

**Abstrakt**

Geneze ropy a zemního plynu v terciálních sedimentech čs. části vídeňské pánve je řešena na základě studia úrovně katagenní přeměny rozptýlené organické substance a chemického složení těžných rop. Jsou konfrontovány výsledky výzkumu těmito metodami. Úroveň katagenní metamorfózy organické substance uvažovaných matečných hornin odpovídá ropnému oknu v hl. cca 3 – 6 km. Organická hmota je převážně III., v menším množství i II. genetického typu. Těžené ropy mají různorodé složení, vázané na jednotlivá stratigrafická souvrství; velmi lehké ropy parafinického, resp. parafinicko-naftenického typu jsou vázány na sedimenty badenu a paleogenní sedimenty magurského flyše, velmi těžké ropy naftenického charakteru na sarmat a ropy lehké až těžké, smíšeného parafinicko-naftenického a naftenicko-parafinického typu se vyskytují v karpátu a eggenburgu až ottnangu. V ploše jednotlivých souvrství je zřejmá závislost chemického složení rop na tektonické příslušnosti hornin. Termodynamika konverze kerogénu matečných hornin a sekundární diferenciacie chemismu rop objasňuje přijatelným způsobem genezi ropných uhlovodíků v terciální výplni pánve; předpoklad však zpochybňuje úroveň katagenní metamorfózy organické substance, kterou je třeba klást do podložních sérií, pravděpodobně do jury. Objasnění geneze přírodních uhlovodíků je třeba věnovat nadále patřičnou pozornost.

**Zusammenfassung**

Die Frage der Erdöl- und Erdgasgenese in tertiären Sedimenten des tschechoslowakischen Teils des Wiener Beckens wird aufgrund der Untersuchung des Niveaus der katagenen Umwandlung verstreuter organischer Substanz und der chemischen Zusammensetzung des geförderten Erdöls gelöst. Im vorliegenden Beitrag werden Ergebnisse dieser Untersuchungsmethoden einander gegenübergestellt. Das Niveau der katagenen Metamorphose der organischen Substanz in betreffenden Muttergesteinen entspricht dem Erdölfenster in einer Tiefe von 3 bis 6 km. Die organische Substanz ist vornehmlich von III., in einer kleineren Menge auch von II. genetischem Typ. Das geförderte Erdöl weist eine verschiedenartige Zusammensetzung auf, die an einzelne stratigraphische Formationen gebunden ist; sehr leichte Erdölarten mit Paraffin- bzw. Paraffin- bis Naphthenbasis sind an die Baden- und Paläogensedimente des Magura-Flysches, sehr schwere naphthenbasierte Erdölarten an das Sarmat gebunden, und schließlich leichte bis schwere Erdölarten von gemischtem paraffin-naphthen- bzw. naphthen-paraffinbasischem Typ kommen im Karpát und Eggenburg-Ottang vor. In der Flächenausdehnung einzelner Schichtenfolgen kommt eine Abhängigkeit der chemischen Erdölzusammensetzung von der tektonischen Zugehörigkeit der Gesteine zum Vorschein. Durch die Thermodynamik der Kerogenumwandlung in Muttergesteinen und die sekundäre Differentiation des Erdölchemismus wird die Geneze der Erdölkohlenwasserstoffe in der tertiären Beckenfüllung auf eine annehmbare Weise gedeutet; die Annahme wird allerdings durch das Niveau der katagenen Metamorphose der organischen Substanz fraglich, das in unterlagernden Serien, wahrscheinlich in den Jura, zu stellen ist. Der Frage der Geneze natürlicher Kohlenwasserstoffe soll auch weiterhin besondere Aufmerksamkeit zugewendet werden.

**OCCURRENCES OF NATURAL HYDROCARBONS AT THE VARISCAN LEVEL OF THE CENTRAL AND ADJACENT SOUTHERN PARTS OF SOUTHEASTERN SLOPES OF THE BOHEMIAN MASSIF**

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For many years now, the Moravian Oil Company has been prospecting for natural hydrocarbons at increasing depths and under increasingly complicated geological conditions. The exploration programme also includes deep boreholes on the southeastern slopes of the Bohemian Massif, the purpose of which is to investigate the Variscan platform and its sedimentary mantle. These boreholes have recently discovered many deposits, some of them accumulated in Paleozoic sediments of the platform mantle.

The basement of the area of interest is composed of plutonites and metamorphosed sedimentary series. The Cadomian-consolidated basement is overlain by a Variscan platform mantle represented by Paleozoic rocks. As to younger formations, Mesozoic and Paleogene rocks are known to occur especially in the southern part of the area. The northwestern part is occupied by the Carpathian Front Foredeep. Most of the area has been covered by flysch nappes of the Outer Carpathians.

Paleozoic sediments have been confirmed by boreholes especially on the high block of the longitudinal step parallel to the Carpathians, which is manifested very significantly in the central part of the slopes. According to the lateral classification of the Variscan Level, the area comprises the eastern edge of the Moravian Karst, Drahaný Highland and Šlapanice Blocks (J. Dvořák 1978). The deeply submerged parts of the platform in the central section have not been verified, as the surface of autochthonous sediments is situated at depths from 4,000 to 5,000 metres there. Fairly high preserved thicknesses of Paleozoic rocks have been confirmed in sunken blocks perpendicular to the Carpathians, especially those of Nesvačilka, Měnin and Němčičky (J. Adámek, J. Dvořák, J. Kalvoda, 1980, J. Adámek — manuscript), where they constitute significant transversal elements of post-sedimentary tectonics.

**Stratigraphic and lithologic development**

The peneplained, highly complex relief composed of crystalline rocks is overlain by a basal clastic sequence of the Old Red facies (Eifelian-Givetian). It is represented by variegated terrestrial clastic sediments, in younger parts intercalated by variegated pelites. Its lithological development is relatively uniform, the thickness very variable, ranging from 10 to 1,700 m.

The sedimentary cycle continues by a carbonate facies during the Frasnian to Upper Fammenian, with local partial hiatuses. The transition between the basal clastics and pure carbonates is represented by reef dolomites and dolomitic limestones containing a terrestrial component (Eifelian — Givetian). A marine transgression during the Lower Frasnian is characterized by grey, massive, micritic and biomicritic limestones. Since the Upper Frasnian, the sea has been getting shallower, the process being associated with the deposition of light-coloured, sand- and clay-containing limestones, often with layers of clastics indicating an extensive sea regression. Between the Upper Fammenian and the Middle Viséan, there is a stratigraphic hiatus in most of the area, especially in deeper parts of the platform. A new transgression takes place from the Middle till Upper Viséan, manifested mainly by a carbonate facies, sometimes alternating with a Culm facies, sometimes the two facies laterally substituting each other. The carbonate facies

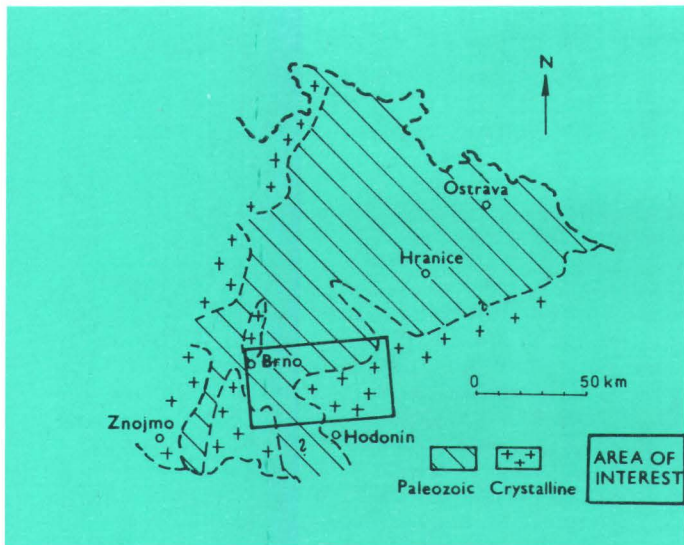


Fig. 1: Area of interest.

thickness is varied, from a few tens of metres to 1,800 m in Svábenice — 1 borehole and up to 1,200 m in the Nesvačilka Block (Těšany — 1 borehole).

The Viséan clayey-carbonatic facies passes over into a typical Lower Carboniferous culm facies (or even into Upper Carboniferous/Namurian A unit characterized by alternating clayey shales and subgraywackes). The highest thicknesses in excess of 1,700 m are in the western part of the Nesvačilka Block (Újezd — 1 borehole); Upper Carboniferous productive rocks (Namurian A) are known to occur in the central part of slopes of the Nesvačilka Block (420 metres in Dambořice — 1 borehole) and especially in the Němčíčky Blocks (over 1,000 m).

**Occurrences of natural hydrocarbons in the different stratigraphic-lithologic levels**

Exploratory works focused on Paleozoic sediments proceeded from the northwest to the southeast in Czechoslovakia, i.e. from the shallow part of the platform into the deeper one. Boreholes in the shallow part sometimes encountered fairly thick Paleozoic sequences and were interesting from the viewpoint of areal and regional geology, but negative with respect to occurrences of natural hydrocarbons. As a rule, only weak- to medium-mineralized water with a low content of dissolved hydrocarbon gases was obtained from these boreholes. Favourable results increased as the exploration proceeded to deeper parts of the platform.

Owing to very variable, rather very poor hydrogen-accumulating properties, the Devonian basal clastics have always been regarded unpromising in terms of potential hydrocarbon occurrences. It is true that Ježov — 2, Koryčany — 3 and Žarošice — 2 boreholes have found surprisingly good hydrocarbon-accumulation properties of sandstones and conglomerates, but, generally, the remaining boreholes yielded only water with dissolved gaseous hydrocarbons, Těšany — 1 borehole giving gas-saturated, oil-type brines from fissure-type reservoir rocks. The first important occurrence of natural hydrocarbons was found on the hillside of the Ždánice elevation, by Uhřice — 6 borehole, in the upper part of the basal clastics. Despite difficult hydrocarbon-accumulating conditions of the sandstones, an inflow of gaseous hydrocarbons in an amount of 17,200 Nm<sup>3</sup>/24 hours, with a small amount of heavy paraffin-naphtenic crude was obtained. The gas is methane, containing no higher gaseous hydrocarbons. The first economically important result was arrived at in the area of the Ždánice — West deposit (J. Krejčí, J. Brzobohatý, 1984). Ždánice — 14

and Ždánice — 55 boreholes have confirmed an accumulation of gaseous hydrocarbons in the Devonian basal clastics the thickness of which is 36 to 69 metres there. According to laboratory analyses, the rocks are classified as impermeable, their primary porosities ranging from 0.8 to 4.5%. Secondary porosity plays a key role there. The potential production, Q<sub>pot. abs.</sub>, of Ždánice — 55 was measured at 27,000 Nm<sup>3</sup>/24 hours, that of Ždánice — 14 equals 20,000 Nm<sup>3</sup>/24 hours. After treating the reservoir rocks with acid, the production increased five times. As to Ždánice — 54 borehole, a hydrodynamic connection of heavily faulted, disintegrating basal clastics and the weathered surface of the crystalline rocks is assumed. Oil is accumulated in crystalline rocks while gas caps are likely to be associated with the Devonian sandstones. The productive zone thickness and economic parameters have not hitherto been verified.

Favourable conditions with respect to the formation and preservation of accumulations of natural hydrocarbons have also been proved in the carbonate Paleozoic sequence. Carbonates affected by epigenetic processes, especially by dolomitization, are best in this regard. Suitable reservoir rocks in the Givetian dolomites, significant oil impregnations along fissures and inflows of gas-saturated water have been found in many boreholes. Těšany — 1 borehole has encountered oiltype brines. In the area of the Měnin Block (Měnin — 1 borehole), a non-industrial inflow of viscous and oxidized oil is associated with Lower Frasnian, karstified and cavernous limestones situated at depths from 50 to 80 metres. During the 70s, the so far only deposit in the bedrock of the Carpathian Foredeep, Nitkovice — Hradisko, was discovered. The initial geological reserves of the deposit were estimated at 121.8 mill. Nm<sup>3</sup> of gaseous hydrocarbons (A. Petr 1983). The local gas accumulation is associated with a hemispherical structure of karstified limestones and dolomites of the Upper Devonian age (Frasnian — Fammenian) occurring at depths from 800 to 880 m, which represent a mixed-type reservoir rock. The gas-bearing zone thickness is up to 79 m. The reservoir pressure is subhydrostatic, its temperature 32°. The gas is methane (85.8% of volume), with traces of higher hydrocarbons and an increased content of nitrogen. Until now, the total production of the deposit has been 80 mill. Nm<sup>3</sup> of gas.

Last year, an interesting result was obtained in the area of the Ždánice crystalline elevation. Letošov — 2 borehole encountered a 220 m thick sequence of Devonian carbonates (Eifelian — Givetian — Lower Frasnian), so far unknown in the region. An interval of 14 metres in the upper part of the carbonates, at a depth of 930 m, was first treated by acid. Crude oil flowed out spontaneously from the borehole at intervals. Lithologically, the reservoir rocks are dolomitized, originally biomicritic Frasnian limestones, hydrodynamically communicating with overlying Miocene sediments. Apart from primary porosity, which is up to 7.1% in this area, secondary fissure-type porosity is also important. The crude oil extracted from the borehole is heavy, paraffin-naphtenic, of a kerosene-oil character.

The first economically important inflow of natural hydrocarbons from Paleozoic sediments in Czechoslovakia was encountered by Němčíčky — 1 borehole, in the area of the Němčíčky Block, at a depth of 5,100 metres. The local gaseous condensate deposit is associated with epigenetically dolomitized, Frasnian — Famennian micritic limestones. The limestones are classified as impermeable, their maximum primary porosity being 6.6%. However, evaluations of logging measurements suggest total effective porosities up to 10%, which mainly result from fissures. The gas is methane, containing higher hydrocarbons. Light oil fractions (gasoline) extracted together with the gas contain paraffins and asphaltico-bituminous substances. The results suggest that there may be a contact with an oil-bearing zone. The deposit pressure is equal to hydrostatic. Extraction parameters were not obtained due to the poor technical condition of the borehole and the presence of underlying water beds. Owing to a collapse of casing, subsequent works

were not possible. Additional boreholes in the area of Němčičky have not allowed for resolving the economic importance of the deposit and the problem still remains open.

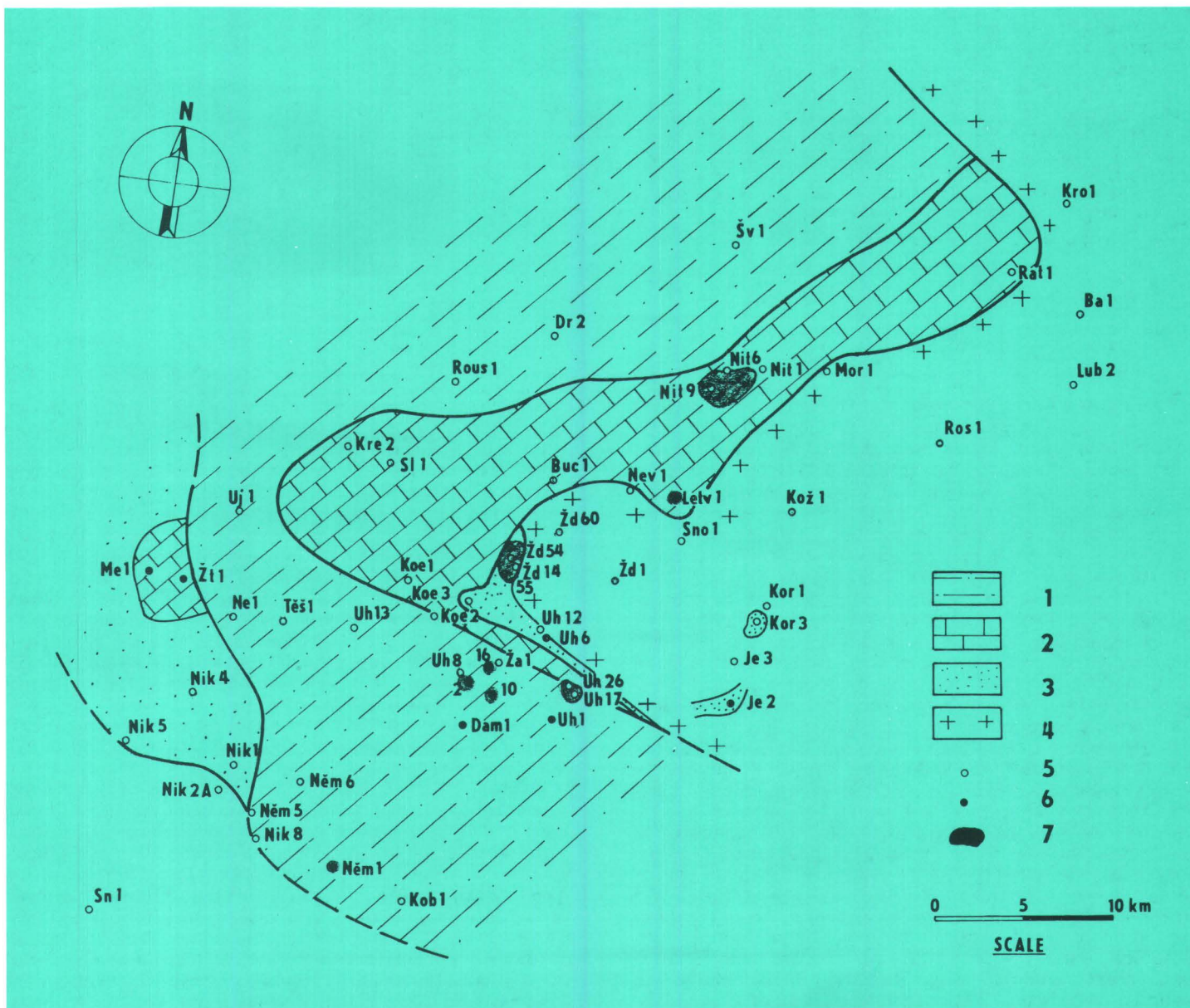
For more than ten years, exploratory works have been going on under very difficult geological conditions on the northwestern slope of the Nesvačilka depression. Their result is a discovery of oil and natural gas deposits associated with the Paleogene filling of the depression and Paleozoic carbonates. The first local borehole, Uhřice — 2, encountered an accumulation of gaseous hydrocarbons and crude oil at a depth of 2,500 metres, in the upper part of Viséan micritic limestones. The primary porosity of the limestones is very low, the key role being played by secondary disturbances. Hydrodynamic tests resulted in an estimated permeability of 228 mD. A pumping test indicated a spontaneous inflow of a crude oil/natural gas mixture. The natural gas: oil ratio averaged 5,000 m<sup>3</sup> off gas to 1 m<sup>3</sup> of oil. The calcu-

lated actual gas production,  $Q_{pot.act.}$ , is 835,000 Nm<sup>3</sup>/24 hours. The oil is very light, of a paraffin character, kerosene-like. The gas is methane, with a high content of higher hydrocarbons, the initial deposit pressure being by 5% higher than the hydrostatic one. The borehole is now being conserved. The edge of the same deposit was encountered by Uhřice — 8 borehole, where a non-industrial inflow of crude oil and gas from Viséan limestones was obtained. Economic accumulations of gases occurring here are associated mainly with clastics dating back to Paleogene.

The western part of the Uhřice deposit also comprises oil accumulations of Uhřice — 16 and Uhřice — 10 boreholes. The surface of heavily tectonically faulted Viséan, massive, organodetritic limestones was encountered in a higher position in Uhřice — 16 borehole than in Uhřice — 2 borehole. The former borehole produced a weak inflow of light, paraffine character and kerosene-like oil. Intensification works

Fig. 2: Sketch of the top of Paleozoic on SE slopes of the Bohemian Massif

- 1 Carboniferous
- 2 Devonian — Lower Carboniferous
- 3 Devonian — Old Red
- 4 Crystalline Basement
- 5 wells
- 6 wells with hydrocarbon shows
- 7 Paleozoic oil and gas fields.



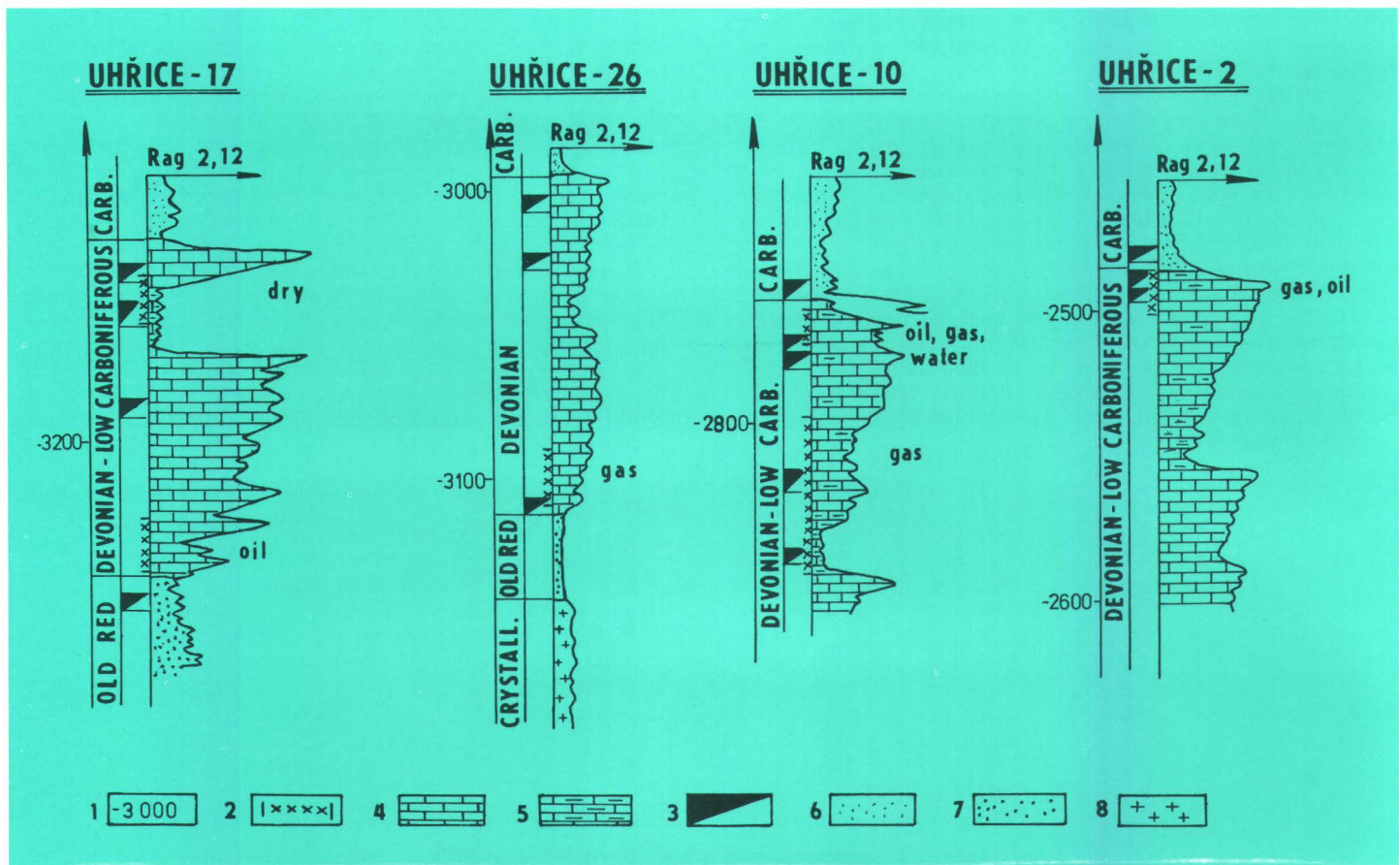


Fig. 3: Comparison resistivity logs in some Uhřice wells

- 1 depth
- 2 test
- 3 cores
- 4 limestones
- 5 argillaceous limestones
- 6 carboniferous sandstones
- 7 Old Red sandstones
- 8 Crystalline rocks

will be carried out at the borehole. The latter borehole has confirmed a separate crude oil accumulation, situated (structurally) much lower than that of Uhřice — 2. At a depth of 2,770 metres, the upper part of Upper Viséan bi-micritic limestones yielded spontaneous, though irregular, inflows of crude oil containing some 5% to 10% of water. Hydrocarbon-accumulation properties, both primary and secondary, are characterized as very poor. The deposit pressure and temperature at 2,761 m are 31.8 MPa and 81°C, respectively. The oil is light, of a paraffin-oil character, with a high content of solid paraffin and a high point of congelation. The borehole is presently being conserved. The results achieved in the western part of Uhřice have confirmed the existence of partial hydrodynamically closed deposits associated with the same stratigraphic-lithologic complex at different levels.

In the eastern part of the Uhřice area, Uhřice — 17 borehole has succeeded in discovering a deposit of oil representing the hitherto deepest economic accumulation of oil in the Czechoslovak territory. Its gas part has been verified by Uhřice — 26 borehole. According to current knowledge, the minimum productive zone thickness is 200 metres. The deposit is associated with the lower part of Devonian carbonates, heavily dolomitized limestones or dolomites of the Lower Frasnian or Upper Givetian age. In terms of their hydrocarbon-accumulating properties, the dolomites are classified as unfavourable, both by laboratory tests and logging measurements. Consequently, intensification is planned. At Uhřice — 17 borehole, a spontaneous inflow of

gas-saturated oil was encountered at 3,230 metres, the initial flow rate being 50 to 60 m<sup>3</sup> of oil /24 hours. The gas: oil ratio is 50 to 200 m<sup>3</sup> of natural gas per 1 m<sup>3</sup> of oil, the deposit pressure is 2.5% higher than the hydrostatic one. Chemical analyses indicate that the oil is light, paraffin-kerosene, with a high content of gasoline fractions. The borehole is presently being conserved. Uhřice — 26 borehole achieved a low inflow of gas with gasoline traces from a depth of 3,100 m, the calculated potential production of which, was 60,000 m<sup>3</sup>/24 hours. After intensification works, the inflow increased several times. At the moment, only indicative exploitation parameters are known. It is planned that production (using a ø 9 mm nozzle) should be approximately 75,600 m<sup>3</sup>/24 hours. The deposit pressure corresponds to the hydrostatic one. The gas is methane (over 90% of volume), with a certain amount of higher hydrocarbons. The boreholes will be used for production on a pilot scale.

Apart from the economic accumulations of natural hydrocarbons, much information has been obtained in the area of Uhřice on their potential occurrences. Uhřice — 1 and Dambořice — 1 boreholes in deeper parts of the Nesvačilka depression have found non-industrial inflows of dry gaseous hydrocarbons from Devonian limestones. Their hydrocarbon-accumulating properties have not been improved even by intensification measures. With respect to potential occurrences of promising hydrocarbon accumulations, it is not possible to rule out the clastic development of Lower and Upper Carboniferous rocks. The most signifi-

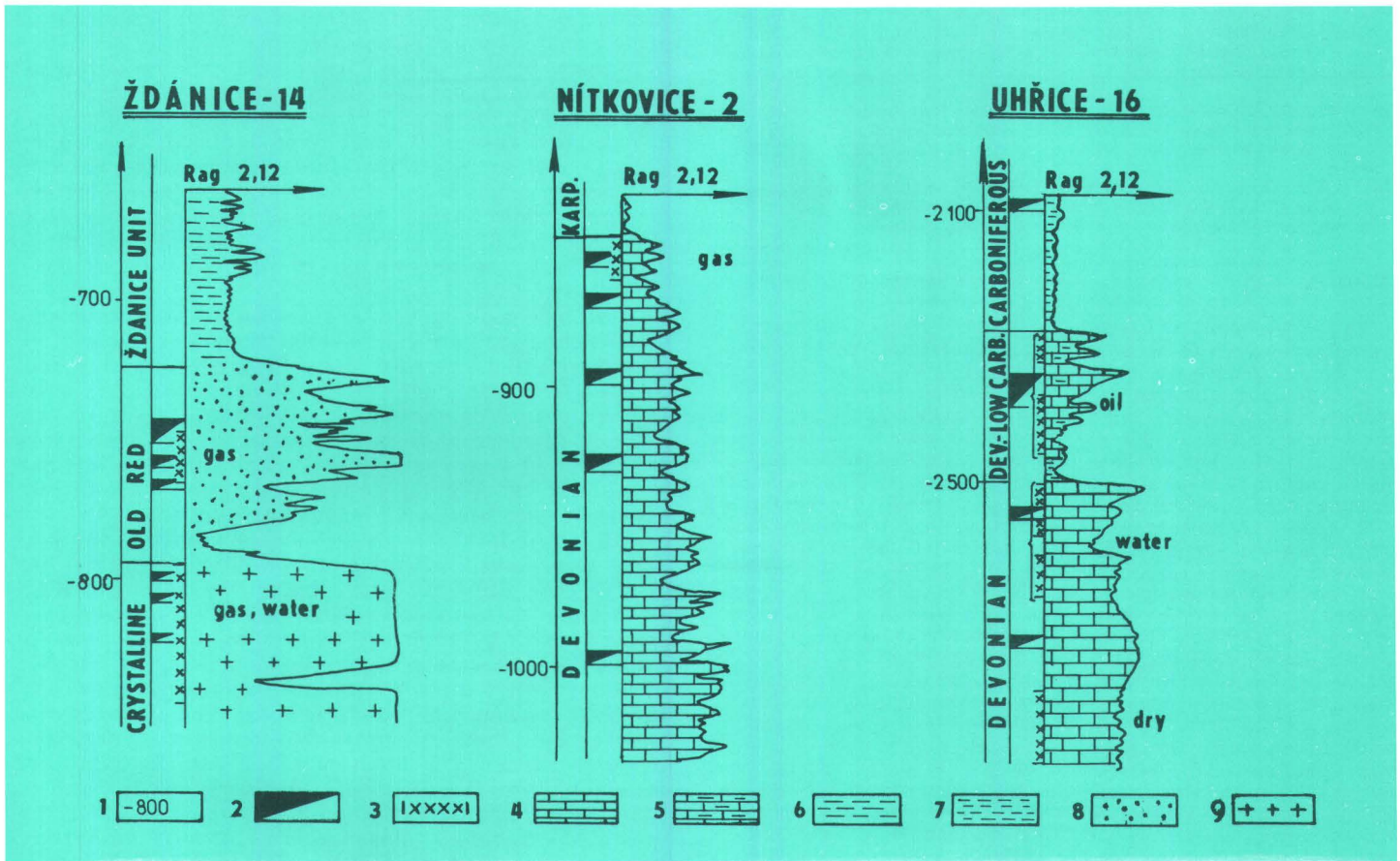


Fig. 4: Comparison resistivity logs in Ždánice, Nitkovic, Uhřice wells  
 1 depth  
 2 cores  
 3 test  
 4 limestones  
 5 argillaceous limestones  
 6 mudstones of Ždánice unit  
 7 carboniferous clayey shales  
 8 Old red sandstones  
 9 Crystalline rocks

cant result has been achieved in the area of the Nesvačilka depression by Uhřice — 9 borehole. Inflows of deposit water containing crude oil and gaseous hydrocarbons and of gaseous hydrocarbons with water (the measured flow rate is approx. 1,000 m<sup>3</sup> of gas/24 hours) have been drawn from porous subgraywackes. However, even this formation displays very variable hydrocarbon-accumulating properties. The clastic development of Upper Carboniferous rocks in many boreholes has been proven to manifest very good accumulation properties, but no significant proper accumulations have hitherto been found.

**Conclusions**

The results of the exploration of Paleozoic rocks in Czechoslovakia achieved so far permit to formulate the following conclusions:

- the formation is favourable with respect to the genesis and preservation of natural hydrocarbon accumulations,
- the formation is equivalent to other promising units
- the formation has specific properties resulting from its complicated lithologic and facial development, which influence both its accumulation conditions and requirements for drilling and horizon-tapping works
- the exploration of the formation is very demanding in terms of methodology and complexity, including seismic works and their evaluation. Especially the use of 3-D seismic measurements is envisaged.
- problems of the origin of hydrocarbons accumulated in

Paleozoic rocks still remain to be solved. Their age is dated back to Paleozoic or Mesozoic, and even Paleogene. However, the problem is undoubtedly associated with a relatively difficult problem of migration and structural-tectonic development.

- further exploratory works will increasingly focus on deep parts of the platform, where hydrodynamically closed horizons have been confirmed.

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## Abstrakt

Na jihovýchodních svazích Českého masivu, v úseku Střed a přilehlých částech úseku Jih, je část průzkumných prací zaměřena na variské patro. V článku je v samostatných kapitolách zhodnocena stratigrafie, litologie a dále ložiska, významné přítoky a indicie přírodních uhlovodíků. Na bazální klastika devonu je vázáno ložisko v oblasti Ždánice. V karbonátovém vývoji paleozoika se akumulace ropy a zemního plynu vyskytují v tektonicky porušených a dolomitizovaných partiích karbonátů. V těchto horninách byla nalezena ložiska Nitkovic, Uhřice-západ, Uhřice-východ a průmyslových přítoků bylo dosaženo z vrtů Němčičky-1 a Letošov-1. I přes specifika, zvyšující nároky na metodu průzkumu, technologii vrtných prací a otvírku jednotlivých horizontů, zůstává perspektivita variského patra pro nalezení dalších akumulací přírodních uhlovodíků nesporná.

## Zusammenfassung

An SO-Hängen der Böhmischen Masse, im Abschnitt Mitte und in anliegenden Gebieten des Abschnitts Süd, ist ein Teil der Erkundungsarbeiten auf das variszische Stockwerk orientiert. In selbständigen Kapiteln werden Stratigraphie, Lithologie, ferner Lagerstätten, bedeutsame Zuflüsse und Anzeichen natürlicher Kohlenwasserstoffe behandelt. An basale Trümmergesteine des Devons ist die Lagerstätte im Gebiet von Ždánice gebunden. In der Karbonatentwicklung des Paläozoikums kommen Erdöl- und Erdgasakkumulationen in tektonisch gestörten und dolomitisierten Karbonatgesteinspartien vor. In diesen Gesteinen wurden die Lagerstätten Nitkovic, Uhřice-West und Uhřice-Ost entdeckt, und förderwürdige Zuflüsse wurden in den Bohrungen Němčičky-1 und Letošov-1 ermittelt. Trotz spezifischer Erscheinungen, durch welche die Ansprüche an die Erkundungsmethodik, Bohrtechnologie und Erschließung einzelner Horizonte erhöht werden, bleibt die Höflichkeit des variszischen Stockwerks in Hinsicht auf Entdeckung weiterer Akkumulationen natürlicher Kohlenwasserstoffe unstreitig.

\* In this line, the results of mathematical modelling of the conversion of kerogen to oil hydrocarbons conducted by M. Strnad are of interest. In the first version of a mathematical model using the parameters of the Rock-Eval temperature maximum pyrolysis  $T_{max} = 430-440^{\circ}C$  the author placed the oil window interval to a depth of 3.7 to 5 km in the Czechoslovak part of the Vienna Basin, the genesis of oil hydrocarbons culminating in the period of 15.5 — 17.6 million years after the commencement of sedimentation.

## PALEO GEOGRAPHIC ASPECTS OF THE STUDY OF OTOLITH FAUNAS IN THE MIOCENE BASINS OF THE CENTRAL PARATETHYS

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The hitherto assembled knowledge on the otolith faunas of the Miocene sediments of the Central Paratethys affords several remarks on the interpretation of the paleogeographic conditions of individual basins and on their changes with time. These remarks are mostly based on the fact that the epipelagic, mesopelagic and bathypelagic habitat of recent fish faunas has been formulated as early as in the Miocene in general characters (Brzobohatý 1981 inter alii) and that the composition of water and the character of surface

water are decisive determinants in the composition of pelagic assemblages of fishes (Robison 1972).

In the sediments of the Eggenburgian, the finds of purely marine otolith faunas have been rather sporadic so far. This can be due to the small degree of investigation and possibly also to problems of fossilization. Biofacies deliberations of a broader scope are therefore not admissible. Recently, however, a very rich otolith fauna has been found near Maigen in the Horn Basin in Niederösterreich, the appreciation of which contributes to the better understanding of the relationships in the western part of the Central Paratethys of this time interval.

The Maigen otolith fauna is composed of 30 species of bony fishes that are represented in various parts of the Molt Beds and Loibersdorf Beds. Except for the Molt Beds, where more prominent brackish influences appear, it has a purely marine character of a very shallow sublittoral without any influence of deeper waters and it documents sedimentation in a very warm subtropical climate. It is mostly composed of Atlantic-Mediterranean and cosmopolitan elements with southward inclination (genus *Brachydeuterus*). It differs from the Lower Miocene faunas of the Aquitaine Basin and the Mediterranean area (Steurbaut 1981, Nolf et Cappetta 1980) by a substantially lesser proportion of Paleogene Indo-pacific relicts. This fact is obviously connected with the regressive tendencies in the Alpine-Carpathian region in the higher Egerian (Rögl et Steiniger 1983) and with the forming of new fish assemblages in this region at the beginning of the Miocene. The presence of an isolated Indo-Pacific representative (genus *Acropoma*) is evidently the result of direct migration from the Indo-Pacific region. The shallow-water assemblages of fishes of the marginal developments of the Eggenburgian at the SE margins of the Bohemian Massif are typical in the decrease of purely marine elements from the SW to the NE. This tendency, which is connected with the absence of Eggenburgian deposits in the region of the Vyškov depression, evokes here the idea of a relatively isolated bay which is closed from the W and the N, and which communicates S and southeastward with a more marine environment.

In the Eggenburgian of the Central Paratethys so far nowhere associations of otoliths of deep-sea fishes have been established. We may establish practically the same for the deposits of the Ottnangian. An individually poor assemblage of mesopelagic elements witnessed in the last-named level in the schlieren of Oberösterreich (vicinity of Ottnang) can be conceived as allochthonous (predators, currents, etc.). If not considering the state of the low degree of investigation, or taphonomic problems, we may interpret this fact so that the configuration of the basins in the Eggenburgian and Ottnangian (hydrographic or bathymetric conditions) was not suitable for the existence of deeper-living fish assemblages, or that the studied basins divided from seas represented for this type of fauna an unsurmountable barrier. Acceptable is the idea of relatively high sills between the Bohemian Massif and the Alpine arch on the connecting region of the present-day Austrian molasse (comp. Rögl et Steiniger 1983).

In the sediments of the Karpatian and Badenian of the Central Paratethys, deep-sea fishes, whose assemblages form here a significant component of all fish fauna, can be encountered on the other hand. Their composition generally reminds of the so-called reduced deep-sea fish faunas (Marshall 1957) composed of the genera participating in the forming of ichthyocoenoses of the higher layers of oceanic waters and occurring also in the basins outside the free oceans but with a good communication with them.

In the Karpatian, these assemblages display a surprising coincidence in the representation of the most frequent elements with assemblages of the Gulf of California (Robison 1972). They indicate the existence of a more or less semi-closed basin with a deep-seated communication with the free sea, with sufficient depth of the basin itself and evidently with the so-called estuarine type of circulation of