a permanent and open exchange of opinions and experiences. In order to maintain the flux of information as efficient as possible, joint green desk and field seminars and workshops in a wide field of scientific and applied topics should be stressed. Results of these investigations should be documented in joint publications. As already in the past in many fields, the highest level of basic research should be maintained also in the future in as many topics of cooperation as possible.

The different educational and geopolitical background of the experts of our two Republics should not coincide with a gap of understanding in the future, but should be understood as a challenge to bring together ideas from different points of view. Already in the past, this bridge of ideas between two states of different political understanding was easy to cross by the geological community, as impressively evidenced by thirty years of uninterrupted successful cooperation in an atmosphere of friendship. And in future this bridge could play the role of a catalysator of ideas and hopefully will bring together mental power and scientific capacity from different points of view. The steady competitive improvement of quality of basic scientific research is the only possible serious basis for successful practical work, which is the prerequisite for economic growth and higher standard of life. With this perspective in mind and in the context of the steadily growing importance of geoscientific research all over the world, Austria and Czechoslovakia should intensify their joint efforts in geoscientific cooperation for the benefit of their populations.

Editors' note

The Festive Volume contains 42 original manuscripts and 3 informative reports. The manuscripts were arranged into six thematic sections: (1) structural geology and geophysics, (2) stratigraphy and paleogeography, (3) petroleum geology and geochemistry, mineral deposits, (4) paleontology, (5) magmatism and metamorphism, (6) miscellaneous. In each group the articles were arranged alphabetically according to the names of their authors. The only exception to this rule is the contribution of Thon — Wessely which summarizes the results of cooperation in the research into crude oil and gas and thus was placed as an introductory article of the thematic group devoted to petroleum geology. All manuscripts are written in English with abstracts in German and Czech or Slovak. Only the paper by Aric is in German because it contains large passages in Old German the translation of which in practice would be not adequate.

Several manuscripts have a wider scope covering more fields and thus their assignment into groups is only approximate. The contributions do not cover the cooperation over the whole 30 years; they discuss recent results predominantly from the past ten years. Informative reports which close the Volume, provide a survey of results reached in the given field and have been already published elsewhere.

The names of institutes of individual authors are given in the original form. Their English translation, abbreviation and addresses are published in the appendix of the Volume.

The authors are responsible for the content and language correctness of their publication.

The deadline for presentation of contributions was the end of 1988, the final reviews were accepted by the publishers on March 3, 1989.

Considering the printing technology used the rules of word division could not be strictly observed.

We wish to thank the authors for working out original papers and instructive illustrations. We believe that the volume shows the wide scope of collaboration between Austria and Czechoslovakia and that it will contribute to a more profound knowledge of geology of Central Europe.

NEW FINDINGS ON THE DEEP STRUCTURE OF THE SOUTHEASTERN SLOPES OF THE BOHEMIAN MASSIF ("SOUTHERN SECTION" — NĚMČIČKY BLOCK)

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1. Introduction

Drilling and geophysical operations have revealed new facts on the geological structure and the functions of some significant faults on the southeastern slopes of the Bohemian Massif in the area of the Němčičky blocks, in the inner part of the Nesvačilka depression and on the adjoining slopes of the Ždánice crystalline high. New data have also been obtained on the extension of individual sedimentary complexes of the Variscan and Neoid levels. The studies conducted permit to determine the southwestern margin of the Variscan area of sedimentation preserved on the deep-seated Němčičky blocks and to define the structure of this region near the limits of the Variscan tectogene. NW-SE-striking tectonic elements were determined in the region under study; they step-like divide the whole area between the Waschberg ridge and the Ždánice high into numerous blocks with faults that evidently disturb the Devonian and Lower Carboniferous carbonate complexes. In the early Namurian, subsidence markedly accelerated on the margins of the Němčičky blocks and in the inner parts of the Uhřice blocks on the southwestern slope of the Ždánice high. Within the Němčičky blocks, subsidence accounts for the enormous thickness of the conglomerates (Němčičky — 2 and 5 boreholes) with pebbles from the Moldanubic zone and from the Dyje or the Brno Massifs. The overlying complexes, composed primarily of sandstones of the coal-bearing Namurian-A, have been compared to the Ostrava sequences. The blocks constitute a slightly asymmetric graben (Fig. 1). The directions of the tectonic lines agree, to a certain extent, with those of significant magnetic anomalies in the broader region (Fig. 4). After a hiatus during the Permian, resedimentation took place in Jurassic time (Lias-Malm) and was terminated by the Kurdějov and/or Ernstbrunn Malm limestones. In pre-Paleogene time, the Mesozoic sediments were removed from the major part of the present (Vranovice and Nesvačilka) depressions, leaving only relics there. Paleogene sediments, filling the Nesvačilka and Vranovice depressions, covered the heavily eroded pre-Tertiary relief. After subsequent Miocene sedimentation, delimited by the fronts of the flysch units on the southeast, the outer flysch nappes were finally overthrust. The structures of the nappes incorporated sediments of the underlying autochthonous Paleogene and the Mesozoic Carpathian Foredeep in the form of more or less separated tectonic fragments.

The development of the region studied can be characterized by three stages of basin development commonly known. The least number of data is available on the "pre-graben stage". The principal period of basinal development — the "graben fill basin" — seems to have started in the Upper Carboniferous. The third stage — the "interior sag graben" — can be associated with the period of Paleogene sedimentation.

The paper presented evaluates new data on the geological structure and development of the Variscan areas of sedimentation in the Němčičky and Uhřice blocks on the opposite slope of the Ždánice high. These data were obtained by deep drilling and reflexion seismic techniques. The development of this area in the transverse direction, i. e. perpendicularly to the bordering faults and the courses of young copying structures (the Nesvačilka and Vranovice depressions filled with Paleogene sediments) was also

studied. These depressions, called the Vranovice and Nesvačilka grabens, were the subject of studies by numerous authors, and were evaluated, from other view-points, in a number of papers: V. Homola et al., 1961; F. Němec, 1973; F. Pícha, E. Hanzlíková, J. Cahelová, 1978; F. Pícha, 1979; and R. Jiříček, 1987. Problems related to the Variscan level were treated mainly by J. Dvořák, 1978; J. Hladil, 1983; J. Kalvoda, 1981; and J. Kalvoda, P. Kostelníček, 1981. Questions concerning the geological development were studied, in a more complex way, by geologists of the Moravian Oil Company, Hodonín and of the Central Geological Survey, Prague and Brno, e. g. by V. Špička, 1971; J. Adámek, 1981; P. Kostelníček, V. Ciprys, 1981. Recent studies by Soviet experts (V. I. Chnykin et al., 1986) have also dealt with these problems.

2. Geologic setting

The rock complexes encountered in the region studied belong to three — Cadomian, Variscan and Neoid — levels that were overthrust by the nappes of the outer flysch units of the western Carpathians.

The Cadomian level, composed of granitoid rocks and metamorphites, was encountered on the slopes of the Ždánice crystalline high, in the Vranovice depression filled with Paleogene sediments and in the Nikolčice blocks. Owing to the great thickness of the sediments (more than 5,000 m), the Cadomian level has not yet been reached by drilling in the Němčičky blocks.

The Variscan level (or its sedimentary cycle) begins with diversified and prevailingly coarse-grained clastic sediments in the broader region. Grey-black silty and clayey shales of Middle Devonian to Eifelian age have also been identified in the cores of Němčičky—3 and 6 boreholes (M. Vavrdová, 1987); their thickness has not yet been determined by drilling in the Němčičky blocks. In the Měnín and Nikolčice areas, the thicknesses of the mostly coarse-grained clastic sediments vary, attaining a maximum of more than 1,700 m in Měnín—1 borehole (J. Adámek, 1975). They are smaller by an order of magnitude in the Nikolčice boreholes. This difference appears to be due to the morphology of the basement and to different block subsidence. In the Upper Eifelian, the prevailingly terrigenous Old Red facies was transgressively covered by the Macocha carbonate sequence containing limestones of the Čelechovice cycle. The carbonates of this cycle yielded limestones of the "Býčí skála", Ochoz and Mokrá cycles (J. Hladil, 1983). Carbonate sedimentation was affected by block movements during the Givetian and, more markedly, during the Upper Frasnian and Lower Famennian. Biofacial investigations of Famennian and Lower Carboniferous limestones that terminated carbonate sedimentation, indicated a shallow area of sedimentation in the Němčičky-Nítkovice platform (J. Kalvoda, 1981, J. Kalvoda in J. Kalvoda, P. Kostelníček, 1981). Tuffite layers, characterized by increased values of natural radioactivity (Gamma Ray Log), are the typical, regionally proved correlate for determining the Famennian) Visean boundary. A significant regression related to a marked hiat lasting until the lower part of the Uper Visean occurred in the period between the Devonian and Carboniferous. The sedimentation of the Myslejovice sequence composed of dark shales, locally with limestone intercalations, continued in the upper part of the Upper Visean. The subsidence of the western marginal Němčičky block accelerated in the early Namurian. The blocks were sinking somewhat more slowly in the present Nesvačilka depression. The rapid subsidence is reflected in the thicknesses of the conglomerates found in Němčičky—2 (150 m) and, recently, Němčičky—5 boreholes (more than 1,000 m) that contain pebbles originating in the Moldanubic zone and the Dyje and or Brno Massifs (J. Polický, V. Fialová, 1980; M. Zádrapa, 1988). The prevailingly sandstone-containing complexes of the coal-bearing Namurian-A are situated at a higher level. Their upper parts display cyclic sedimentation with coal seams with predominating continental (fluvial and lacustrine) facies and transitions to marine facies. After a hiatus beginning from the Upper Carboniferous (Namurian-A), the development of the Neoid level started with the Jurassic and the sedimentation of basal prevailingly clastic Jurassic facies (Lias-Dogger) took place (locally with the redeposition with older Upper Carboniferous material — J. Adámek, 1986). These sediments leveled the peneplaned pre-Jurassic relief. This is obvious from the relatively small, not much varying thicknesses of the basal Jurassic clastic sequence (Gresten sandstones and claystones, Nikolčice sandstones and dolomites). The sedimentation of the Klentnice pelitecarbonate sequence indicates the deepening of the area of sedimentation. This is evidenced by the facies development of the base of this sequence, characterized by the decreasing thickness of the Vranovice carbonates and the increasing thickness of the Mikulov marlstones. The upper part of the Mesozoic, consisting of Kurdějov limestones and marlstones in the Němčičky blocks, is indicative of basin stabilization characterized by slight oscillations. Jurassic sedimentation was closed with Ernstbrunn limestones. The relief was repeneplaned in the subsequent period-practically up to Tertiary time. The development of Mesozoic (Jurassic to Upper Cretaceous) sediments in the broader region could be demonstrated, in a more complete range, south of the region described and in Lower Austria (F. Brix, A. Kröll, G. Wessely, 1977; J. Adámek, 1986). In the Nesvačilka depression, most of the Mesozoic sediments were removed, leaving only relicts on the slopes, much like in the Vranovice depression. The heavily eroded pre-Tertiary basement was transgressed by the sea in the Paleogene. Paleogene sediments gradually filled not only both depressions, but also the adjoining uplifted areas between the depressions (Němčičky area — Němčičky 5 and 6 boreholes) and the area south of the Vranovice depression. Their present extent is much smaller as a result of subsequent denudation and tectonic abrasion by the nappes. The Miocene sediments (Eggenburgian-Karpatian) that are confined to the Nikolčice blocks were substantially affected by tectonic abrasion coupled with faulting tectonics. This fact is evidenced by their fragments incorporated into the fronts of the flysch nappes (I. Zapletalová, 1975). Miocene sediments are absent farther southeast, that means in the area of the Němčičky blocks. Paleogene and Jurassic sediments were also integrated into the structures of the nappes.

The interrelations in the development of blocks following the NW-SE course of the Jurassic Nikolčice-Kurdějov ridge have been described already (J. Adámek, J. Dvořák, J. Kalvoda, 1980), but no adequate data were available, at that time, that would allow to divide the region perpendicularly to the two depressed areas filled with Paleogene sediments. New findings from recently drilled wells and reinterpretations of older wells and geophysical (mainly reflexion seismic) measurements permit to evaluate the development of the Variscan and Neoid levels and the nature of the southwestern contact between the Variscan and Cadomian levels. The region described includes places where the Paleozoic (Devonian — Upper Carboniferous) sedimentary cover has been preserved. Jurassic sediments have been preserved, to a varying extent, on both margins of the cover, i. e. in the Nikolčice-Němčičky area on the one side, and in the Ždánice-Uhřice area on the other side. Due to the inverted development of the individual blocks and subsequent erosion, the geological structure of the pre-Tertiary basement is rather complex in this region. In addition to Jurassic sediments, it comprises also those of the Variscan level and even crystalline rocks of the Cadomian level. Their major parts are covered with autochthonous Paleogene rocks. The autochthonous formations are overthrust by nappes of the West Carpathian flysch belt (Fig. 1). The structure of the Variscan level bears the character of an asymmetric graben trough bounded by faults, markedly

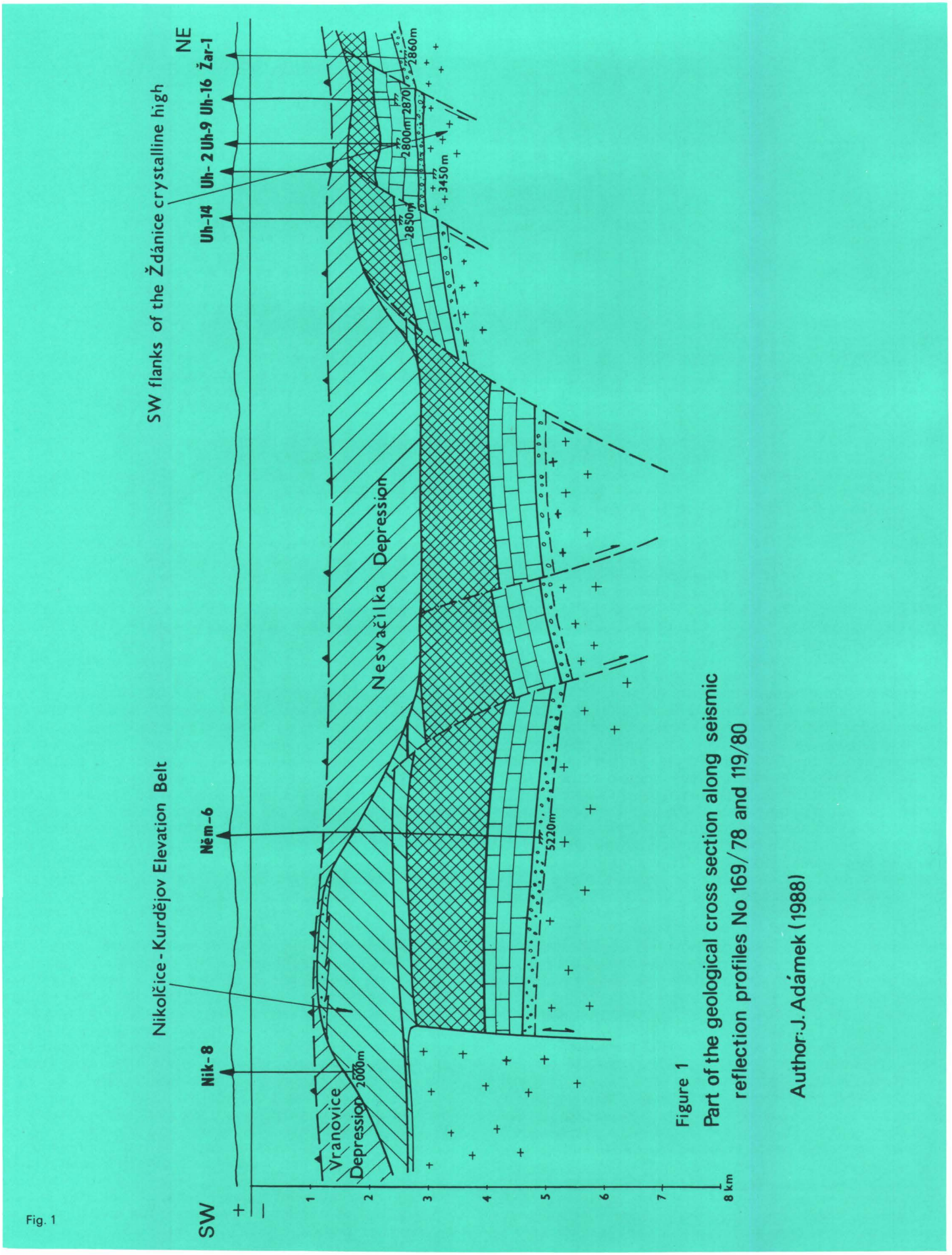
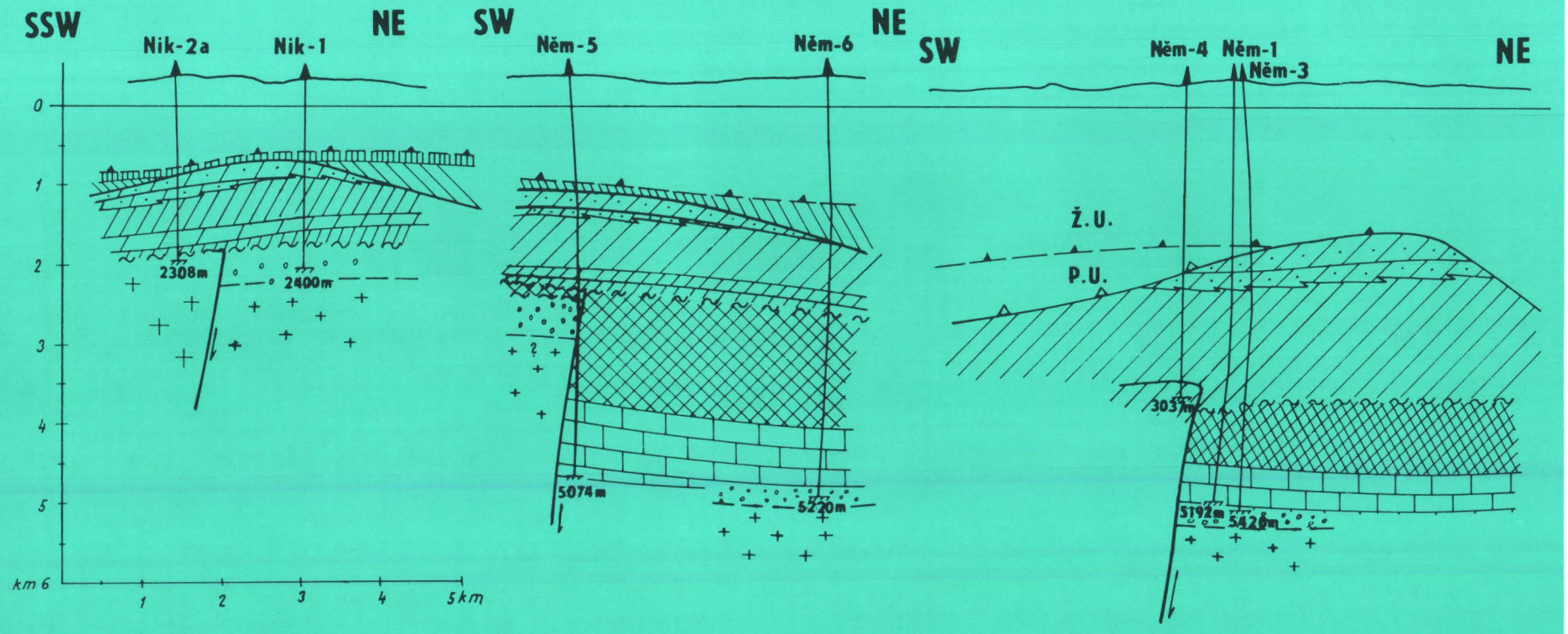


Figure 1
Part of the geological cross section along seismic reflection profiles No 169/78 and 119/80

Author: J. Adámek (1988)

Fig. 1

Fig. 2



A. Geological cross section through Nikolčice - 2a and Nikolčice - 1 boreholes

B. Geological cross section through Němčičky-5 and Němčičky-6 boreholes

C. Part of the geological cross section along seismic reflection profile No 168/74

EXPLANATION FOR FIGURE NO. 1 AND 2

- Well
- Ždánice unit
- Pouzdřany unit
- Autochthonous Miocene
- Paleogene
- Jurassic with basal parts
- Carboniferous
- Paleozoic limestone
- Basement of Bohemian Massif (crystalline) and Devonian clastics

deepened, with almost completely preserved sequences of the higher parts of the Variscan level (Upper Carboniferous — Namurian-A) in the southwestern part of the region (Němčičky blocks). As a result of inversion and erosion, the thicknesses of the Upper Carboniferous sediments decrease towards the northeast along the step-like faults. On the southwestern slope of the Ždánice crystalline high, the Paleozoic rocks are covered with Jurassic sediments, or the latter rest immediately on the Cadomian basement. Farther northeast (on the Ždánice high), the Cadomian level forms the pre-Tertiary relief. The Variscan level is covered with thick Jurassic sediments in the area of the Němčičky and Nikolčice blocks. The tectonic character of the southwestern boundary of the Paleozoic sediments is evedenced by three profiles (Fig. 2). The whole structure, however, is much more complex; the tectonic recurrence of carbonate sequences, e. g. in Němčičky—1 borehole, can be explained by the effects of a disturbance zone with nearly vertical faults. The primary spatial distribution of the Variscan level was substantially larger (e. g. Nikolčice—5 borehole with clastics of the Old Red facies, occurrence of Frasnian carbonate pebbles in the Upper Carboniferous complex in Němčičky—5 borehole — J. Kalvoda, personal communication). All the above indicates that, in the Devonian, the extent of the carbonate platform was larger than it is at the present time. In the uplifted blocks, platform carbonates have been preserved as denudation remnants only in downdip intermediate blocks. Lithostratigraphic correlations of the top of the carbonate complex (Famennian — Visean) suggest that their epigenetic disturbance most likely occurred during a pronounced subsidence in the lower part of the Upper Carboniferous (Namurian-A), mainly at the southwestern margin of the Němčičky blocks (as opposed to the Cadomian level) and on the slopes of the Ždánice crystalline high (Figs. 1 to 3). At that time, subsidence was isostatically compensated by the uplifting of blocks situated beyond the present principal Upper Carboniferous area of sedimentation. During the sedimentation of the top parts of the Upper Carboniferous, the Němčičky block area appears to have been tectonically more active than the slopes of the Ždánice high. After the sedimentation of the Upper Carboniferous had terminated, the area was peneplaned and the basal clastic Jurassic sequence was deposited after a long-lasting hiatus. Tectonic activity apparently reappeared only during the sedimentation of the pelitic part of the Klentnice sequence. As a result, the thicknesses of the pelites and the pelite-carbonate cycle increased and the base of the latter changed in facies. The uper parts of the Jurassic sedimentary cycle were denuded, in part, probably owing to an inversion on the slopes of the Ždánice high. In the region under study, Jurassic sediments have been preserved practically only on the incised blocks.

3. Conclusions

The investigations conducted in the area of interest have yielded new facts on the Paleozoic, Mesozoic and Paleogene lithostratigraphic complexes present in the Nesvačilka depression. The development of the region permits two evolutional stages to be determined: the main "graben fill basin" stage active in the Lower Carboniferous and the "interior sag graben" stage in the Paleogene. The age of the "pre-graben stage" cannot be determined because of lacking data. On the basis of the development of the region, the principal unconformities were identified on which suitable reservoir rocks could have formed in the periods between the Upper Carboniferous and Jurassic (Lias-Dogger) and between the Mesozoic (Tithonian) and Tertiary (Paleogene). Oil-bearing capacity can be attributed to the clastic sediments of the Upper Carboniferous covered, deep below the nappes, with Jurassic marlstones (Mikulov marlstones). In the shallower part of the region, the upper levels of the Upper Carboniferous are connected with clastic facies at the base of Jurassic sedimentation. Oil traps can be formed in clastic sequences of the overlying Jurassic sediments or at the base of Jurassic pelite-carbonate layers (Vranovice carbonates). The period between the Mesozoic and Tertiary is more suitable with respect to the formation of reservoir rocks, mainly in the old Tertiary (Paleogene) basin fill. The regionally distributed facies of the underlying Mesozoic in the deeper parts of the Jurassic area of sedimentation (generally facies of a more pronounced pelitic nature) are less suited to form oil traps. Oil and gas deposits on the slopes of the Ždánice high are associated with the Paleogene basin fill (sandy facies). Of less importance are the carbonate layers (Visean) and the Famennian pure limestones layers. The carbonate facies are sealed, at the top, by Upper Visean shales of the Myslejovice sequence. In the Uhřice area, oil traps are present in these carbonates, the distribution of the traps being closely related to the lithological development of the carbonates. In addition to the factors mentioned above, tectonic development is of decisive importance to the formation of oil and gas traps.

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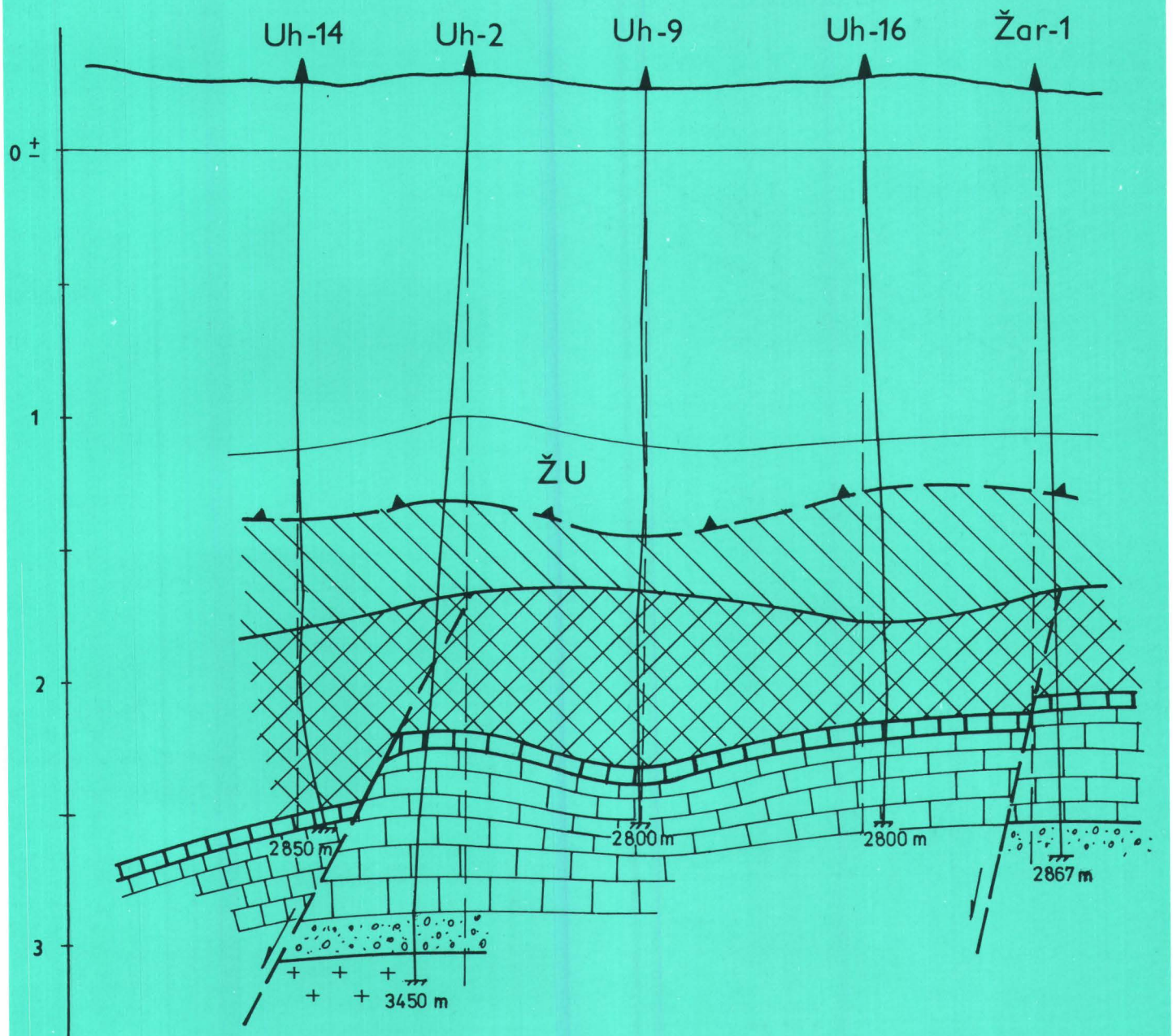

GEOLOGICAL CROSS SECTION THROUGH
UHŘICE-14,2,9,16 AND ŽAROŠICE-1 BOREHOLES

(CORRELATION OF PALEOZOIC SEDIMENTS)

Lower Carboniferous
Visean (Limestones)

Devonian
Givetian - Famennian (Limestones)

Fig. 3

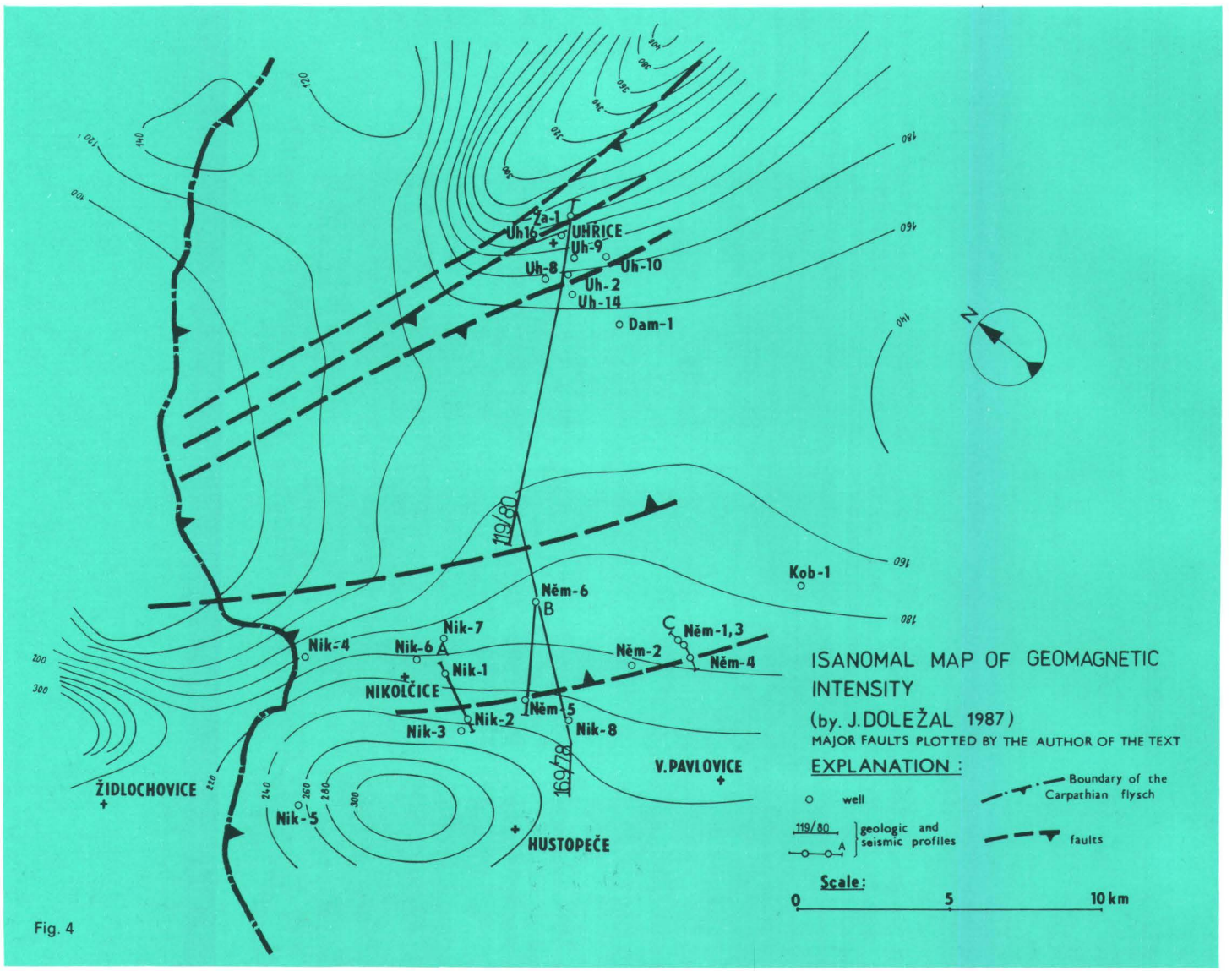

Fig. 4

Abstrakt

Na jv. svazích Českého masívu, v prostoru němčičských ker, stejně jako v interní části nesvačilské deprese a na přiléhajících svazích ždánické krystalinické elevace, byly vrtními a geofyzikálními pracemi zjištěny nové poznatky o geologické stavbě a o funkci zlomů SZ—JV průběhu. Zlomy člení stupňovitě celý prostor mezi waschberskou krou a ždánickou elevací na řadu ker a porušují evidentně karbonátové komplexy devonu a sp. karbonu. Na základě širšího zpracování je také možno vymezit jz. okraj zachovaného variského sedimentačního prostoru a určit stavební styl této pro variský tektogén okrajové oblasti. Kry tvoří mírně asymetrický příkop a směry tektonických linií jsou přitom v jistém souladu se směry významných magnetických anomálií. Vývoj tohoto studovaného prostoru je možno charakterizovat třemi známými etapami vývoje pánví, přičemž o stadiu tzv. „pregrabenu" máme nejméně údajů. Hlavní období vývoje pánve, tj. během výrazné funkce zlomů („graben fill basin"), začalo nejspíše ve spodní části svrchního karbonu a třetí stadium, vázané na období sedimentace po ukončení výrazné zlomové činnosti („interior sag graben"), je možno vázat na paleogenní cyklus.

Zusammenfassung

An SO-Hängen der Böhmischen Masse, im Raum der Němčičky-Schollen sowie im inneren Teil der Nesvačilka-Mulde, und an anliegenden Hängen der Ždánice-Kristallinerhebung sind durch geophysikalische und Bohrarbeiten neue Erkenntnisse vom geologischen Bau und von der Funktion der von NW nach SO streichenden Brüche erworben worden. Durch diese Brüche wird der ganze Raum zwischen der Waschberg-Scholle und der Ždánice-Erhebung in mehrere Schollen aufgeteilt und die Karbonatkomplexe des Devons und Unterkarbons offensichtlich gestört. Aufgrund einer weiteren Auswertung der Forschungsergebnisse kann auch der SW-Rand des erhaltenen variszischen Sedimentationsraums abgegrenzt und der Baustil dieses Randgebiets des variszischen Tektogens bestimmt werden. Die Schollen bilden einen mäßig asymmetrischen Graben, wobei die Streichrichtungen der tektonischen Linien in gewissem Einklang mit den Richtungen bedeutsamer magnetischer Anomalien stehen. Die Entwicklung des Untersuchungsgebiets kann durch drei bekannte Beckenentwicklungsetappen charakterisiert werden, wobei uns die wenigsten Angaben über das Stadium des sog. „Prägrabens" zur Verfügung stehen. Die Hauptperiode der Beckenentwicklung, d. h. die Periode von ausgeprägter Funktion der Brüche („graben fill basin"), begann höchstwahrscheinlich im unteren Teil des Oberkarbons, und das dritte Stadium, das an die Sedimentationsperiode nach dem Abschluß ausgeprägter bruchtektonischer Vorgänge gebunden ist („interior sag graben"), kann mit dem paläogenen Zyklus in Zusammenhang gebracht werden.