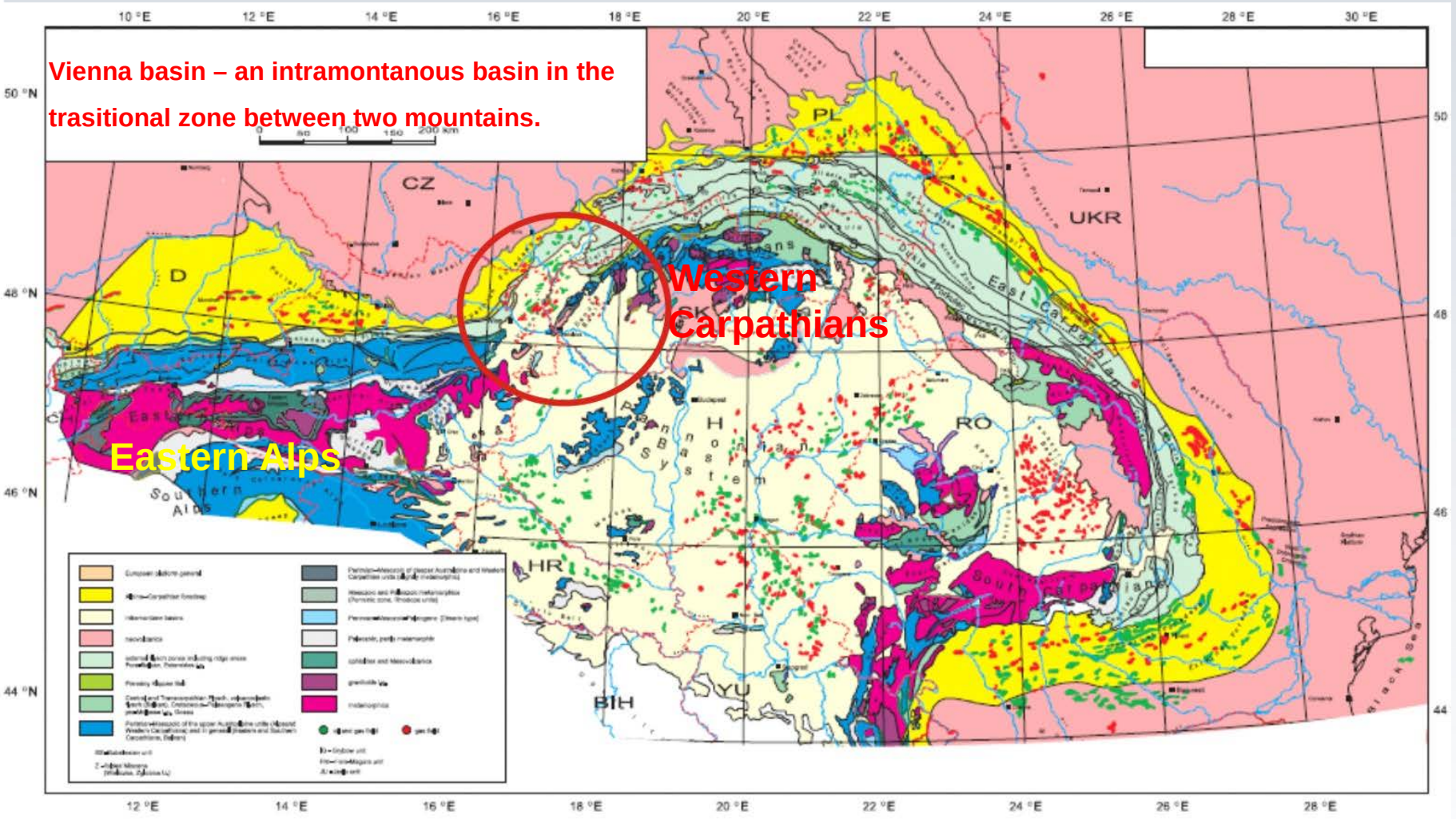
PREPARATION OF A RESEARCH PILOT PROJECT ON CO_2 GEOLOGICAL STORAGE IN THE CZECH REPUBLIC (REPP-CO_2)

INPUT GEOLOGICAL DATA - BASIC INFORMATION ABOUT THE VIENNA BASIN AND OIL AND GAS FIELD BRODSKÉ

Oldřich Krejčí, Juraj Franců, Vladimíra Krejčí and Martin Paleček

Czech Geological Survey

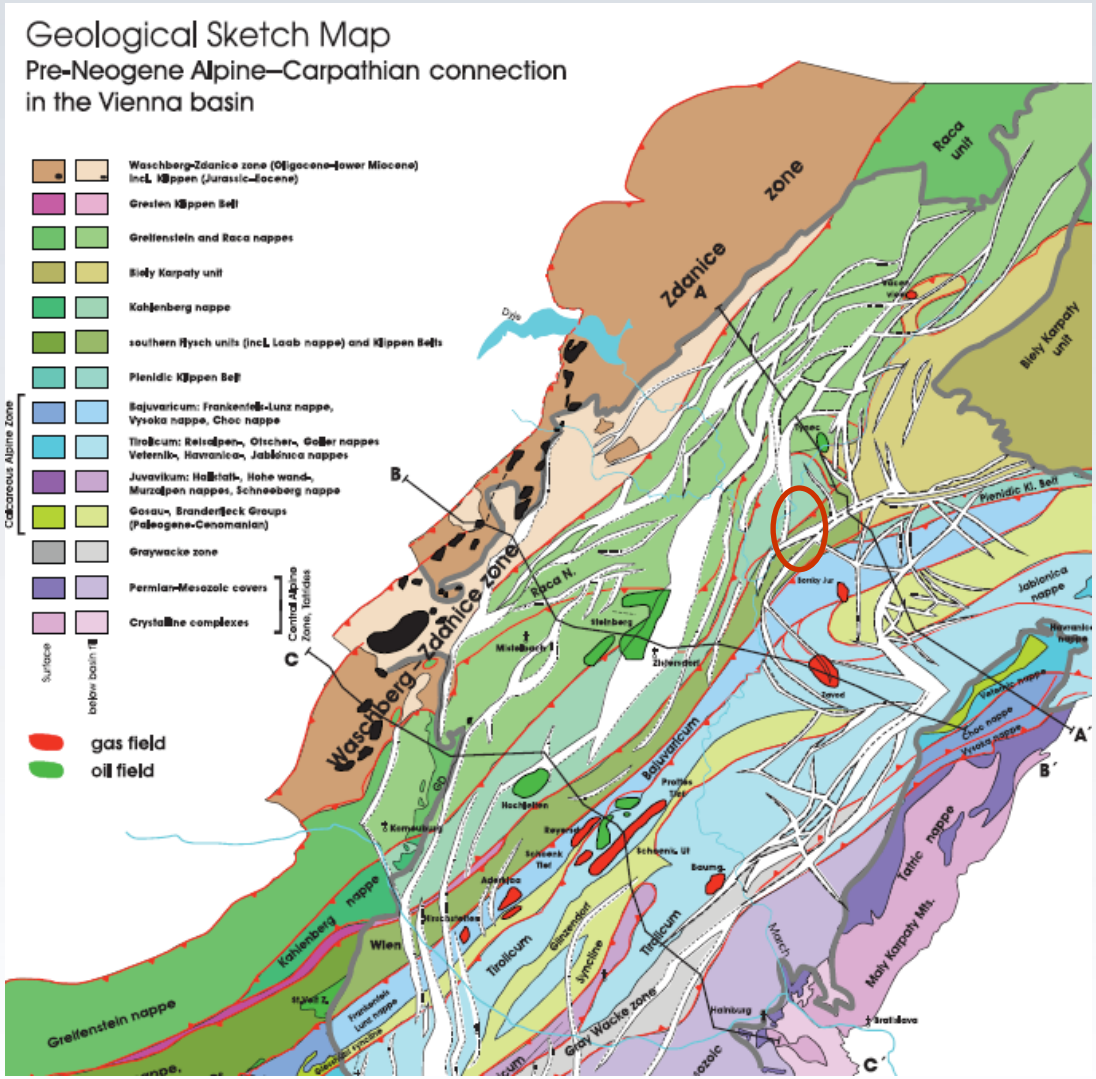
General overview and distribution of oil and gas fields in the Circum Carpathian Region of Central Europe. From Golonka, Picha 2006.



Geological and geotectonic position of the Vienna basin.

- The pull-apart or piggyback nature of the basin at present is well understood and commonly accepted.
- The basin-floor section below the Neogene fill consists of the Alpine–Carpathian imbricated system. From north to south, these individual thrust piles are the Waschberg–Zdanice zone, the Flysch zone, the Calcareous Alps and the Central Alps, and the Tatrides.
- Oil and gas are trapped in all units of the basin, from the Neogene fill down to the autochthonous sedimentary cover. Generally, the traps are structural, but recently, stratigraphic traps have also been drilled successfully.
- Information from the Vienna basin were achieved by drilling more than 6000 wells (the deepest to a total depth of 8553 m).

Vienna Basin – a transitional zone between Eastern Alps and Western Carpathians (Golonka and Picha 2006).



Tectonic map of the Vienna basin and its surrounding. The pull-apart origin is predisposed by systems of left lateral strike slip faults. After Decker et al. (2005).

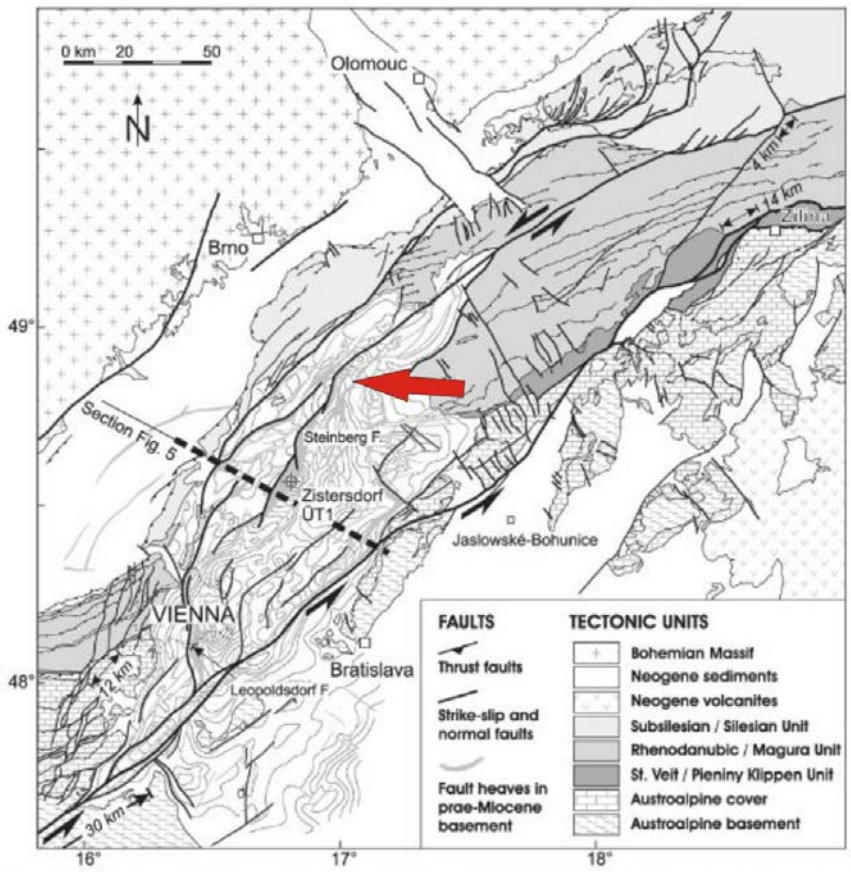
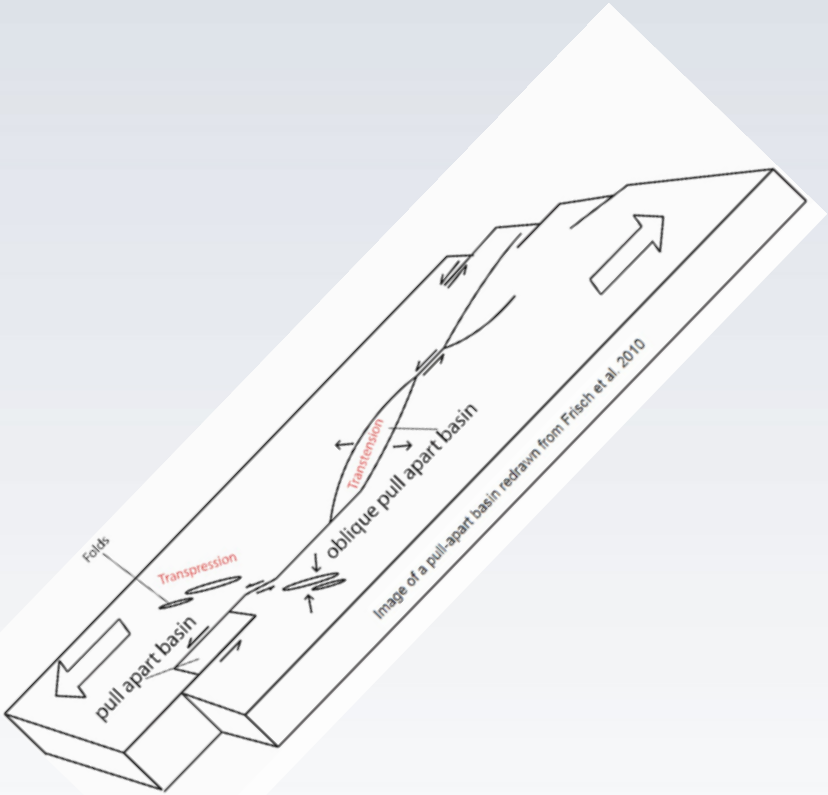
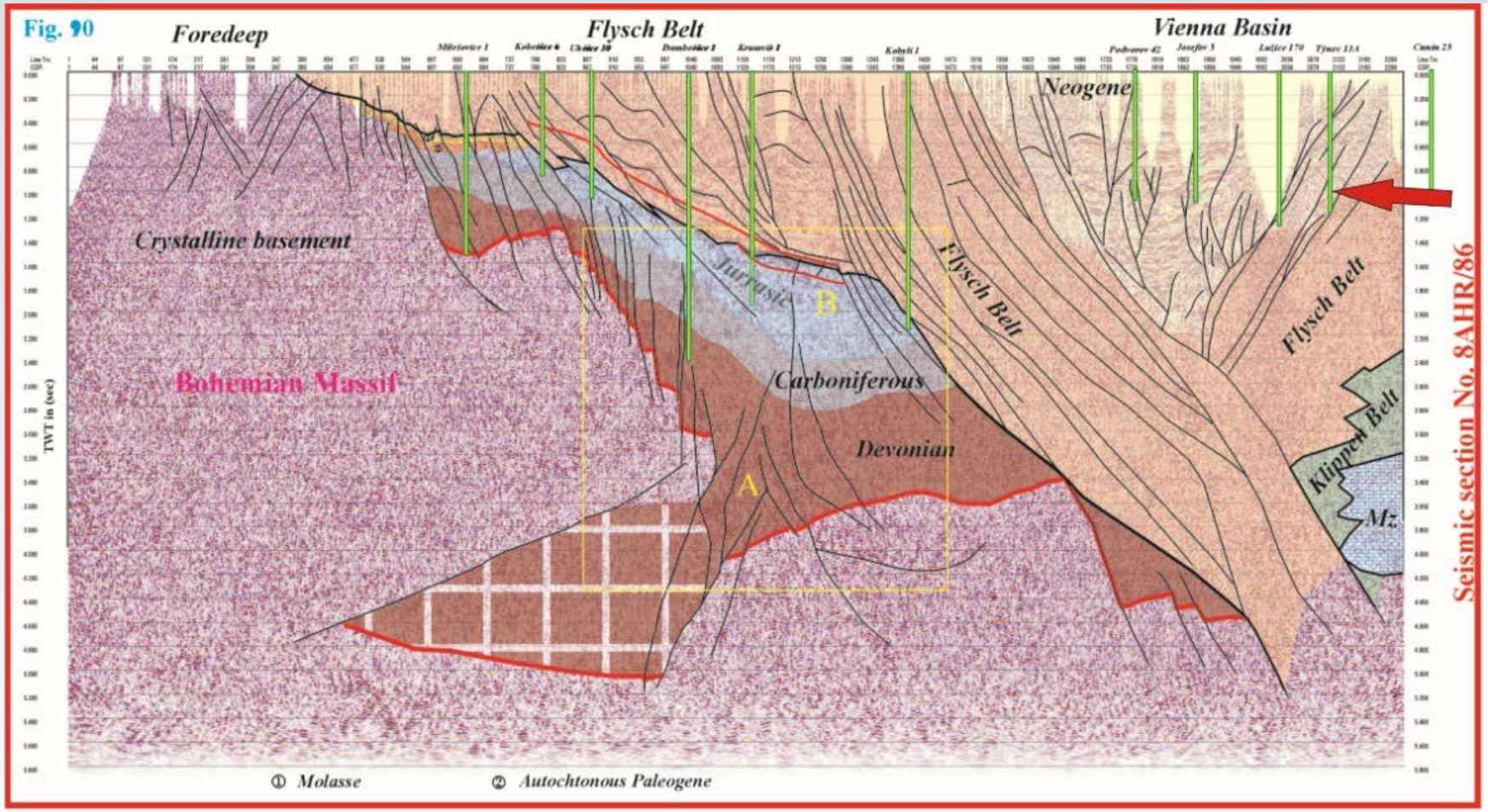


Fig. 2. Tectonic map of the Vienna Basin and its surrounding. Synthesized from Geological Maps of Austria (1:50.000), Czecho-Slovakia (1:200.000), Fuchs and Grill (1984) and Krèil and Wessely (1993).

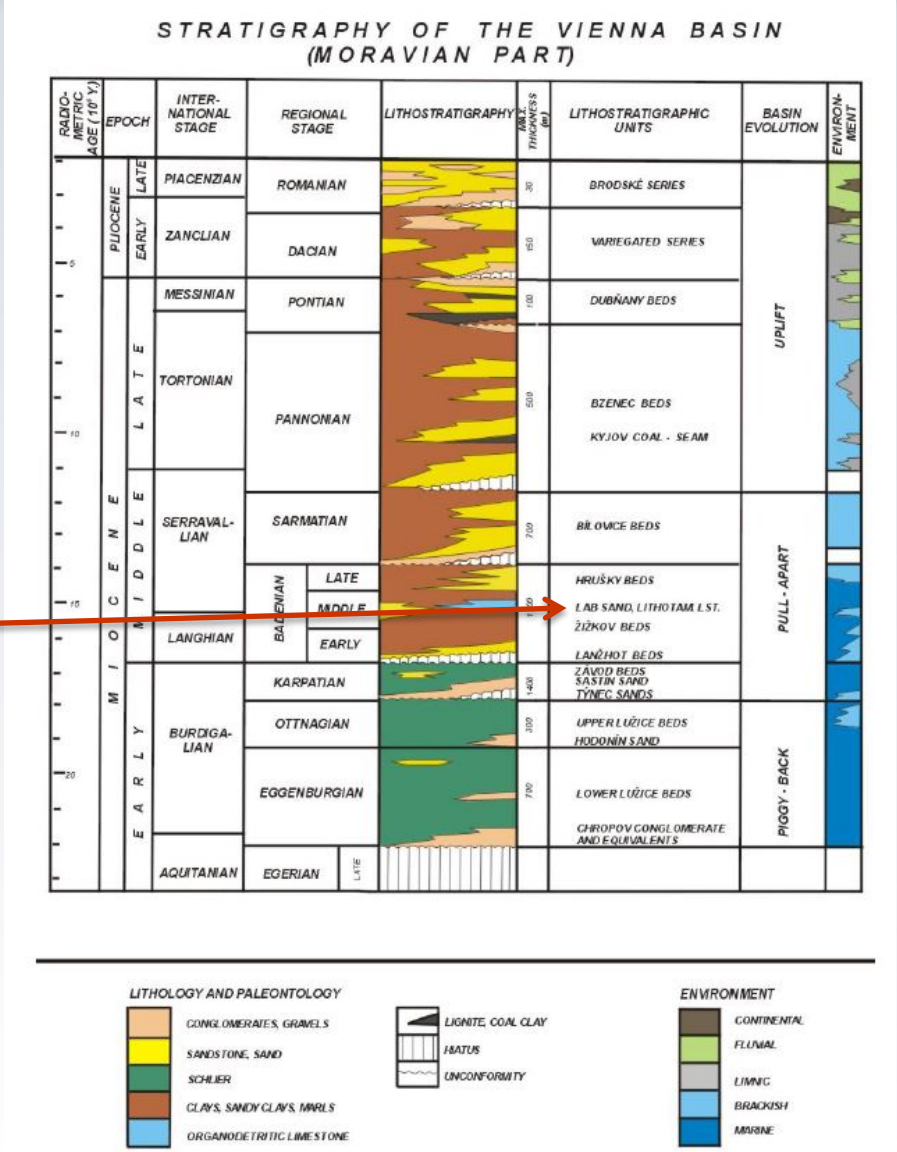


Interpretation of the regional seismic 2D line No 8AHR/86 with Brodské locality position.

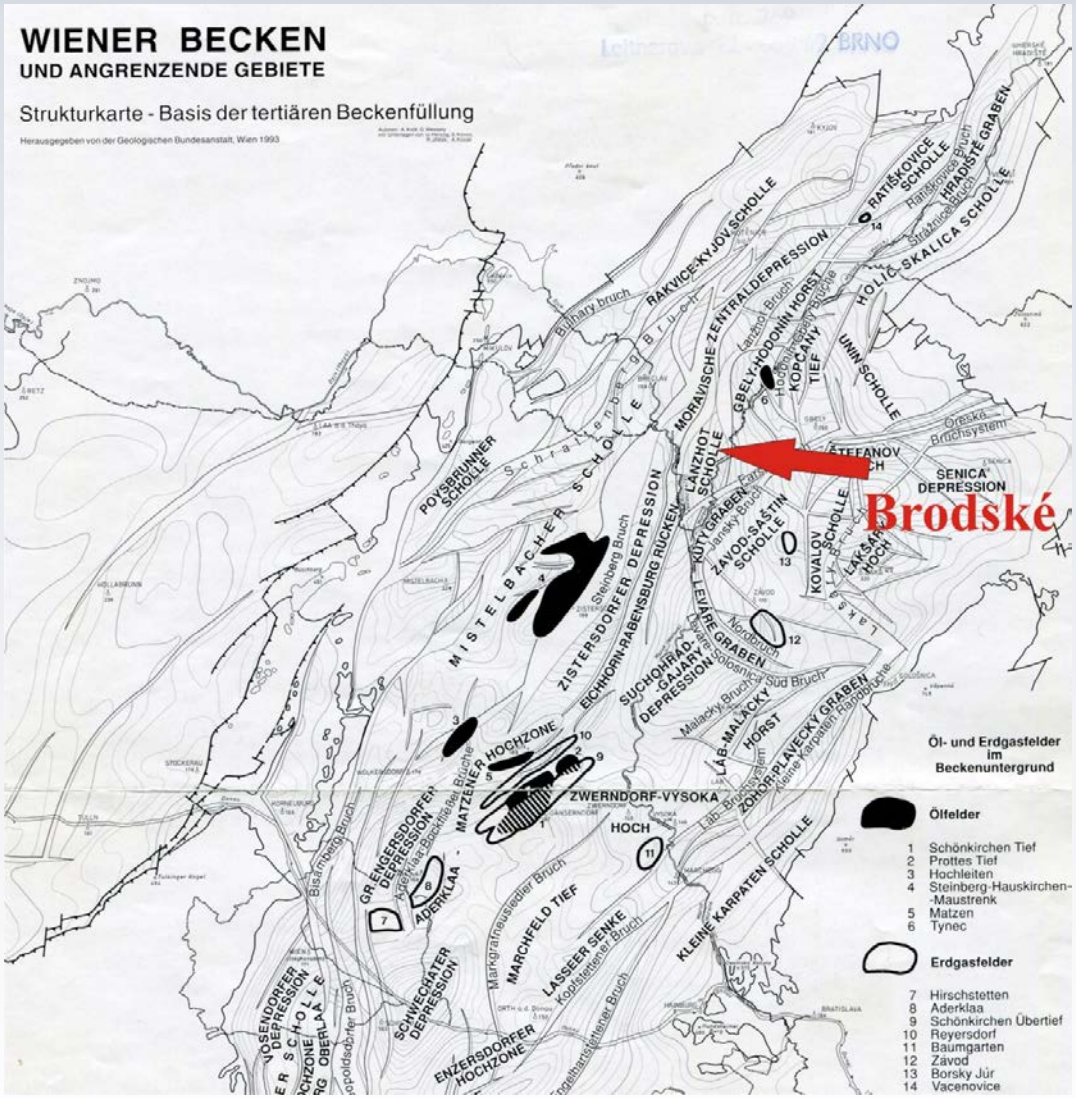


Stratigraphical position of the Brodské oil and gas field.

Brodské oil field



Vienna basin. Structural map with tectonic elements.



ACTIVITY 1: BASIC DATA FOR STORAGE COMPLEX ASSESSMENT – partial tasks

1.1. Site data

1.2. Geological data

1.3. Geophysical data

1.4. Reservoir and caprock parameters

1.5. Hydrogeological parameters

1.6. Geochemical parameters

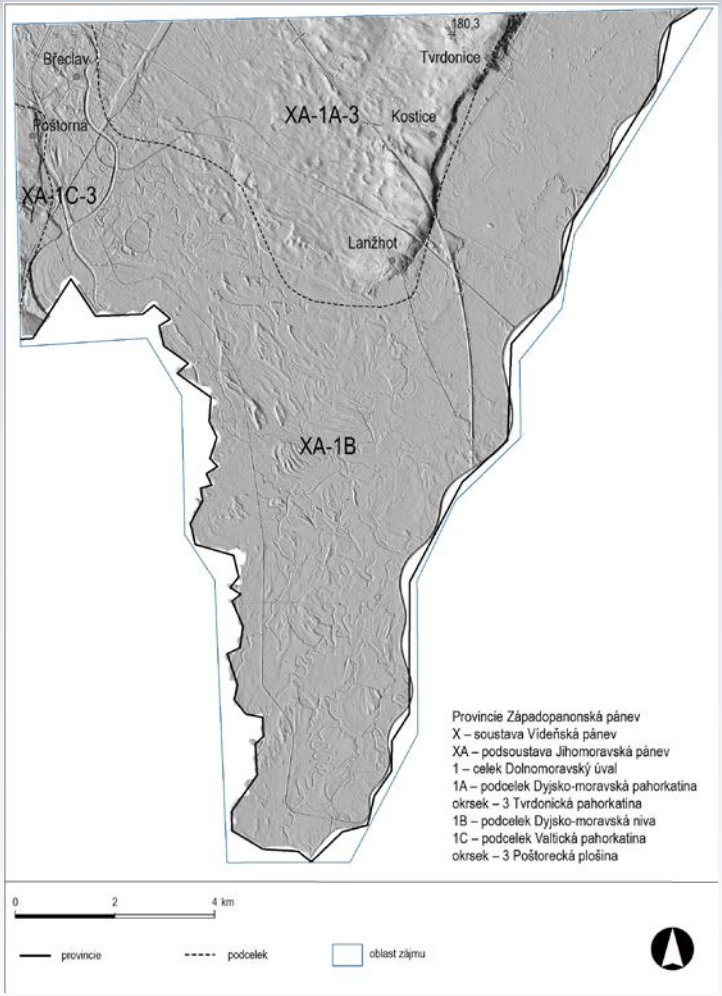
1.7. Geomechanical parameters

1.8. Seismicity

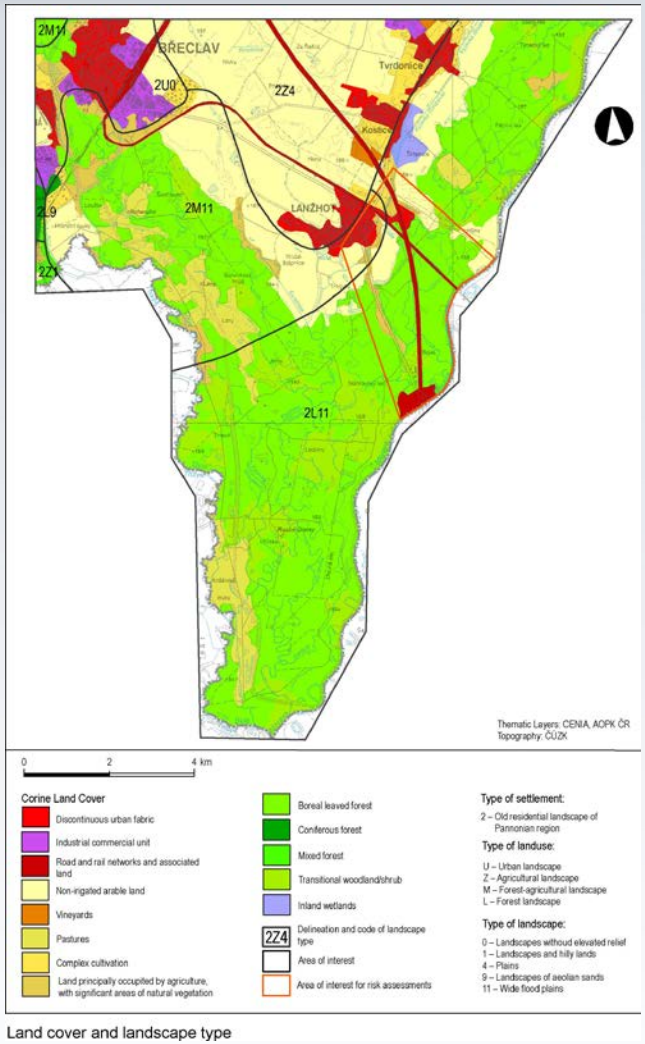
Basic information about the oil and gas field Brodské in the Vienna basin.

- Deeper exploration of the oil field Brodské began in 1917 by borehole Brodské -1.Between 1927-1928 were drilled Brodské - 2 and 3 boreholes. These initial exploration work were placed in the Slovak Republic.
- In the years 1949-1950 was with the borehole Brodské 4 - discovered oil-bearing horizon in the Middle Badenian sediments. Exploration and mining of this productive leyer lasted until 1964.
- In 1962, a survey was restored, but only at a high block. This area is unsuitable for this project because it is located in the structural depths of -670 to -780 m and is in the Slovak Republic located.
- In the oil deposit Brodské were a total of 103 wells drilled, including the Slovak part with varying degrees of information. In the Czech Geological Survey databases is data on 40 wells, but usually only the basic information (coordinates, the depth, brief geological profile).

BASIC DATA FOR STORAGE COMPLEX ASSESSMENT
Task 1.1. Site data.



Geomorphological map in LIDAR image for the broader area of the conflict of interests.



Land cover and landscape type

Land cover and landscape type.

BASIC DATA FOR STORAGE COMPLEX ASSESSMENT
Task 1.1. Site data.

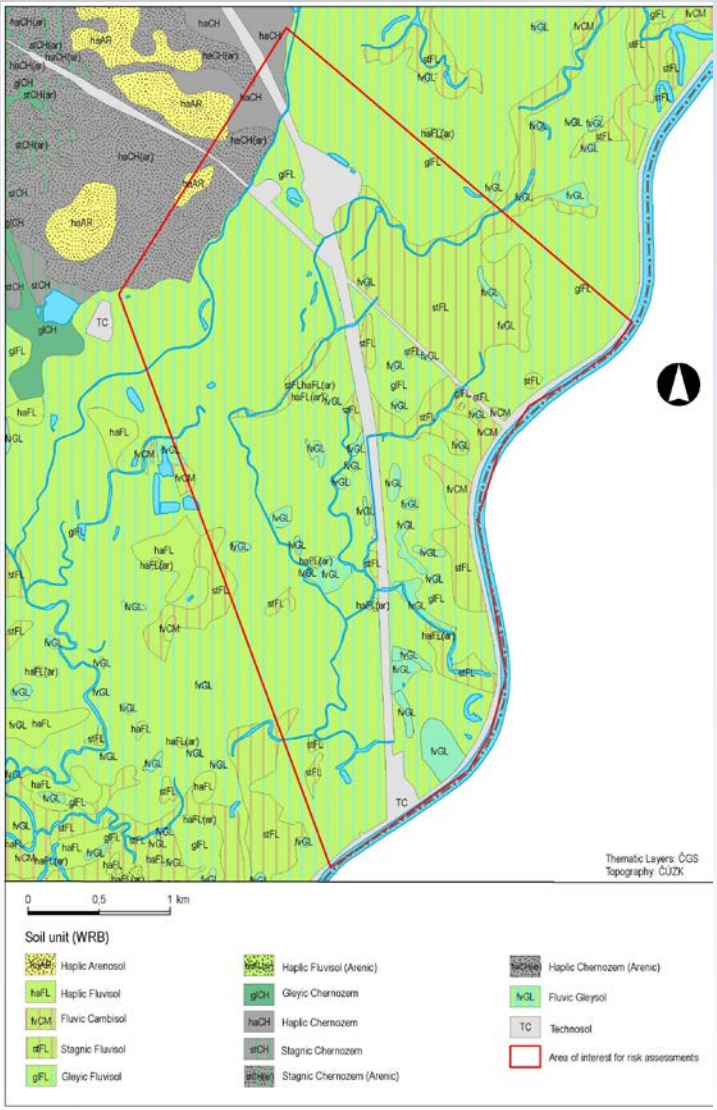
Data for risk assessment - potential vulnerable elements –prepared by J. Janderková

Soils

Almost the entire area of interest belongs to the Morava river alluvial soil region predominantly with Fluvisols and Gleysols. Only very small part in the NW belongs to the Pannonian forest and forest-steppe soil region predominantly with Chernozems.

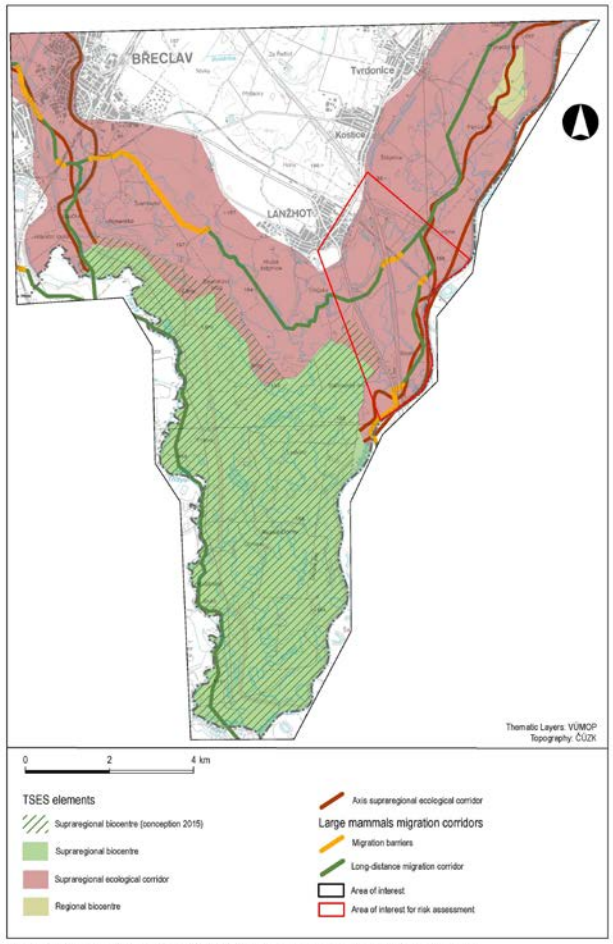
The soil types which have formed on the floodplain sediments include predominantly gleyic Fluvisol, stagnic Fluvisol and fluvic Gleysol, sporadically Haplic Fluvisol (arenic) on the air-blown sands.

The soils are deep, have poorly differentiated horizons, evidence of stratification and redoximorphic features in the lower part of the profile. Their physical properties vary slightly with depth and site as a result of variable conditions during sedimentation.



Soil Map

BASIC DATA FOR STORAGE COMPLEX ASSESSMENT
Task 1.1. Site data.



Territorial System of Ecological Stability TSES and Long-Distance Migration Corridors

Dataset for risk assesment consists of:

Land use map;
Settlement map;
Transport lines;
Pipelines and power lines;
Aquifers;
Surface water;
Terrestrial surface environment;
Potential vegetation and biogeographical division
Nature conservation areas;
Territorial system of ecological stability and long-distance migration corridors;
Soil map.

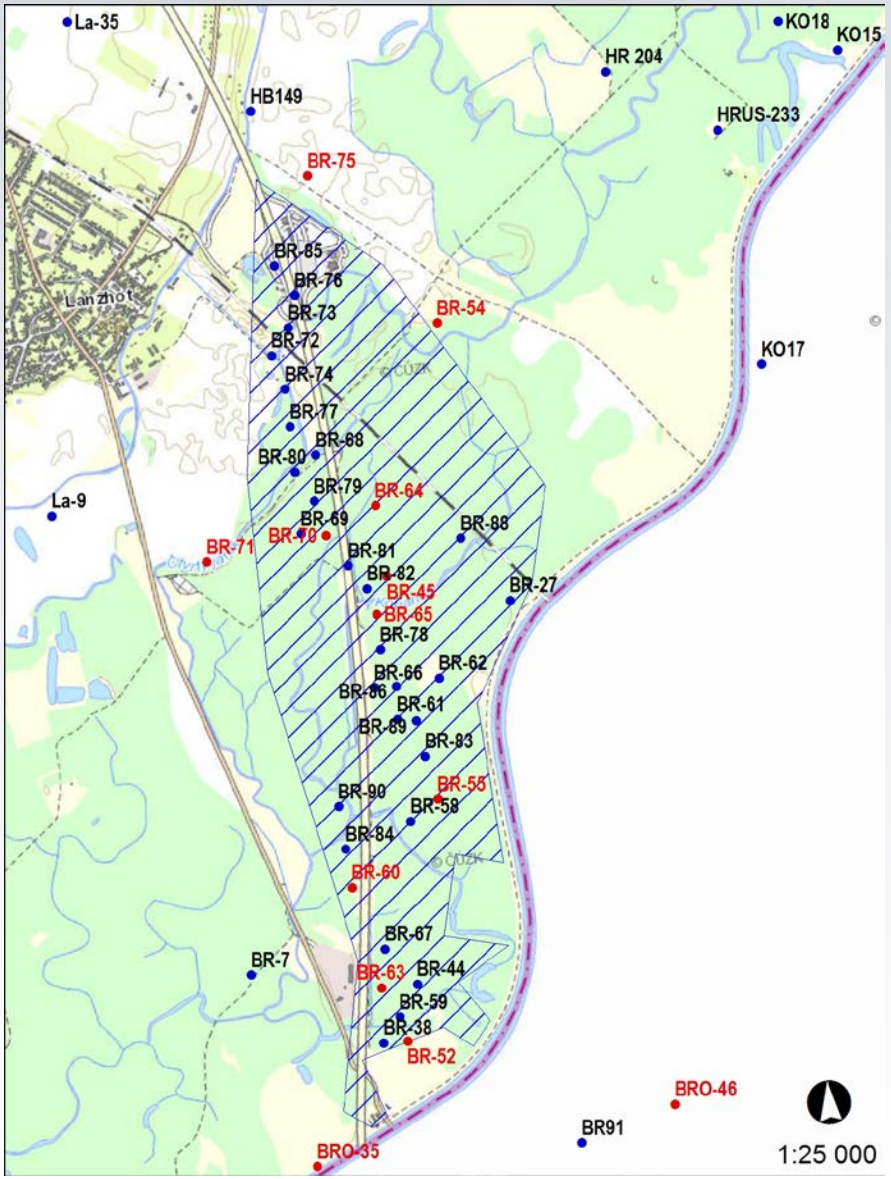
The data in question from Moravian Oil Company and Czech Geological Survey included:

- borehole data, incl. information on coordinates, datum elevation, total depth, well deviations, geology, stratigraphy;
- final geological reports on wells;
- final technical reports on wells;
- well completion and abandonement protocols;
- well logs and well evaluation (porosity, permeability, saturation and fluid composition, sand and clay content;
- production tests;
- geological data, incl. 2D sections, models;
- geothermic well profile data;
- borehole cores (including sampling for laboratory experiments);
- petrographic cores and cuttings descriptions;
- seismic data, incl. 2D sections and 3D data cube and interpretation features;
- check shots data;
- reservoir data, incl. reservoir rock, caprock and reservoir fluids properties, p-T values;
- production history data and report on reserves calculation;
- hydrogeological, geochemical, petrophysical and geomechanical data, (incl. cuttings);
- oil and gas samples (from the field or, if unavailable, form the broader area).

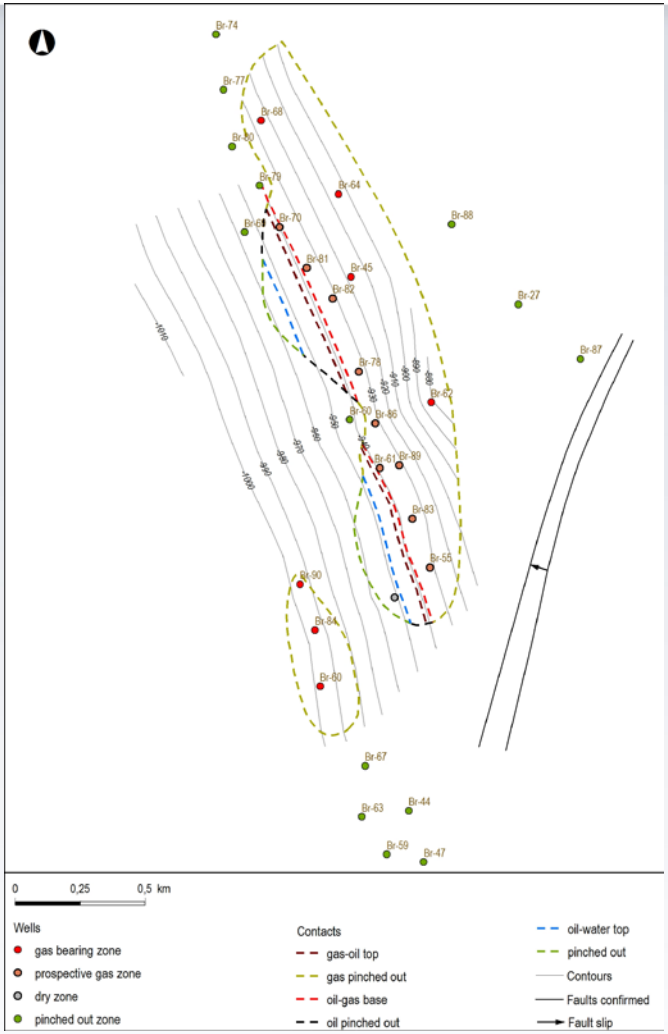
BASIC DATA FOR STORAGE COMPLEX ASSESSMENT

Task 1.2. Geological data.

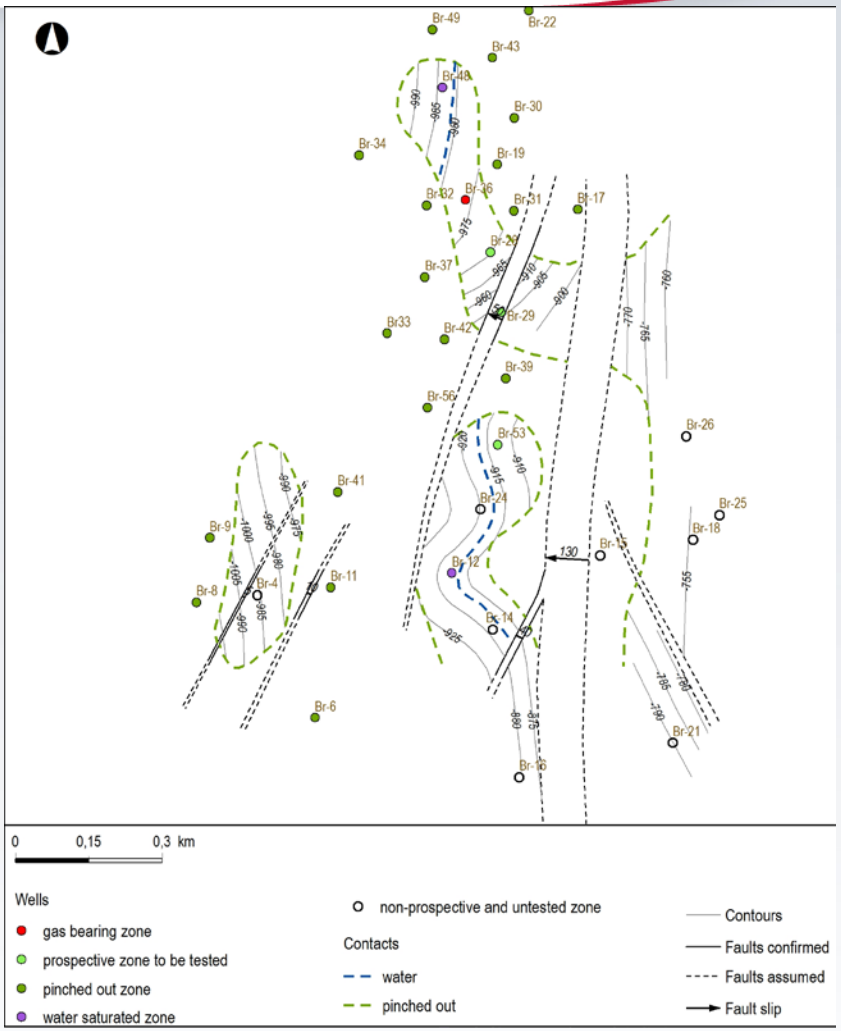
Boreholes location from the Archive of the CGS with former mining area (LBr1). Numbers of wells with core fragments material are marked by red.



BASIC DATA FOR STORAGE COMPLEX ASSESSMENT
Task 1.2. Geological data.

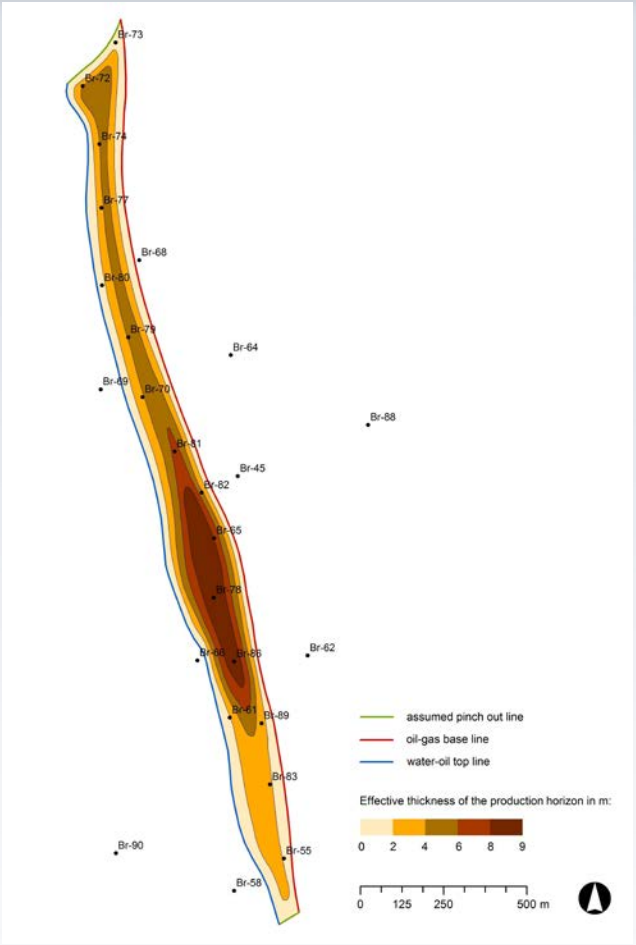


Structural map of the Badenian 12a horizon, northern part (author M. Paleček).

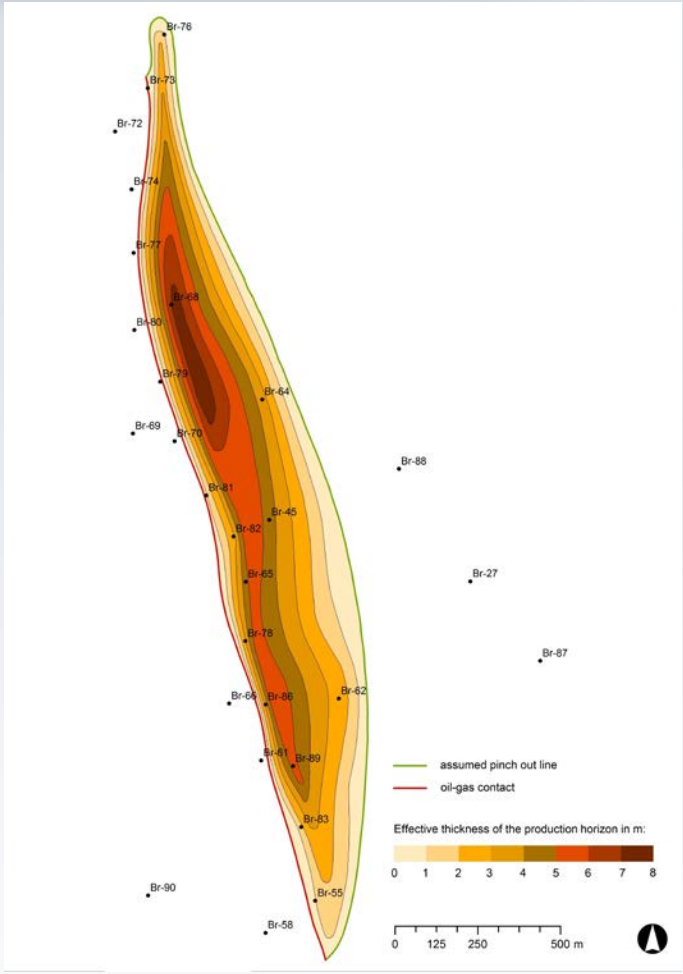


Structural map of the Badenian 12a horizon, southern part (author M. Paleček).

BASIC DATA FOR STORAGE COMPLEX ASSESSMENT
Task 1.2. Geological data.

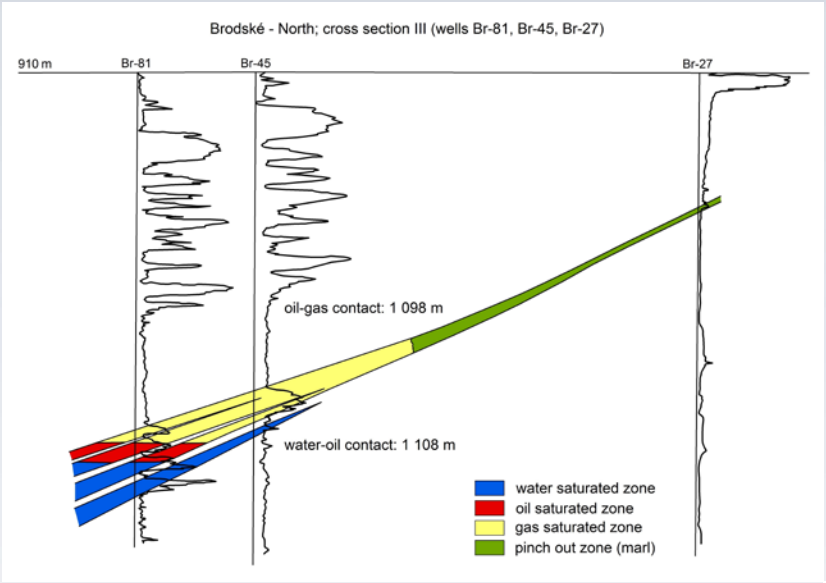


Map of the thickness of the oil saturated zone (Badenian 13 and 14 horizons, author V. Krejčí).



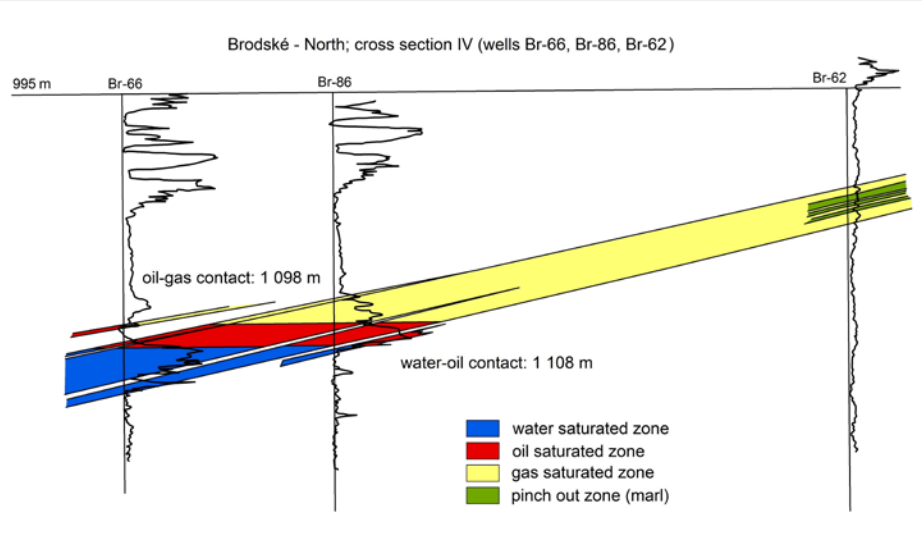
Map of the thickness of the gas saturated zone (Badenian 13 and 14 horizons, author V. Krejčí).

BASIC DATA FOR STORAGE COMPLEX ASSESSMENT
Task 1.2. Geological data.

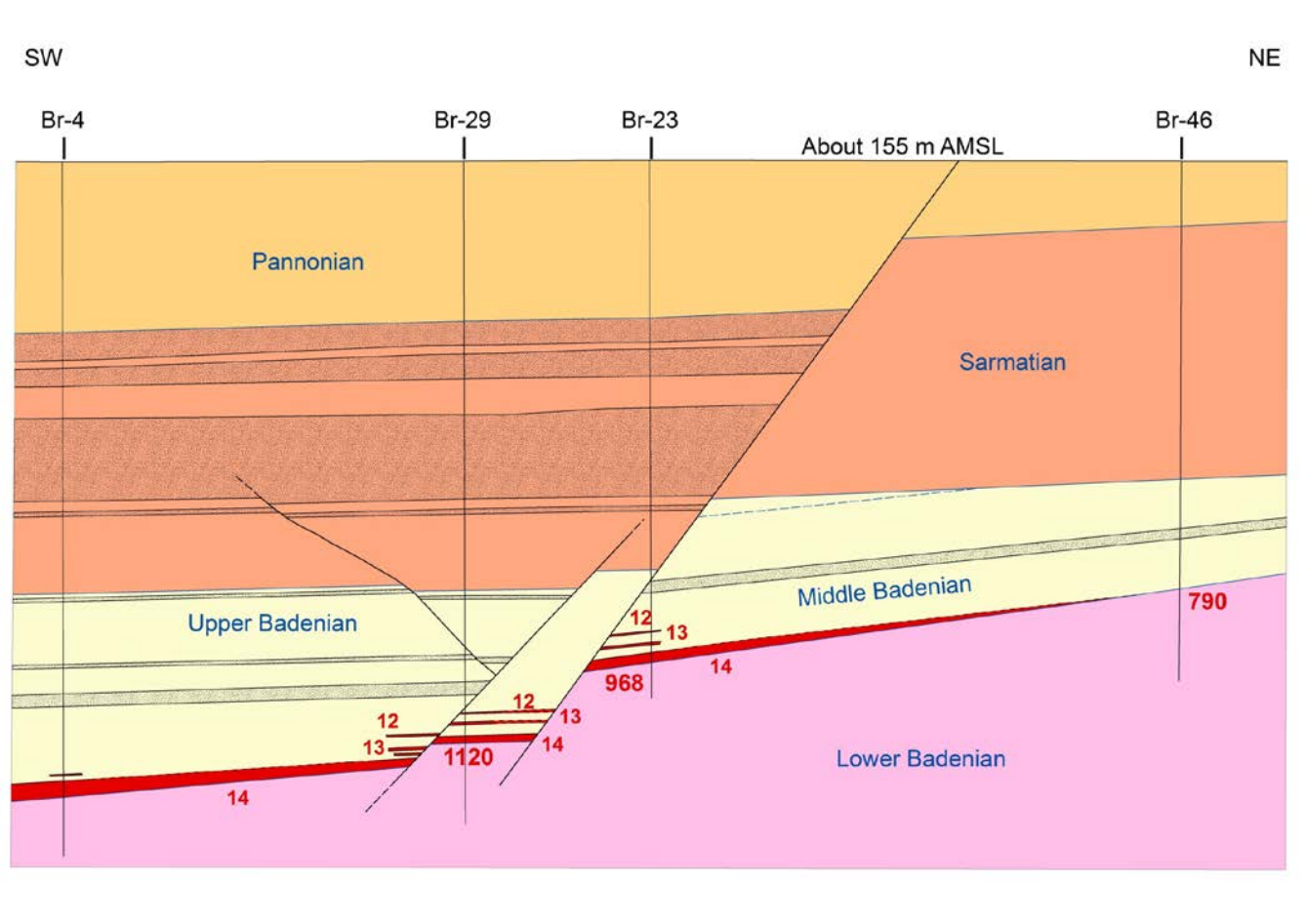


Brodské - North; cross section III (wells Br-81, Br-45, Br-27, author V. Krejčí).

Brodské - North; cross section IV (wells Br-66, Br-86, Br-62, author V. Krejčí).



BASIC DATA FOR STORAGE COMPLEX ASSESSMENT
Task 1.2. Geological data.



Regional cross-section trough the Brodské field from SW to NE. Oil and gas positive horizons 12 – 14 are red. Oil and gas saturated zone is very thin - several meters only, it was problematic to catch it by cores (technology was 50 years old).

Brodské-75; 1075 – 1080 m, core material.

BASIC DATA FOR STORAGE COMPLEX ASSESSMENT
Task 1.2. Geological data.

CORES APPLICABLE FOR GEOMECHANICAL AND OTHER ANALYSES

During the sampling of Brodské locality cores was found that the conserved core from the deposit are not from deposit horizons and are free of solid rock and sandstone. They were therefore made withdrawals from analogous sites Hrušky in the vicinity of Brodské site.
Again there were some exceptions, we have not found excellent cores samples. It was not possible to take one piece core, and divided into several equal parts because material lacking.
The samples for geotechnical and further analysis will be required mineralogical and geochemical analyzes and will be necessary the remnants maintained for the whole time of the the project.
Due to the current date and status of the project is clear that some experimental laboratory tests not going to meet the scheduled quantity and quality or not at all. It was necessary to develop some additions to the project and modify its text into reality!

For the experimental tests with samples of rocks and their reactions with liquid and gaseous fluids there are not unfortunately suitable shaped rock bodies with good permeability.
This is due to several factors:
Oil bearing horizons are too thin (up to 9 meters) and drilling with the older technology could not be reached during drilling, the findings of them were made by well logs.
If there is an appropriate core sample from positive horizons, it was totally consumed by older laboratory tests.
Rock cores that are available today are not directly from positive horizons and have low permeability (including analogical Hrušky site).
High permeability were measured today only in boreholes Brodské 45 (1300-1307 m), Hrušky-43 (1548 1558 m - everything below the oil field) and in IRIS from Brodské-52 (1150-1156 m base of the Middle Badenian).

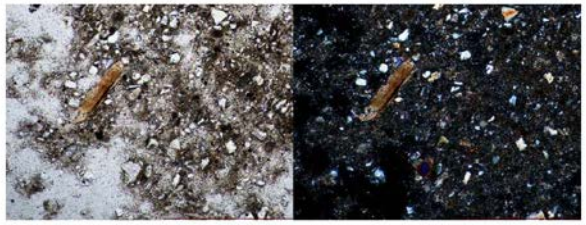
BASIC DATA FOR STORAGE COMPLEX ASSESSMENT
Task 1.2. Geological data.

Obr. 2 Makrofoto vzorku Brodské 70.

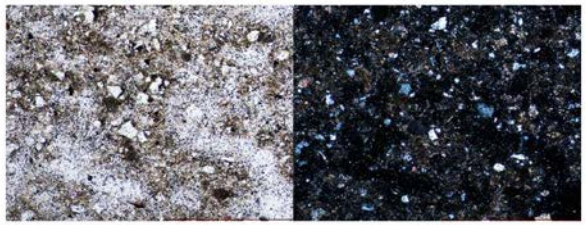
3. Mikroskopické zhodnocení vzorků z výbrusů

Pro mikroskopická pozorování byly připraveny výbrusy ze vzorků Brodské 45 a 70. Ze zbývajících vzorků nebylo možné vzhledem k jejich rozpadavému charakteru mikroskopické preparáty připravit. Z jeder byly připraveny dva orientované výbrusy. Výbrus A orientovaný rovnoběžně s osou válcovitého jádra a výbrus B orientovaný kolmo na osu. Mikroskopické zhodnocení je pouze orientační, většina zrn je svou velikostí pod rozlišením optického mikroskopu. Výbrus není možné považovat za reprezentativní, při jemném broušení preparátu došlo k částečnému odplavení materiálu vzorku a vzniku prázdných míst.
Níže jsou uvedeny mikrofotografie dokumentující charakter vzorků.
Vzorek Brodské 45 je podle mikroskopického hodnocení možné označit za karbonátový jílovitý prach. Podíl písčitých zrn odhadem nepřesahuje 25%, střední hodnota jejich velikosti je 63,71 µm.
Vzorek Brodské 70 obsahuje vyšší podíl větších – písčitých částic. Střední hodnota jejich velikosti je 251 µm a jsou tvořeny především úlomky křemene. Střední hodnota velikosti prachovitých částic je 56,62 µm. Horninu můžeme označit za karbonátový prach.

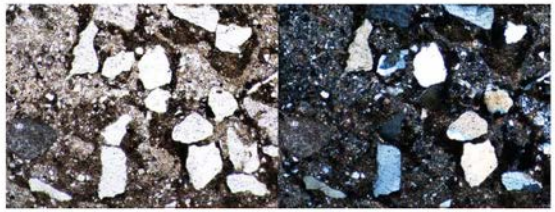
REPP-CO2 V1.7 Výsledky analýz vzorků - stanovení petrografického složení hornin z makrovzorků a výbrusů pomocí metody mikroskopie a RTG difrakce



Obr. 3 Mikrofotografie vzorku Brodské 45, preparát A, při rovnoběžných (vlevo) a zkřížených (vpravo) polarizátorech. Delší strana fotografie měří 2,25mm.



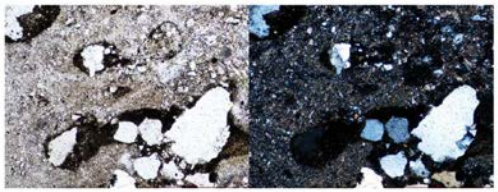
Obr. 4 Mikrofotografie vzorku Brodské 45, preparát B, při rovnoběžných (vlevo) a zkřížených (vpravo) polarizátorech. Delší strana fotografie měří 2,25mm.



Obr. 5 Mikrofotografie vzorku Brodské 70, preparát A, při rovnoběžných (vlevo) a zkřížených (vpravo) polarizátorech. Delší strana fotografie měří 2,25mm.

Macro- and microphotograps of core material and its petrographical evaluation.

BASIC DATA FOR STORAGE COMPLEX ASSESSMENT
Task 1.2. Geological data.



Obr. 6 Mikrofotografie vzorku Brodské 70, preparát B, při rovnoběžných (vlevo) a zkřížených (vpravo) polarizátorech. Delší strana fotografie měří 2,25mm.

4. Fázové složení vzorků

Metodika – použité práškové RTG difrakční analýzy

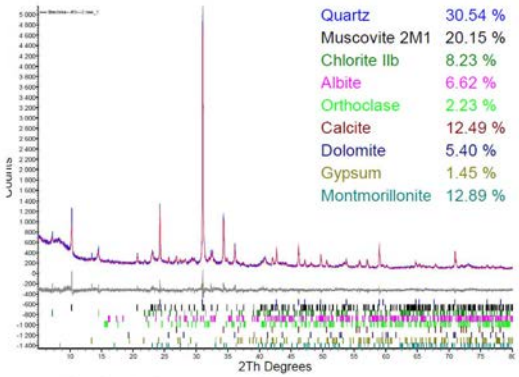
Vzorky pro práškovou RTG difrakční analýzu byly podrceny na čelistovém drtiči, namlety na vibračním mlýnku a kvartovány. Podíl vzorku byl následně domlet na mikronizačním mlýnku McCrone v izopropanolu (5 g vzorku, 10 ml izopropanolu, 10 minut mletí), vysušen a zhomogenizován. Zmikronizovaný a zhomogenizovaný vzorek byl natlačen do měřicí kyvety a změřen.

Měření probíhalo na přístroji Bruker-AXS D8 Advance (Německo) s 2θ/θ geometrií měření a s pozičně citlivým detektorem LynxEye za podmínek: Záření CoKα/Fe filtr, napětí 40kV, proud 40 mA, krokový režim s krokem 0.014° 2θ, s celkovým časem na kroku více než 2s (podle složitosti záznamů sumace více než pěti měření s krokem 0.25 s) a s digitálním zpracováním výsledných dat. Jak pro měření, tak pro vyhodnocování byl použity firemní programy Bruker Diffrac Suite.

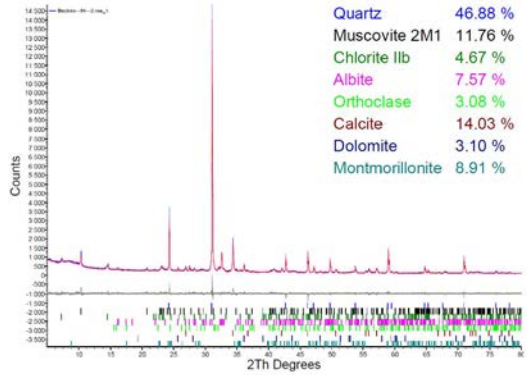
Pro kvalitativní vyhodnocení byla dále použita databáze difrakčních dat PDF-2, verze 2011 (International Centre for Diffraction Data, Pensylvania, USA).

Pro ověření přítomnosti fází a také pro semikvantitativní analýzu byl použit program Bruker Topas verze 4.1. Kvantifikace je založena na Rietveldově metodě strukturní analýzy z práškových difrakčních dat a spočívá v modelování difrakčních spektra s použitím známých strukturních dat (mřížkové parametry, pozice atomů ve struktuře, prostorová grupa, obsazovací faktory atd.) pro jednotlivé minerály a s následným porovnáním s naměřeným difrakčním záznamem pomocí vícerozměrné regrese. Vstupní strukturní data byla převzata z Bruker Diffrac^{TM} Topas structure database. Kvantifikace montmorillonitu,

REPP-CO2 V1.7 Výsledky analýz vzorků - stanovení petrografického složení hornin z makrovzorků a výbrusů pomocí metody mikroskopie a RTG difrakce



Obr.8 Fázové složení vzorku Brodské 63.

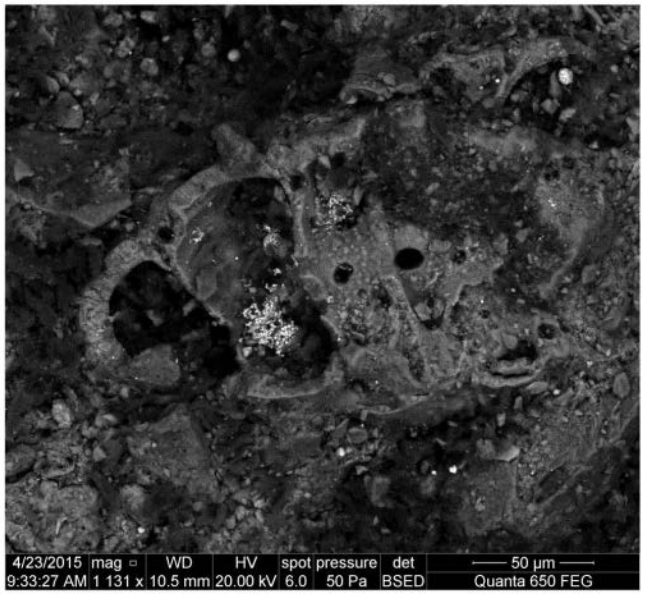


Obr.9 Fázové složení vzorku Brodské 64.

Whole chemical composition was evaluated by microscopic observation and X-ray powder diffraction.

BASIC DATA FOR STORAGE COMPLEX ASSESSMENT
Task 1.2. Geological data.

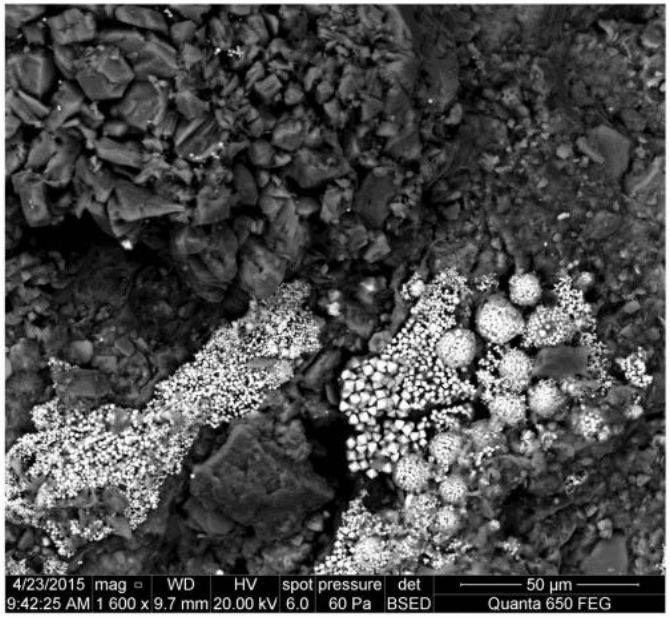
REPP-CO2 V1.7 Výsledky analýz vzorků - stanovení petrografického složení hornin z makrovzorků a výbrusů pomocí metody mikroskopie a RTG difrakce



Obr.11 Brodské 45 - bioklast

Bioclasts.

REPP-CO2 V1.7 Výsledky analýz vzorků - stanovení petrografického složení hornin z makrovzorků a výbrusů pomocí metody mikroskopie a RTG difrakce



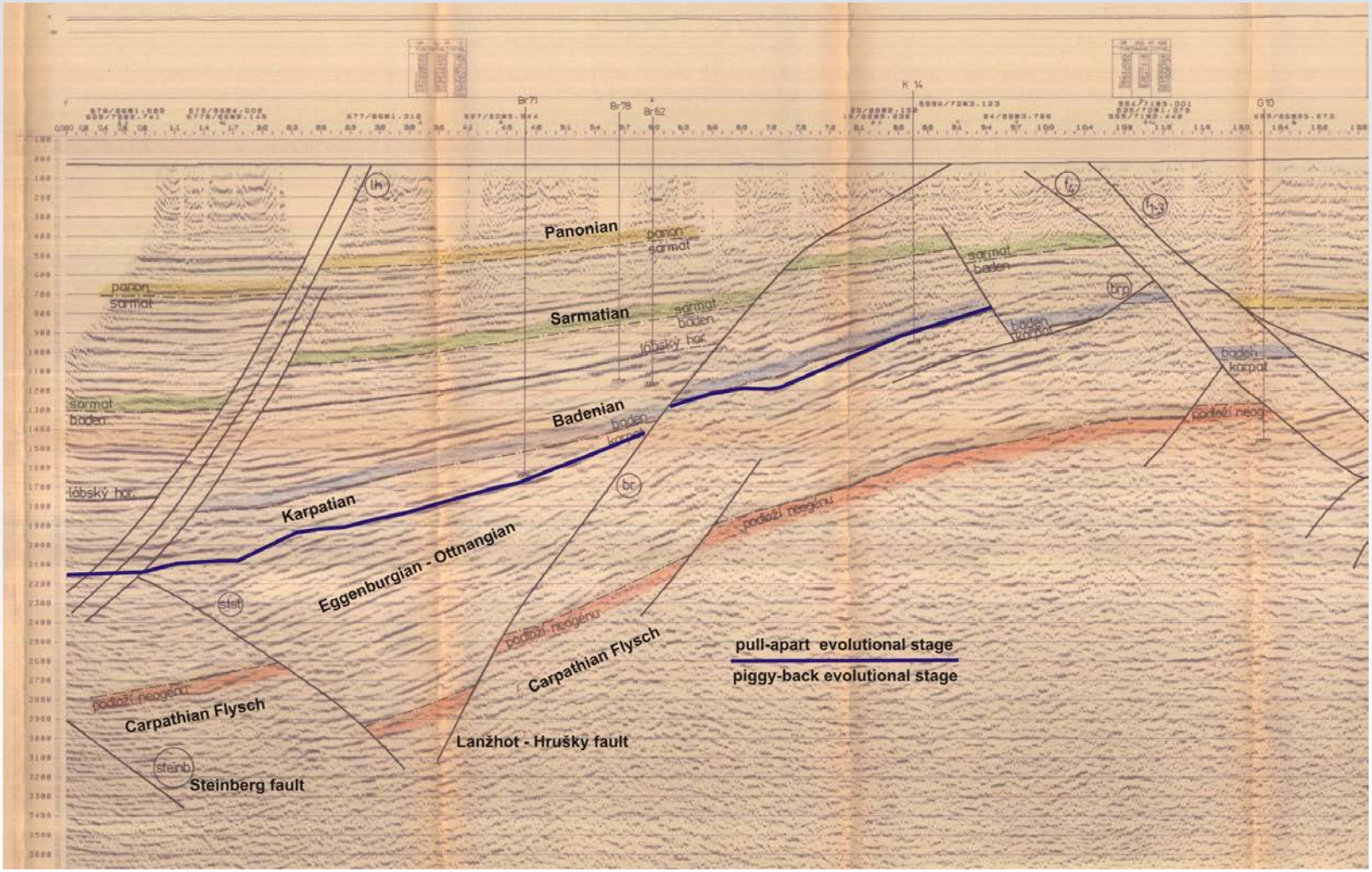
Obr.12 Brodské 45 – světlé částice tvořeny pyritem, šedé částice sádrovcem.

Gypsum (gray) and pyrite (ligt).

Microprobe microanalysis; morphology of microcrystals is easily observed in SEM/SE (detection of secondary electrons in SEM).

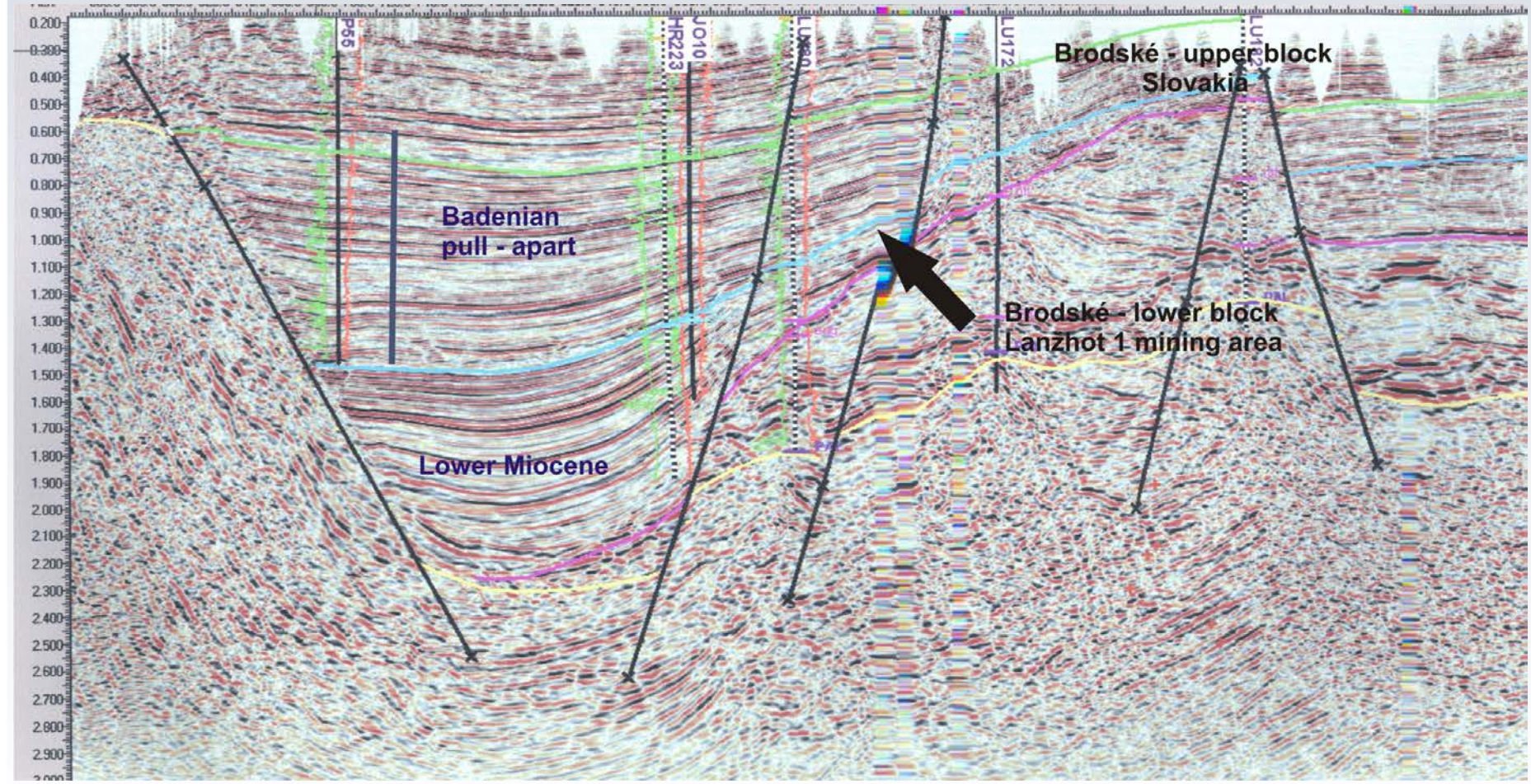
BASIC DATA FOR STORAGE COMPLEX ASSESSMENT
Task 1.3. Geophysical data.

Seismic depth section 2D S22/89 trough the Neogene sediments in the oil and gas field Brodské.

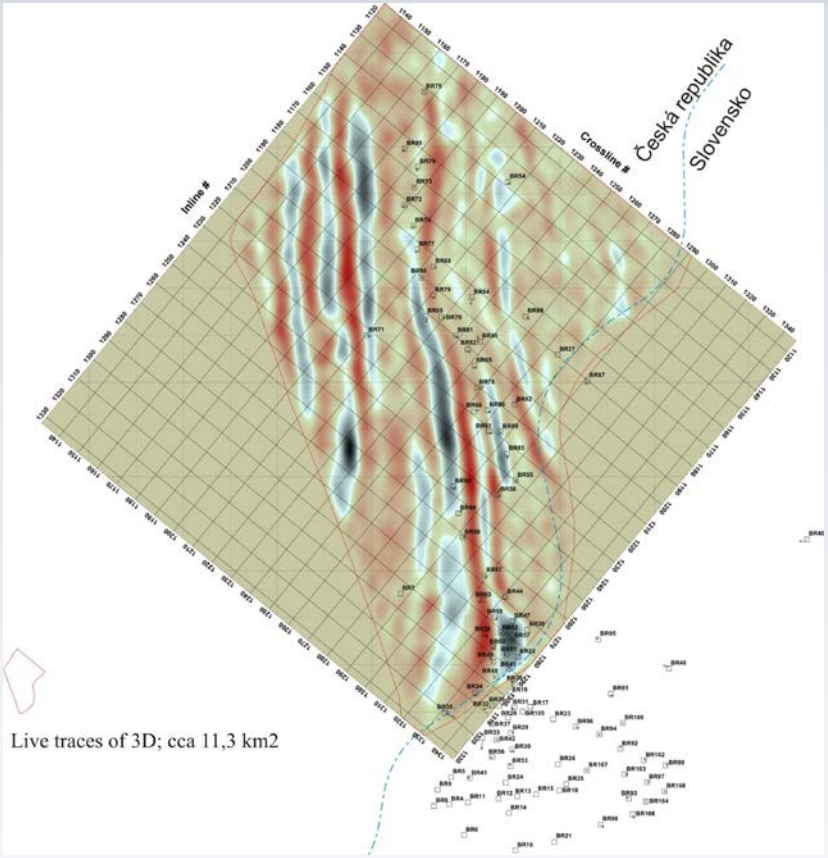


BASIC DATA FOR STORAGE COMPLEX ASSESSMENT
Task 1.3. Geophysical data.

Example of 3D seismic line north of the Brodské oil field (depth section). Published data of Moravian Oil Company.

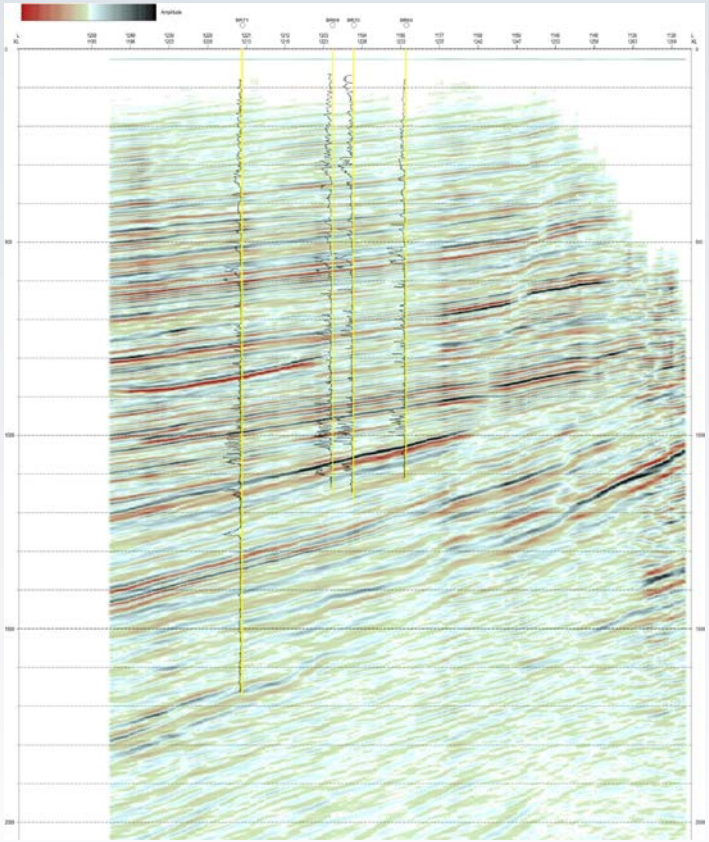


BASIC DATA FOR STORAGE COMPLEX ASSESSMENT
Task 1.3. Geophysical data.

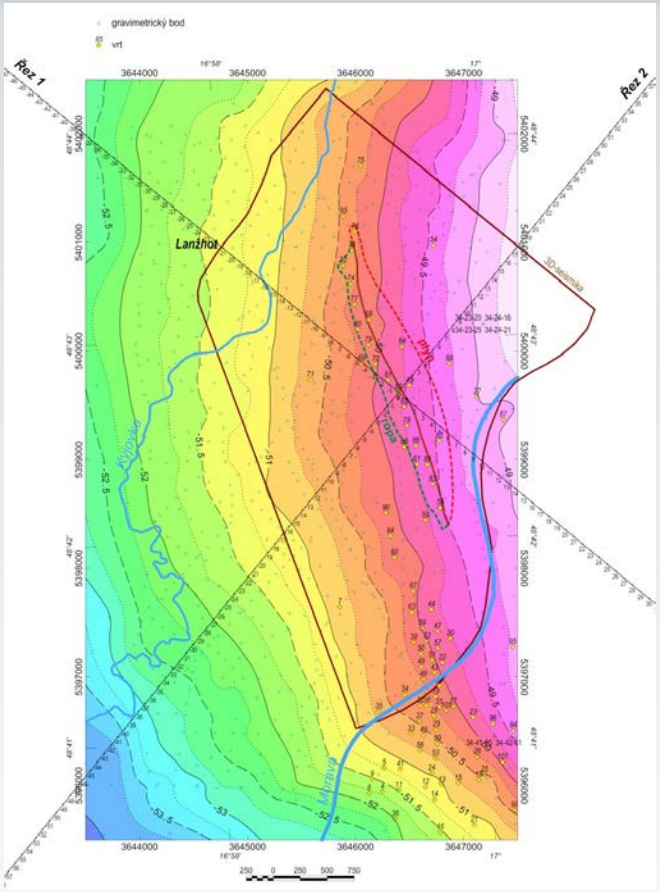


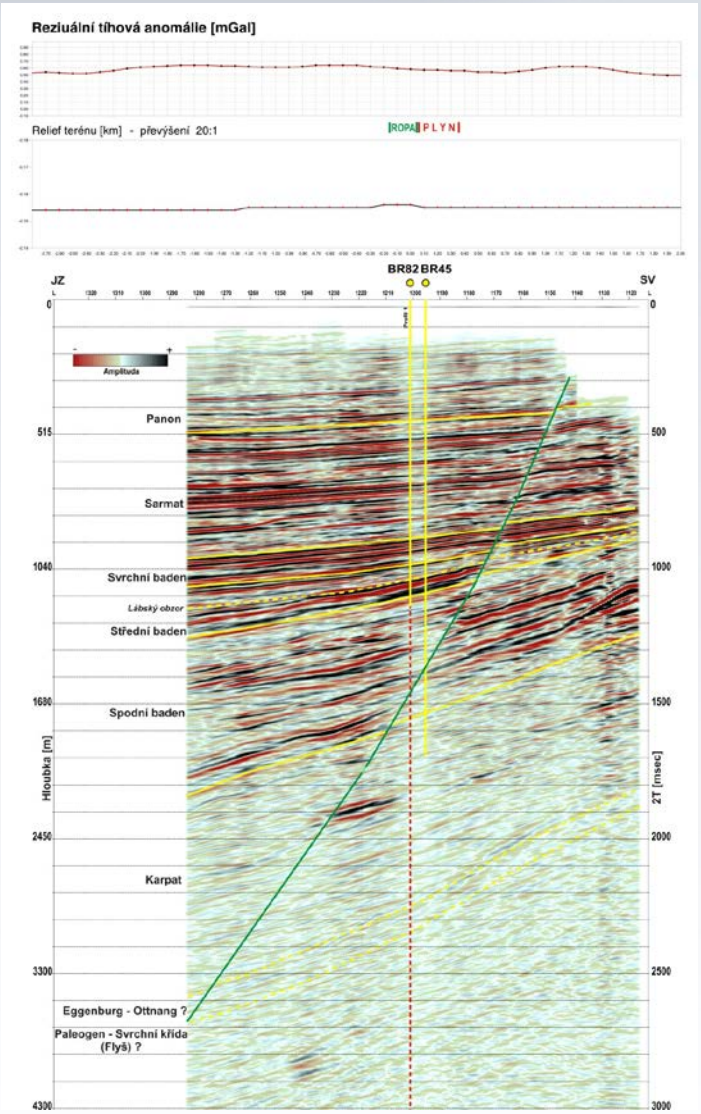
Area of live 3D seismic traces (inlines and crosslines) with wells location (author M. Pereszlényi).

3D time crossline 1120 (wells Br-71, Br-69, Br-70, Br-64, (author M. Pereszlényi).



BASIC DATA FOR STORAGE COMPLEX ASSESSMENT
Task 1.3. Geophysical data.

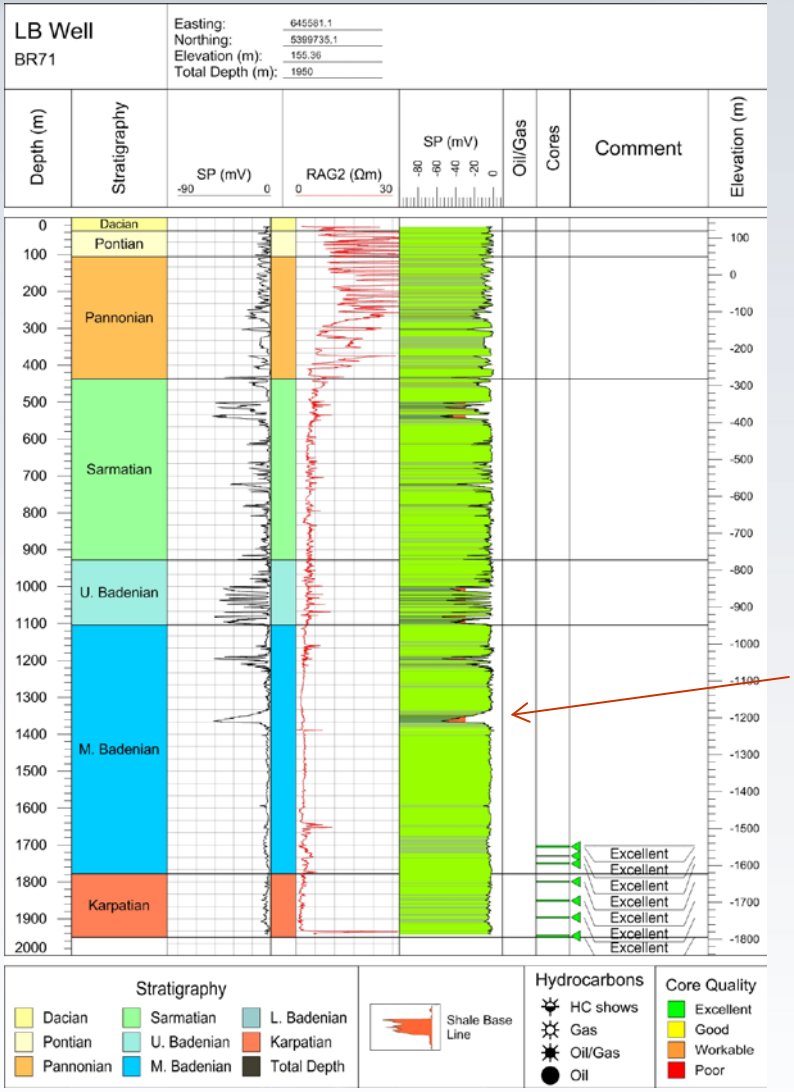




Schematic total Bouguer anomaly map from new gravity measurements and detail gravity and seismic 3D section 1 (NW-SE).

BASIC DATA FOR STORAGE COMPLEX ASSESSMENT
Task 1.3. Geophysical data.

Example of the complex inteptretation of the well Br-71 (authors J. Franců, L. Jurenka, S. Nehyba and O. Prokop). Principal input for static model of the site.



productive horizon

cores

BASIC DATA FOR STORAGE COMPLEX ASSESSMENT
Task 1.3. Geophysical data.

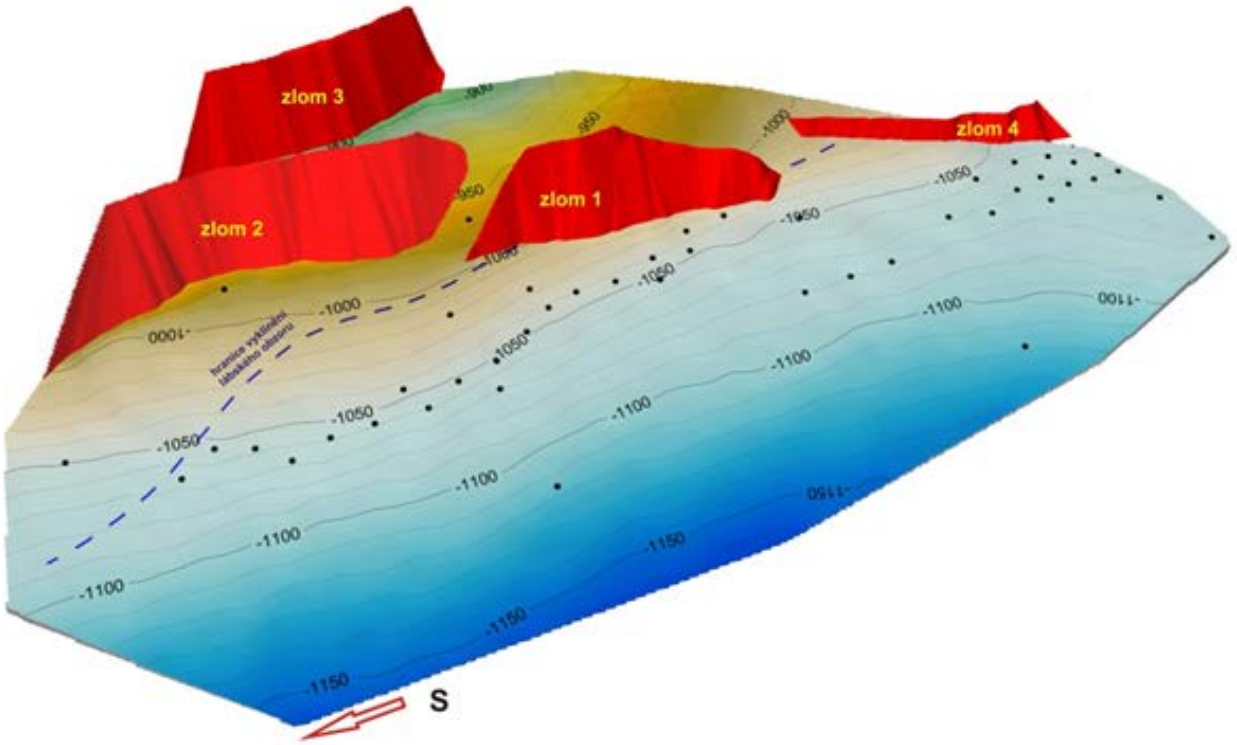


Fig. 14. 3D view of the LBr1 oil and gas bearing horizons. Time map on the top of the Lab horizon. Faults, which limit the deposit in the depth do not come to the surface and are terminated blindly. M. Pereszlenyi and J. Francu.

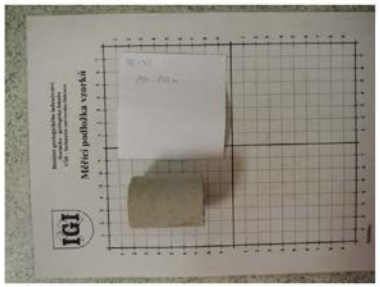
BASIC DATA FOR STORAGE COMPLEX ASSESSMENT
Task 1.4. Reservoir and caprock parameters.

Br-45 (1300 - 1307 m)

P_c (psi)	V_p (cc)	K [air] (mD)	K (mD)	φ (%)	V_b (cc)	V_g (cc)	ρ_g (g/cc)	ρ_b (g/cc)	b (psi)
600	17,21	1260,59	1211,17	27,47	62,66	45,45	2,65	1,93	0,612
1000	17,06	1266,52	1208,37	27,26	62,58	45,52	2,65	1,93	0,722
1450	16,91	1152,21	1152,21	27,06	62,50	45,59	2,65	1,93	$9{,}893 \cdot 10^{-6}$
600	17,06	1221,48	1163,41	27,22	62,67	45,60	2,65	1,93	0,749

Br-35 (850 - 855 m)

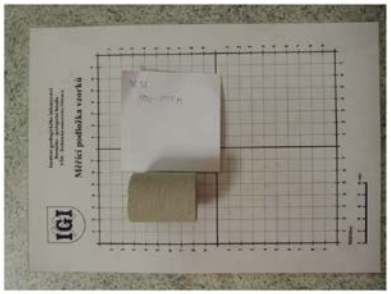
P_c (psi)	V_p (cc)	K [air] (mD)	K (mD)	φ (%)	V_b (cc)	V_g (cc)	ρ_g (g/cc)	ρ_b (g/cc)	b (psi)
600	8,39	0,035	0,035	14,76	56,91	48,51	2,62	2,23	$9{,}425 \cdot 10^{-6}$
1000	8,18	0,024	0,024	14,40	56,82	48,64	2,61	2,24	$9{,}693 \cdot 10^{-6}$
1450	7,87	0,016	0,016	13,88	56,73	48,86	2,60	2,24	$1{,}002 \cdot 10^{-5}$
600	8,07	0,020	0,020	14,18	56,90	48,83	2,60	2,23	$9{,}268 \cdot 10^{-6}$



REPP-CO2 V1.17 Výsledky nových petrofyzikálních měření

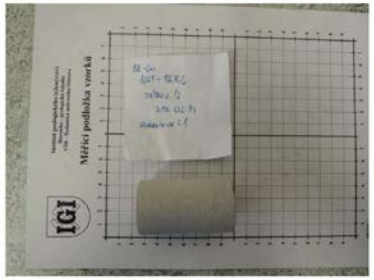
Br-52 (1150 - 1155 m)

P_c (psi)	V_p (cc)	K [air] (mD)	K (mD)	φ (%)	V_b (cc)	V_g (cc)	ρ_g (g/cc)	ρ_b (g/cc)	b (psi)
600	11,06	3,62	2,76	18,99	58,22	47,16	2,45	1,99	4,64
1000	10,78	2,42	1,73	18,53	58,14	47,37	2,44	1,99	5,96
1450	10,44	1,78	1,19	17,98	58,06	47,62	2,43	1,99	7,43
600	10,56	2,01	1,35	18,14	58,21	47,65	2,43	1,99	7,26



Br-60 (1665 – 1665,6 m)

P_c (psi)	V_p (cc)	K [air] (mD)	K (mD)	φ (%)	V_b (cc)	V_g (cc)	ρ_g (g/cc)	ρ_b (g/cc)	b (psi)
600	9,38	1,49	1,04	12,84	73,08	63,70	2,61	2,28	6,56
1000	9,30	1,39	0,91	12,75	72,97	63,67	2,61	2,28	7,99
1450	9,23	1,25	0,85	12,67	72,86	63,63	2,62	2,28	6,88
600	9,33	1,42	0,92	12,76	73,08	63,76	2,61	2,28	8,04



New petrophysical parameters measurements.

BASIC DATA FOR STORAGE COMPLEX ASSESSMENT
Task 1.4. Reservoir and caprock parameters.

Furthermore, we have prepared for IRIS oil from the site Hrušky. This fresh oil from one well from Hrušky site was used for experimental simulations.

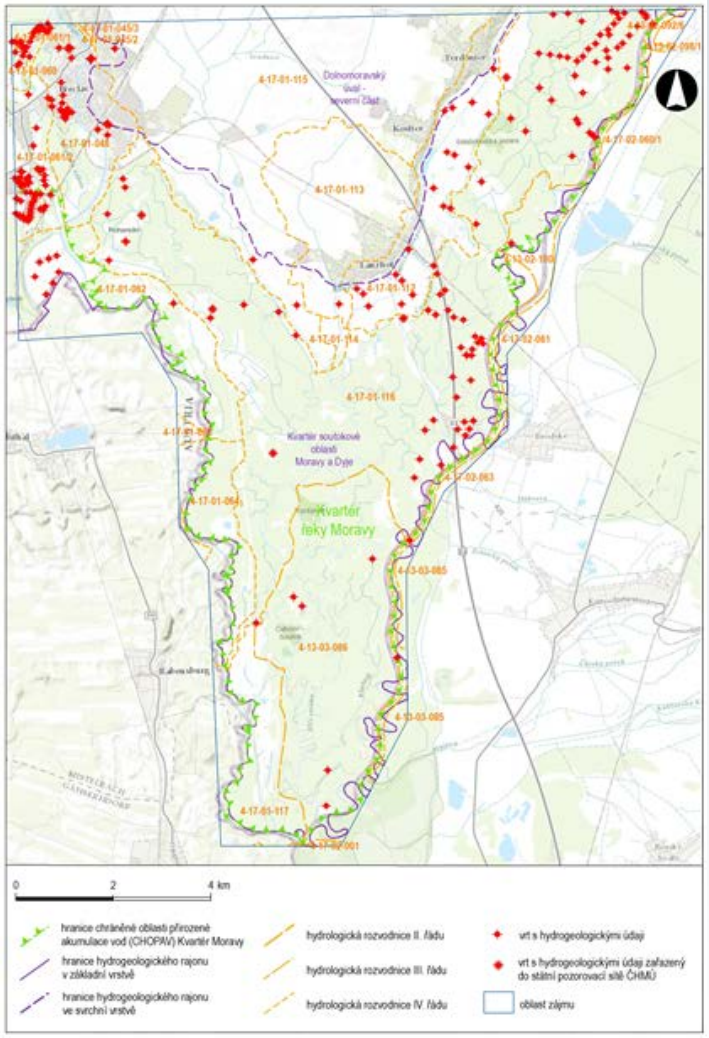
BASIC DATA FOR STORAGE COMPLEX ASSESSMENT
Task 1.5 Hydrogeological parameters.

Task 1.5: Planned deliverables

ID	Description
D1.20	Shallow groundwater regime report for the Brodské reservoir + data file to be stored in the project geodatabase

Typical Landscape in the area with periodical floods.

18. 5. 2015



Schematic map of hydrogeological objects in the broader area.

ACTIVITY 1:
BASIC DATA FOR STORAGE COMPLEX ASSESSMENT
Task 1.7 Geomechanical parameters

Hrusky-5
Core 13, Box 2, Interval 1946 – 1949 m

Diameter 6 cm; Lenght 3 pcs 11, 13 and 23 cm

Middle Badenian in interval 1600 – 1962 m from structural position Brodske locality - the deposit.

BASIC DATA FOR STORAGE COMPLEX ASSESSMENT
Task 1.7. Geomechanical parameters.

1 Core shaping

Anders Nermoen

Two approaches were employed to shape the cores into cylinders with an initial diameter and lengths. Drilling was performed using NaCl – brine (in May) and Isopar – H (in June/July) for cooling. In addition, we used a turning lathe machine to shape the core (15th of June). The end-pieces can be used later for e.g. geochemical investigations if that should become necessary. The core residuals are sent back to Czech Republic. Before the cores are mounted into the test cells they are trimmed at both ends.

1.1 Drilling

Cores were put in plastic bags and placed in gypsum within a box to be held in place during drilling (see left part of Figure 1). The cores were given a drilling number from 1 to 10, Table 1. Here the status of the drilling and test type is shown. After the drilling, the core residuals were dried and shown in Figure 2.

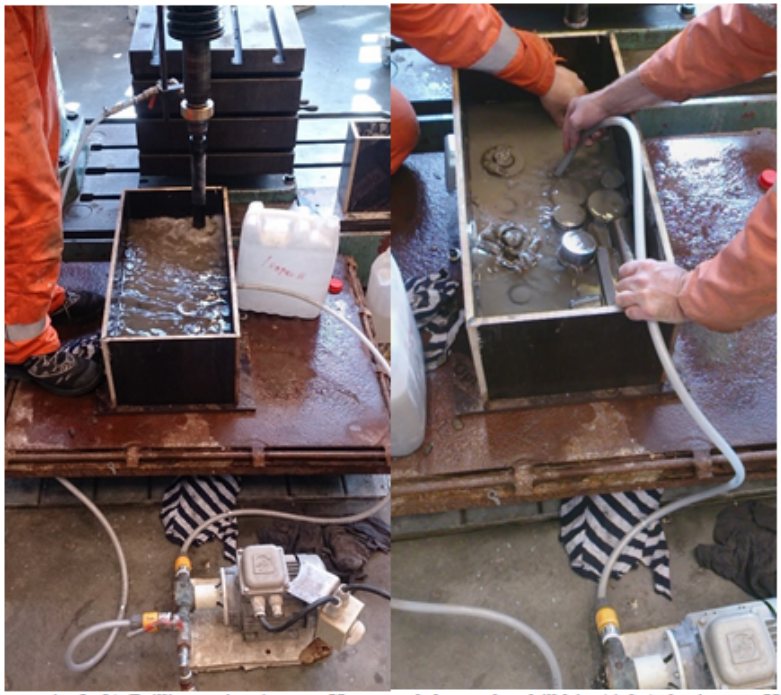


Figure 1. (left) Drilling using isopar H to cool down the drill bit. (right) the isopar H is sucked out of the box after drilling. (16th of June 2015).

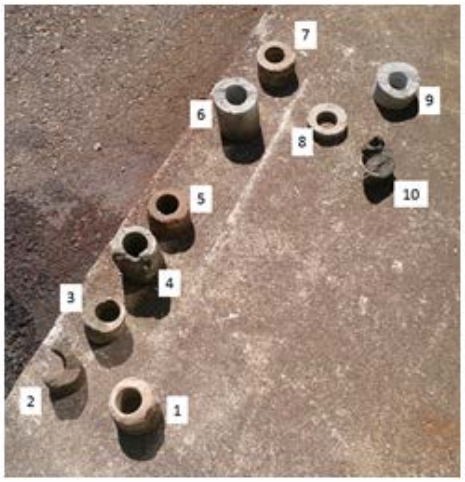


Figure 2. Core residuals after drilling (16th of June). Similar core drilling residuals are from the other tests as well. This material is to be sent back to Czech Republic.

BASIC DATA FOR STORAGE COMPLEX ASSESSMENT
Task 1.8 Seismicity

Task 1.8: Planned deliverables

ID	Description	Deadline
D1.32	Seismologic catalogue of the Site	9/2015

REPP-CO2: Katalog zemětřesení v širším okolí LBr-1

Jana Pazdírková, Ústav fyziky Země PřF MU Brno, 2015

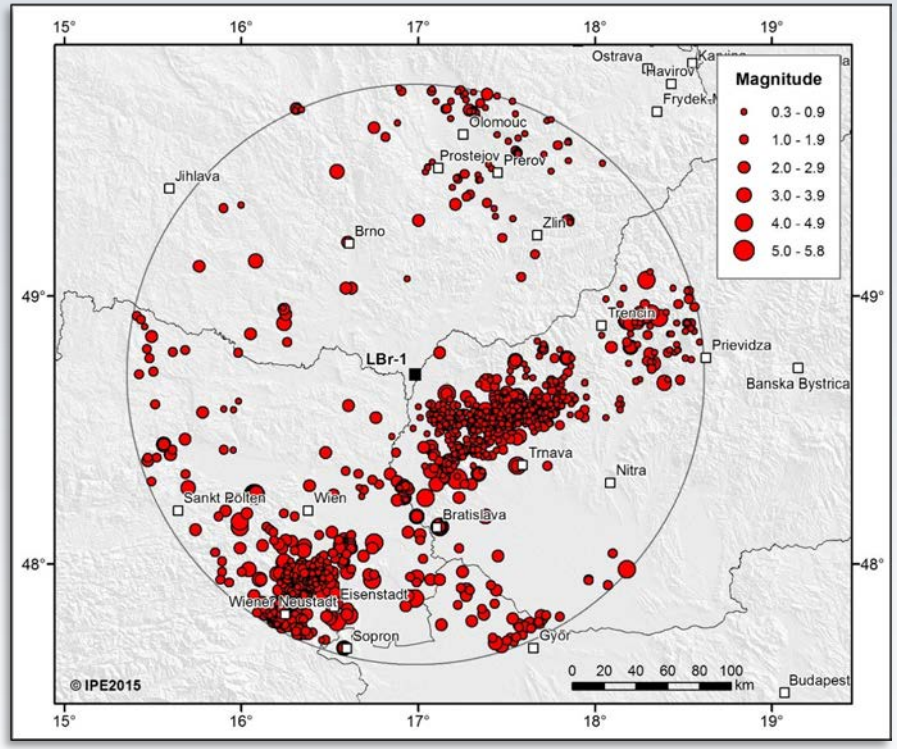
Datum	Čas vzniku [UTC]	Souřadnice epicentra zem.šířka ° N	zem.délka °E	Hloubka [km]	Magnitudo	Intenzita	Obec	Vzdálenost od LBr-1 [km]
1283 5 18		47.815	16.242	8	3.5	5.0	Wiener Neustadt	114
1411 6 1		47.815	16.242	8	3.5	5.0	Wiener Neustadt (?)	114
1515 2 26		48.370	17.560		4.5	6.5	Trnava	57
1538 8 30		47.680	16.580		3.2	4.0	Sopron	119
1581 7 16	22 45	48.071	16.581	8	4.3	6.0	Schwadorf (?) nebo 21.7.1581	77
1586		48.370	17.560		4.6	7.0	Trnava	57
1590 5 28		47.680	16.580		3.2	4.0	Sopron	119
1590 6 19		47.680	16.580		3.2	4.0	Sopron	119
1590 6 29		48.140	15.990	12	4.5	6.0	Hochstrass	97

Years 1590 – August 2015

2015	9	6	8	5	43.2	48.515	17.642	4	0.9		Nižná	53
2015	9	6	20	30	21.9	48.504	17.311	3	0.8		Plavecký Mikuláš	33
2015	9	10	2	29	31.4	49.475	17.053	13	0.5		Prostějov	85

Regional earthquake catalogue
(IPE Brno; Jana Pazdírková)

- Region 120 km around LBr-1 centroid
- Total 1478 seismic events in period 1283-2015 A.D.
- Magnitude M_L range 0.3 – 5.8
- ~1/3 of events from macroseismic data (~before 1995), ~2/3 instrumental data (mostly after 1995)
- Strongest earthquakes:
  - M_L 5.8 Neulengbach (Austria, 1590; 84 km to LBr-1)
  - M_L 5.7 Dobrá Voda (Slovakia, 1906; 38 km to LBr-1)
- Nearest earthquake:
  - M_L 2.6 Kopčany (Slovakia, 1874; 13 km to LBr-1)



Geodatabases - an integral part of all partial tasks solved within the project.

An example of the database – data file with newly calculated well log data.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	WELL	Depth_1_m	Depth_2_m	Depth_interval_m	R0	R0_unit	SP_Mv	Vsh_perc	F_factor	F_factor_	Porosity	Porosity_	Correction_for_clay_content	Calculated_porosity	Comment
2	BR-90	1085	1190	105											
3	BR-90	1085	1156	71	5	Ωm	0	100						0	seal
4	BR-90	1156	1190	34	5		-50	0	14,3	F = R0/Rw Rw=0,35	20,0	p=F*(-0.55)	0	20	
5	BR-89	1040	1110	70											
6	BR-89	1040	1084	44	4		0	100						0	seal
7	BR-89	1084	1102	18	6		-45	0	17,1	F = R0/Rw Rw=0,35	18,0	p=F*(-0.55)	0	18	gas field
8	BR-88	952	1020	68										0	seal
9	BR-86	1040	1110	70											
10	BR-86	1040	1085	45	3,5		0	100						0	seal
11	BR-86	1085	1110	25	3,5		-35	36	10,0		23,5		4	19,5	ložisko
12	BR-85	1050	1110	60											
13	BR-85	1050	1095	45	3		0	100						0	seal
14	BR-85	1095	1099	4	6		-5	88	17,1		18,0		10	8	
15	BR-85	1099	1104	5	3		0	100						0	seal

Parametr	Popis			
R0	rezistivita	(Ωm)		
SP	spontánní polarizace	(mV)		
Vsh	jílovitost	(%)	Vsh = 1 – (SP / SSP)	
F	formační faktor	F = R0/ Rw = a * p E-m		
Por	pórovitost	(%)		
SSP	statický potenciál spontánní polarizace		SSP = -K log(Rmf / Rw)	
seal	těsnící jílovitý horizont			
gas field	ložisko plynu			

Geological data for Activity 4.
Reliquidation of old well Brodské-72.

Fig. 5. Wear of the drilling bit during the reopening the well Brodske-72.

Fig. 6. Returns from the bailer (sludge pump) from the well brodské-72.

Fig. 7. Drilling cutter 147 mm.

Fig. 8. Launch of the packer in ti the well Brodské-72.

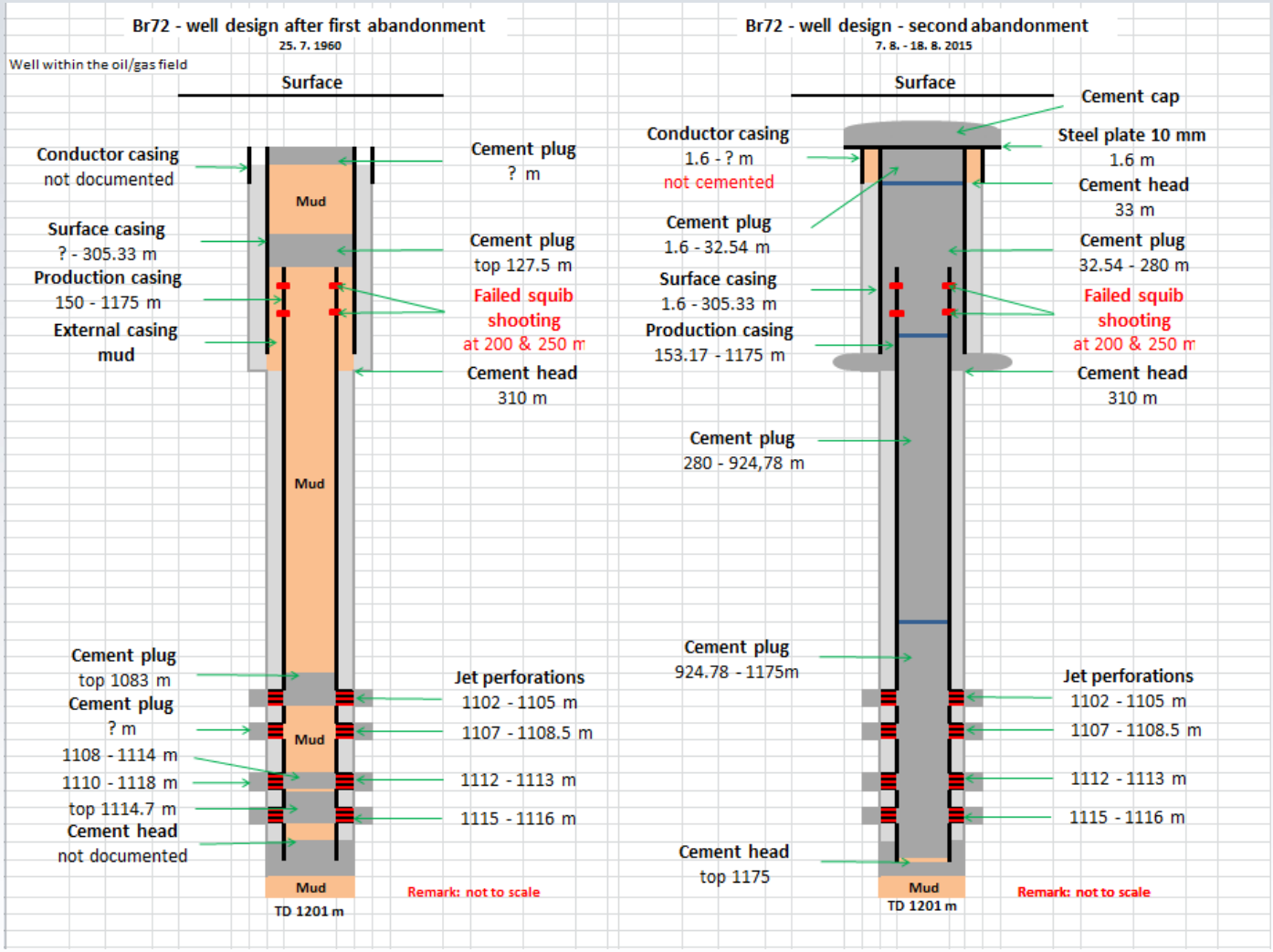
Geological data for Activity 4
Reliquidation of old wells Brodské – Brodské 64.

Likvidace starých ekologických zátěží

Vrt Brodské 64

MND
Energy from Nature

Geological data for Activity 4.
Reliquidation of old wells Brodské – 72.



CONCLUSIONS

- In our project have met the needs primarily of the modern software for modeling geological processes and 50 years old substrates (cores, reports, analyzes), which were created under different methodological conditions. It is therefore necessary Czech written and drawn most of data (poor quality for scanning, partly illegible) converted into modern form as input for computers.

- The preserved archival material found no mineralogical analysis of rocks and only a small amount of data on permeability, porosity, pressure and temperatures. It is therefore necessary to carry out a new analysis of the preserved material cores.

- Due to the current date and status of the project is clear that some experimental laboratory tests not going to meet the scheduled quantity and quality or not at all. It is necessary to develop some additions to the project and modify its text into reality!

CONCLUSIONS

- **In 1944-1948, before opening the exploration of the LBr-1 oil and gas field, exploratory drilling on lignite was performed in the area, using the so called "counterflush" technology (CF, reversed flush boring). The maximum drilling depth was 210 m. Within the extent of the LBr-1 field only the L-138 well occurs, wells L-90 and L-50 are in the vicinity (see schematic map). The first assessment of risks related to possible interconnection of these shallow CF wells with the gas and oil bearing deep-seated horizons shows that this risk is low, because of the sealed faults that limit the reservoir at depth and do not extend up to the surface, disappearing from seismic signal well below the level of the CF wells.**

- **Currently, the ecological destruction of boreholes at the locality funded from the state budget as the removal of old environmental burdens. This work is done by a specialized company. In the area of the LBr-1 field (Brodske North) itself, only wells Br-58, Br-68 , Br-72 and Br-78 (see schematic maps) have been re-abandoned so far. There are 18 further wells where only the initial abandonment at the end of production was carried out, including the wells Br-62 and Br–64 with recorded accidents. These wells are therefore potentially risky from the CO_2 leakage point of view and need to be examined in detail.**