equilibrium mineral assemblage of the xenoliths is clinopyroxene, plagioclase, garnet, ± orthopyroxene, ± amphibole ± quartz.

The garnet-clinopyroxene thermometer of Krogh (1988) have been used to obtain the equilibrium temperature. The pressure has been calculated with the PT Mafic program (Soto and Soto 1995) using the Holland and Powell (1988) calibration of the garnet-clinopyroxene-plagioclase-quartz barometer. The results with their error bars (two sigma deviation) are illustrated in Fig. 1. The p-T diagram shows two different arrays of data points. Most data plot along a certain band between approximately 900 °C, 0.9 GPa and 1100 °C, 1.6 GPa. This group may represent the geothermal gradient existing in the lower crust during the equilibration of the garnet granulites. It also shows that the thickness of the mafic lower crust was at least about 20 km before the extension of the Pannonian Basin. Sporadic occurrence of garnet free, clinopyroxene-orthopyroxene-plagioclase granulite xenoliths also point to the fact that this estimate should be treated as minimum for the mafic lower crust prior to extension. Two samples (Szbk-206 and A-11) show significantly lower temperatures (760–840 °C) than the other group. However, their pressure data (1.1–1.4 GPa) are similar to those of the "main group". These two samples differ from all other in their mineral chemistry. They contain less plagioclase and orthopyroxene but more garnet and clinopyroxene than other samples. Plagioclase is richer in albite component, and garnet contains more almandine in these two samples. The differing P-T conditions of formation of the two garnet granulite groups show that the lower crust cannot be treated as a wholly equilibrated rock column, but consists of two parts equilibrated at different P-T conditions. The "main group" represents garnet granulites equilibrated at high temperatures and the two xenoliths showing lower temperatures represent rocks equilibrated at similar depths, but at the amphibolite-granulite facies boundary.

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Variscan Structure of Hranice Paleozoic Area (Moravosilesian Paleozoic Zone)

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The Hranice Paleozoic belongs to the Rhenohercynian belt of the Middle European Variscides (Bohemian Massif). Although the mobilistic model of this area was proposed in fifties (Homola 1950) the fixistic interpretation prevailed. Dvořák and Friáková (1978) interpreted different sedimentary facies in tectonic blocks as the result of synsedimentary tectonic movements of the blocks.

The "laminated" limestones occurring in different stratigraphic levels in the different blocks were considered as sedimentary slope facie (e.g. Dvořák 1991). The first problem with these limestones is in stratigraphy: the age was not based on biostratigraphy but only on superposition. The lateral changes to limestones of different type and age are important for solving this problem. The second problem is in their structure: the lamination with strong lineation is not sedimentary structure but the result of tectonic strain under ductile to semiductile conditions (foliation, cleavage). Hence, the "laminated" limestones represent high-strained limestones (carbonate mylonites); their precursors are either the limestones of the Líšeň Fm. (nodular limestones, intraclast breccias, limestone turbidites with shales) or the reefoid limestones of the Macocha Fm.

Different strain indicators (Špaček et al. 2001) were used to distinguishing tectonic limestones facies, which include weakly recrystalized protoliths, protoblastomylonites and blastomylonites. Mylonites are forming wide shear zones, which were localized in geological maps as well as in boreholes (V501-V503, V504, V505, LV60). The thickness of the shear zone in the V501 borehole is 92 m, for example. These ductile shear zones dip in 45° to the WNW and lineation is trending to the WNW. Microstructures (boudinage, book-shelf structures, stretched peloides etc.) indicate minimal elongation up to 1000% parallel to foliation across shear zones. The kinematic markers indicate the top-to-ESE thrusting.

Stratigraphic sequences are usually duplicated in association with the shear zones, which is evident in geological maps as well as in some boreholes. Based on microfacies study and lithostratigraphy, significant thrust planes were usually localized in central parts of shear zones. Three main thrusts were recognized:

1. Thrust between Hranice and Černotín (Frasnian reefoid limestones of the Macocha Fm. thrusted over Famenian limestones of the Líšeň Fm. and/or over the Culmian siliciclastic rocks);
2. Thrust in the Ústí surroundings (Famenian limestones thrusted over upper Tournaisian–lower Visean limestones);
3. Thrust East of Hluzov (duplication of the Macocha Fm.).

Comparing stratigraphic and tectonic data from eastern margin of the Bohemian Massif the end of thrusting is dated to latest Westphalian–early Stephanian.

Alpine-style tectonic model (Čížek and Tomek 1991) explains the origin of laminated limestones. They are the result of tectonic processes, which transform limestones of different types and ages into special tectonic facies imitating sedimentary lamination. The study was supported in part by grant project MSM0021622412 and grant FRVŠ 1950/2005.

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Complex History of the Lithospheric Mantle Beneath the Western Pannonian Basin

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Pyroxene-spinel symplectites in 6 samples from the Little Hungarian Plain xenoliths have been found and studied in detail. The symplectites are composed of orthopyroxene, which constitutes the mass of the mineral assemblage, whereas spinel and clinopyroxene are subordinate (Fig. 1). The occurrence of this specific mineral assemblage shows a continuous variance with respect to partial melting and recrystallization. The most pristine symplectites are characterized by fine-grained orthopyroxene aggregates and vermicular spinels in intimate textural relation with elongated clinopyroxenes.

Melting of the symplectites occurs with synchronous precipitation of isometric, euhedral olivine grain shapes. The vermicular spinels, probably due to the reaction with the infiltrating melts are surrounded by very fine-grained, isometric spinel crystals. At the final stages of the reaction orthopyroxenes vanish and melt is observed instead together with the precipitated olivines, indicating that a reaction of

orthopyroxene + Si-poor melt = olivine + Si-rich melt

occurred. The xenoliths that host these symplectites are porphyroclastic displaying specific olivine orientation patterns (Fig. 2). Some of the larger orthopyroxene and clinopyroxene porphy-

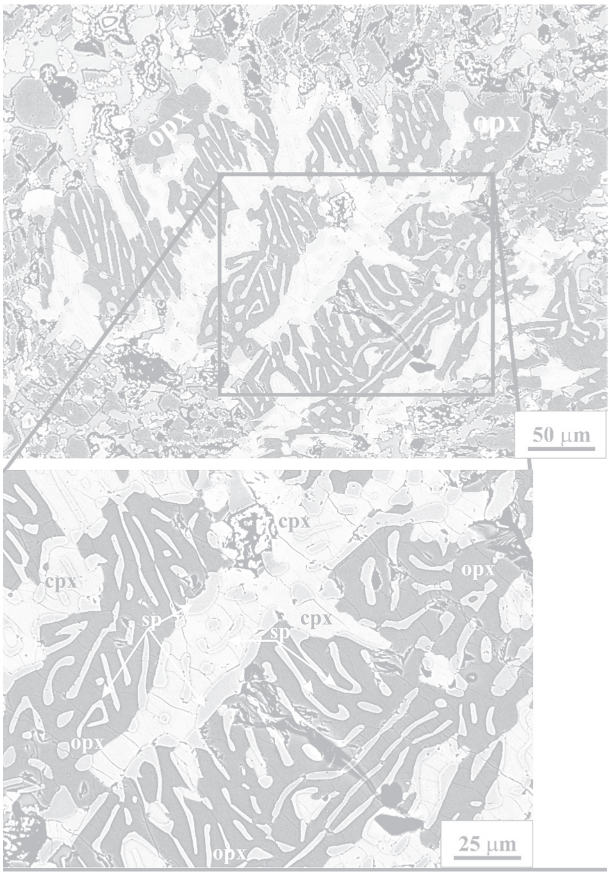

Fig. 1. Pyroxene spinel symplectite with breakdown products and an enlarged image of the symplectite itself. Intimate intergowth of clinopyroxene and spinels can also be observed. Porphyroclastic spinel lherzolite from the LHPVF (GC03-03), opx orthopyroxene; cpx clinopyroxene; sp spinel. SEM image.