A. MAIN RESULTS OF THE PROJECT

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The present report summarizes main results of the project and interpretations. In a wider sense, the whole report, with its many specialized data sets, represents a new model of the western part of the Bohemian Massif. The important results of specialized studies and the main features of the new model are discussed, and presented in a condensed form in this chapter.

A.1. RESULTS OBTAINED ON INDIVIDUAL TOPICS

The regional geophysical survey, including **detailed gravimetry** (Šrámek et al., this volume) and **airborne magnetic and radiometric methods** (Pokorný et al., this volume), has complemented measurements of the last two decades by covering some important gaps (Fig. 3). Data from the newly surveyed areas were processed and plotted, together with the older data, in unified sets of 1 : 50 000 maps deposited in the Archives of the Czech Geological Survey and Geofond, Prague. This provided regional coverage up to the international boundary with Germany and allowed comparative study of units and geological objects both sides the international boundary.

Gravimetry, and in part also magnetometry, gave quantitative information on subsurface extension of many contrasting plutons, intrusions, and horizons of basic metavolcanic rocks, necessary for a 3-D structural study of the Earth's crust. A gravity model of the crust along the seismic 9HR profile (Švancara-Chlupáčová, this volume) constrains data and interpretation resulting from the reflection seismic study of the profile (Tomek et al., this volume) and provides an important basis for interpretation of geological structure of the Earth's crust in this region.

The deep reflection seismics is the main geophysical tool for recognition of crustal structure. **The 9HR line**, 200 km long, starts in Klingenthal, 2.7 km inside Germany (and thus nearly tying to the profile DEKORP MVE-90, running in Germany along the axis of the Krušné hory Mts.) and continues through Kraslice, to Prachatice (Fig. 1). In terms of the technique used, it is the first major seismic profile in the interior part of the Bohemian Massif aimed at characterization of the internal crustal structure. The most important information obtained includes: position of the Mariánské Lázně Complex and its subsurface continuation to the SE, beneath the Teplá-Barrandian Unit (TBU), structure of the southeastern part of the Saxothuringian Zone, the internal structure of the TBU with numerous SE-dipping reflecting horizons, showing vertical extension through much of the crustal thickness, and probable continuation of the TBU nearly 30 km SE of the Central Bohemian Suture beneath the Moldanubian Zone. An anticlinal structure (Holubec 1968) seems to be confirmed for the whole upper crust in the SE part of the TBU.

At the NW, the reflection pattern indicates a delaminated lower-middle crust under the Saxothuringian Zone and the Karlovy Vary Pluton. This relation could indicate connection between tectonic underplating and delamination, production and accumulation of large volumes of granitoid melts, followed by their intrusion into upper crust.

The remarkable contrast in reflection seismic properties of the TBU crust and the Moldanubian crust is also significant. The reflection patterns in the Moldanubian Zone are comparable to those observed in the crust composed of high-grade gneisses and migmatites; the relatively short and variably oriented reflecting domains correlate with the complicated, polyphase planar structures documented in surface geology.

For the first time, information is obtained on probable emplacement of basaltoid intrusions at the crust/mantle boundary as the abyssal manifestation of the volcanic activity during the Tertiary. The associated increased geothermal gradient and degassing constitute important factors in the formation of abundant springs of mineralized waters in the west Bohemian spa region.

The Saxothuringian Zone comprises (1) the Cadomian Krušné hory and Smrčiny (-Fichtelgebirge) parautochthonous crystalline core with orthogneisses, overlain by (2) two nappes, the lower of which contains, among others, HP-LT eclogites; the upper one contains medium- to low-grade crystalline schists with scarce indications of a HP-LT metamorphism (Holub-Souček 1994). Rocks considered to be early Ordovician, i.e., the Frauenbach Beds and Phycodes Formation, occur in the extreme periphery of the region studied.

The Cambrian age of granite intrusions, later transformed to orthogneisses in the core unit, is now documented by Pb-Pb isotopic analyses on zircon (Kröner et al. 1995). Eclogites carrying evidence of early progressive evolution and occurring in the lower nappe, yielded a 329 ± 19 Ma Sm-Nd garnet-omphacite-whole rock isochron (Hurych-Brueckner 1995). Pressures of equilibration of some acidic rocks with relics of jadeite range from 2.2 to 2.5 GPa, minimum pressures indicated for some ordinary eclogites are 1.2 to 1.5 GPa, and temperatures vary from 550 to 730 °C. Garnet-kyanite-chloritoid mica schists, also in the lower eclogite-bearing nappe, indicate T of 570–580 °C and P of 1.45 GPa (Konopásek 1994). This corresponds well with data from Saxony, summarized by Blümel (1995).

Rock units in the structural stack including the Krušné hory crystalline complex, the lower nappe, and higher up the Vogtland-Saxony Palaeozoic exhibit thus significant leaps in conditions of the Variscan metamorphism. This points to a significant role of the Variscan nappe tectonics (Sebastian-Rötzler 1995).

The so-called Ohře crystalline unit, which belongs to the Krušné hory crystalline complex as its SE lateral part, extensively covered by the Tertiary sediments (the North Bohemian brown coal basin), has been characterized on the basis of numerous boreholes (Mlčoch 1994). Granulites exposed between Stráž nad Ohří and Kadaň were affected by polyphase deformation and metamorphism. The early, HP granulite facies conditions range from 750 to 800 °C and 1.5 to 1.7 GPa (Kotková 1993). It is remarkable that the decompression recrystallization took place in amphibolite facies, while imprint of a LP-HT granulite facies producing orthopyroxenes is absent. This indicates for granulites of the Ohře unit a P-T-time paths different from that of the Saxony granulite massif.

The study of lithology, stratigraphy, structure, and metamorphism in the Saxothuringian Cheb-Dyleň crystalline unit and its suspect "transition" relations to the NW edge of the Moldanubian Zone in the Bohemian Forest resulted in definition of five local Saxothuringian and one Moldanubian sequences (Fiala-Vejnar, this volume). A set of MP-MT metamorphic zones of the Variscan regional metamorphism shows p rogression towards the junction with the Moldanubian Zone and corresponds well to the pattern determined in the adjacent Bavarian territory (Wagener-Lohse and Blümel 1986). This regional metamorphism is overprinted by a LP periplutonic metamorphism defined by andalusite, cordierite, and cordierite + K-feldspar zones, tied to the Variscan granitoids (e.g., Žandov pluton).

The Kladská Unit comprises local metabasaltic and metasedimentary units along the NW and SE margins of the MLC. Large parts of this unit were formerly considered as belonging to the MLC. Consequently, they were re-defined as the Kladská Unit (Kachlík, this volume), forming a SE margin of the Saxothuringian Zone. This re-definition is based on the lithologic, metamorphic, and structural differences between the Kladská Unit and the MLC. The Kladská Unit consists of low- to medium-grade LP metabasalts, metasediments, and acidic metatuffs that never undergone MP and HP metamorphism (Kachlík, this volume). These rocks geochemically differ in their more evolved protolith and alkaline to subalkaline nature from less differentiated tholeiitic basic rocks of the MLC. The most prominent structural features are the NE-SW trend, dip to the SE, prolate fabric, and predominating sense-of-shear indication top-to-the-NNW.

The Mariánské Lázně Complex (MLC) was defined recently as an independent unit in between the Saxothuringian Zone and the TBU (Matte et al. 1990). The combination of geophysical methods provided information on the contact zones between the MLC and the Saxothuringian Zone, and between the MLC and the TBU, and on the subsurface continuation of the MLC. Petrological and geochemical study of eclogites, garnet amphibolites, and metagabbros in the MLC shows similar geochemical composition of these rock groups, corresponding dominantly to MORB-like protoliths. The synthesis of information on eclogites resulted in systematic classification and division according to their mineral and geochemical characteristics (Jelínek, this volume), and the age of HP metamorphism (370–380 Ma) in the MLC was obtained (Beard et al. 1995). Geothermobarometric study of garnet amphibolites provided the complete P-T data set from the core and the SE margin of the complex. The range of values obtained supports rather complex tectonic evolution of the individual segments of the MLC under upper amphibolite facies superimposed on the HP eclogite event (Štědrá, this volume).

The comparative study of metagabbros (Svobodová-Ulrych 1993) in the MLC and in the Teplá Crystalline Unit (Cháb-Jelínek, this volume) indicates differences in their original tectonic setting and/or differences in magmatic differentiation.

A protolith zircon age for the Výškovice metagabbro at 496 ± 1 Ma corresponds approximately to the ages obtained by the same method from metagabbros in the Münchberg Massif (Bosbach et al. 1991), and from the ZEV unit (KTB samples; von Quadt 1990) as well as do the geochronological data of the main metamorphic events in both units. The geochemical features of basic rocks from the MLC and the Münchberg Massif are also comparable (Patzak et al. 1991; O'Brien 1991; von Quadt 1990, 1993).

In summary, the MLC has been characterized as consisting of allochthonous melange segments of oceanic crust, subducted to deep levels with P max. > 1.5 GPa, metamorphosed during the Palaeo-Variscan stage, and while in middle to upper crustal position, thrust over the SE margin of the Saxothuringian Zone. The MLC thus represents a segment of the important suture in the geological pattern of western Bohemia.

In **the Teplá-Barrandian Unit** (TBU) the studies were focused mainly on metamorphic zonation of the Teplá Crystalline Unit (i.e., the NW part of the TBU) and on chemical characteristics of volcanites. This resulted also in better knowledge of tectonics of the Teplá Crystalline Unit in connection with geological mapping undertaken by workers from the Faculty of Science, Charles University. New data on the TBU volcanites were used for a detailed and better documented interpretation of their original tectonic setting. The most important results are summarized as follows:

1. The metamorphism at the NW of the TBU was polyphase. Surprisingly, its first stage was a LP one. The second stage, typical Barrovian MP-MT, reached T 600 °C and P up to 1 GPa; pressure reached its maximum near the outer edge of kyanite zone. The third stage was retrograde and started by crystallization of sillimanite. Cháb-Žáček (this volume) assume a Cadomian age for the first and second stage of metamorphism; in contrast, Zulauf et al. (1995) suggest the Variscan age for the second, MP-MT stage.

2. The SE border of the kyanite zone is not an isograd, but coincides with a thrust or strike-slip fault, at least in the SW of the Teplá Crystalline Unit. Rocks of the kyanite zone are dismembered in three tectonic slices, the central one

carries relict eclogites, metagabbros, and the Teplá orthogneiss.

3. A shear-fault zone trending NNW-SSE divides the Teplá Crystalline Unit in two parts. In the E part, staurolite zone is extremely broad and shows a coarser crystallization compared to the W part.

4. An important set of radiometric ages was obtained by our German and Czech colleagues, confirming the dominance of the Cadomian intrusions in the W part of the TBU (e.g., Dörr et al. 1995).

5. New chemical data for additional occurrences confirm and better document the previous conclusions concerning the original mid-ocean ridge and within plate settings of basaltic rocks of the Precambrian Blovice Formation (Waldhausrová, this volume) and the petrochemical characteristics of the Cadomian intrusions.

In the Moldanubian Zone, the work was focused mainly on evaluation and interpretation of geochronological, geochemical, and structural data, obtained in various parts of the Moldanubian Zone during the last decade, in part in various projects, and on integration of these data with the existing and new geophysical information. The interpretations emerging from these data are presented in the section "Relations of major units" in this chapter.

Results of studies in the framework of the present project, dealing with individual subareas and topics, are summarized as follows:

1. In the extreme SE of the region of interest, the study of polymetamorphic evolution and geochemistry of eclogites in the Světlík eclogite belt (O'Brien-Vrána 1995), in the upper structural part of the Monotonous Unit and at the base of the Lower Proterozoic Světlík orthogneiss (Wendt et al. 1993), characterizes the Světlík thrust as a major intra-Moldanubian suture, transposed by the D3 deformation. These eclogites, carrying an early record of prograde evolution and a late granulite facies imprint, are distinct from eclogites in the granulite massifs, featuring mainly high-pressure crystallization from melts under upper mantle conditions. Consequently, it is not possible to assign all high-pressure rocks to a single (now disrupted) tectonic unit. The NE-SW trending boundary between the Monotonous Unit and the Kaplice Unit, suggested as the "Main Moldanubian Thrust" (Rajlich et al. 1986, Matte et al. 1990) is a rather late feature (normal fault), marking the NW limit of the D3 shearing in the Kaplice Unit, modified by late extension.

2. The petrological analysis of the Královský hvozd Unit in the Moldanubian Zone, adjacent to the Central Bohemian Suture, resulted in recognition of a domain structure, where individual domains show contrasting structural and metamorphic evolution (Babůrek 1995).

3. The interpretation of a detailed gravimetry study of the Prachatice granulite massif (Šrámek et al., this volume) indicates that along its E and W border the massif is bound by sub-vertical, N-S trending shear zones, associated with minimum vertical jumps of 8 km. This shows for the first time, that the synmetamorphic D2 shearing in the Moldanubian Zone was accompanied by vertical movements of this magnitude (Vrána, this volume).

4. The granitic protolith of the Hluboká orthogneiss, i.e., a representative of the Blaník type orthogneisses, has been dated to 508 ± 7 Ma by Pb-Pb on zircon (Vrána-Kröner 1995). This, and another Cadomian datum of approximately 550 Ma, obtained for the Stráž orthogneiss (east of the region in Fig. 1) (Košler et al. 1996) points to an important presence of the Cadomian crustal rocks in the Moldanubian Zone of southern Bohemia.

5. New geochemical data on Moldanubian paragneisses (Vrána et al. 1993; Vrána, this report) completed the existing information (Bouška et al. 1985) and made possible a comparison with clastic metasediments of other units.

The young, mainly **Tertiary alkaline volcanic rocks** in the region, are characterized from the volcanological and petrochemical aspects (Hradecký-Shrbený, this volume). The volcanological study of the Doupov Mts. complex is the main new contribution. Petrochemistry of a wide differentiation series ranging from olivine basaltoids, through foidite types, to trachytes is characterized and compared with the neighbouring volcanic regions in central Europe.

The series of specialized geophysical topics starts with a new **ray interpretation of the VI/70 seismic transect** across the Bohemian Massif (Novotný, this volume). Using more advanced methods, data from the 1970 profile (Greiz-Jáchymov-Pelhřimov-Břeclav) were processed, and resulted in a more accurate position of the Moho-boundary, compared with the original version.

Deep geo-electrical research in the western margin of the Bohemian Massif (Červ et al., this volume) indicates a structural continuity in the region between the Franconian line in the W and the West Bohemian shear zone. Differences in electrical conductivities in the Teplá-Barrandian Unit as compared to the Moldanubian Zone are characterized, as well as differences in orientations of local and regional vectors. Anomalous domains of increased conductivity, accompanying some major fault zones, have been also measured and interpreted as due to increased fluid flux and deposition of graphite and/or sulphides.

The magnetotelluric sounding along the 9HR profile (Pícha-Hudečková, this volume) followed the reflection seismics measurements (Tomek et al., this volume) and provided the seismic section with another independent parameter – electrical resistivity. The respective section was compiled almost through the whole crust and several tectonic units; it is interpreted with reference to rock type variation and geological structures. The measurements show a major difference between the Moldanubian crust and the Teplá-Barrandian Unit, and characterize increased conductivity associated with several tectonic boundaries.

The palaeomagnetism and palaeogeography chapter (Krs et al., this volume) summarizes the basic palaeomagnetic data for the Bohemian Massif and also brings new important results on pre-Carboniferous sequences, including the Cambrian, Ordovician and Devonian in the Barrandian and in Devonian resting on the Brunovistulian basement in Moravia. Palaeolatitude data for the Late Devonian and older formations show their original positions at southern hemisphere and their gradual northward drift. Palaeotectonic rotations are also interpreted. The possibility of a major rotation, indicated by data on the Devonian limestones in the Barrandian, as compared to limestones in the Moravian zone, points to important tectonic phenomena; the indication of high rotation should be verified by additional study.

The study of physical properties of rocks from the KTB boreholes (Chlupáč et al., this volume) included petrophysical study of relations between the physical properties of rocks and their texture, and the dependence of these properties on variation in pressure and temperature. Resulting data on electrical conductivity, magnetic properties, and velocity of longitudinal waves are important for interpretation of measurements in the borehole and were used for interpretation of measurements by deep geophysical methods.

The seismological study of the Kraslice/Vogtland/Oberpfalz region (Nehybka-Skácelová, this volume) brings evaluation of data obtained by the five-station seismological digital network in the Kraslice area and of the refraction seismic measurements. A detailed knowledge of velocities made it possible to localize active faults with sufficient accuracy using 2-D velocity models and to draw conclusions about the types and sources of local seismic activity.

The chapter **Time-space distribution of seismicity in the west Bohemian earthquake swarm region** (Horálek-Fischer, this volume) presents a preliminary model of seismic energy release in space and time for the western part of the Bohemian Massif. A detailed 3-D geometry of distribution of the seismic hypocentres is presented.

The chapter **Geothermics** (Šafanda et al., this volume) evaluates the regional heat flow patterns, effects of the young volcanic activity on the temperature field, effects of groundwater movement, and effects on the temperature field of the long-term climate changes. The inversion of the temperature log from the KTB pilot borehole is interpreted to indicate that the observed increase of the temperature gradient with depth can be explained as a response to the global climate warming at the end of the last glacial.

Hladíková et al. (this volume) in the part **The distribution of carbon, oxygen and sulphur isotopes in rocks and ore deposits of the Moldanubian Zone and the Teplá-Barrandian Unit** report and evaluate data on stable isotopes. In particular, marbles and graphitic rocks in the Varied Group in the Moldanubian Zone, black shales and carbonates in the TBU, and sulphides and carbonates from hydrothermal ores in western Bohemia are characterised and interpreted.

The character of palaeofluids in the western part of the Bohemian Massif (Ďurišová-Dobeš, this volume) was derived from the study of fluid inclusions. The rock types and units studied include granulites in southern Bohemia, a volcano-sedimentary assemblage in the Teplá-Barrandian Unit, Au-bearing quartz veins in the Moldanubian Zone, and hydrothermal veins in the Stříbro ore district. The composition of fluid inclusions are compared and the thermobarometric constraints for the fluids are derived. Inclusions with a complex composition (C-O-H-N) occur in metamorphic mineral associations; only water-rich fluid inclusions were found in post-metamorphic associations. CO_2-rich – mostly CO_2 liquid-only iclusions, H_2O-CH_4 - water solutions, and $N_2(+CO_2,+CH_4)$-vapour mixtures were also analyzed.

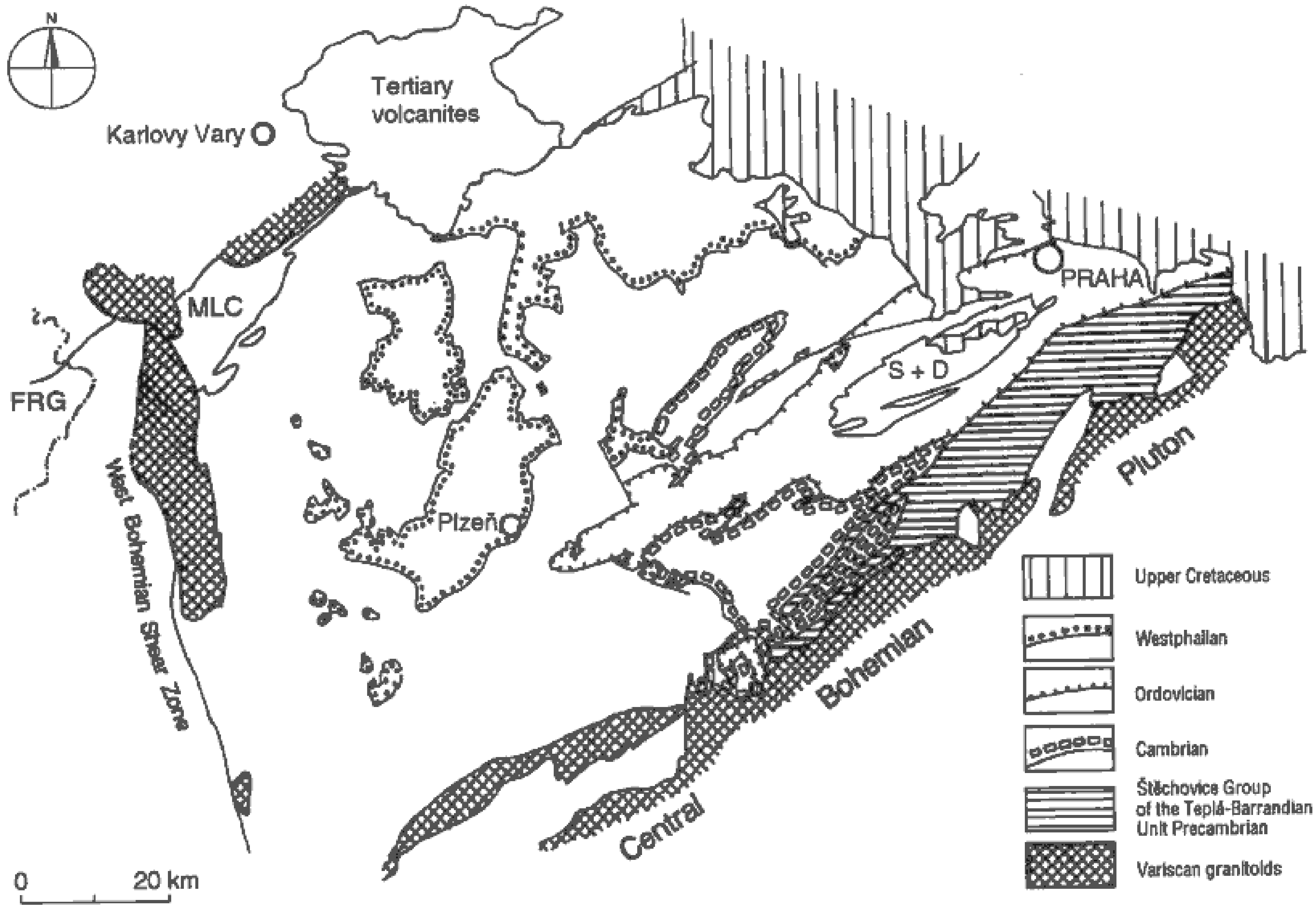
The chapter **Epigenetic hydrothermal mineralization** (Vavřín, this volume) presents an overview information on epigenetic mineralizations in the region of interest. The distribution patterns of several types of mineralization are significantly dependent (among other factors) on the regional tectonic structure, on the existence of major and also smaller fault zones with recurrence of movements, and on intrusions of granitoid plutons. Indirectly, data on epigenetic mineralization contribute to understanding the recurrent activities of fluids in this part of the Bohemian Massif, which correlate with superimposed mineralizations documented in individual localities and veins.

The study of **Sr and Nd isotopic composition of the young Bohemian and Moravian basaltic rocks** (Vokurka-Bendl, this volume) is aimed at the information on composition and evolution of the source regions in the underlying lithosphere and asthenosphere, from which the basaltic rocks are derived. The data represent a probe in the deep domains which are out of reach of many geophysical methods. The isotopic information is presented together with a review of petrochemical information. Slight differences in the $^{143}Nd/^{144}Nd$ ratios of the Bohemian and Moravian basaltic rocks are interpreted as a consequence of a regional variation in the character of their upper mantle sources. It is suggested that the LIL enrichment of mantle reservoirs becomes less important from the western margin of the Czech Republic towards the east.

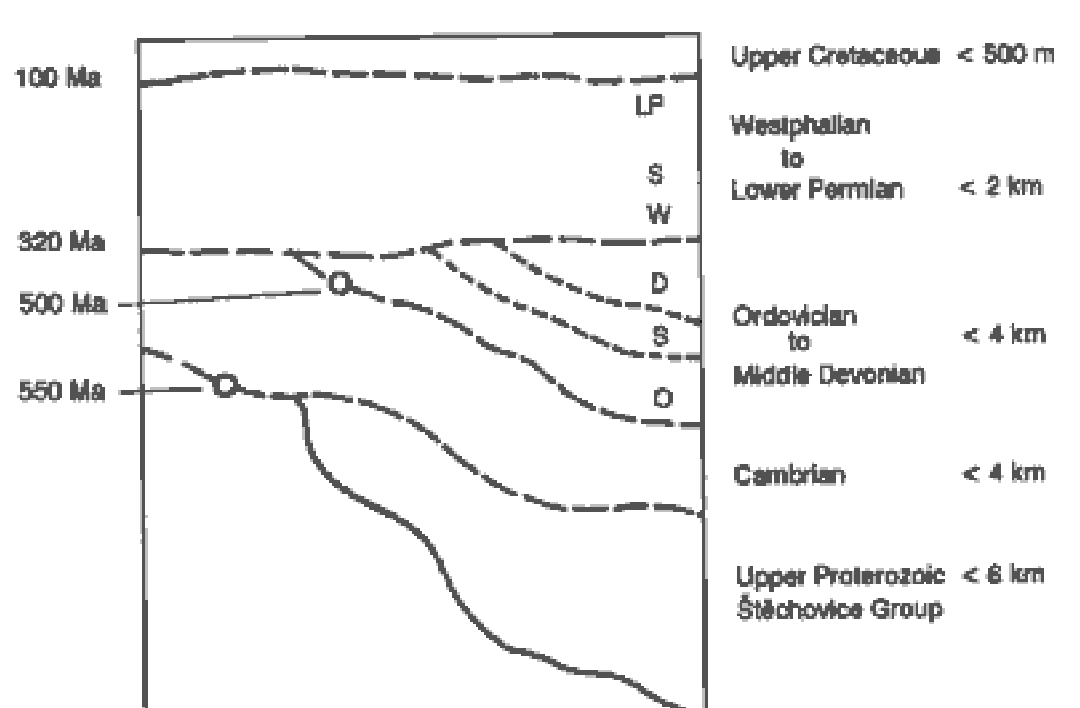
A.2. RELATIONS OF SOME MAJOR UNITS: CONTRASTING EVOLUTION OF THE TEPLÁ-BARRANDIAN UNIT AND THE MOLDANUBIAN ZONE DURING THE VARISCAN OROGENIC PROCESSES

The present knowledge of these two major units permits to formulate the main differences between the TBU and the Moldanubian Zone evolution during the Variscan orogenic processes. The TBU is a segment of pre-Variscan crust, which retained in its inner parts (central Bohemia) during the Variscan a prominent structural coherency. This is expressed in preservation of several unmetamorphosed sedimentary units, ranging from Cambrian to Upper Cretaceous, which successively transgressed the Upper Proterozoic basement of the TBU.

The present radiometric database for the Moldanubian Zone, in combination with structural, petrological and geochemical information, shows that this unit comprises number of heterogeneous crustal and upper mantle segments. The crustal partial units range in age from Lower Proterozoic to Lower Palaeozoic (also defined as several distinct terranes – Matte et al. 1990) and were clearly assembled only during the Variscan. It is in particular important to show that geochronological data, including cooling ages, indicate a major upward mass flow in the Molda-nubian Zone during the neo-Variscan. This feature



4. Regional pattern of trangression surfaces of major sedimentary units including the Cambrian, Ordovician, Westphalian, and Upper Cretaceous on the Upper Proterozoic basement of the Teplá-Barrandian Unit. Modifications of the transgression surfaces by faulting and folding are ignored.



5. A schematized section of the upper crust of the Teplá-Barrandian Unit showing superposition of trangression surfaces of major sedimentary units from the Cambrian to the Upper Cretaceous on the Upper Proterozoic basement. The relations indicate significant episodes of conservative crustal isostasy. See text for discussion.

is essential in explaining the proportion of rocks with a Variscan early HP history (P > 1.5 GPa) succeeded by HT conditions (700 to 1000 °C) under relatively low pressures (~ 0.5 GPa) and the notable proportion of upper mantle rocks exposed on the Earth's surface.

A.2.1. The Teplá-Barrandian Unit

The Teplá-Barrandian Unit (TBU) localized in a nearly central part of the Bohemian Massif shows gravity and magnetization properties which make it distinct from the neighbouring units (Šrámek-Mrlina and Pokorný et al., this volume). In the region of interest, it is bound by shear (-fault) zones with a steep dip – i.e. the Central Bohemian Suture, the West Bohemian shear zone, and the Litoměřice fault zone, used for intrusion by a number of the Variscan granitoid plutons. The combination of the tectonic position of the TBU and the subdued effects of the Variscan deformation and metamorphism, which dominate in the surrounding units, constitute the features of the TBU as a unit different from the neighbouring units. Fig. 4 shows the regional pattern of transgression surfaces of sedimentary units in the TBU, including Cambrian, Ordovician, Westphalian, and Upper Cretaceous, on the Upper Proterozoic basement. This situation indicates recurrent and significant episodes of a conservative isostasy which should explain preservation (though largely in erosional relics) of several sedimentary sequences in the uppermost crust (Fig. 5) through the interval of nearly 500 Ma.

Variscan subsidence of this crustal block, accompanied by accumulation of a thick sedimentary sequence, or a subsidence due to loading by allochthonous tectonic units (possibly derived by sliding from the rising "Moldanubian homeland") during the Variscan time, followed by pre-Westphalian erosion, could also result (incidentally) in the present pattern. This case would mean that the conservative isostasy did not apply during the Variscan time span. It is widely accepted that sedimentation ceased in the Barrandian during the uppermost middle Devonian, when it changed from carbonate to siliciclastic one (the Srbsko Formation). The uppermost Roblín member represents a sequence from immature flysch through mature flysch, probably up to supermature molasse (Kukal 1994).

Since the deformation styles of the Lower Palaeozoic in the Barrandian suggest a greater thickness of the overlying crust, compared to the values following from the present erosional section, the question on thickness and character of possible units overlying the Lower Palaeozoic prior to the Westphalian transgression is legitimate. This question should be addressed by future studies since it is important for understanding the evolution of the relative vertical positions of the neighbouring TBU and the Moldanubian crustal segments.

A.2.2. The Moldanubian Zone

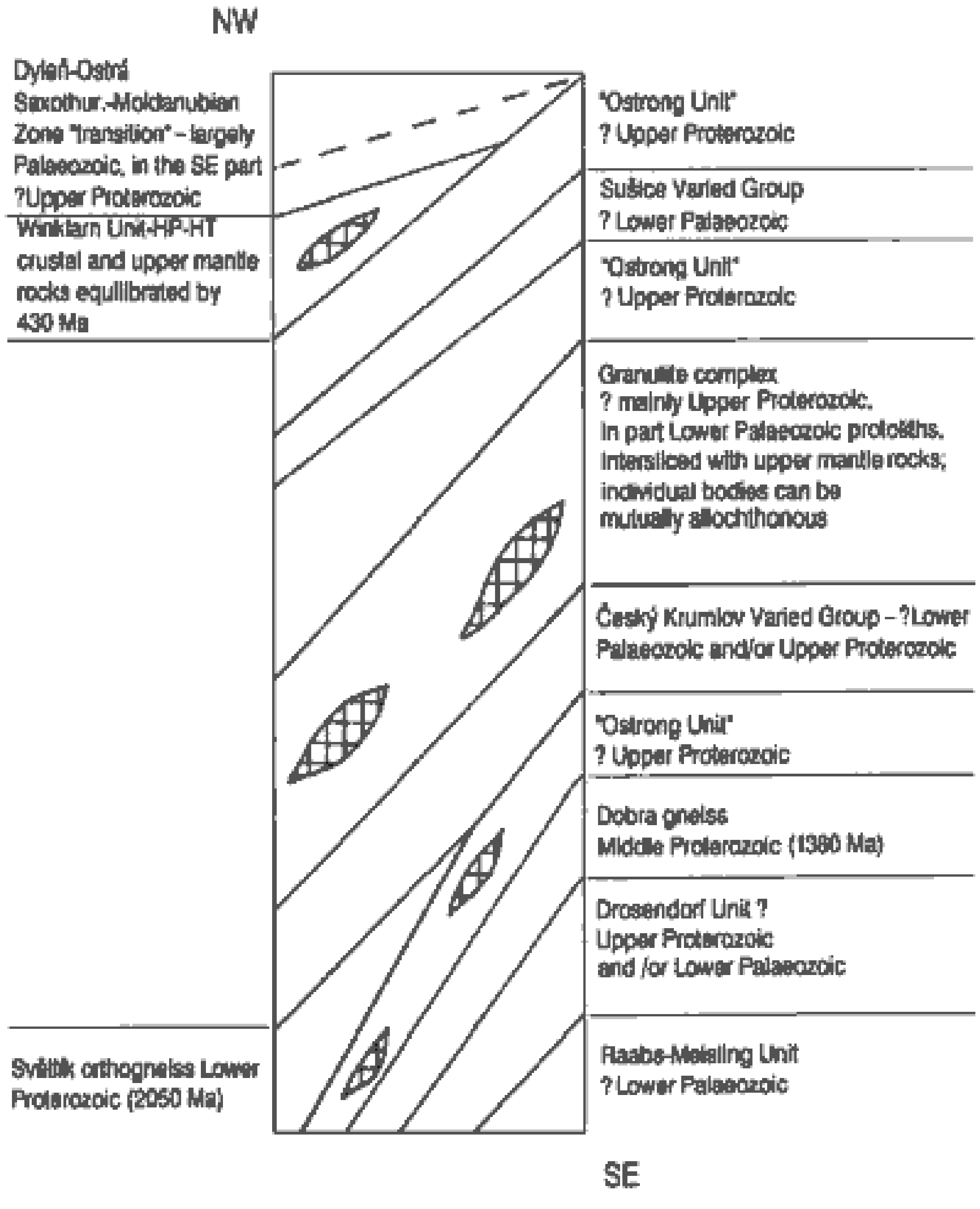
The Moldanubian Zone, bordering in the SW and W Bohemia the TBU from two sides (Fig. 1), shows lithology different from that of the TBU through much of the crustal thickness, as shown by the geophysical data (Šrámek et al. and Pokorný et al., this volume). The seismic profile 9HR (Tomek et al., this volume) provides information on a remarkably contrasting character of the TBU crust and the Moldanubian crust. Considering the heterogeneous assemblage of units comprised in the Moldanubian Zone, including Lower Palaeozoic units (Fig. 6), it is obvious that the heterogeneous population of several terranes and units was assembled only during the Variscan processes. This feature is seen as a prominent difference if compared with the TBU showing a relative structural coherence since Lower Cambrian.

The differences between the TBU and the Moldanubian Zone are most directly brought out by radiometric data in combination with the thermobarometric information on equilibration of the respective mineral assemblages. These data provide evidence that a variety of high-pressure rocks in the Moldanubian Zone, mainly eclogites and granulites, which evolved in part from Lower Palaeozoic protoliths, experienced equilibration at the base of double-thick crust (i.e., in the upper mantle levels) and now occur on the Earth's surface, in the uppermost level of the crust approximately 38 km thick. These rocks often closely associate with other HP/HT rocks which crystallized during the palaeo-Variscan and neo-Variscan events from mantle melts in upper mantle levels (part of eclogites, garnet pyroxenites, garnet and spinel peridotites) (Medaris et al. 1995a, b).

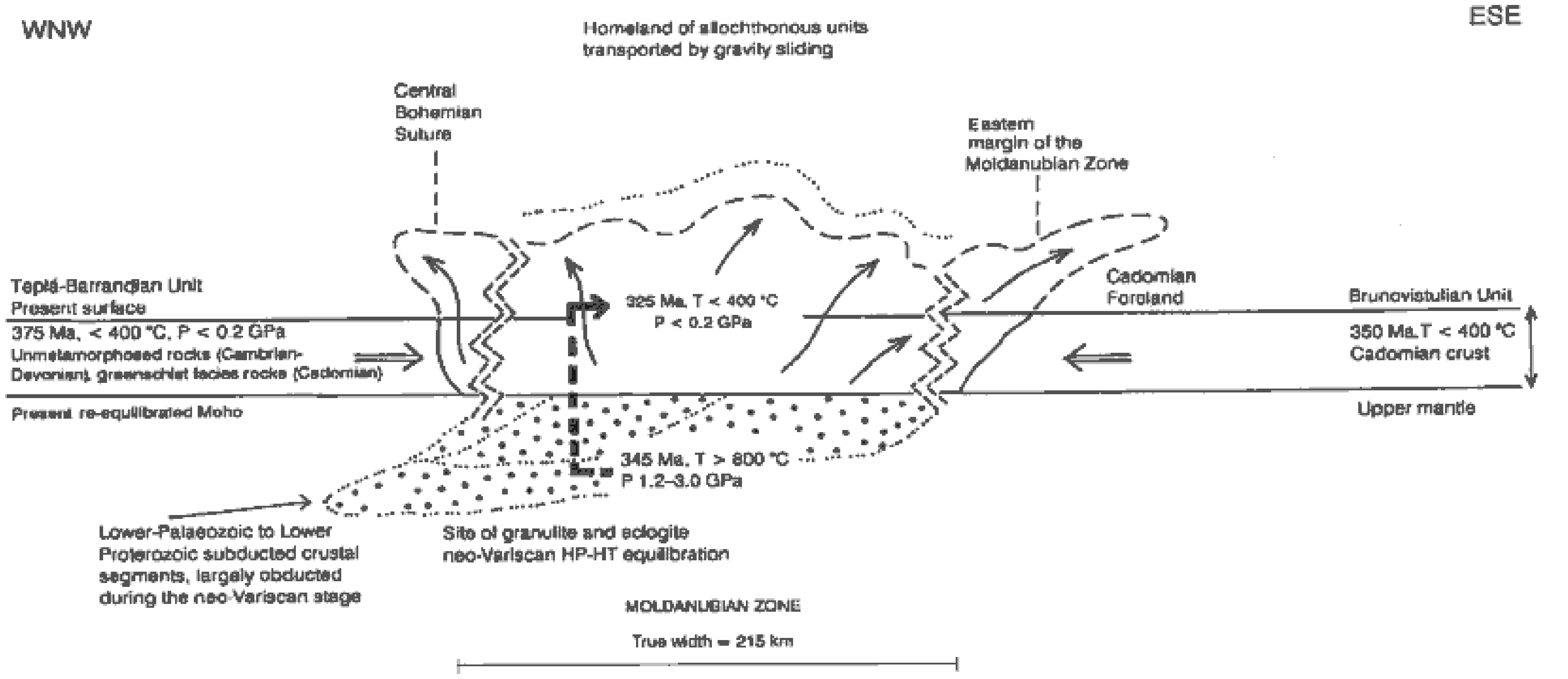
These relations imply that the cumulative effect of several deformation stages affecting the Moldanubian rocks must be a major upward transport of crustal and upper mantle masses. Such a scenario (Fig. 7) is necessary for explanation of the regional occurrence in the present erosional section of metamorphic and meta-igneous rocks with the Variscan HP/HT equilibration history, followed by a LP/HT annealing. The early and intermediate deformation structures are extensively obliterated by younger deformations, often characterized by high deformation rates, and finally, late extensional deformation modified the anomalously thick pile of crustal and, in part, upper mantle masses.

Laterally, in the east of the Bohemian Massif, the Moldanubian Zone is translated on the Cadomian Brunovistulian Unit and in the west on the TBU. The last relation is supported in particular by the 9HR reflection profile (Tomek et al., this volume).

In western Bohemia, kinematic indicators in mylonites in the West Bohemian shear zone correspond to uplift of the Moldanubian Zone relative the TBU (Zulauf 1994). Along



6. A highly schematized review of the neo-Variscan heterogeneous assemblage of the crustal and upper mantle units constituting the Moldanubian Zone. The partial units are arranged in allusion to the geographic distribution from NW (top left) to SE (bottom right). The allochthonous bodies of upper mantle rocks are shown by a cross-ruling pattern.



7. A highly schematized crustal section of the Moldanubian Zone and the neighbouring units carrying mainly records of the Cadomian evolution – i.e., the Teplá-Barrandian Unit at the NW and the Brunovistulian Unit at the SE. Note that the regional variations in grade of the Variscan metamorphism, palaeo-Variscan and neo-Variscan ages of metamorphic crystallisation, and Ar-Ar cooling ages indicate a major upward transport of crustal masses of the Moldanubian Zone relative the neighbouring units in the course of the neo-Variscan evolution.

the Central Bohemian Suture, in the segment adjacent to the Klatovy apophysis, kinematic indicators on cleavages in the TBU, steeply dipping toward WNW, also correspond to the relative uplift of the Moldanubian Zone (Zulauf, personal communication 1995). It is most probable that the steep dip of shear zones bordering the TBU reflects relatively late evolution stages, corresponding perhaps to the transition from plastic to brittle deformation; during early stages, the discontinuities probably had more moderate dips.

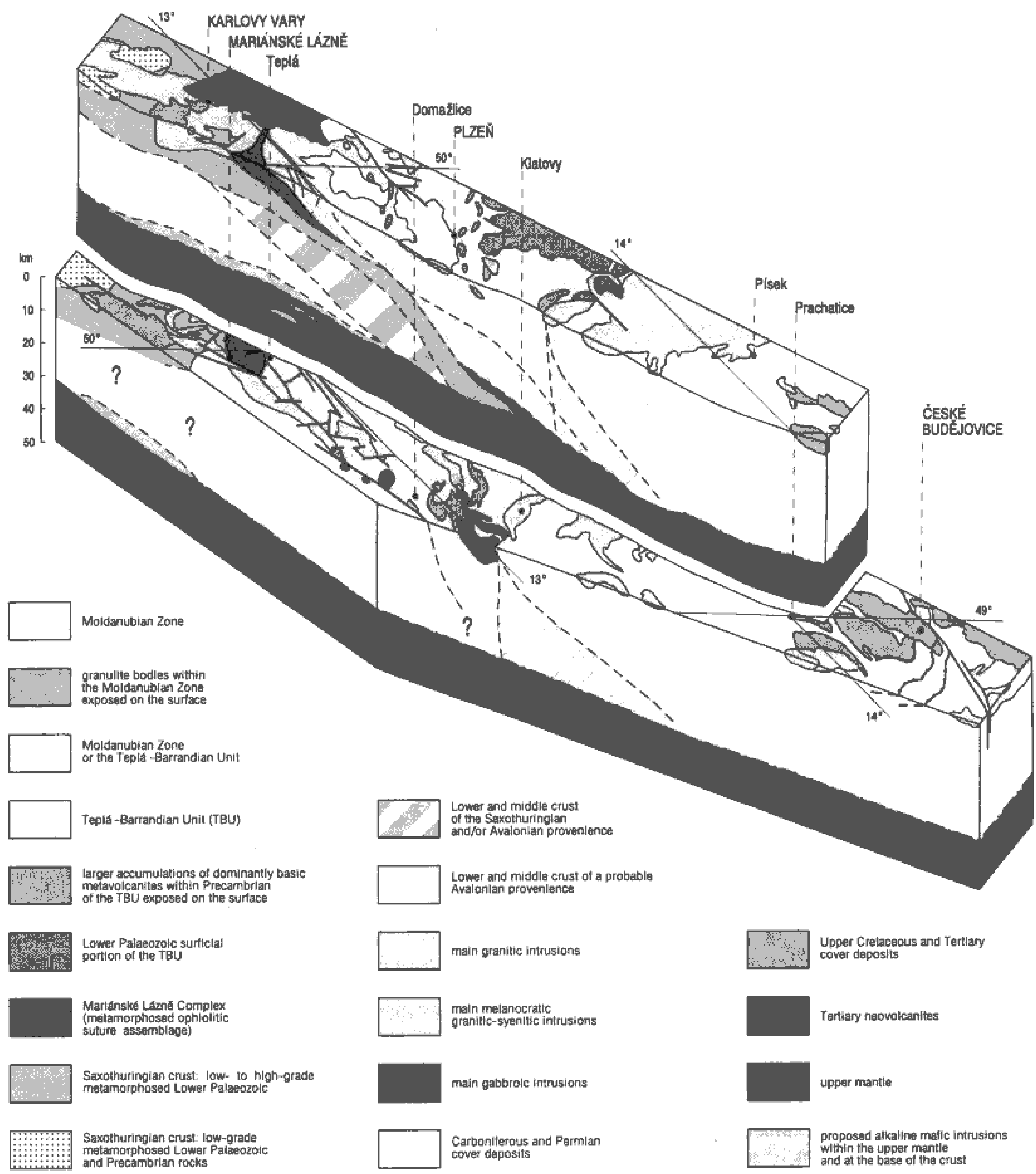
The model profile (Fig. 7) suggests potential gravity transport of uppermost crustal segments from their "Moldanubian homeland" and their translation on laterally adjacent units, caused by the constriction and uplift of the Moldanubian Zone. In addition to such tectonic erosion (of unknown extent), a high-rate surficial erosion of the Earth's crust took place in pre-Westphalian times, as follows from the analysis of Culm in Moravia (Kumpera-Martinec 1995). It is in fact surprising, that comparable sediments do not occur in the TBU, in view of its tendency to conservative isostasy. Alternatively, former presence of such sediments (and some underlying allochthonous units ?) and their pre-Westphalian erosion can be suspected.

The observed and interpreted relations indicate probable absence of a continuous layer of Cadomian crust in a lower crustal level (a kind of westward continuation of the Brunovistulian Zone) beneath the Moldanubian Zone. High-pressure granulites and eclogites, at least in part derived from the subducted plate, were obducted and telescoped together with some upper mantle masses into relatively high crustal levels of the Moldanubian Zone. Also, some exotic allochthonous segments of ancient, pre-Cadomian crust (Světlík orthogneiss, Dobra gneiss) were emplaced into the Moldanubian complex in the course of mass transport on a lithospheric scale. This situation is not compatible with preservation of a more or less continuous Cadomian layer in the lower crust.

A.3. CONSEQUENCES OF LITHOSPHERIC LAMINATION

The petrochemical and isotopic study of upper mantle rocks in several major units of the Bohemian Massif (carried out in various projects) resulted in important information on composition of some source regions in the upper mantle during the Variscan events. Rarely, even pre-Variscan mantle rocks, such as those in the Winklarn Series (von Quadt-Gebauer 1993), were enclosed in the Moldanubian Zone. The study of mantle rock xenoliths in the Tertiary volcanites shows remarkable homogeneity of the essentially lherzolitic population of xenoliths through much of northern Bohemia and northern Moravia (Jakeš-Vokurka 1983, Fediuk 1994). Additional, though indirect, information on mantle composition is provided by isotopic and petrochemical study of the Tertiary (to Quaternary) basaltoid volcanites (Vokurka-Bendl and Hradecký-Shrbený, this volume), which indicates only a mild and long-range variation in composition of mantle sources.

The differences between mantle rocks sampled by the Variscan and Tertiary processes respectively, suggest the principal role of re-equilibration and laminar flow of mantle during the respective time interval. Consequently, the mantle re-equilibration resulted in a cut-off of structures at the base of crust, which were originally continuing into the upper mantle during the Variscan highly orogenic stage. The subducted lithospheric plate or segments, whose former presence is indicated during the Variscan event, espe-



8. Geological model of the crustal and upper mantle structure in western and southwestern Bohemia (based on Tomek et al. and geological and geophysical data in this volume).

cially under the Moldanubian Zone and parts of the Saxothuringian Zone, were removed by a combination of processes including production of granitoid melts (intruded in the upper and middle crust), isostatic re-equilibration of the crust, and possibly by a lithospheric lamination. These aspects are mentioned as it is significant to note the probable extensive obliteration of the Variscan tectonic structures below the Moho discontinuity (including anomalous structural relations of the crust and upper mantle). This situation is indicated by the position of the Moho discontinuity below the Saxothuringian Zone, the Teplá-Barrandian Unit, and the Moldanubian Zone (Tomek et al., this volume, Novotný, this volume). The lithospheric lamination and the extensive erosion of the Variscan belt on the Earth's surface severely limit the information available for the reconstruction of relatively early orogenic setting.

A.4. THE CRUSTAL SECTION OF WESTERN AND SOUTHWESTERN BOHEMIA

The 9HR seismic profile (Tomek et al., this volume), complemented by gravity model profile (Švancara-Chlupáčová, this volume), and the magnetotelluric measurements (Pícha-Hudečková, this volume) in combination with geological information was used for construction of crustal cross section along the Kraslice-Prachatice line (Fig. 8). It shows the main features of the crustal structure as a model interpretation supported by geophysical and geological data. Various aspects of this model and the original data are discussed in a number of chapters in this report.

According to the interpretation of the 9HR reflection seismic profile (Tomek et al., this volume) and data in some other chapters in this report, the TBU and all the geological units occurring more northerly represent a set of high allochthons. Only the SE part of the TBU is preserved in its whole-crustal thickness. The other units, the MLC and the Saxothuringian Zone, rooted under the TBU, are strongly thinned and laminated, forming relatively thin bodies dipping to the SE and tilted to a subhorizontal position only in the upper crust. All these units appear to be underthrust by a seismically strongly laminated Avalonian (or Mid-German Crystalline Rise-type) crust. The 9HR profile, as it is interpreted, features the Variscan orogen in western Bohemia as a typical example of a thick-skinned tectonics.