

UKRAINIAN
OIL & GAS
ACADEMY



AN INNOVATIVE PARADIGM OF THE
COMMERCIAL HYDROCARBON POOLS MAPPING –
A SECURE TOOL FOR PROVIDING OF UKRAINE
AND FUTURE EXPORTS



Hydrocarbon resources of Ukraine - 32 billion tons

Prepared gas pools – 274.6 billion m³

Ready oil pools – 28.4 million tons

65 new commercial wells are proposed



WAYS FOR GAS PRODUCTION BREAKTHROUGH IN UKRAINE

No	Project	Legend	Exploration area, km ²	Reserves, mln. ToE
National Strategic Projects to Increase Gas Production in Ukraine by Mapping Commercial Hydrocarbon-Bearing Pools				
1	Black Sea deepwater and shelf		75 270	5 400
2	Carapaces of Central part of DDB		12 150	1 754
3	Non structural traps within DDB and Carpathian oil and gas province		176 910	500
4	Shale gas within Teisseyre-Tornquist zone including Oleska PSA		23 460	4 000
5	Tight gas pools including Juzivska PSA		8 180	15 000
6	Weathering crust and desintegration zones of the crystalline basement of Northern Slope of DDB		39 770	6
7	Turnaisian and Visean carbonate TBR reservoirs of the central part of DDB		24 060	5 000
8	Krosno zone		3 270	158
9	4-th floor folds in Boryslav-Pokyttia zone, depth interval 5-9 km		2 100	319
10	Deep commercial gas-bearing pools in Shebelynka gas-condensate field		240	31
11	Total onshore		290 140	26 807
12	Total offshore		75 270	5 400
13	Total		365 410	32 207



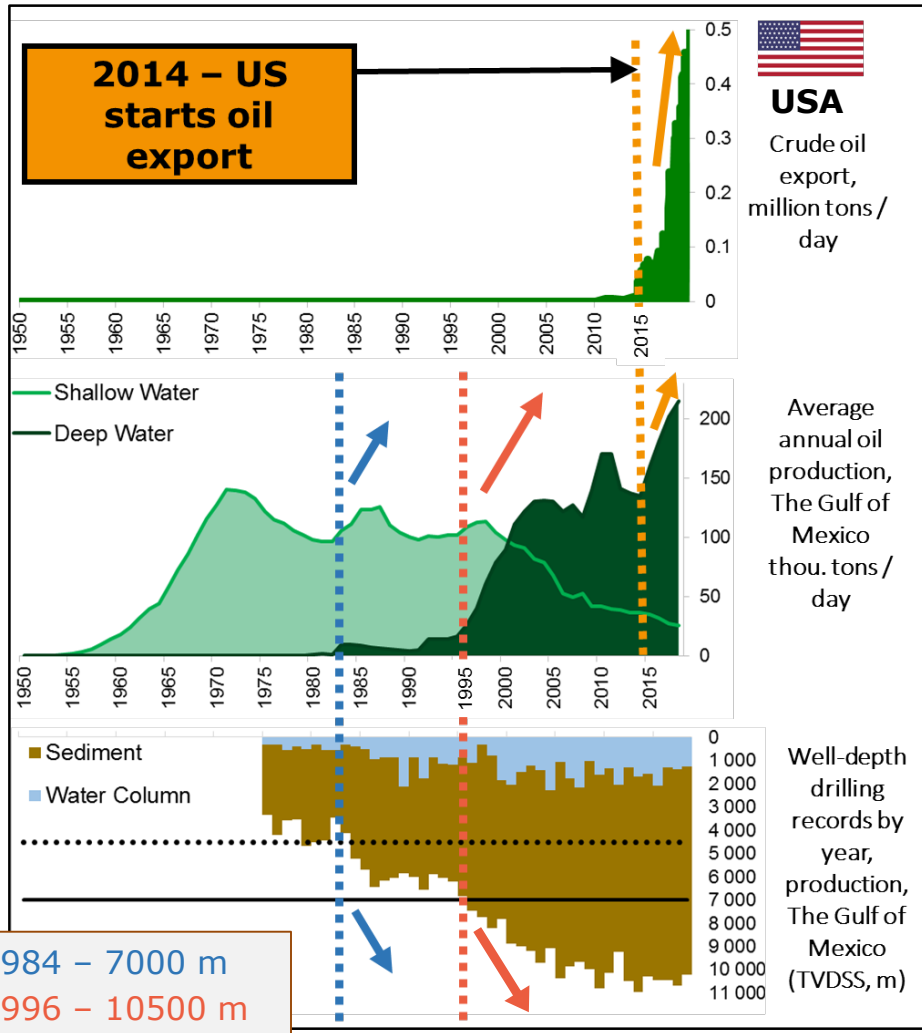
	First-priority commercial hydrocarbon-bearing pools, mapped by DEPROIL in 2016-2020		85 licenses studied by DEPROIL, 138 new wells recommended
	New discoveries, made with DEPROIL association		Machukhy and Bogatoika licenses with carbonate pools explored by DEPROIL
	Zakaria gas discovery		

TRANSITION ON THE DEEP HORIZONS IS ONLY ONE WAY FOR GAS PRODUCTION BREAKTHROUGH

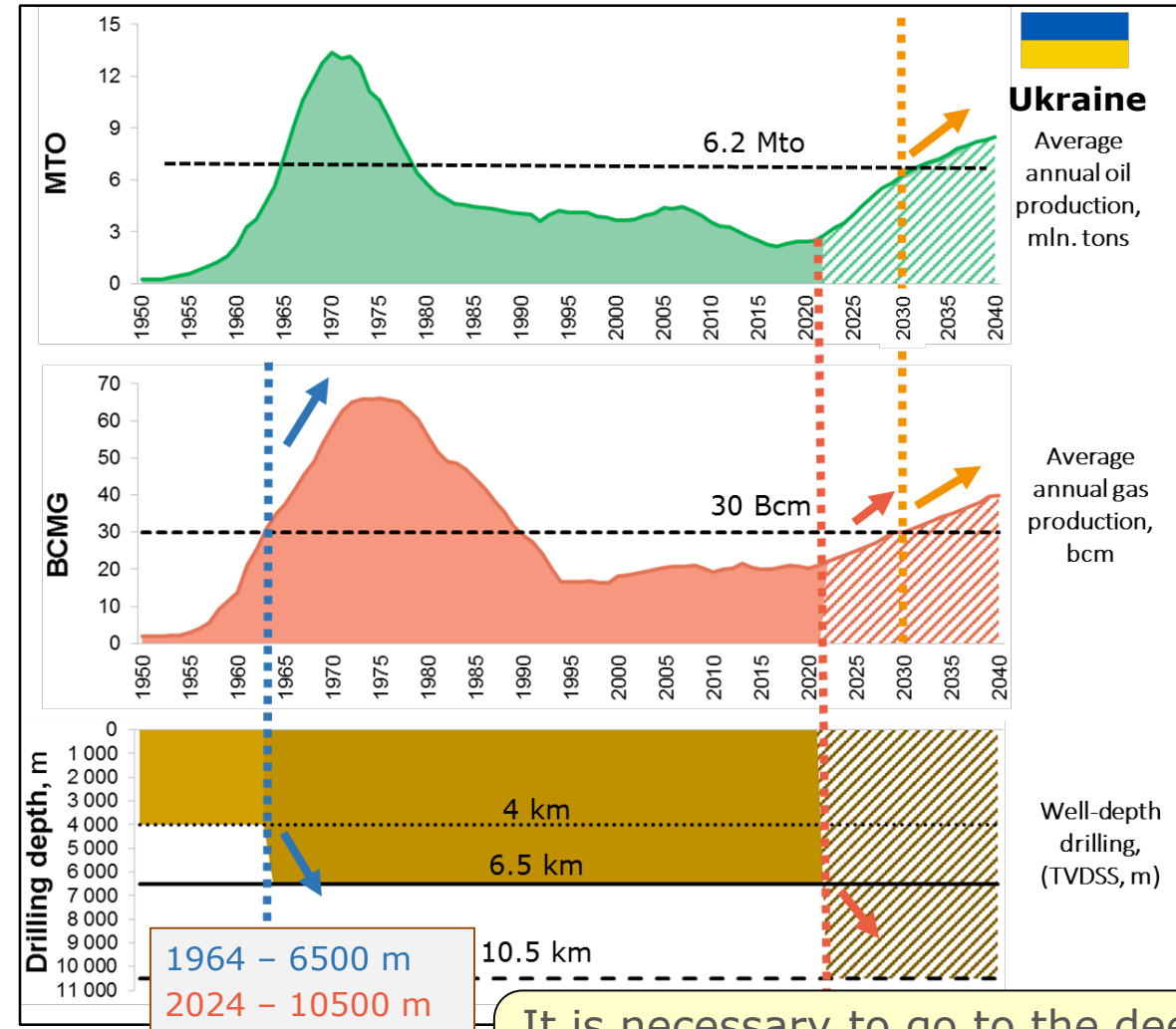


DEPROIL
DETAILED OIL & GAS PROSPECTING

USA experience



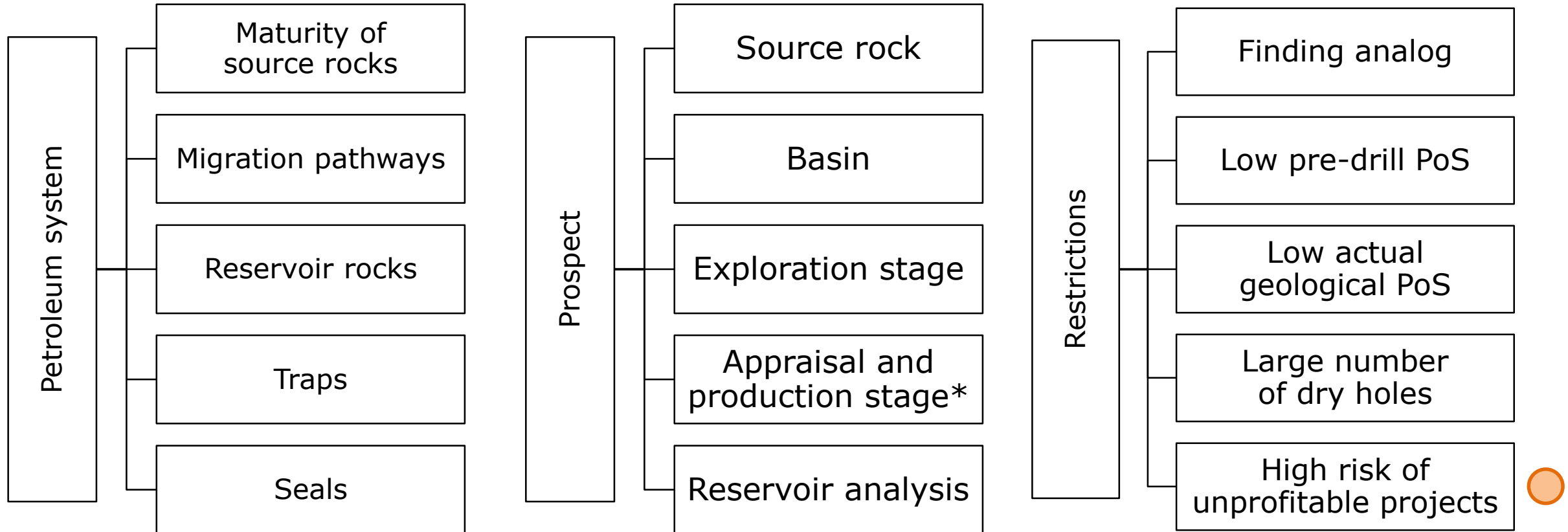
Ukrainian experience



It is necessary to go to the deeper oil and gas-bearing horizons and drill the wells deeper than 6500 m

«Deepwater Gulf Of Mexico Report 2019 (BOEM 2021-005)
Department Of The Interior Bureau Of Ocean Energy Management, 2021»
(<https://www.boem.gov/regions/gulf-mexico-ocs-region/deepwater-gulf-mexico-report-2019-boem-2021-005>)

THE OIL SYSTEM IS THE BASIS OF THE EXISTING PARADIGM FOR THE PREPARATION OF NEW PROSPECTS FOR DEEP DRILLING



* COMMERCIAL POOL APPEARS

THE ACTUAL GEOLOGICAL SUCCESS RATE FOR NEW HYDROCARBON DISCOVERIES – 30 YEARS OF GLOBAL EXPERIENCE*

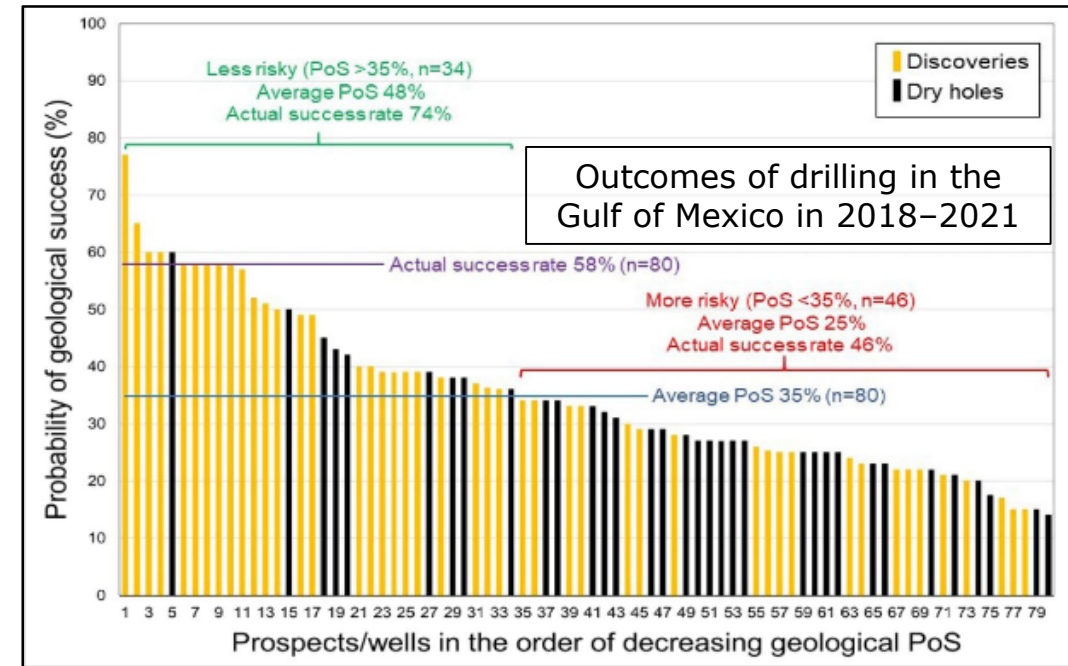
NORWAY
1990-2002
OFFSHORE
300 WELLS
POS 45%

NETHERLANDS
2005-2018
OFFSHORE & ONSHORE
126 WELLS
POS 64%

MEXICO
2018-2021
OFFSHORE & ONSHORE
300 WELLS
POS 58%

IN 30 YEARS (1990-2021)
506 WELLS DRILLED
52% AVERAGE POS
REACHED
THE ACTUAL SUCCESS RATE HASN'T INCREASED!

Pre-drill Assessments and Drilling Outcomes in Mexico in 2018–2022 and Historical Experience from Norway and the Netherlands: Lessons Learned and Recommendations for Future Petroleum Exploration*
Alexei Milkov, Full Professor of Colorado School of Mines



Area	Time period	Number of wells	Average pre-drill PoS (%)	Actual success rate (%)
Norway (offshore)	1990 – 2002	300	29	45
The Netherlands (onshore/offshore)	2005 – 2018	126	53	64
Mexico (onshore/offshore)	2018 – 2021	80	35	58
Total		506	36	52

*Alexei Milkov, Natural Resources Research (© 2022)
<https://doi.org/10.1007/s11053-022-10074-3>

ACTUAL POS FOR THE DRILLING OUTCOME ON THE LARGE KOBZIV GAS POOL

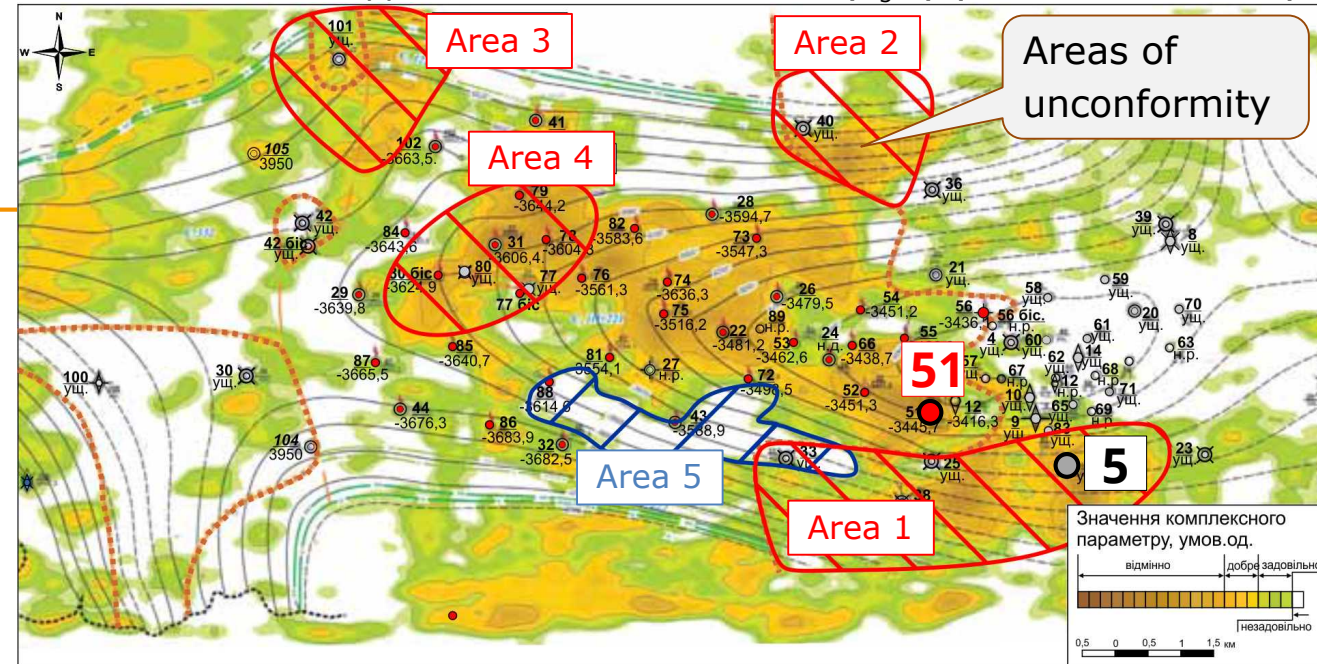
➔ The contour of the commercial gas pool within producing horizon Г-6² by 3D seismic inversion and drilling results:

- PoS for all drilled wells – 52%
 - PoS for wells drilled inside the seismic conditional contour of the pool – 64%

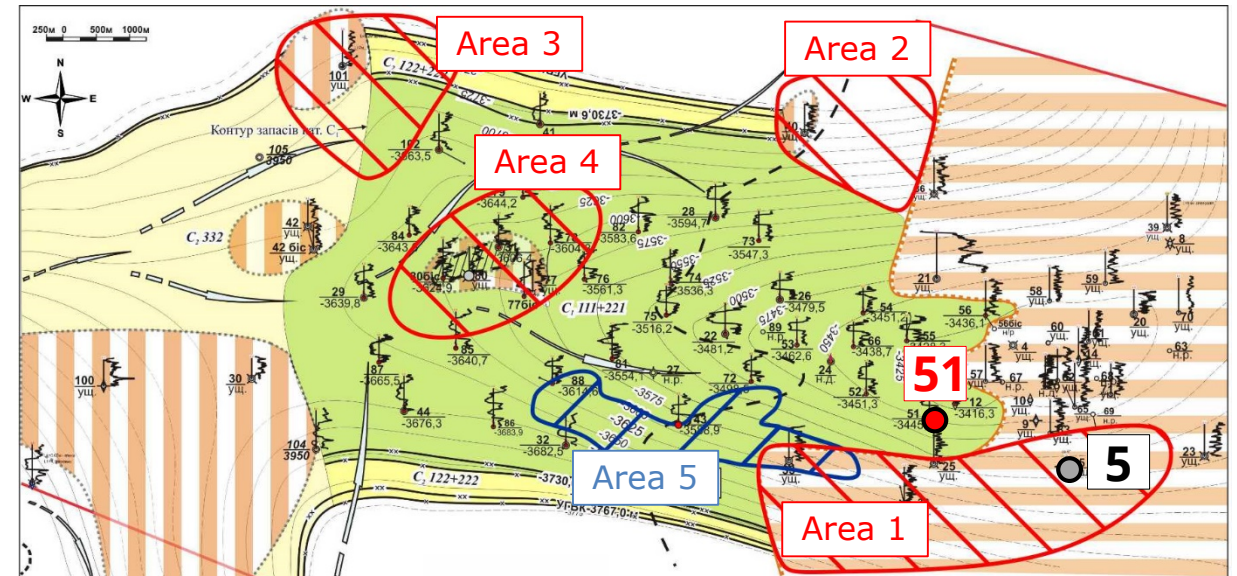
Total wells	Commercial	PoS
68	35	52%

Total wells inside the seismic contour	Commercial	PoS
48	31	64%

The qualitative property of the commercial pool by the 3D seismic inversion results, 28-42 ms upper the seismic horizon Va1 (C₃kt) (Machuzhak M.,2013)



Lithofacies of the productive horizon G-62 map by drilling outcome (Kryvulya S., 2012)



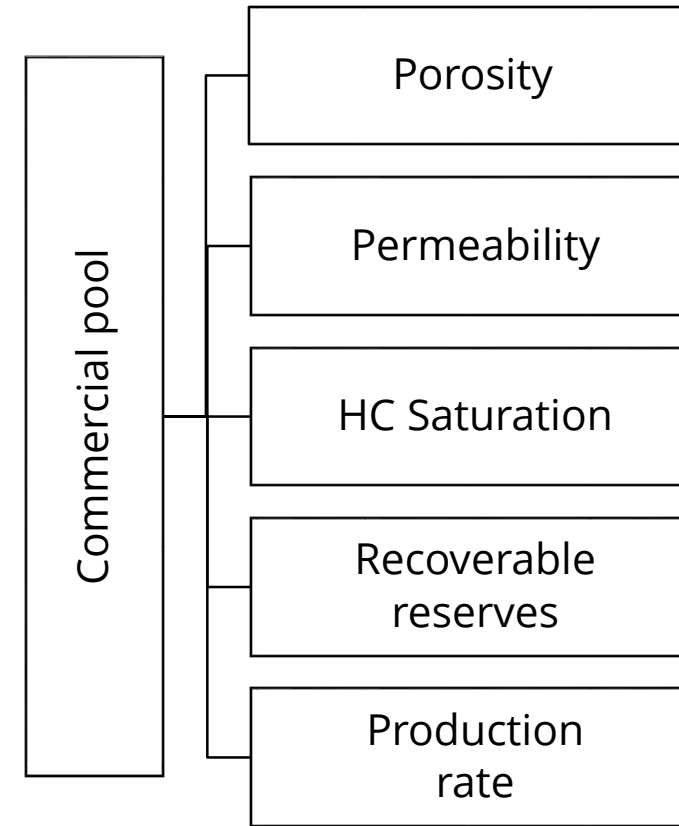
COMMERCIAL HYDROCARBON-BEARING POOL AND COMMERCIAL WELL

Commercial hydrocarbon-bearing pool –

is a subsurface body of rock having porosity, permeability, hydrocarbon saturation, reserves, and the production rate enough to be commercially viable

Commercial well – any oil or gas drilling site that produces enough oil or gas to be commercially viable

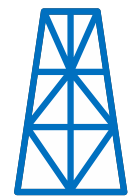
Dry hole – any drilling site that does not produce enough oil or gas to be commercially viable



Commercial pool

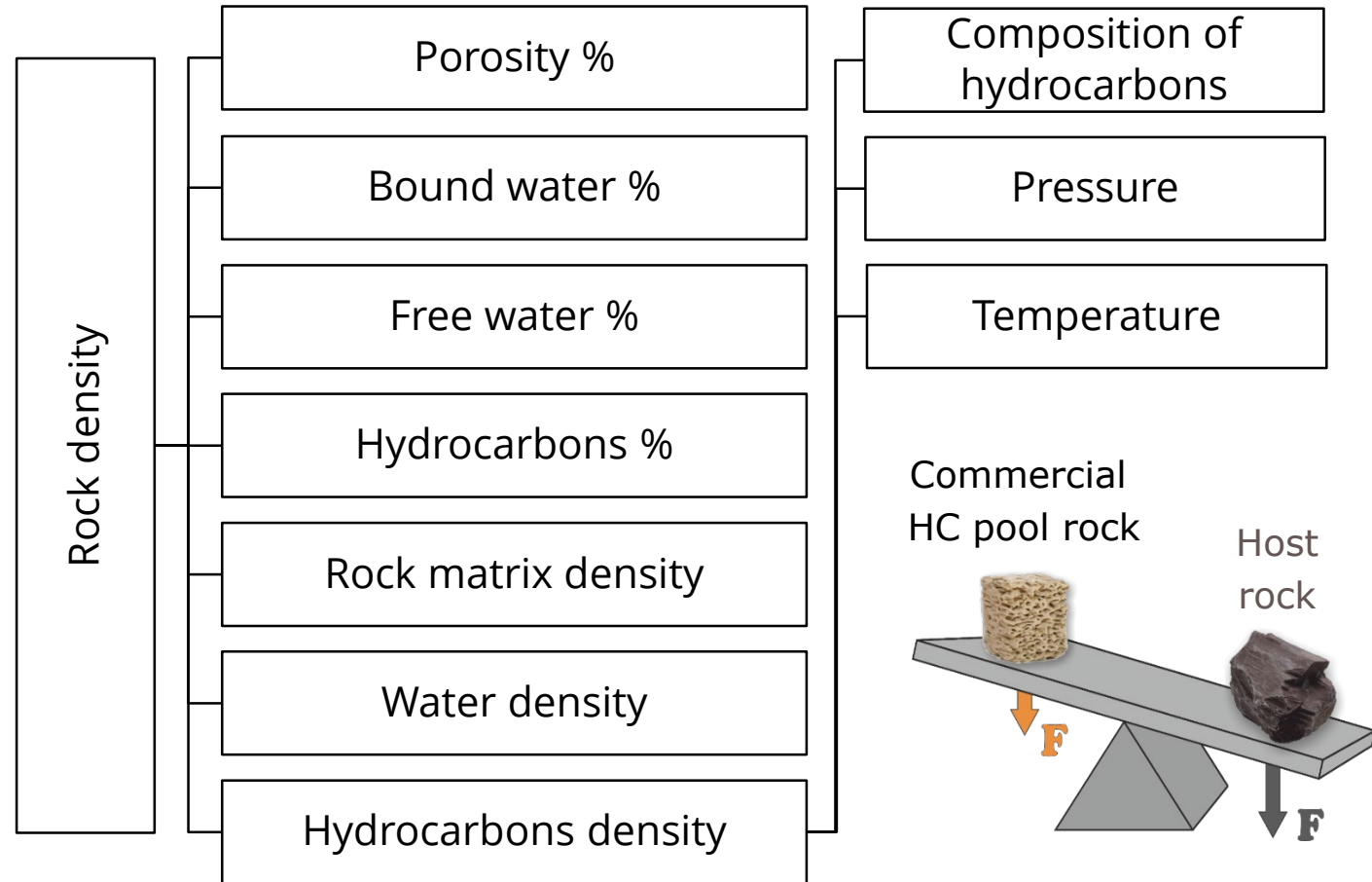
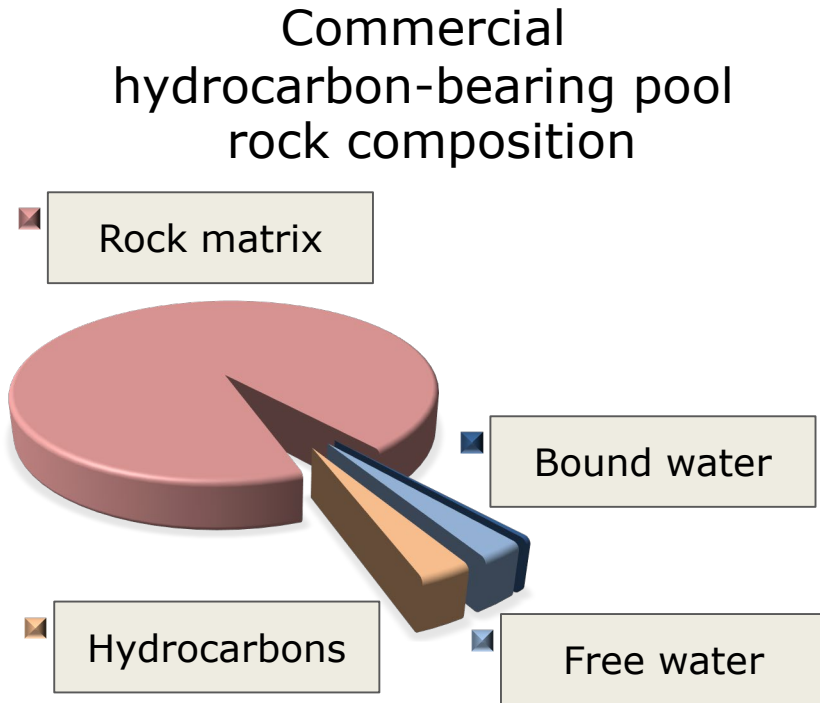


Commercial well



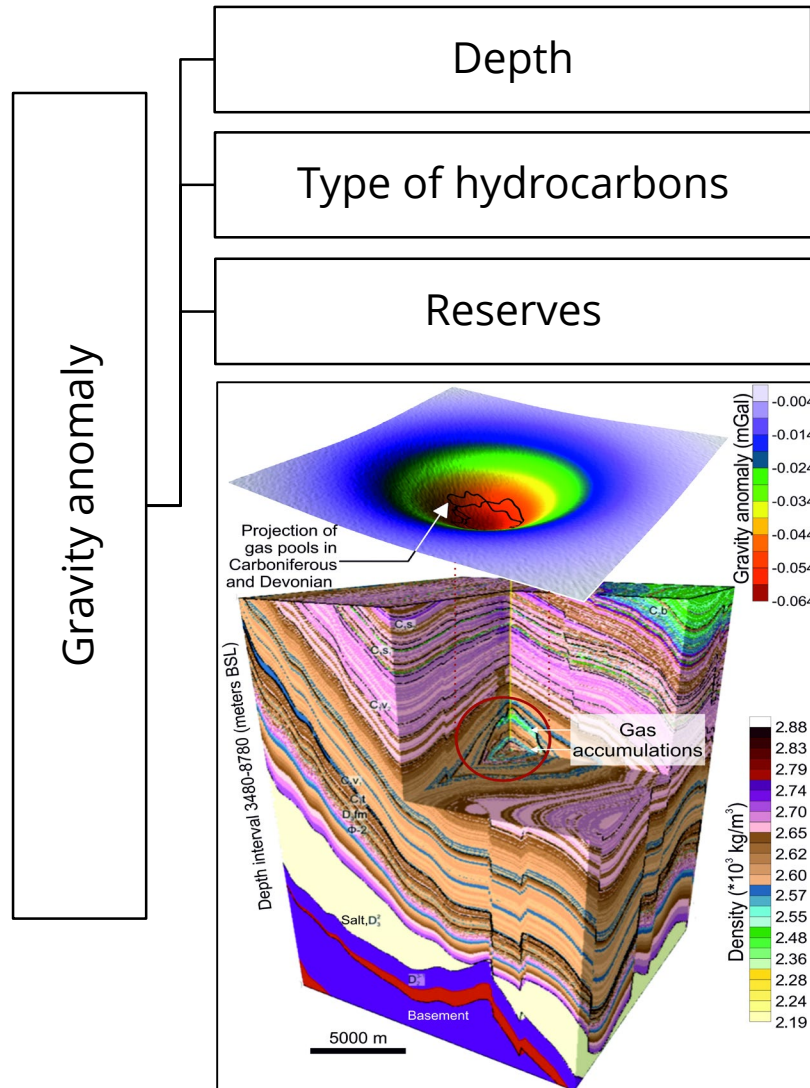
Dry hole

ROCK DENSITY – GLOBAL CHARACTERISTICS OF THE COMMERCIAL HYDROCARBON-BEARING POOL

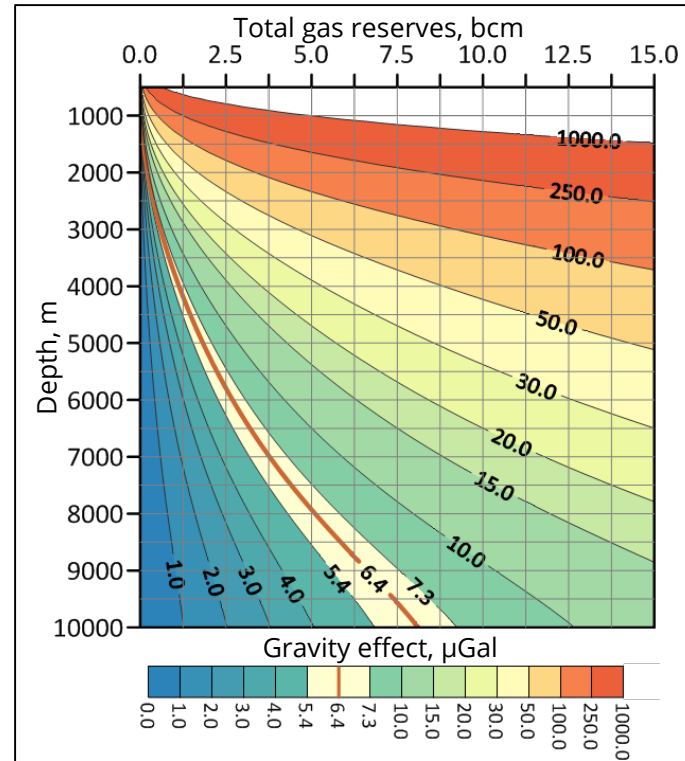


Commercial HC pool rock density is always less than the density of host rocks

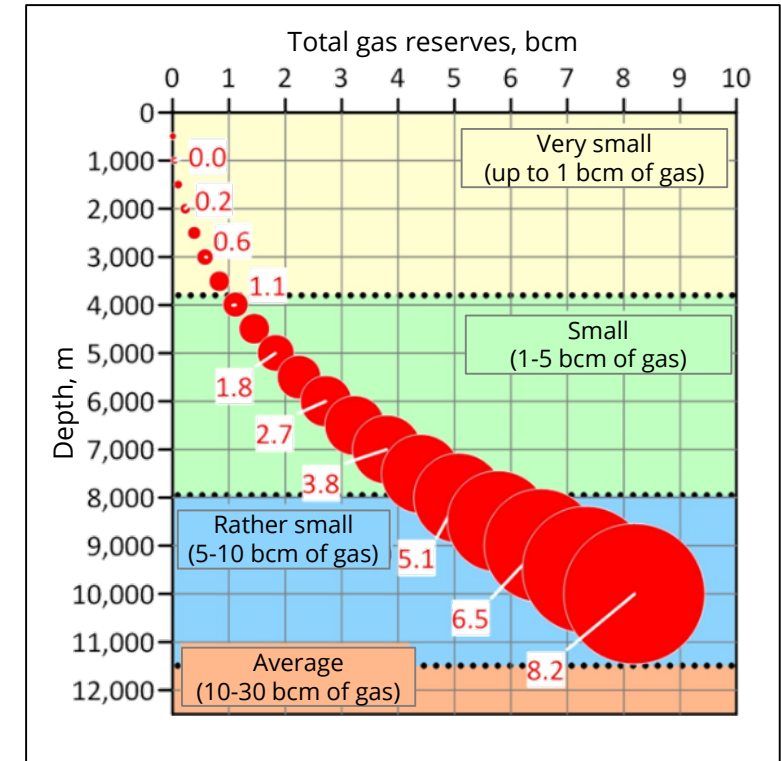
GRAVITY ANOMALIES ASSOCIATED WITH COMMERCIAL HYDROCARBON-BEARING POOLS



Gravity anomaly associated with commercial pool depending on reserves and depth

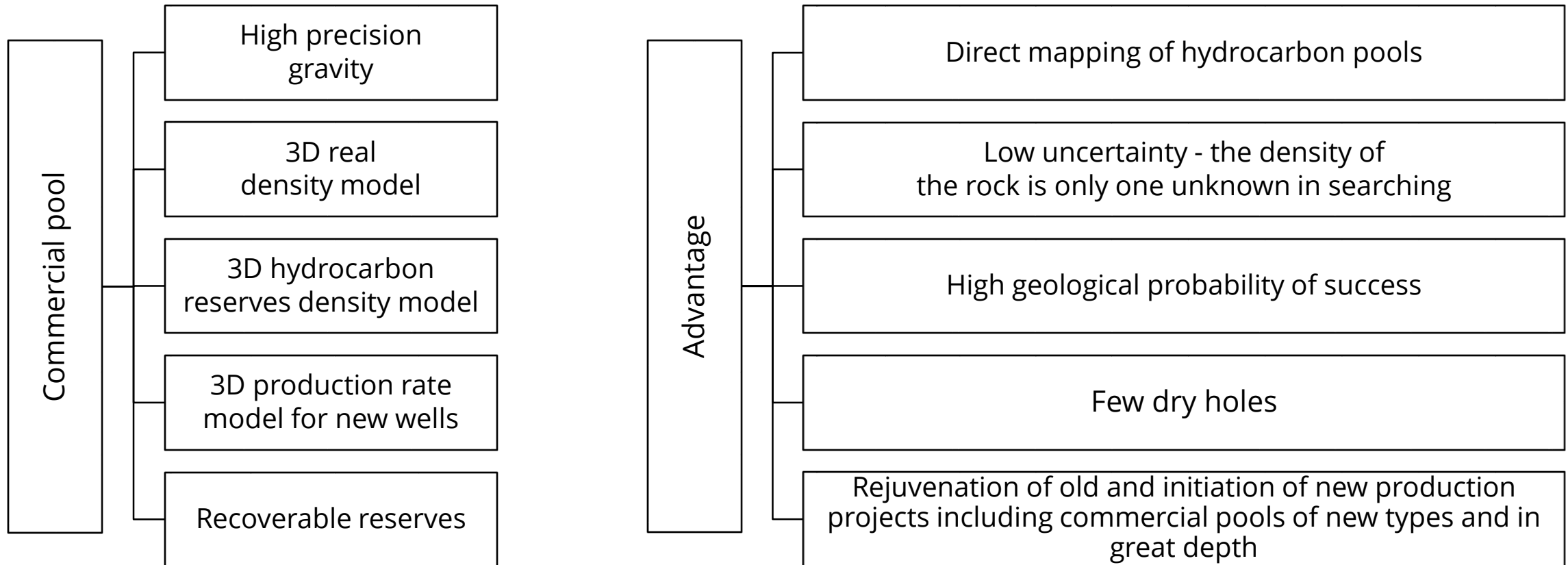


Minimum gas reserves available for mapping depending on pool's depth



Minimal reserves of commercial hydrocarbon pools available for mapping correspond to its bedding depth

INNOVATIVE PARADIGM FOR EXPLORATION OF COMMERCIAL OIL AND GAS POOLS



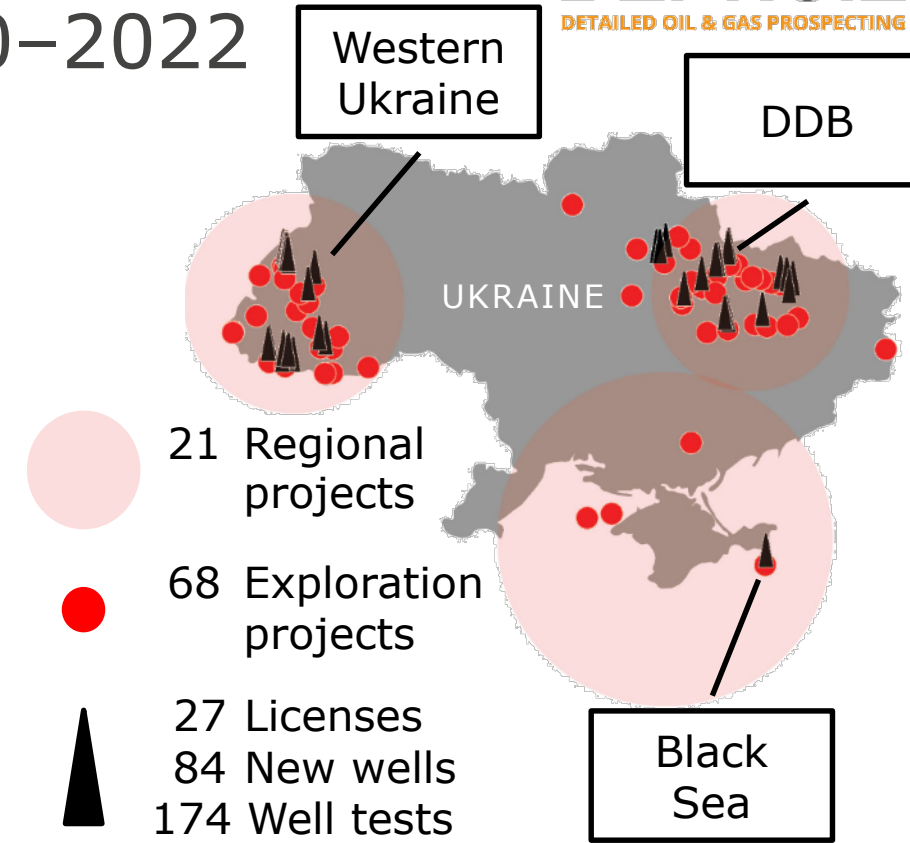
INPUT DATA FOR ESTIMATION OF ACTUAL PROBABILITY OF SUCCESS IN INNOVATIVE EXPLORATION PARADIGM APPLYING IN UKRAINE 2000–2022



DEPROIL
DETAILED OIL & GAS PROSPECTING

➤ 174 well tests in 84 newly drilled wells within 27 licenses performed by 12 oil companies in Ukraine used for estimation of the actual geological PoS

Region	Name of the license	Licenses	Depth	Wells	Well tests
Western Ukraine	Zakhhidna Lukva, Chertizg, Mykulychyn, Pivdenne Bushtyno, Dobriany, Lishchyn, Buchach, Tyniv, Solotvyno, Orkhovychi-Dubanevychi, Sadjava, Mykytynetska, Zgdenievo	13	3878	48	128
Dnieper-Donets Basin	Gashynivka-Chkaliv, Bogatoika, Zahidni Vilshany, Krasnokutsk, Gertsevanivka, Pivdenna Runivshchyna, Ostroverhivka, Mechedivka-Golotovshchuno, Svyrydivka, Vasyshchi, Skydanivka, Pivnichni Skvortsji, Machukhy	13	6292	35	45
Black Sea	Subbotin	1	3100	1	1
Total		27		84	174

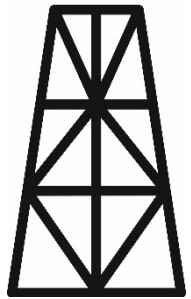




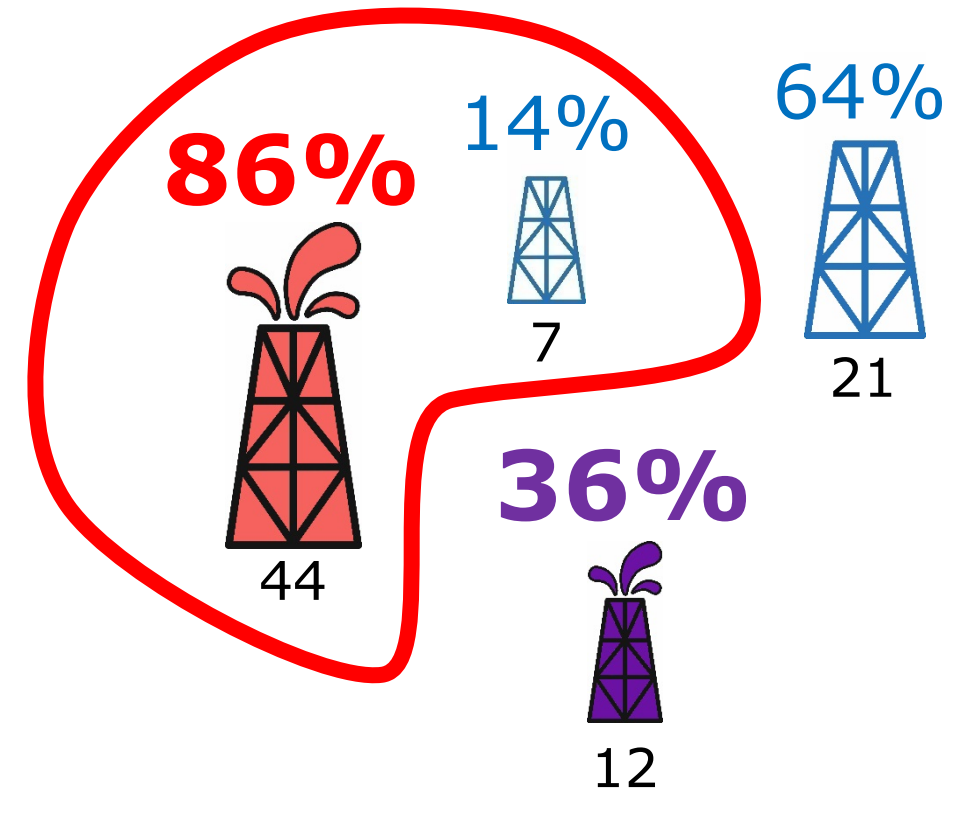
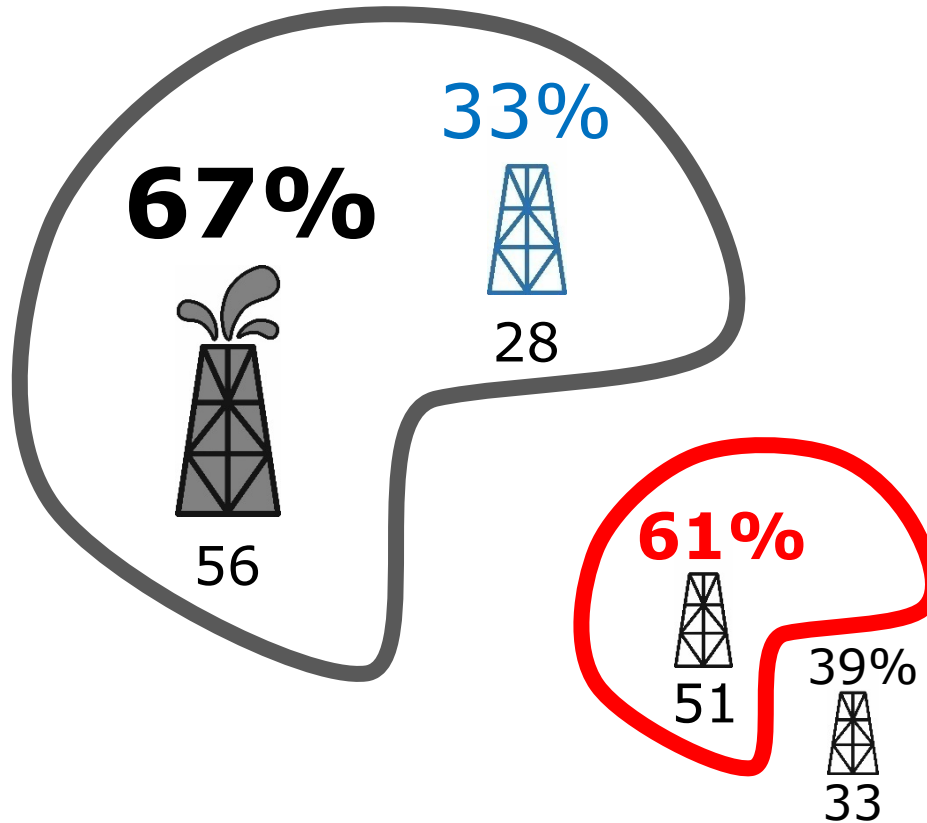
OIL AND GAS ROULETTE – EXISTING AND INNOVATIVE RULES

Existing rules

Innovative rules



84
new
wells



Prospect
outline



HC pool
outline



Drilled
wells



Commercial
wells



Dry
holes

OIL AND GAS ROULETTE – EXISTING AND INNOVATIVE RULES

Existing rules

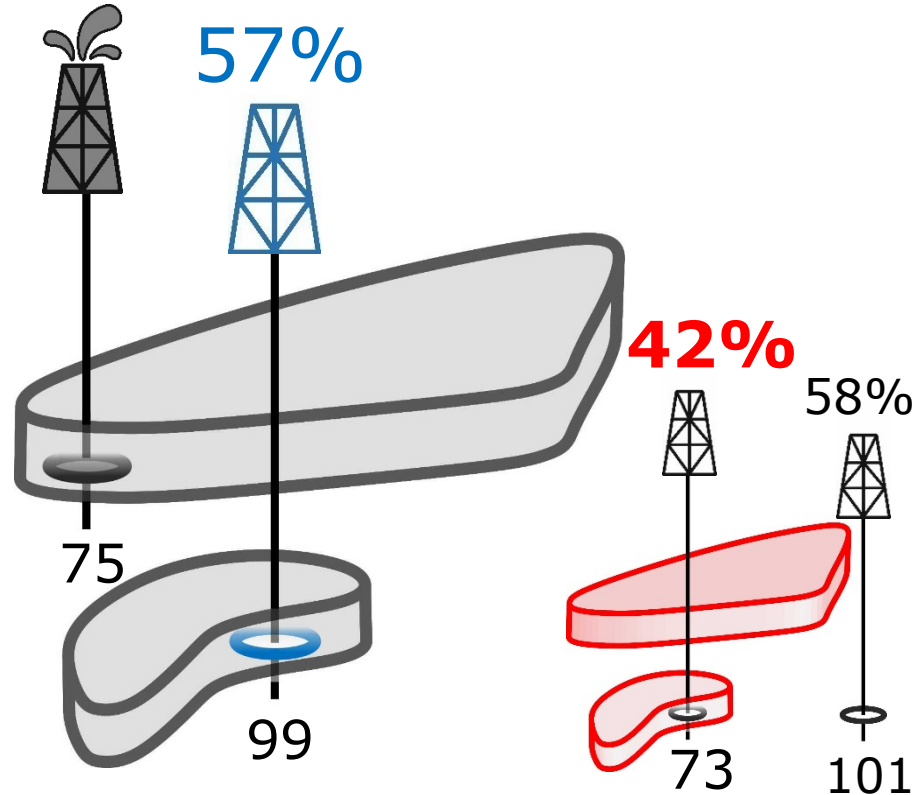
43%

57%

42%

58%

174
new
well tests



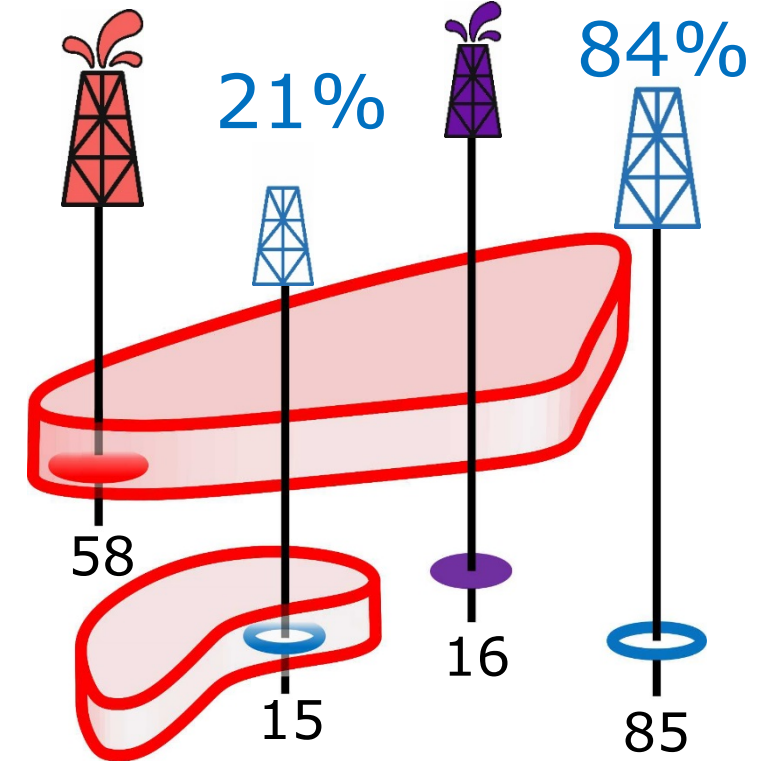
Innovative rules

79%

16%

21%

84%



Prospect outline



HC poll outline



Well tests



Commercial well tests

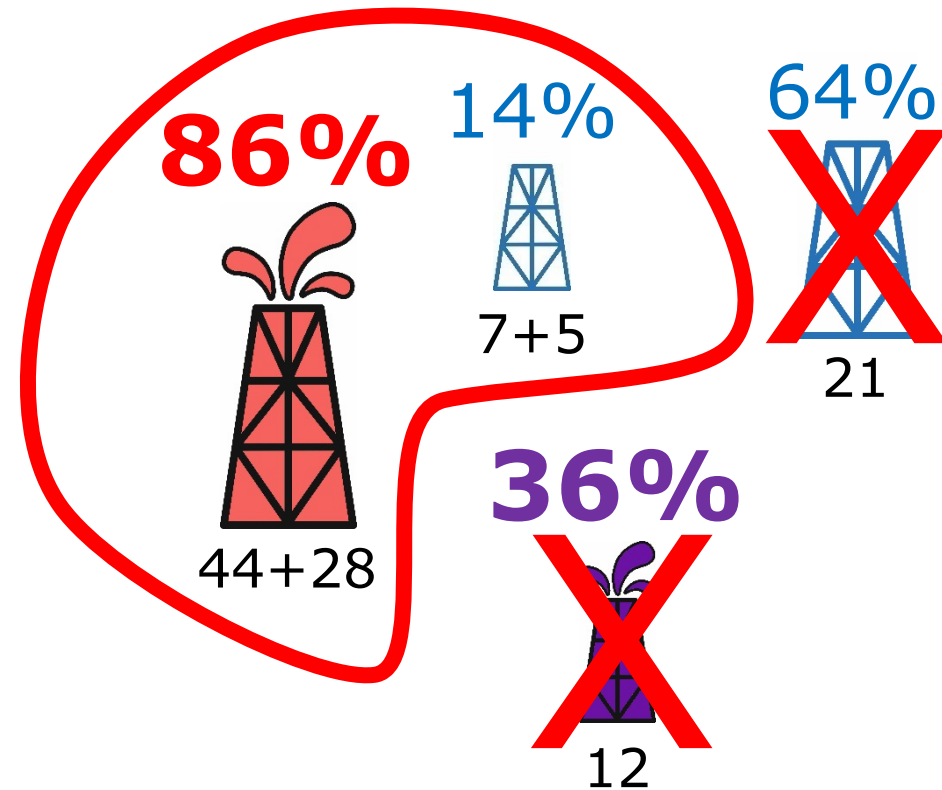


Dry well tests

WHAT-IF SCENARIO > ALL WELLS ARE DRILLED INSIDE THE PREDICTED COMMERCIAL POOL CONTOUR

- Wells drilled outside the pool – 33
- Commercial wells outside the pool – **12**
- Wells would turn commercial – **28**
- Additional commercial wells – **16**
- Additional volume of gas –
● **520** thousand m³/day
156 million m³/year
0.5 billion \$

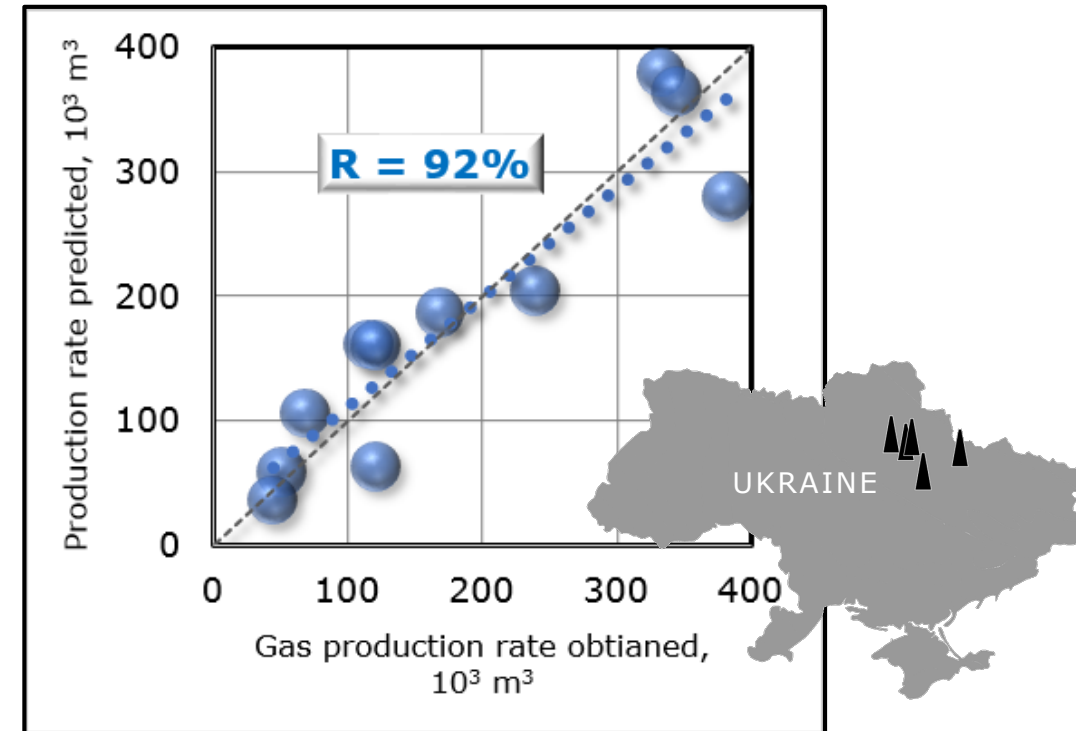
Innovative rules





COMMERCIAL PRODUCTION RATE WHILE WELL TESTING – ACTUAL PROBABILITY OF SUCCESS

- 11 wells initial gas production rates pre-drill prediction
- Average relative prediction error – -6%
P95 error confidence – -6%±18%
- Actual PoS for the pre-drill initial gas production rate prediction – **92%**





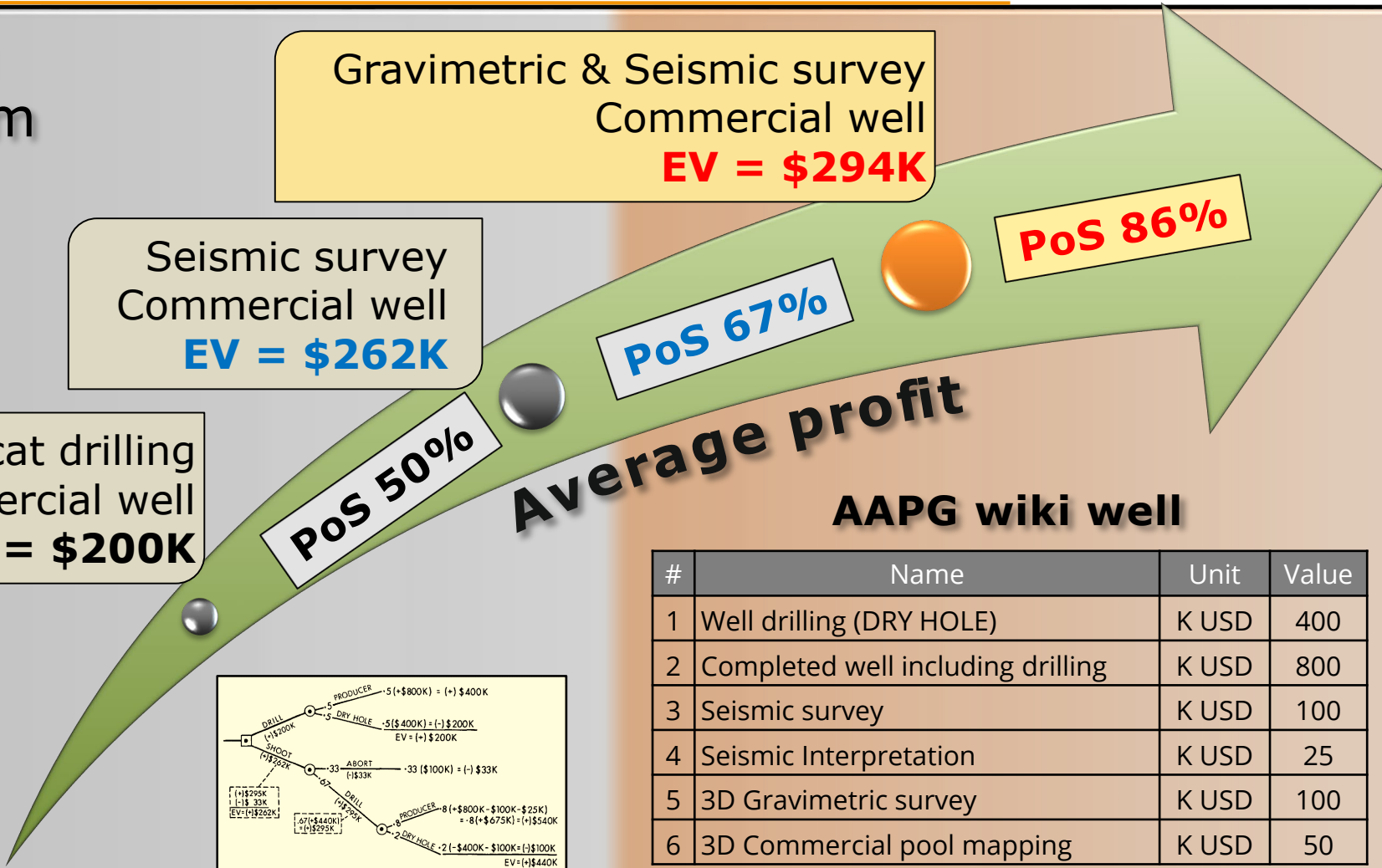
EXPECTED VALUE FOR DEVELOPMENT WELL DRILLING FROM THE INNOVATIVE EXPLORATION PARADIGM APPLYING*

Existing paradigm

Gravimetric & Seismic survey
Commercial well
EV = \$294K

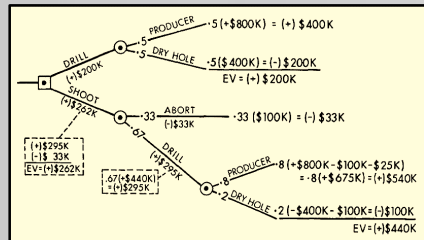
Seismic survey
Commercial well
EV = \$262K

Wildcat drilling
Commercial well
EV = \$200K



\$294 000
+47%
increase of profit

\$200K



#	Name	Unit	Value
1	Well drilling (DRY HOLE)	K USD	400
2	Completed well including drilling	K USD	800
3	Seismic survey	K USD	100
4	Seismic Interpretation	K USD	25
5	3D Gravimetric survey	K USD	100
6	3D Commercial pool mapping	K USD	50

Innovative paradigm

* AAPG Wiki - Risk: expected value and chance of success
<https://wiki.aapg.org/Risk: expected value and chance of success>



EXPECTED VALUE FOR DEEP OFFSHORE AND DEPTH EXPLORATION WELL DRILLING FROM THE INNOVATIVE EXPLORATION PARADIGM APPLYING

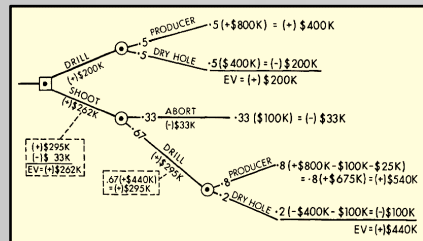
Existing paradigm

Gravimetric & Seismic survey
Commercial well
EV = \$87M

Seismic survey
Production well
EV = \$59M

Wildcat drilling
Production well
EV = \$40M

40M USD



Average profit
Well depth 7200 m

#	Name	Unit	Value
1	Well Drilling (DRY HOLE)	M USD	80
2	Complete well including drilling	M USD	160
3	3D Seismic survey	M USD	15.0
4	Seismic Interpretation	M USD	2.0
5	3D Gravimetric survey	M USD	4.0
6	3D Commercial pool mapping	M USD	1.0

PoS 86%

PoS 67%

PoS 50%

87M USD
+118%
increase
of profit


Innovative paradigm

HYDROCARBON RESERVES AND RECOMMENDATIONS ON DRILLING NEW COMMERCIAL WELLS BY RESULTS OF THE INNOVATIVE EXPLORATION PARADIGM APPLIED IN 2017-2022

Estimated hydrocarbon reserves:

- Gas – 274.6 bcm
- ■ Oil – 28.4 million tons
- Recommended wells – 65



 10 first-priority wells with total reserves of 19.23 bcm of gas and 0.56 million tons of oil

No	Licence	Location	Fluid	Target horizons	Gas reserves, bcm	Oil reserves, mil. tons	Depth, m	Wells
1	Skydaniivska	DDB	Gas	C ₁ V ₂ , C ₁ t	10.942	-	-6900	4
2	North Skvortsivska	DDB	Gas	C ₂ m, C ₂ b	2.164	-	-2700	3
3	Khoroshkivska	DDB	Gas	C ₁ S ₂ , C ₁ V ₂ , C ₁ V ₁ , PE	3.107	-		4
4	Machuska	DDB	Gas	C ₁ t, D ₃ fm	40.0	-	-5400	6
5	Zgdenievska	Folded Carpathians	Gas	P ₃ gl	8.9	-	-6856	5
6	Marchenkivska	DDB	Gas, oil	C ₁ V ₂ , D ₃ fm, PE	12	1.8	-3818	6
7	Tarkhanivska	DDB	Gas, oil	C ₁ V ₂ , D ₃ fm, PE	12.8	16.6	-3960	10
8	Rozpashnivska	DDB	Gas	P ₁ nk, P ₁ kt, C ₃ , C ₂ m, C ₂ b	37.2	-	-5128	14
9	Western Novoukrainska	DDB	Gas	P ₁ nk, P ₁ kt, C ₃ , C ₂ m, C ₂ b, C ₁ S ₂	132.2	-	-8100	8
10	Sadjavska	Pre-Carpathian	Gas	P ₁ ks, K ₂ , J, S, E	15.3	-	-3235	5
	Total				274.6	28.4		65



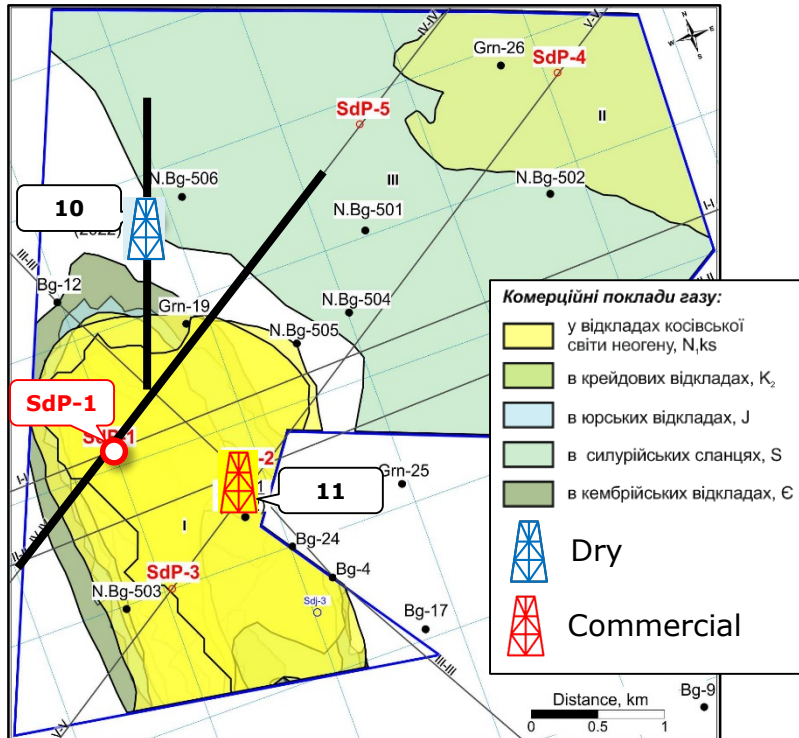
DEPROIL
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SADJAVSKA PSA LICENCE PRECARPATHIAN FOREDEEP. Gas reserves - 15.3 bcm

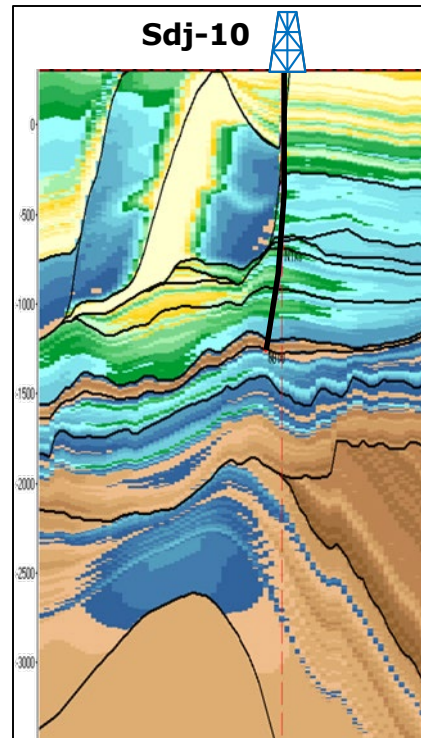


Well	Hydro-carbon	Target horizon	Depth, m	Gas reserves, bcm	PoS	N ₁ ks Initial gas flow rate, th. m ³ /day
SdP-1	Gas	N ₁ ks, K ₂ , J, €	-3200	1.13	100%	100

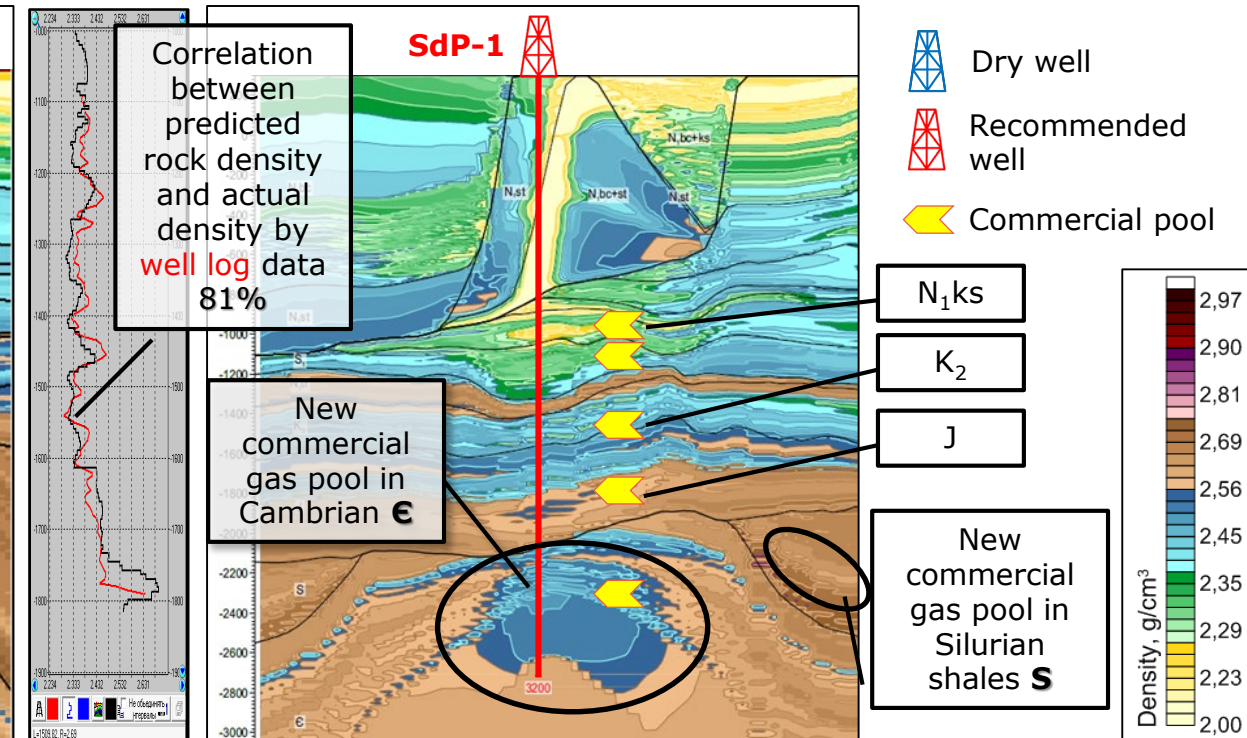
Generalized map showing new mapped commercial gas-bearing pools



Density cross-section through dry hole 10



Density cross-section through recommended well SdP-1





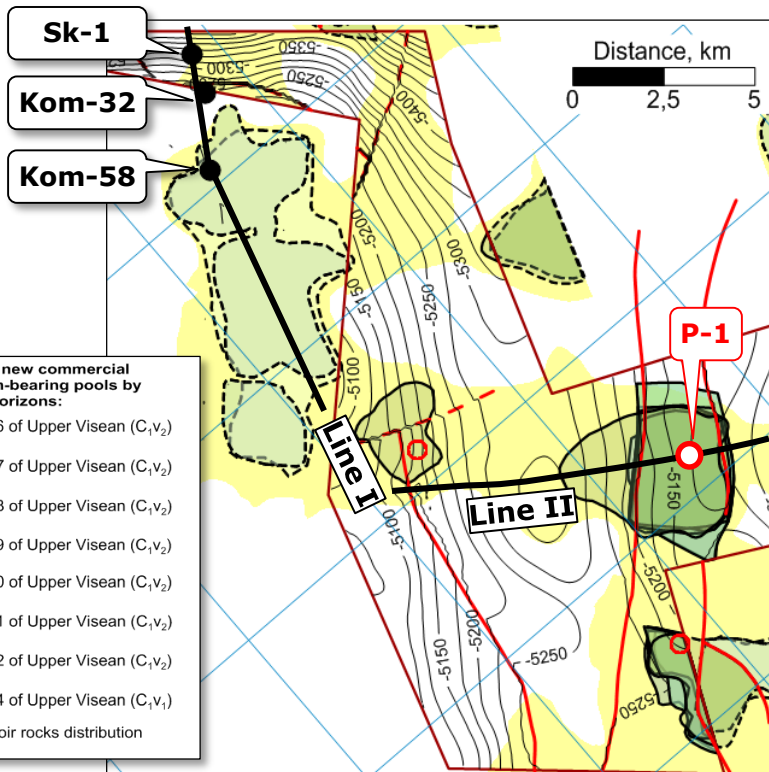
DEPROIL
DETAILED OIL & GAS PROSPECTING

SKYDANIVSKA LICENSE DNEIPER-DONETS BASIN. Gas reserves - 11 bcm

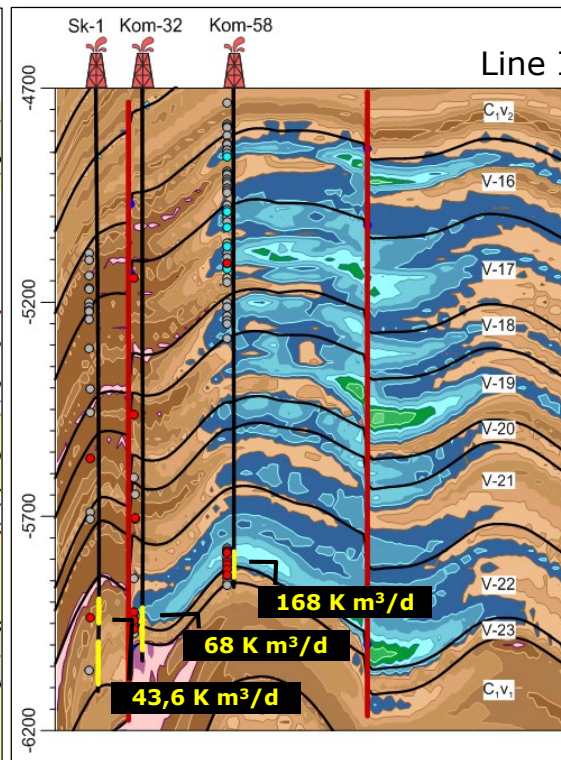


Well	Hydro-carbon	Target horizon	Depth, m	Gas reserves, bcm	PoS	V-22 Initial gas flow rate, th. m ³ /day	V-19 Initial gas flow rate, th. m ³ /day
P-1	Gas	C ₁ V ₂ , C ₁ t	-6922	5.043	100%	244	605

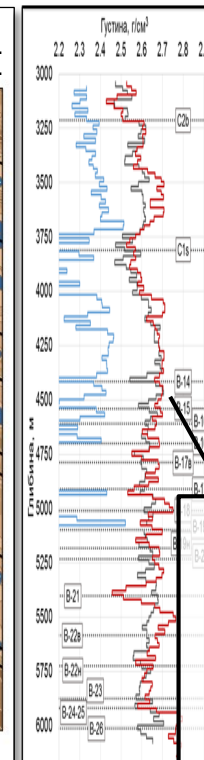
Generalized map showing new mapped commercial gas-bearing pools



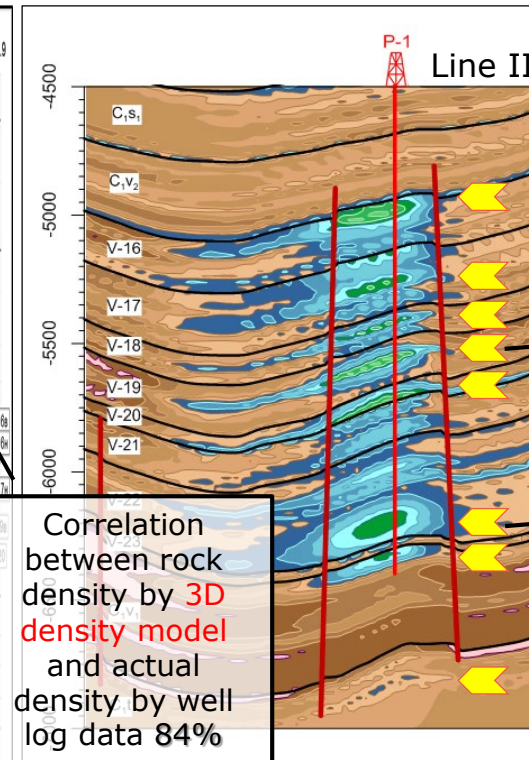
Density cross-section through new drilled commercial wells



Kom-58

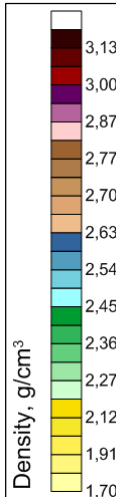


Density cross-section through recommended well P-1



- Discovery
- Recommended well
- Commercial pools

Correlation between rock density by 3D density model and actual density by well log data 84%





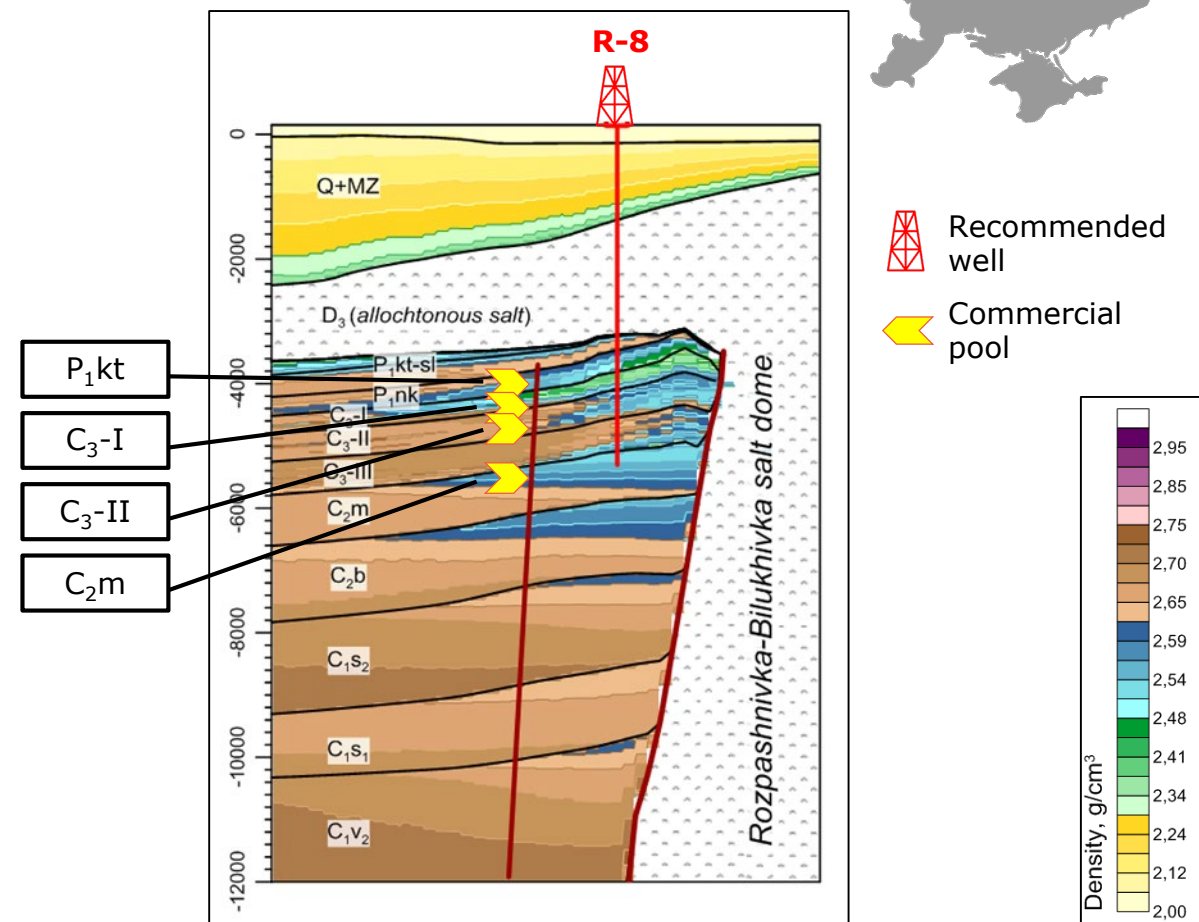
DEPROIL
DETAILED OIL & GAS PROSPECTING

ROZPASHNIVSKA LICENSE DNIEPER-DONETS BASIN. Gas reserves - 37 bcm

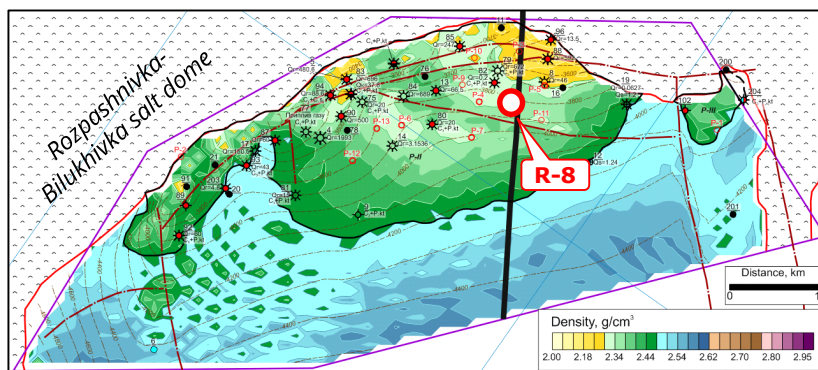
Well	Hydro-carbon	Target horizon	Depth, m	Gas reserves, bcm
R-8	Gas	P ₁ kt, C ₃ -I, C ₃ -II, C ₂ m	-5450	2.2



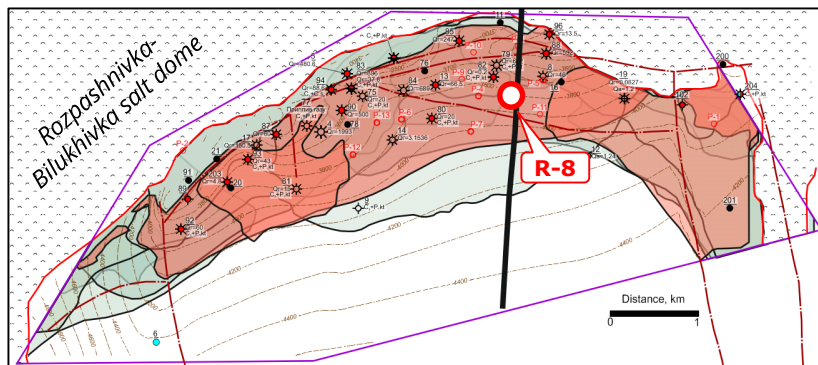
Density cross-section through recommended well R-8



Rock density within target horizon C₃-I

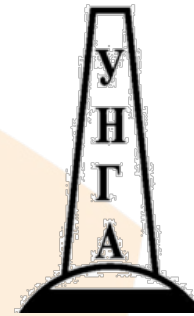
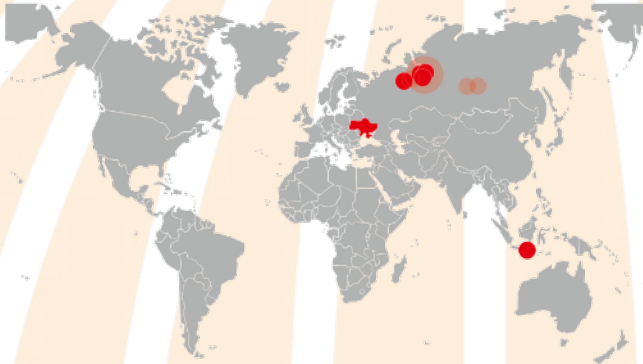


Mapped commercial gas pools



Contours of new commercial hydrocarbon-bearing pools by producing horizons:

in Mykityvska suite of the Lower Permian, P ₁ nk	in Moskovian of the Middle Carboniferous, C ₂ m
in Kartamyshska suite of the Lower Permian, P ₁ kt	in Bashkirian of the Middle Carboniferous, C ₂ b
in the Upper Carboniferous formation, C ₂ -I-II-III	in Upper Serpukhovian of the Lower Carboniferous, C ₂ s ₂



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