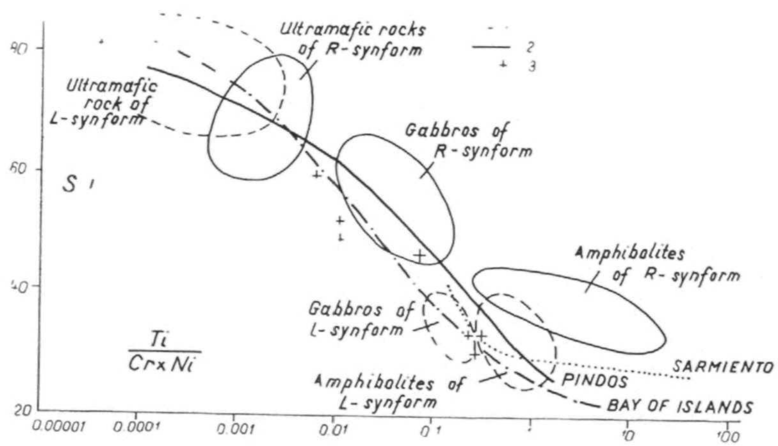

Fig. 8. Semilog plot of the Solidification Index (S. I.) (= 100 MgO/MgO + FeO + $+Fe_2O_3 + Na_2O + K_2O$) versus Ti/Cr×Ni for ophiolite members of the Letovice crystalline complex: a correlation with other ophiolite complexes. 1 — rocks of the L-synform, 2 — rocks of the R-synform, 3 — rocks of the ophiolite suite following the Central Saxonian Lineament (Werner, 1981)

et al. (in press) from the vicinity of Mariánské Lázně in Western Bohemia. The basic volcanics converted into many types of amphibolites (with garnet at some places) alternate with metagabbros. Along the central NE deep fault a larger ultrabasic body was emplaced. Nearly all members of the classical ophiolite suite are present in the Mariánské Lázně ophiolite complex, except probably of cumulate ophiolite complex. Geochemically the rocks of the Mariánské Lázně metaophiolite complex represent the metamorphic products of tholeiites and ocean floor basalts.

Upper Riphean ophiolite association of the Central Saxonian Lineament zone is made up of serpentinized dunites and peridotites, pyroxenites, several types of gabbros, amphibolites and less metamorphosed mafic and intermediate volcanics. There are sufficient geochemical data for correlation with the metaophiolites of the Letovice crystalline complex (Werner, 1981).

The ultrabasic rocks of the L-synform of the Letovice complex and the ultrabasic rocks of the Central Saxonian Lineament zone are practically identical: both correspond to the depleted mantle. C. D. Werner (1981) does not mention the cumulate ophiolite zone. However, Werner's analysed gabbros correspond to some extent with the cumulate gabbro of the R-synform (Fig. 4). The Saxonian metaophiolites are interpreted as ophiolite nappes with the homeland region along the Central Saxonian Lineament zone. They are unconformably overlain by sediments with basal conglomerates of Vendian age and by Paleozoic sediments.

A nearly complete ophiolite suite has been found at the margin of the faulted Sowie Góry Mts. (Maciewski, 1973). Abundant ultrabasic rocks are probably of two types (lower ultrabasic rocks and cumulate ultrabasic rocks with some concentration of chromite). The gabbros present are very probably also of two types. The gabbros at Nowa Ruda are closely connected with troctolite (classical locality of this rock) and olivine gabbro and obviously represent the rock of the cumulate zone. Another type of gabbro transgressive to ultrabasic rocks belongs to the upper gabbro zone of the complete ophiolite sequence. Basic volcanics are transformed into amphibolites. A sheeted dyke complex may be also present (Majerowitz, 1979; Narebski et al., 1982).

A metaophiolite complex, probably of Upper Proterozoic age, is also situated along the NNE—SSW contact between the Saxo-Thuringian and Moravo-Silesian regions (Mísař, 1979). The amphibolites represent metamorphosed mafic volcanic and strongly sheared gabbros. The banded harzburgite with pyroxenite layers (Mísař, 1966) and rhodingite are perhaps lower ultrabasic rocks — tectonites of mantle peridotites.

The described metaophiolite complexes of the Saxo-Thuringian zone of the Bohemian Massif are common in their structural position. They follow marginal zones of geosynclinal troughs and/or deep fault zones along the contact between troughs and internal elevations. The metaophiolite suite of dismembered type with a cumulate gabbro-peridotite zone is found only where the strike-slip deep fault zone inside the Saxo-Thuringian zone approaches the Moravian Silesian fault zone. The places may represent triple junctions from the time of the Cadomian geotectonic cycle — the Letovice ophiolite junction and the Sowie Góry Mts. junction.

The metaophiolite complexes of the Saxo-Thuringian zone also have some time and genetic relations to the abundant geosynclinal basic volcanism. The most representative of them are spilites and diabases of the Central

Bohemian region (Fig. 1). F. Fiala (1977) characterized the volcanics westerly of Prague as ocean floor basalts and those farther to the S of Prague as volcanics originated from calc-alkaline magma of the orogenic belt along the continental margin or an island arc. The metavolcanics (greenschists and amphibolites) of the Central Bohemian region (synclinorium) correspond to abyssal tholeiites described by M. Opletal et al. (1980).

All volcanic rocks of the Central Bohemian region alternate with geosynclinal greywackes and laminated pelites. These types of sediments with volcanic rocks are typical for marginal (back arc) basins or for basins between the outer and inner arcs (Mitchell and Garson, 1981). Some similarities may also be found in sedimentation and volcanic processes in a marginal sea of the Sarmiento type (Tarney-Dalziel and Wit, 1976).

Before passing the stage of compression, the marginal basin floor was influenced by crustal thinning, rifting, basic volcanism inside and island arc volcanism along the basin margins. All these processes may lead to formation of a new oceanic floor in the marginal sea.

The general character of the Saxo-Thuringian zone as a region that is strongly morphologically a structurally differentiated margin sea of Upper Proterozoic age seem also to be documented by new investigations of P. Jakeš et al. (1979) and J. Cháb et al. (1982). They concluded that the clasts in Proterozoic greywackes are largely derived from islad arc volcanic rocks and calc-alkaline volcanic rocks of continental margin but very rarely from ocean floor tholeiites. This paleogeographical scheme indicates that the ophiolite complexes of the Saxo-Thuringian zone were emplaced along deep faults (lineaments) inside the Saxo-Thuringian marginal sea and/or along its margins, especially where a triple junction can be assumed.

The sedimentary and volcanic rocks of the Saxo-Thuringian zone were affected by Cadomian metamorphism. The metamorphic mineral assemblage of the Letovice metaophiolite complex originated under conditions with a temperature of about 400—600 °C and a pressure of about 2—5 kb. These conditions do not exceed the limits of Cadomian metamorphism gived by J. Cháb and M. Suk (1977). Generally, the intensity of Cadomian regional metamorphism of rocks of the Saxo-Thuringian zone is not uniform. This is also true for the metamorphic grade of the Letovice crystalline complex. The rocks of the L-synform belong to the amphibolite facies (with garnet) whereas the rocks of the R-synform were metamorphosed under the conditions of green schists facies. This also seems to be very important if complex nappe tectonics is accepted for the Letovice crystalline unit.

Conclusions

The basic and ultrabasic rocks of the Letovice crystalline complex are considered to be members of dismembered ophiolites metamorphosed in amphibolite and green schist facies. Ultrabasic members most probably represent ultrabasic rocks "tectonites" in the L-synform and cumulate ultrabasic rocks in the R-synform. Metagabbros and metavolcanics (amphibolites) generally correspond to the rocks of the layered gabbro-peridotite zone and of the volcanics as seen in all classical ophiolite sections.

Paleotectonic analyses and general geochemical data allow interpretation of the Letovice metaophiolites as part of the Saxo-Thuringian zone developed as a complex, in strongly differentiated marginal sea.

The geotectonic position of the Letovice metaophiolite and other corresponding ophiolite complexes (Mariánské Lázně, Saxony area, Staré Město zone, Sowie Góry Mts.) is very probably controlled by deep faults (rifts) inside the Saxo-Thuringian zone and/or by the marginal faults especially when they approach the Moravian-Silesian fault zone. The metaophiolite complexes are in some way related to basic volcanic activity and greywacky sedimentation present (e. g. Barrandian Upper Proterozoic etc.) in the Saxo-Thuringian zone during the Cadomian geotectonic cycle.

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Rozdělené metaofiolity letovického krystalinika ve stavbě sasko-durynské zóny Českého masívu

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Nová geologická a geochemická data byla shromážděna z krystalinika v okolí Letovic. V krystaliniku se nacházejí spodní ultrabazické horniny (tektonity), horniny kumulátového komplexu, bazické vulkanity a velmi sporadicky i horniny žilného typu. Všechny tyto horniny lze považovat za metamorfované členy rozděleného klasického ofiolitového komplexu. Stupeň regionální přeměny zasahuje z facie zelených břidlic do facie amfibolitové v závislosti na pozici těchto hornin v základních megastrukturách letovického krystalinika. Geologické, petrografické i geochemické znaky i diferenciační trend bazických a ultrabazických hornin letovického krystalinika odpovídají ofiolitovým komplexům např. lokalit Pindos, Bay of Island, Troodos, Oman, Papua a dalších.

Geotektonicky svrchnoproterozoické letovické metaofiolity jsou součástí svrchnoproterozoického strukturního patra sasko-durynynské zóny středoevropských hercynid (variscid). Jsou dobře srovnatelné s horninami mariánsko-lázeňského komplexu, s ofiolitovým komplexem centrálního saského lineamentu, s metabazity a ultrametabazity staroměstského svorového pásma a také s ofiolity v lemu kry Sovích hor. Všechny zmíněné ofiolitové komplexy patrně vznikaly v geotektonickém prostředí okrajového moře sasko-durynské zony zvláště v místech hlubinných zlomů sledujících okraje vnitřních depresí a elevací. Pro okrajová moře a vnitřní deprese jsou vedle hlubinných zlomů charakteristické znaky jako ztenčování zemské kůry a v konečném obrazu vytváření nové oceánské kůry. Tím se svrchnoproterozoické strukturní patro sasko-durynské zóny od paleozoického patra téže zóny velmi zřetelně odlišuje.