



**Energize the CEE Region  
Focusing Reliable Energy Security**

**Workshop**

**16-17 November 2023, Visegrád**

**Society of Petroleum Engineers**



# Exploration results, challenges and solutions of Nyékpuszta HPHT gas-condensate field, SE Hungary

**Viktor Lemberkovics**<sup>1</sup>

**Endre Dombrádi**<sup>2</sup>

**Károly Kiss**<sup>1</sup>

**Tamás Szakál**<sup>1</sup>

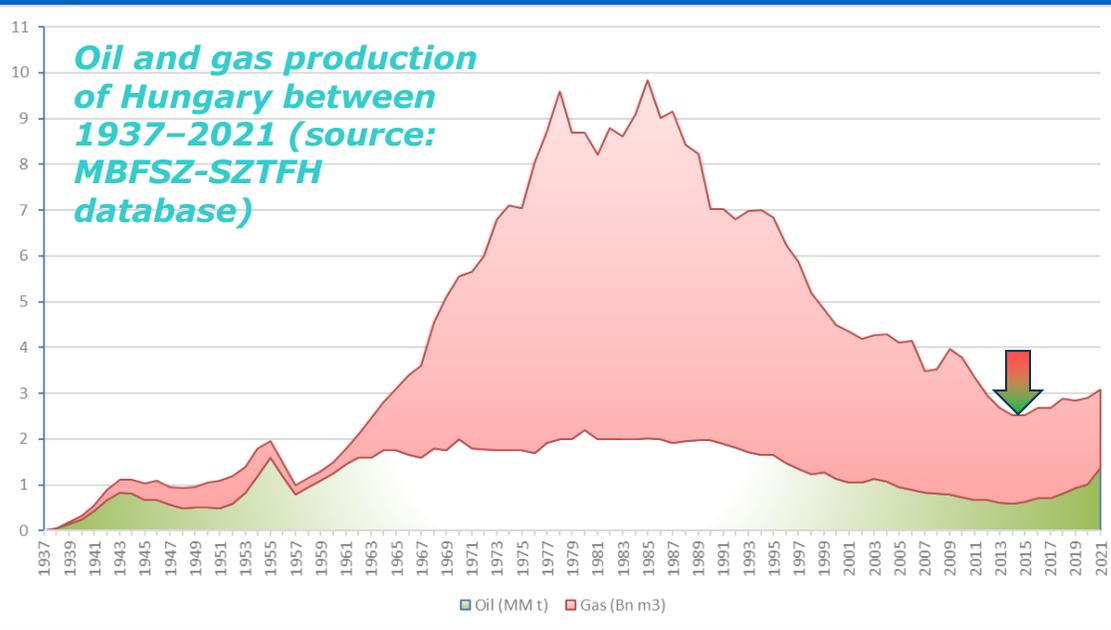
**Gábor Bada**<sup>2</sup>

<sup>1</sup> MVM CEEnergy Zrt.

<sup>2</sup> TDE-Aspect group



# Unconventional HC E&P in Hungary – *the reasons*



- ✓ > 300 HC field and > 2.9 billion barrel oil equivalent (bboe) reserve to date
- ✓ >2.4 bboe is produced, cca. 2/3 gas, 1/3 liquid HC dominantly from **conventional reservoirs**
- ✓ **Most significant discoveries were happened at 70's!**
- ✓ **Domestic production is slightly increasing (oil ↑, gas ↓) but today cca. 75-80% of HC is imported**

**Limited running room to discover „significant” conventional resources, but increasing pressure for HC supplying stability (war, economical crisis, instable geopolitical situation) ⇒ intensify domestic E&P ⇒ focus on unconvensionals.**

## Resource triangle (HOLDITCH 2013)

Conventional reservoir thin section

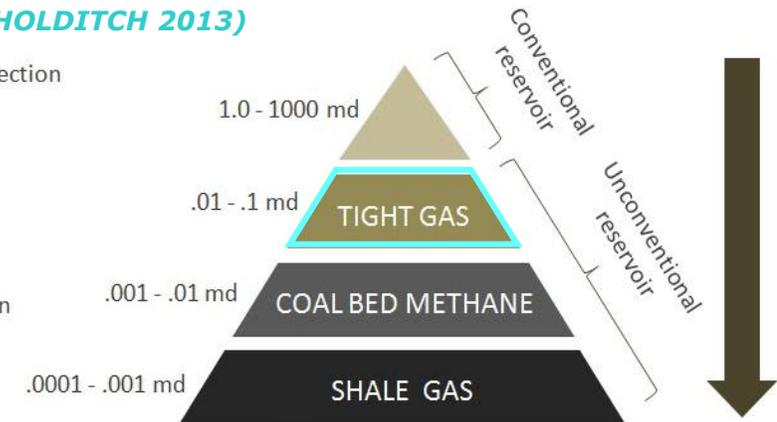


Image source (3)

Tight gas reservoir thin section



Image source (3)



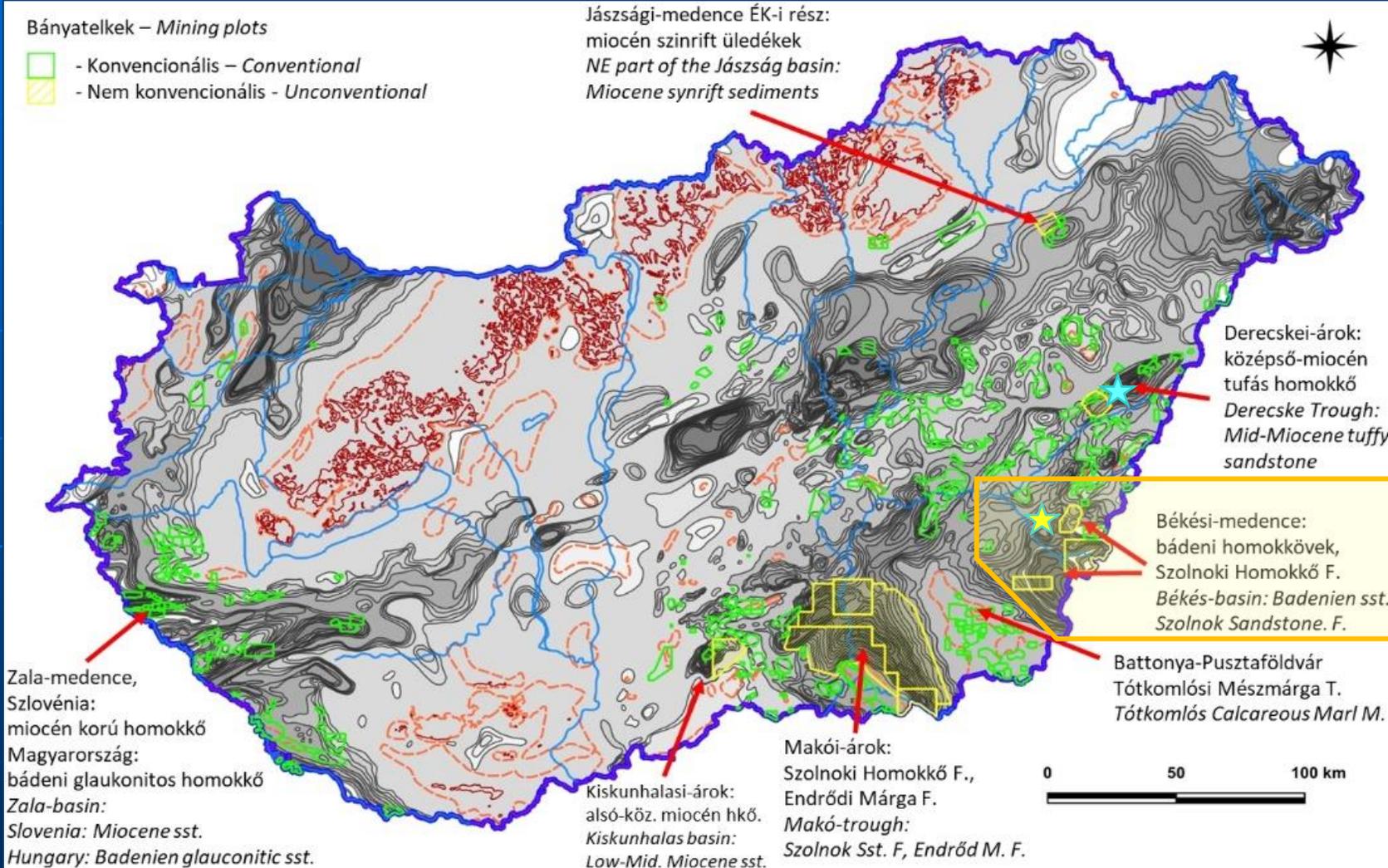
From top to bottom (2)

- Increasing \$\$\$\$
- Increasing technical challenge
- Decreasing permeabilities

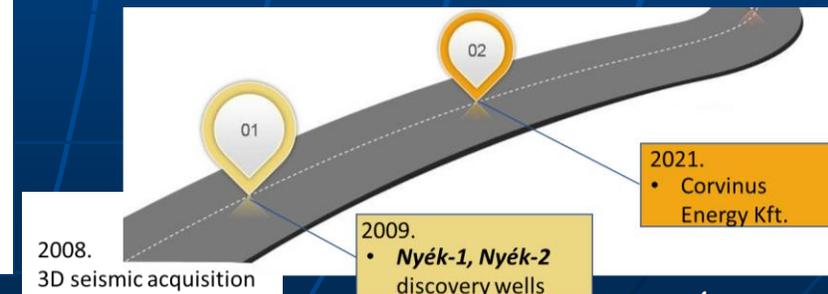
1.) [http://www.naturalgas.org/overview/unconvent\\_ng\\_resource.asp](http://www.naturalgas.org/overview/unconvent_ng_resource.asp)  
 2.) [http://www.necanews.org/dev/documents/090922\\_pflug\\_gerhard\\_1.pdf](http://www.necanews.org/dev/documents/090922_pflug_gerhard_1.pdf)  
 3.) <http://energy.usgs.gov/factsheets/Petroleum/reservoir.html#fig2>

# Hungary – „Adaptation of US analogies”

Exploration map of unconventional hydrocarbon resources in Hungary (modified after KOVÁCS Zs. et al. 2018)

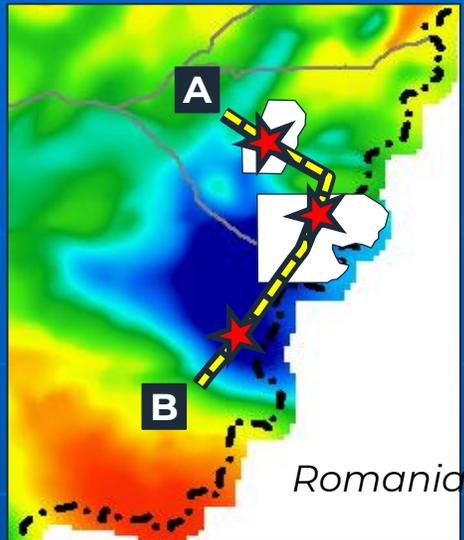


- ✓ Extensive exploration efforts from 00's
- ✓ Economically limited success so far – Beru, MOL & Zala basin, Slovenia
- ✓ TDE/Aspect – MVM CEEnergy 2021: joint venture for Békés basin – Corvinus project



# Corvinus – original geological model

Theoretic geological model for tight gas sand accumulations in Békés basin – TDE/Aspect 2019

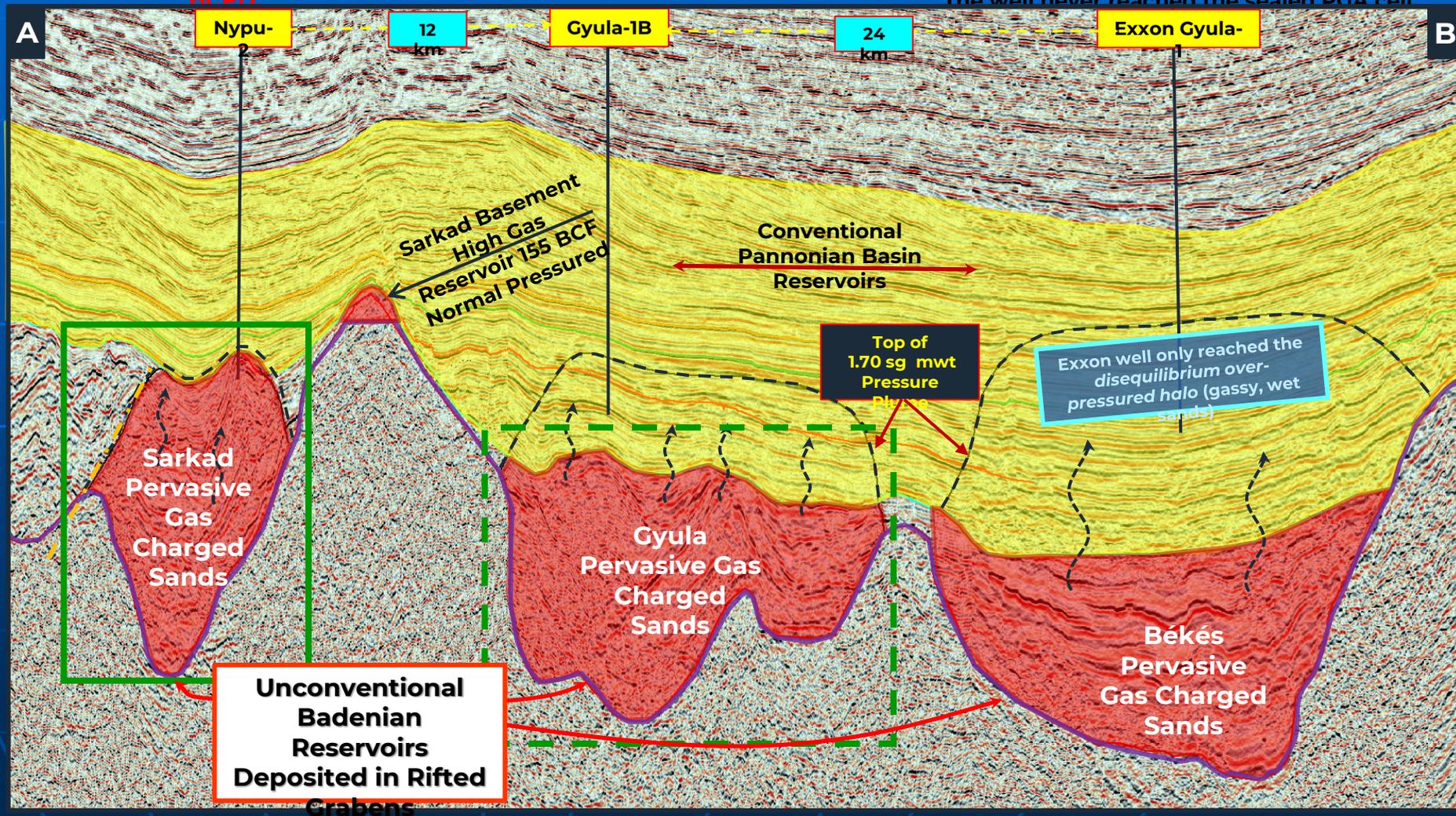


**HHE Nyek-2 drilled the top 70m of overpressured Nypu sands below the regional seal. Well was frac'd and stabilized at 1 MMCFPD & 151**

**Gyula-1B drilled highly gas charged Pannonian sands. Found an over-pressure plume above a potential PGA.**

**Exxon Gyula-1 drilled an over-pressured gas charged Lower Pannonian sand. The well was frac'd and completed flowing 0.05 MMCFPD with 181 BWPD.**

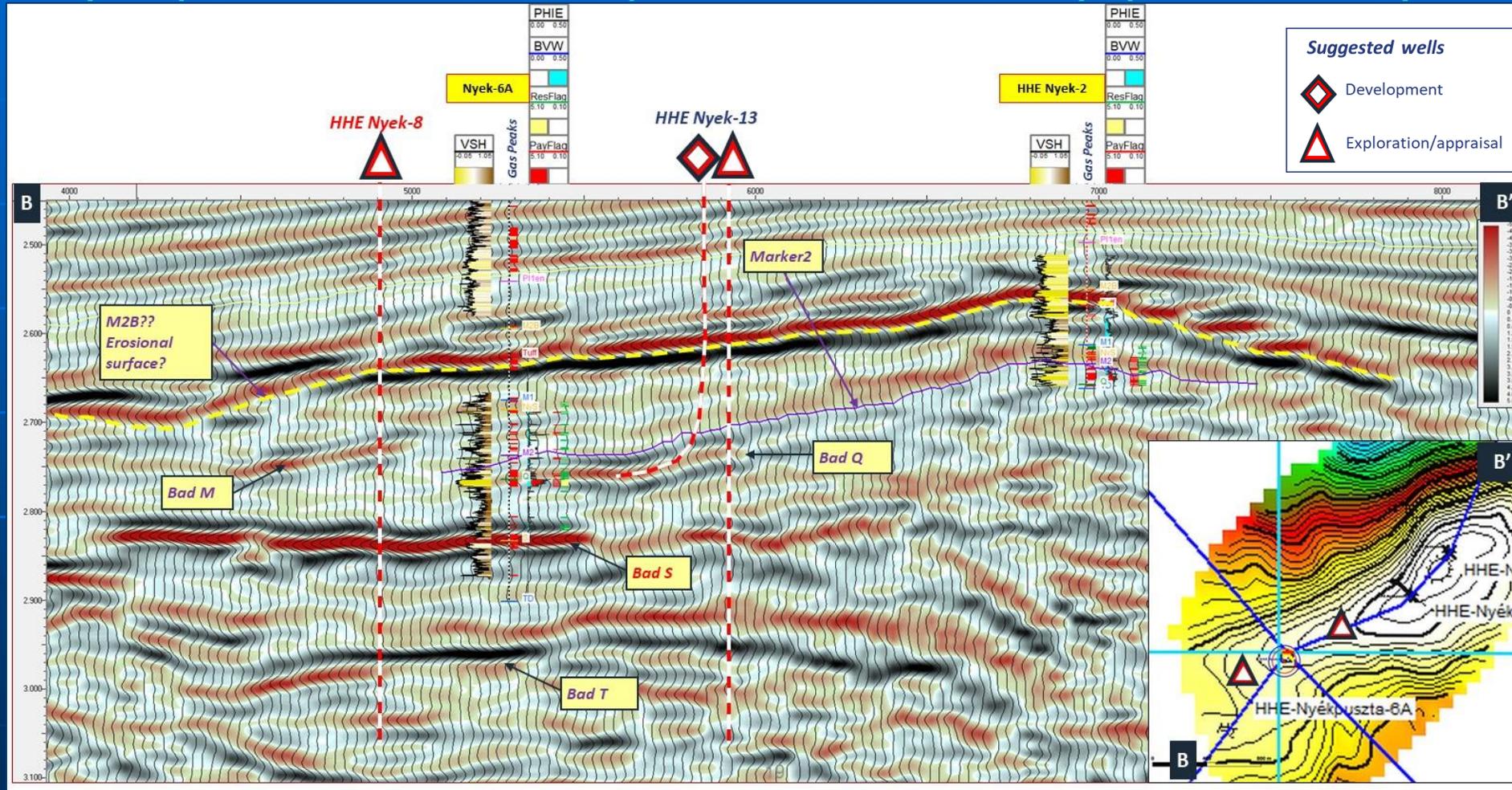
The well never reached the sealed PGA cell



- ✓ Model was called „pervasive gas accumulation” in tight reservoirs
- ✓ Dominantly seismic model calibrated with 1 well – Nyek-2
- ✓ Presence of good quality gas-condensate rich petroleum system

# Corvinus – geological model 2022

Partly interpreted seismic section across apex of structural maximum – Nyékpuszta HC discovery



➤ Several re-processing campaigns

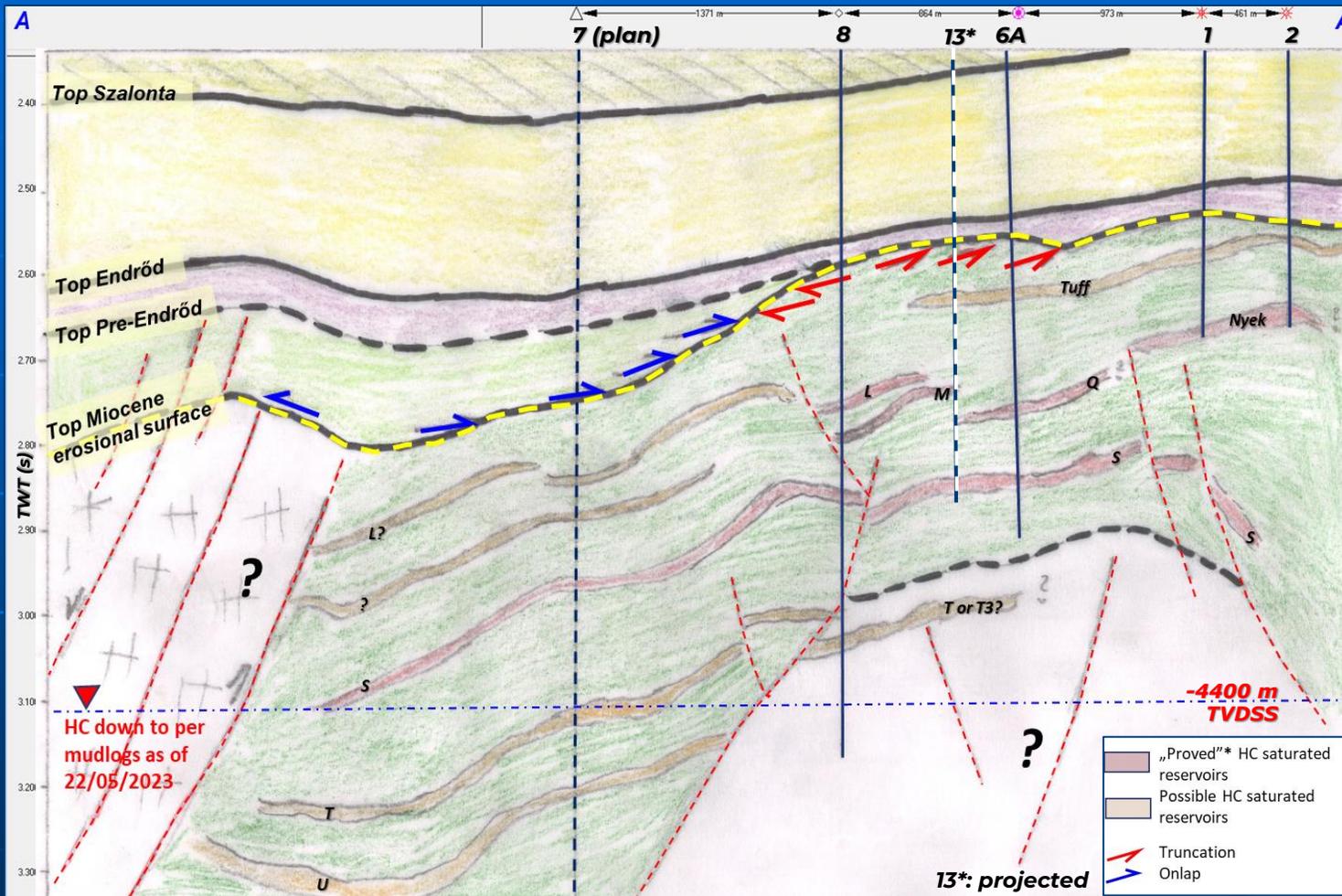
➤ Value of „anomalous” seismic reflectors

➤ Nyék-6A as proper calibration point

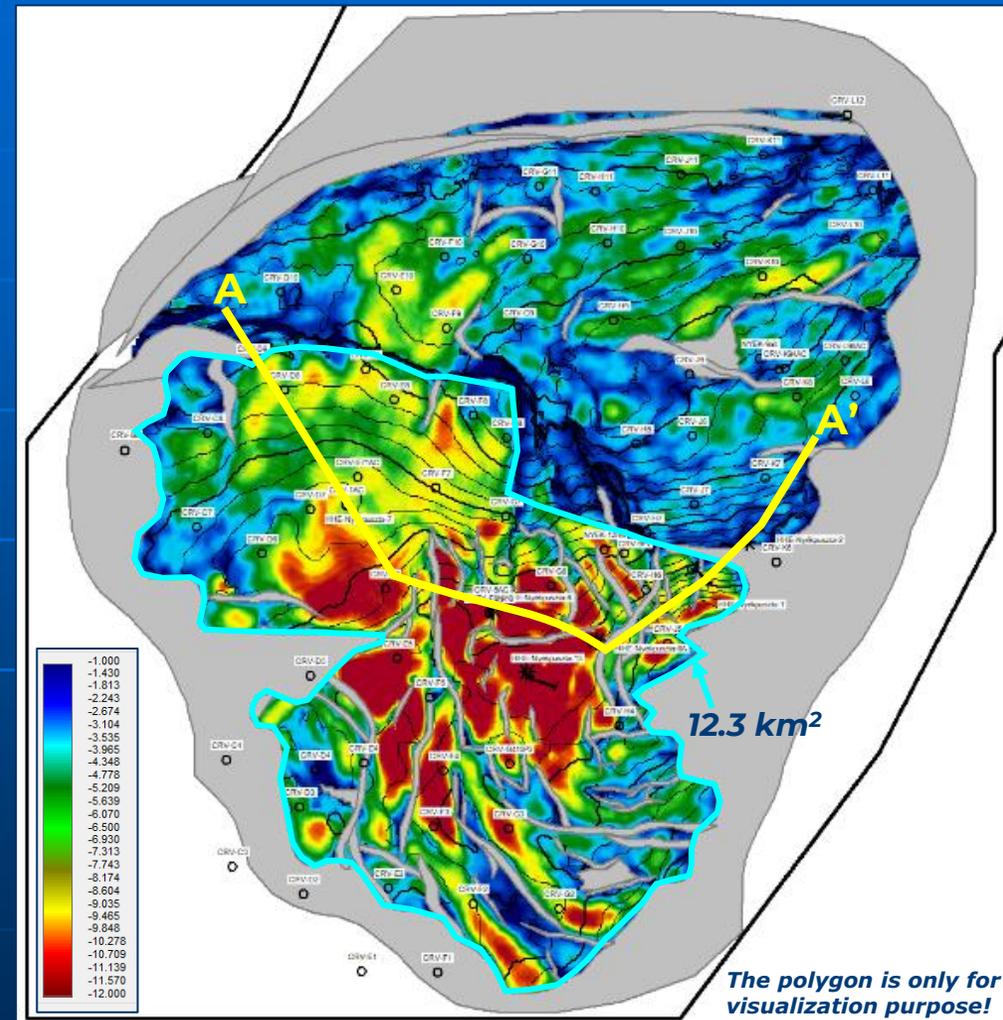
➤ Planned exploration and development wells

# Corvinus – current geological model

Idealized geological section across the structural apex of Nyékpuszta HC field



Bad-S reservoir – full stack amplitude attribute map



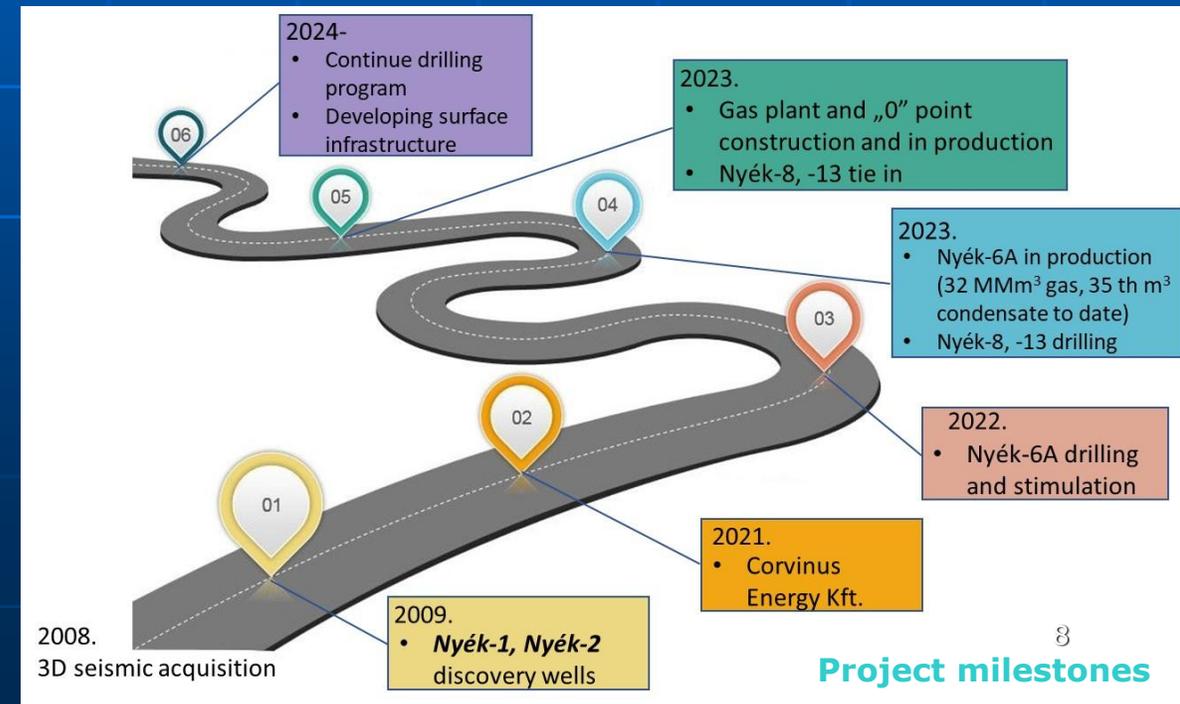
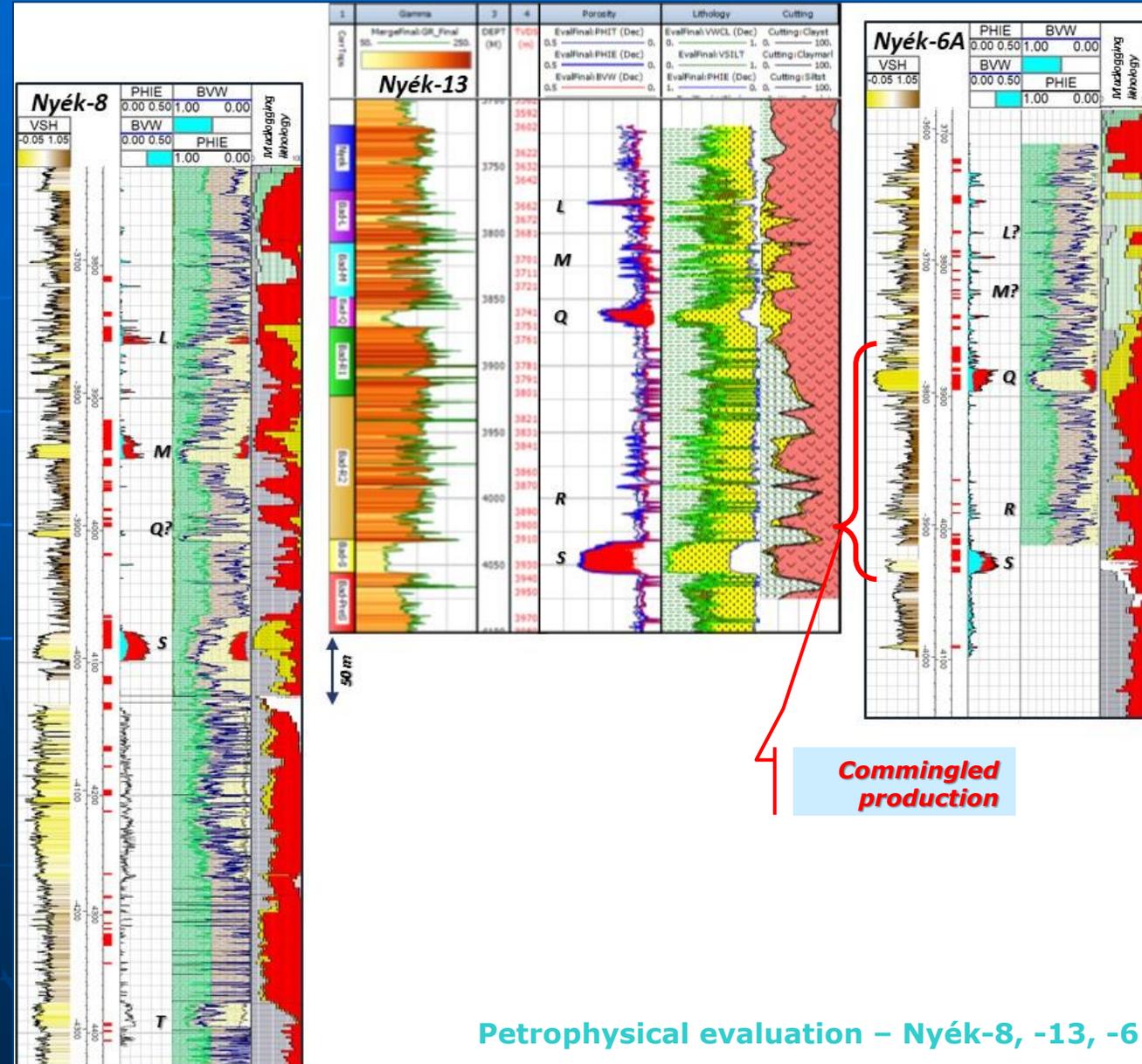
- Full 3D coverage, 2+3 wells
- >500 m\* rich gas saturated total thickness, HPHT
- Structurally inverted, further downdip potential

\* Based on mudlogs, petrophysical evaluation, well tests and production

# Corvinus – current geological model

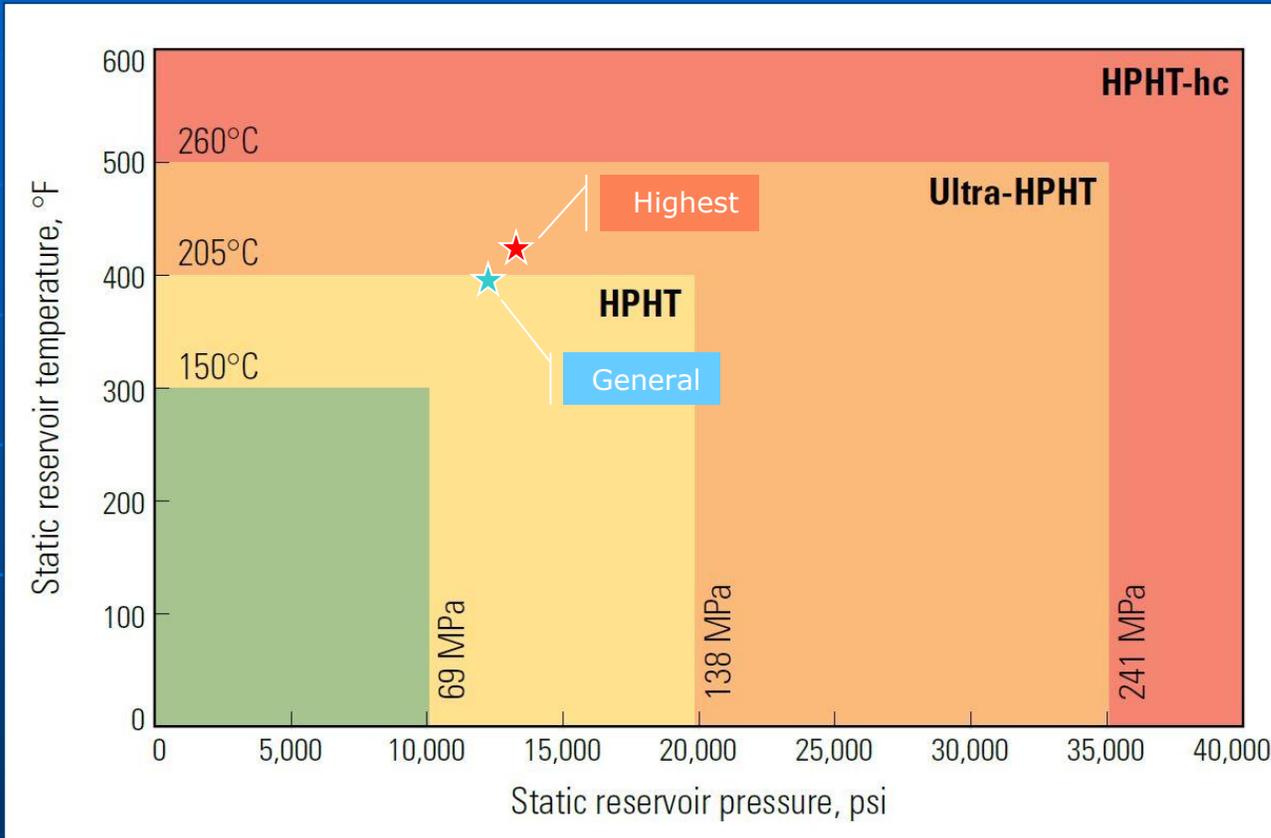
- 1-30 m thick tuffaceous sandstone, sandy tuff reservoirs ⇒ the main ones are seismically identifiable
- Various porosity (6-25%!), but low permeability (<0.1 mD)
- High gas saturation (55-70%) of pay zones

## ❑ Uncertainties?



# Challenges of information gathering

## Wireline + Mudlogging



- ❑ Limited tool availability - HPHT
- ❑ Limited tool selection - not developed (NMR, FMI, etc)

## Mudlogging + Wireline

Oil based (NADF) barite weighted mud (>2 kg/dm<sup>3</sup>)



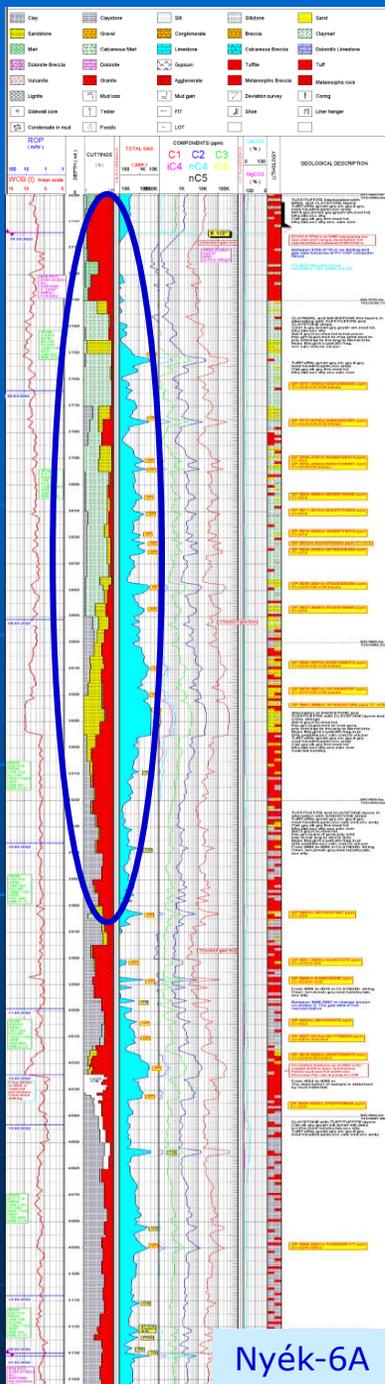
GeoVolve TERRABIT PDCs



Cuttings like „the sea of dilute shit“  
(after Ford Fairlane 😊)

# Challenges of mudlogging

## Masterlogs Nyék-6A & -13



## Cuttings

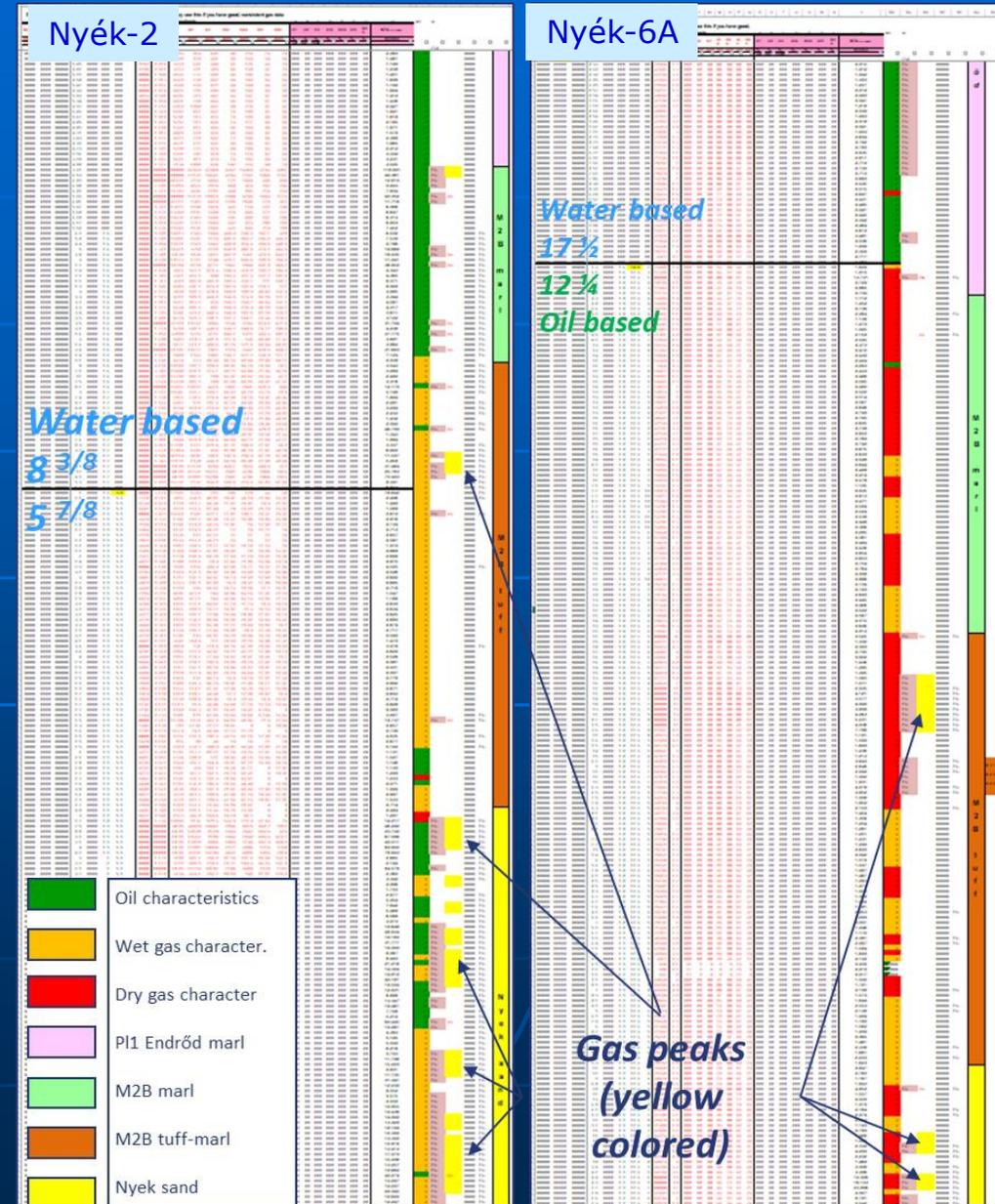
- Lithology and organic geochemistry are strongly affected by cleaning (typically with diesel)

## Gaslogs

- Oil based mud is changing drilled gas composition – typical drying effect  $\Rightarrow$  gas ratio analysis is practically useless

## Mitigation?

## Gas ratio analysis - Nyék-2 & -6A

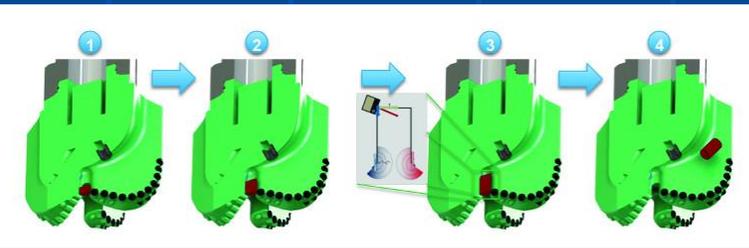


# Mitigation of mudlogging problems

Conventional coring



Microcore bit



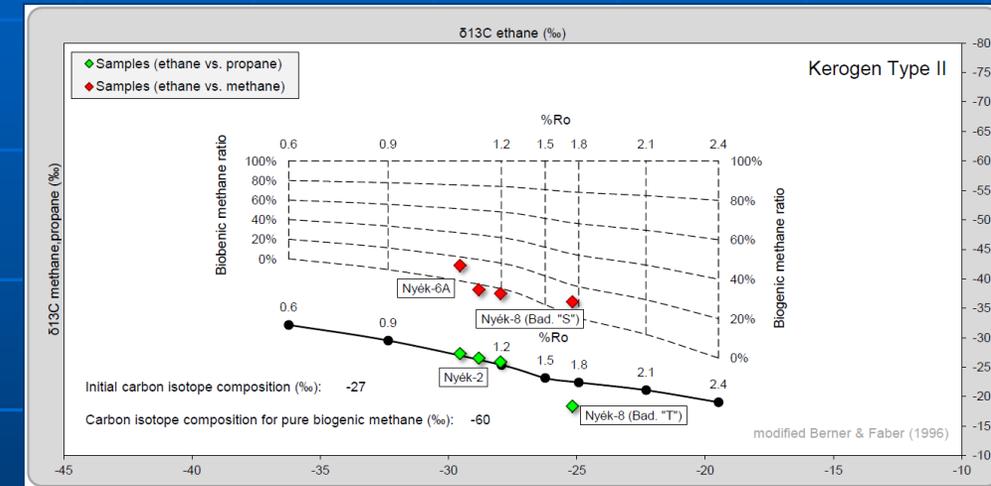
## Lithology, organic geochemistry and petrophysics

- Conventional coring – expensive but a must
- Microcore bit - Beru

## Organic geochemistry and technological evaluation

- Usage of Isotube gas samples
- Not for composition, but for  $\delta^{13}\text{C}$  measurements – **under testing**
  - Maturation, biogenic-thermogenic components
  - Commingled production – ratios
  - Etc.

Sampling of mudgas - Isotube



Graph of bernier and faber model



Calibration points: gas and condensate samples from test / production

This is not pálinka!



# Challenges of wireline logging

Above the mentioned pT and mud related issues

- Recurring borehole stability problems ⇒ significant OH data loss ⇒ information value of replacement CH logs is limited
- Improper wireline tool set for state of art lithological and saturation evaluation ⇔ volcanoclastic sediments!
- Conventional log set is measurable ⇔ unconventional condition!

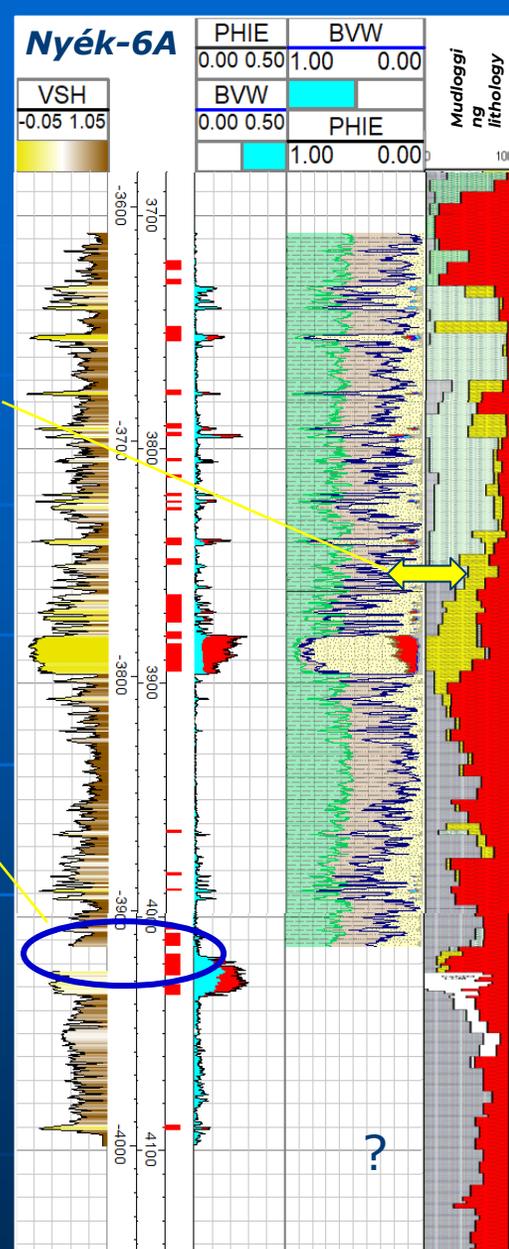
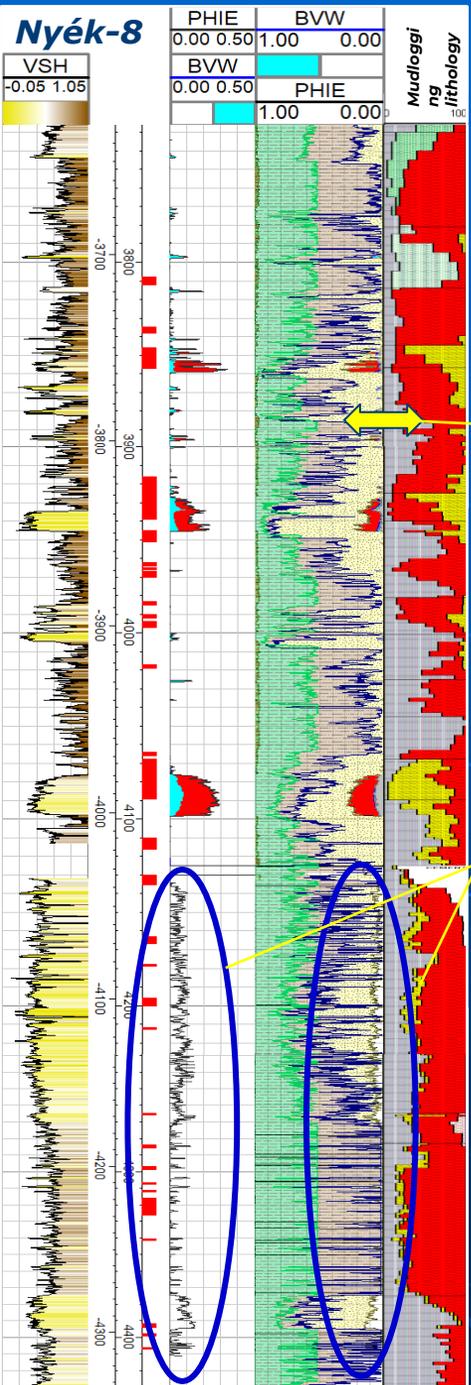
**Mitigation?**

Mismatch between mudlogging and computed lithology - tuff

Mismatch between mudlogging and computed lithology - tuff

Lack of saturation data

Lack of openhole data



Post operation analysis			
Well	Section	Reason	Result
Nyek-6A	17 1/2" OH	Improper borehole condition	Information/data loss from the bottom part of the section
Nyek-6A	8 1/2" OH	Improper borehole condition	Openhole information/data loss from the main Bad-S target. Extra cost to acquire cased hole logs.
Nyek-8	12 1/4" OH	Improper borehole condition	Additional run, extra cost for wireline and rig time.
Nyek-8	8 1/2" OH	Improper borehole condition. Despite a whipstock was near the obstruction it does not look to cause the problem, as well as the inclination of the hole remained low and no sudden changes in that.	Additional runs, unsuccessful. Almost the complete openhole information/data lost in the 8 1/2" section. Extra cost to acquire cased hole logs. Effect on further development of borehole/project.

# Mitigation of logging problems

## Solution for borehole problematics (stability)

- ✓ Use LWD technique instead of Wireline avoiding sticking – LWD was used in Nyék-13 as washdown run after drilling
- ✓ Could use conventional tools – cooling with circulation (\$\$\$)

## Solution for tool selection

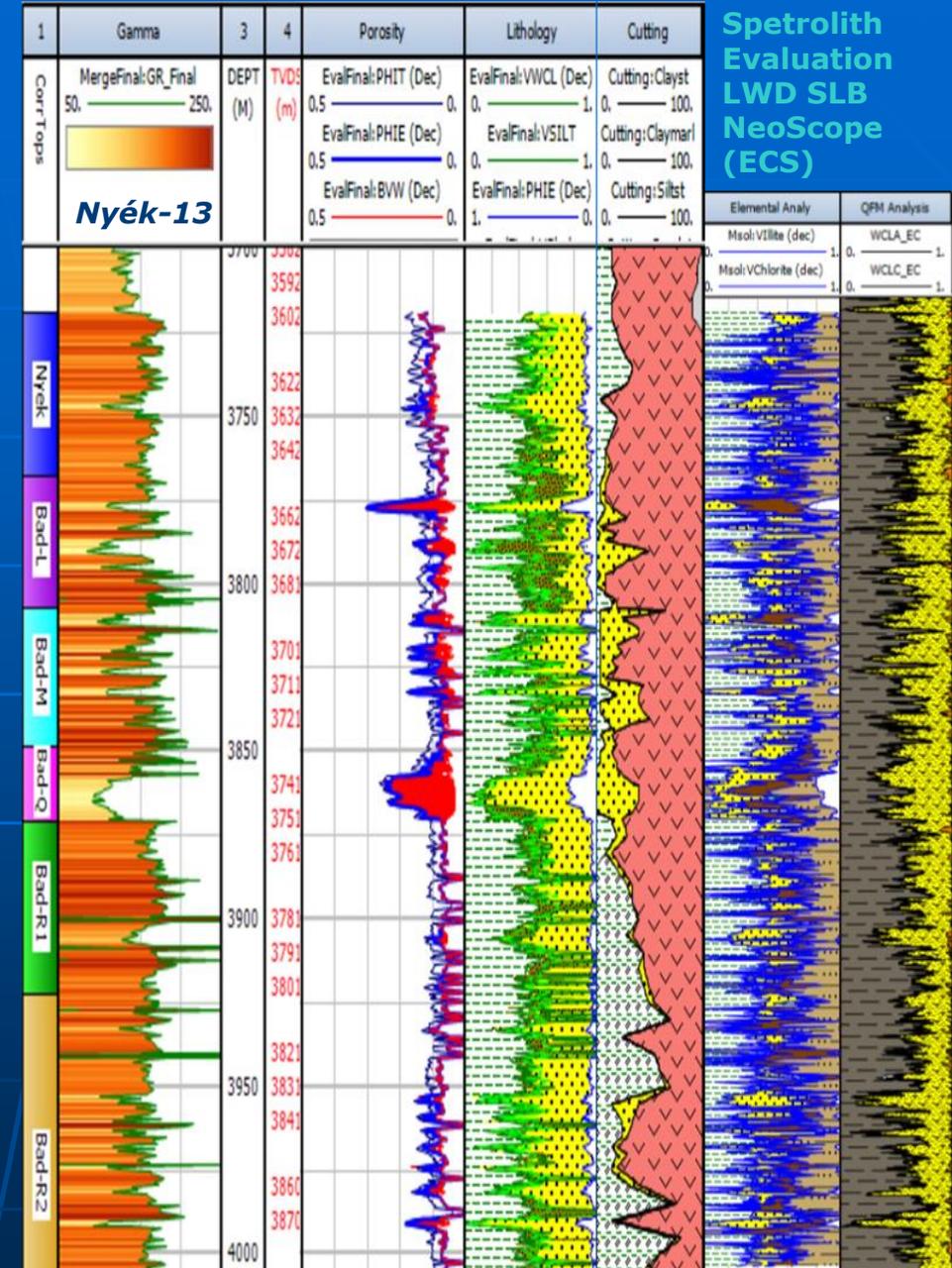
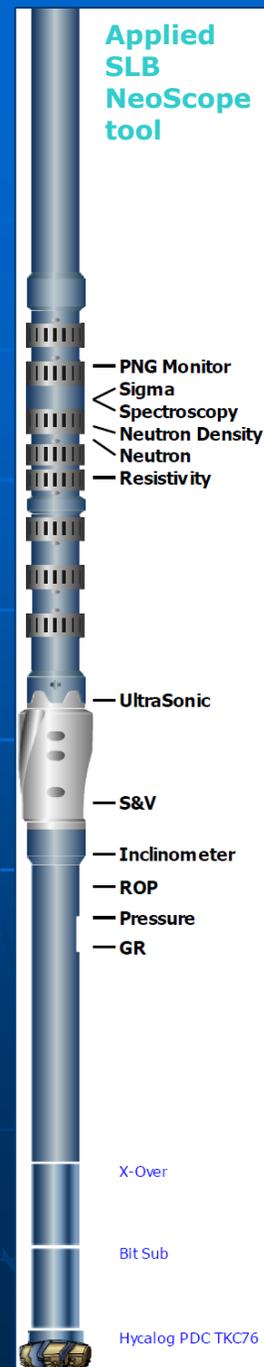
- ✓ LWD contained elemental capture spectroscopy ⇒ mineral composition and lithology

## Results

- ✓ No borehole condition issue
- ✓ Additional state of art tool for lithology – heavy mud is still an issue

## Future

- ❑ LWD usage during drilling?
- ❑ More specific tools for formation evaluation (FMI in OBM, NMR, etc)



# Conclusions

- **Nyékpuzta HC field is unconventional not just from reservoir but other physical-chemical conditions point of view**
- **Despite development of geological and reservoir models harsh exploration environment still holds strong limitations on information gathering and quality**
- **Mitigation of these limitations requires a continuous „out of the box” thinking to maximize information volume and value**
- **It's believed that further drilling and development campaigns could be more smooth, valuable and cost effective with presented / forecasted solutions**

# Thank you for your kind attention!

