



# State classification of mineral resources and reserves of Ukraine as an evaluation instrument of investment proposals on energy resources

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# ECONOMIC-GEOLOGICAL EVALUATION OF MINERAL DEPOSITS IN UKRAINE

According to the subsoil legislation of Ukraine, **economic-geological evaluation of mineral reserves** follows the process of subsoil area use from the beginning of geological study till the full development.

Mineral deposits or subsoil area that are provided for use shall be reassessed every 10 years of their usage, and in case of significant changes in quantity or quality of inventory or technical and economic indexes of effectiveness (more than 20-50%).

# ECONOMIC-GEOLOGICAL EVALUATION OF MINERAL DEPOSITS IN UKRAINE

State Commission of Ukraine on Mineral Resources carries out economic-geological evaluation (EGE) of mineral resources and reserves as well as scientific and research thematic works on formation and development of methodology for economic-geological evaluation of mineral reserves and resources.

According to actual geological and feasibility study of the productive field, **Ukrainian Mineral Resources Classification of State Subsoil Fund** presents *initial, previous* and *detailed* economic-geological assessments.

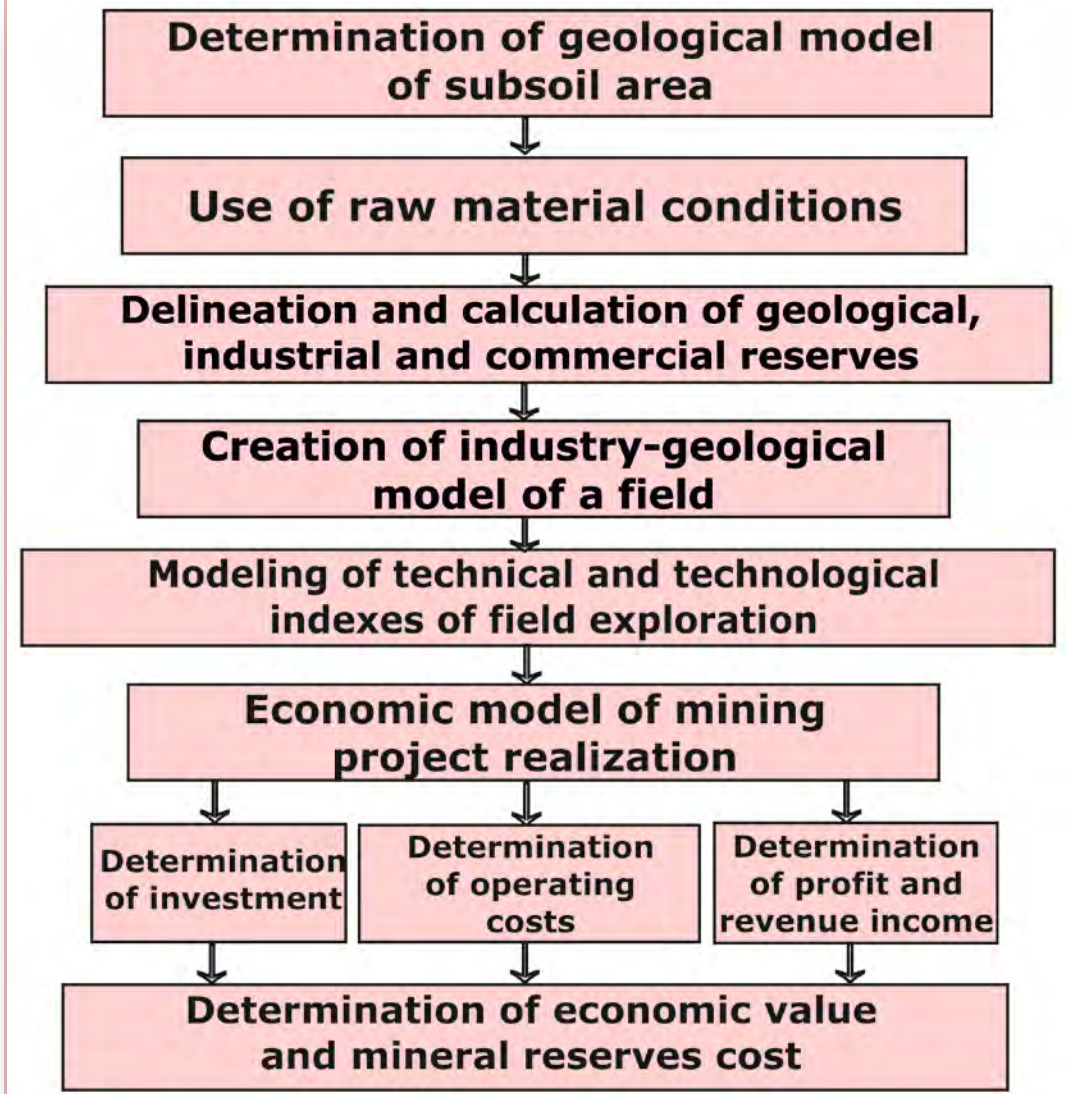
# ECONOMIC-GEOLOGICAL EVALUATION OF MINERAL DEPOSITS IN UKRAINE

*The sequence of economic-geological evaluation of subsurface*

**EGE-3 – initial economic-geological evaluation**

**EGE-2 – provisional economic-geological evaluation**

**EGE-1 – detailed economic-geological evaluation**



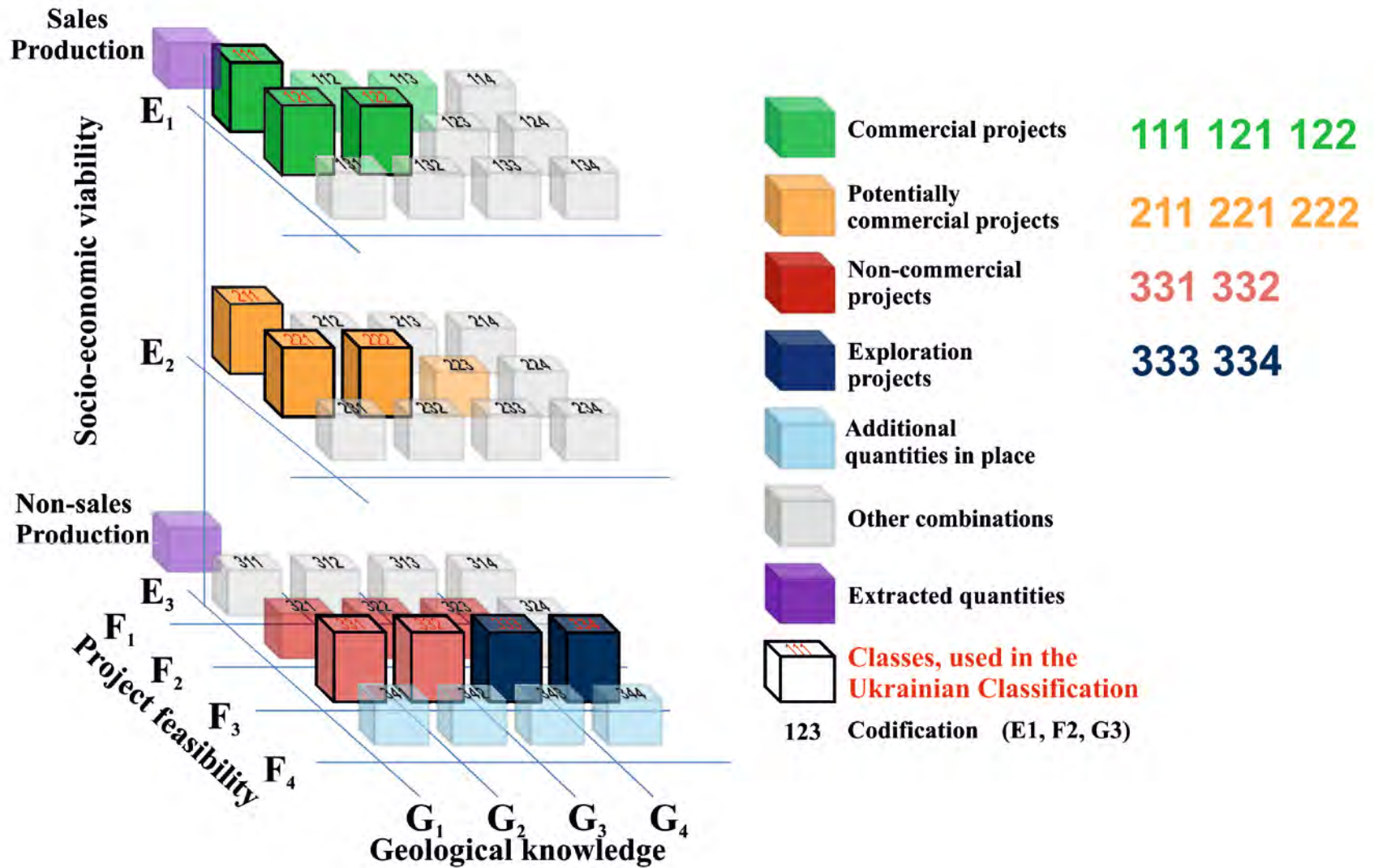
Ukraine was the first that had adapted its Classification of mineral reserves and resources to the United Nations Framework Classification following the UN ECOSOC Resolution No 227/1997, according to which United Nations Framework Classification was recommended for practical use by UN member-countries.

Ukrainian Classification of mineral reserves and resources is a **framework** and can be used for all types of minerals.

# UKRAINIAN MINERAL RESOURCES CLASSIFICATION

Economic value	The degree of feasibility study	The degree of geological study	Class Code
1. Balance reserves (1..)	EGE-1 (.1.)	Explored reserves (..1)	111 Explored
	EGE-2 (.2.)		121 Probable
		Prospected reserves (..2)	122 Probable
2. Conditionally balance and outbalance reserves (2..)	EGE-1 (.1.)	Explored reserves (..1)	211
	EGE-2 (.2.)		221
		Prospected reserves (..2)	222
3. Mineral reserves or resources, economic value of which is not defined (3..)	EGE-3 (.3.)	Explored reserves (..1)	331
		Prospected reserves (..2)	332
		Inferred resources(..3)	333
		Possible resources (..4)	334

# CATEGORIES AND CLASSES OF THE UNFC-2009 AND CLASSES USED IN UKRAINIAN CLASSIFICATION OF MINERALS



# UKRAINIAN MINERAL RESOURCES CLASSIFICATION OF STATE SUBSOIL FUND

The given above scheme presents a comparison between Ukrainian Classification of mineral reserves and resources and the UNFC-2009.

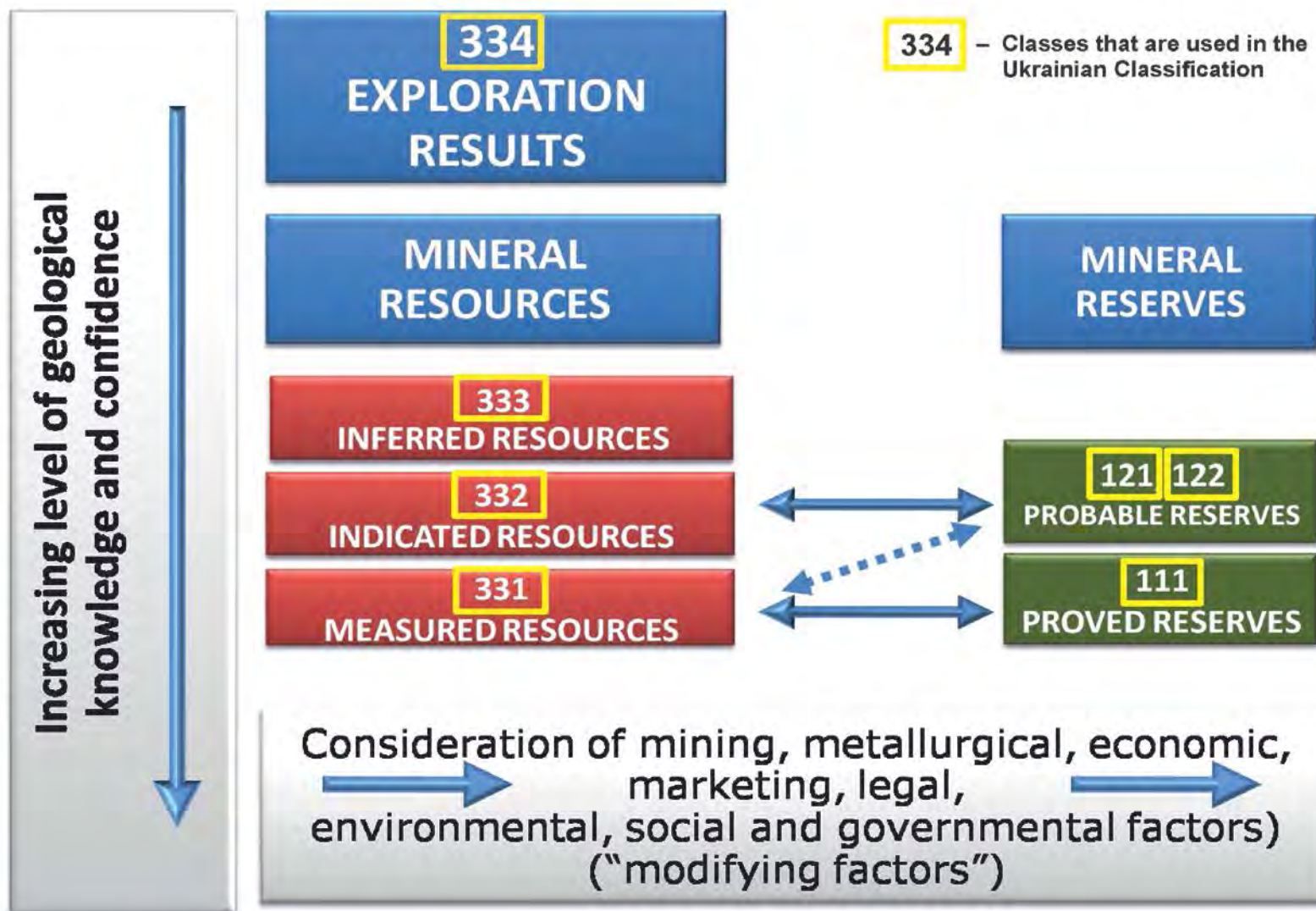
From among **40** Classes, which are specified by the UNFC, only **10** are used in Ukrainian Mineral Resources Classification.

Despite different Class names, the quantities of minerals, which have common socio-economic viability (**the E axis**), project feasibility (**the F axis**) and geological knowledge (**the G axis**), can be identified with one and the same numeric code.

Thus, both classifications UNFC-1997 and UNFC-2009 are comparable.



# MAPPING OF UKRAINIAN MINERAL RESOURCES CLASSIFICATION AND THE CRIRSCO TEMPLATE



## MAPPING OF UKRAINIAN MINERAL RESOURCES CLASSIFICATION AND THE CRIRSCO TEMPLATE CLASSIFICATION

The presented above mapping of Ukrainian Classification to the CRIRSCO Template illustrates that among **10** classes of mineral resources, which belong to Ukrainian Classification, **7** are represented in the CRIRSCO Template.

It is connected with the fact that Balance and Outbalance reserves, which are marked as **221**, **222** and **211** Class Codes, can not be applied to the CRIRSCO Template. These Classes are included into the category of “**Mineral Resources**”.

However, mineral resources that belong to one of the CRIRSCO Template Classes can be identified with one of the Class Codes, specific to Ukrainian mineral resources Classification.

# MAPPING OF UKRAINIAN AND SPE (PRMS) CLASSIFICATIONS

Ukrainian Mineral Resources Classification					SPE (PRMS)		
Category	Balance	Conditionally balance	Out-balance	Economic value is not defined	Reserves/Resources	Project Maturity Sub-classes	Production
A, B	111				Proved Reserves	Approved for development	1P
		221			Resources	Development pending	1C
A, B	121				Probable Reserves	Justified for development	2P
		221			Resources	Development unclarified or on hold	1C
C <sub>1</sub>	111				Proved Reserves	Approved for development	1P
		221			Resources	Development pending	2C
C <sub>1</sub>	121				Probable Reserves	Justified for development	2P
		221			Resources	Development unclarified or on hold	2C
C <sub>2</sub>	122				Possible Reserves	Justified for development	3P
		222			Resources	Development unclarified	3C
C <sub>2</sub>	122				Possible Reserves	Justified for development	3P
		222			Resources	Justified for development	3C
C <sub>3</sub>				333	Resources	Development unclarified or on hold	3C
C <sub>1</sub>			221	–	Resources	Development not viable	2C
C <sub>2</sub>			222		Resources	Development not viable	2C
C <sub>3</sub>				331	Prospective resources	Prospect	High estimate
C <sub>3</sub>				332	Prospective resources	Prospect	High estimate
C <sub>3</sub>				333	Prospective resources	Prospect	Best estimate
D <sub>1</sub> +D <sub>2</sub>				334	Prospective resources	Prospect; play	Low estimate

## MAPPING OF UKRAINIAN MINERAL RESOURCES CLASSIFICATION AND SPE (PRMS) CLASSIFICATION

The Society of Petroleum Engineers (SPE) estimates the probability of hydrocarbon resources availability and economic efficiency of reserves extraction.

According to the SPE Standards and depending on the total feasibility assessment, all **Reserves** fall into the “P” Category and all **Contingent Resources** belong to the “C” Category.

The mentioned above table presents a partial result of comparison between SPE (PRMS) Classification and Ukrainian mineral resources Classification what demonstrates a provisional mapping of the Classifications.

## SUMMARY ON COMPARISON BETWEEN UKRAINIAN MINERAL RESOURCES CLASSIFICATION AND OTHER TRANSNATIONAL CLASSIFICATIONS

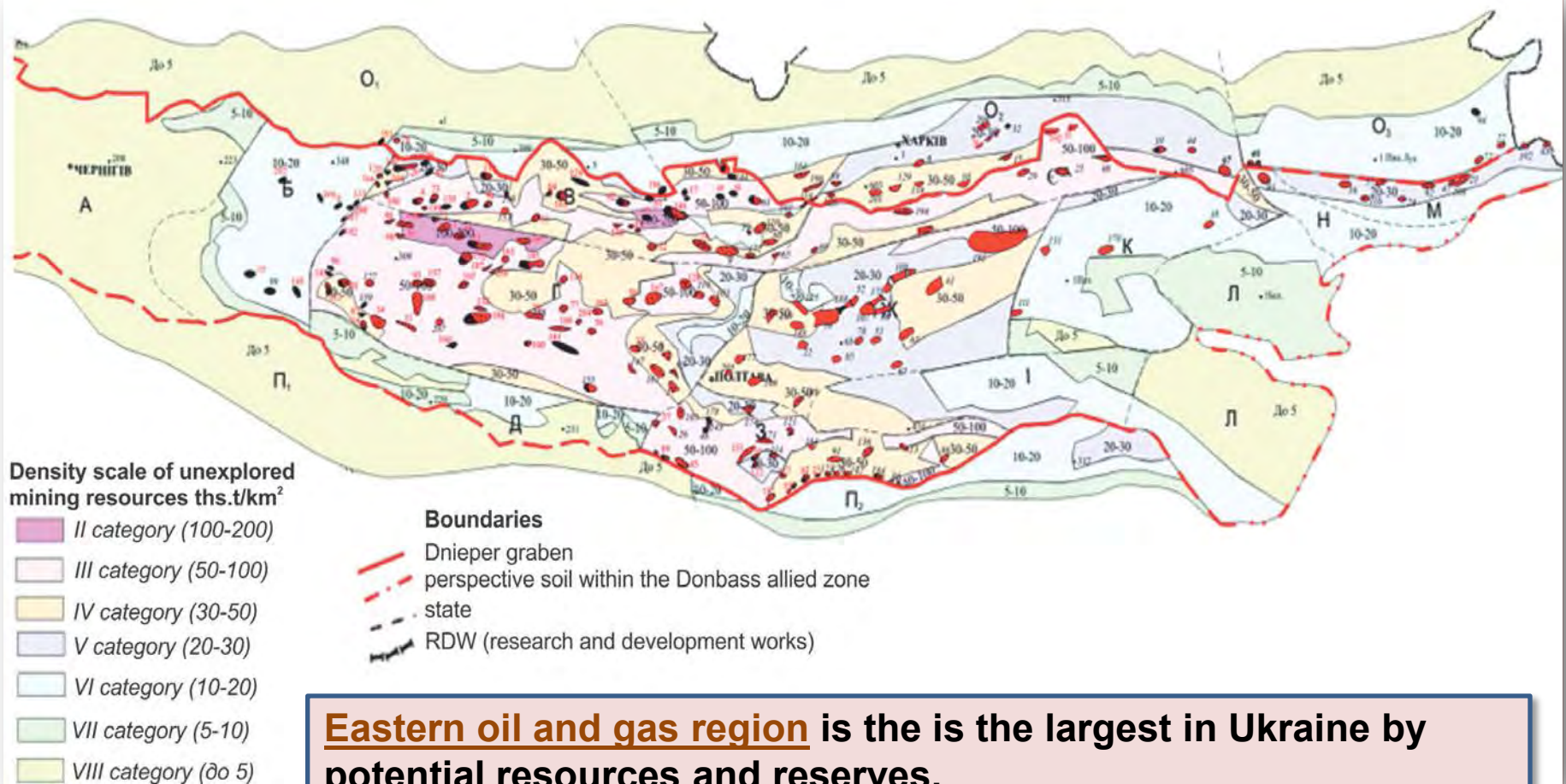
❖ Thus, keeping up the established approaches to the principles of mineral reserves Classification and the existing State balance of Ukrainian mineral reserves, the Classification provides adaptation of mineral resources base and common experience of subsoil use to conditions that are represented in UNECE, CRIRSCO and SPE (PRMS) Classifications;

❖ Accumulation and processing of information on economic-geological evaluation of mineral deposits, along with application of internationally accepted approaches and principles, contribute to: optimum understanding of Ukrainian raw material base and attraction of investments for further project implementation, connected with subsoil use.

# OIL AND GAS REGIONS OF UKRAINE



# EASTERN OIL AND GAS REGION OF UKRAINE



**Eastern oil and gas region is the largest in Ukraine by potential resources and reserves.**

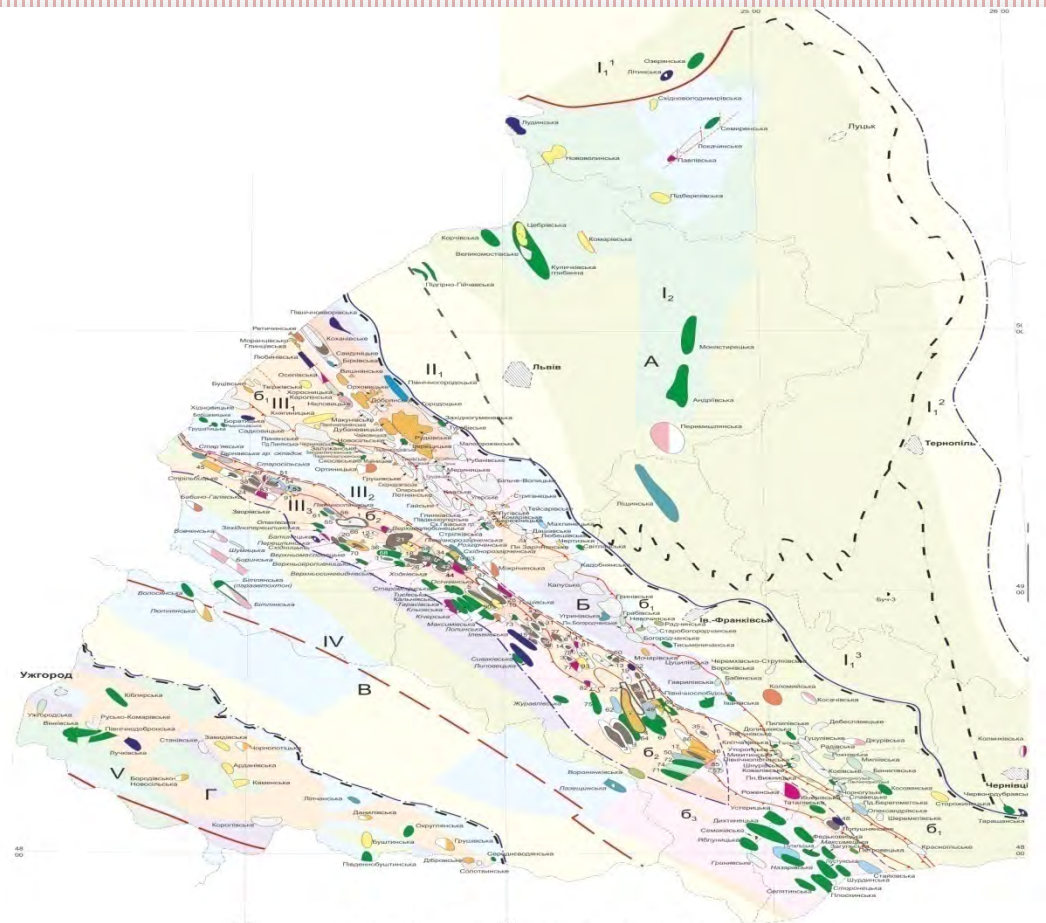
**It has 205 fields, 121 of them are being developed (gas – 64, gas condensate – 72, oil – 53).**

**The degree of the initial potential resources realization – 57%.**

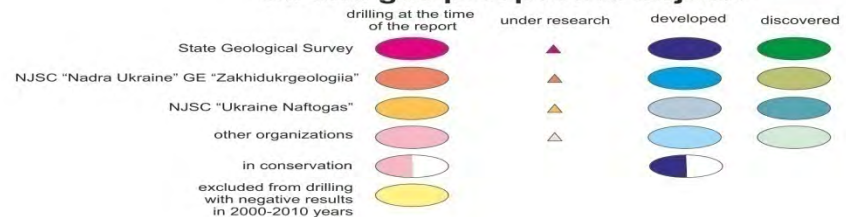
# WESTERN OIL AND GAS REGION OF UKRAINE

Western oil and gas region is the most long-exploited in Ukraine and the smallest by potential resources and reserves.

It has **103** fields, 62 of them are being developed (gas – 13, gas condensate – 4, oil – 40)



**Oil and gas prospective objects**





# SOUTHERN OIL AND GAS REGION OF UKRAINE



**Southern oil and gas region is the least developed.**

**The degree of initial resources realization – 5%.**

**The largest deposits were discovered within the shelf area: gas condensate fields – Shtormovoe, Shmidtovskoe, Halitsynskoe; oil fields – Subotinskoe (Black Sea); gas fields – Northern- and Eastern-Kazantipskoe (Sea of Azov).**

**The explored offshore reserves – 64 bcm.**

## Characteristics of reserves and exploration process

**68** perspective areas were found at a sea depth of 100m, **23** of them were prepared for exploration drilling with the average resource potential of 1 – 5 million tons of coal equivalent/object.

**8** fields were opened within the Black Sea offshore and **5** fields – within the Sea of Azov offshore. Among these, **6** fields are under development, **4** – are prepared for pilot commercial development (PCD), **2** – are under exploration, **1** – is in conservation.

**Balance reserves** of proven offshore fields amount to **44** million tons of coal equivalent.

**Resource potential** – is a *third* of the undiscovered natural gas resources and a *fifth* of the undiscovered oil resources, belongs to water area of Black Sea and Sea of Azov (remaining undiscovered mineral resources, which are basic for the mining industry development, amount **4979** million tons of coal equivalent, including: oil and condensate – **1148** million tons and gas – **3831** billion m<sup>3</sup>. The development degree of resource potential of the shelf – up to 5%).

The most perspective for the search of significant deposits is a deep part of the Black Sea.

Its potential recoverable resources reach more than 1000 million tons of coal equivalent (54% of the total Black Sea resources).

## CAPITAL EXPENDITURES AND INVESTMENTS

**Sea depth up to 70–140 m.**

**The available technical potential in Ukraine:**

- the average cost of 1 well drilling – 20 million US dollars;
- the average cost of 1 deposit developing and equipment – 0.5 billion US dollars;
- the average cost of 1 connection pipeline – 100–200 million US dollars.

**Sea depth over 140 m.**

**The technologies of world leading companies:**

- the average cost of 1 deposit developing and equipment – 1.5–2 billion US dollars;
- the average cost of 1 connection pipeline – 300–500 million US dollars.

**Current state:** advanced conditions for the creation of joint ventures.

In order to increase production from the shallow shelf, the financing of operations on geological exploration must be increased up to 100 – 200 million USD/year); and in several times (up to 0.5 – 1 billion USD/year) on buildup of production that totals up to 2–5 million tons of coal equivalent/year.

### INVESTMENT

To create the conditions so that major oil companies could obtain license blocks or set up joint ventures in order to carry out the work programs on deepwater resources development .

Expected investment in exploration for each of the units – up to 0.5 billion US dollars.

Investment appraisal of the deposits development – up to 1.5 – 2 billion US dollars.

Ukraine ranks the 9<sup>th</sup> place in the world  
by the total reserves of coal-bed methane

**12 – 13 trillion m<sup>3</sup>** – general resources of coal-bed methane in Ukraine (coal + sandstones);

**1.2 trillion m<sup>3</sup>** – calculated according to the State Committee on Science and Technology (SCST) program, 1989 methane resources in the Donbas coal-bed of proved and prospective areas;

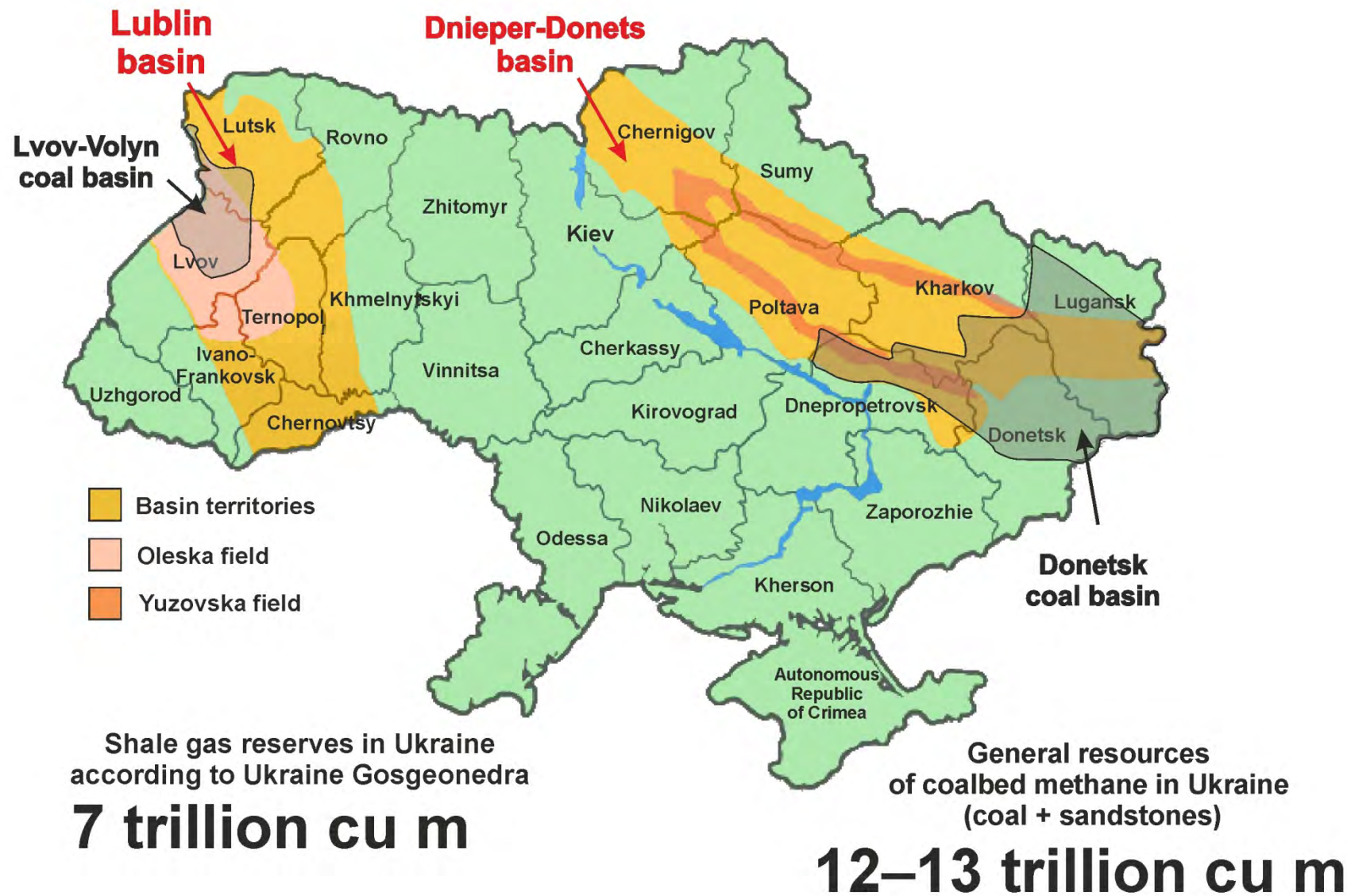
**3 – 3.5 trillion m<sup>3</sup>** – real methane **resources** that can be extracted from coal-beds and rocks;

**314 billion m<sup>3</sup>** – methane reserves of 186 mines and sites, including 95 operating mines accounted for the State balance of Ukraine as of 01.01.2010;

**8 – 12 billion m<sup>3</sup>/year** – estimated potential of methane production per year;

**1.4 billion m<sup>3</sup>/2009** – amount of gas that was released in the process of coal mining (72.2 million tons); the recycled amount – 70 million m<sup>3</sup> (5%).

# PROSPECTIVE ZONES OF UNCONVENTIONAL GAS PRODUCTION



## The most perspective objects:

### Dnieper-Donets depression

Black shale of Devonian and Carboniferous strata:

- area — approx. 100 ths. km<sup>2</sup>
- thickness — more than 1000 m
- depth of occurrence — up to 2000-4000 m

Including consolidated collectors in the rocks of Mid- and Lower Carboniferous age:

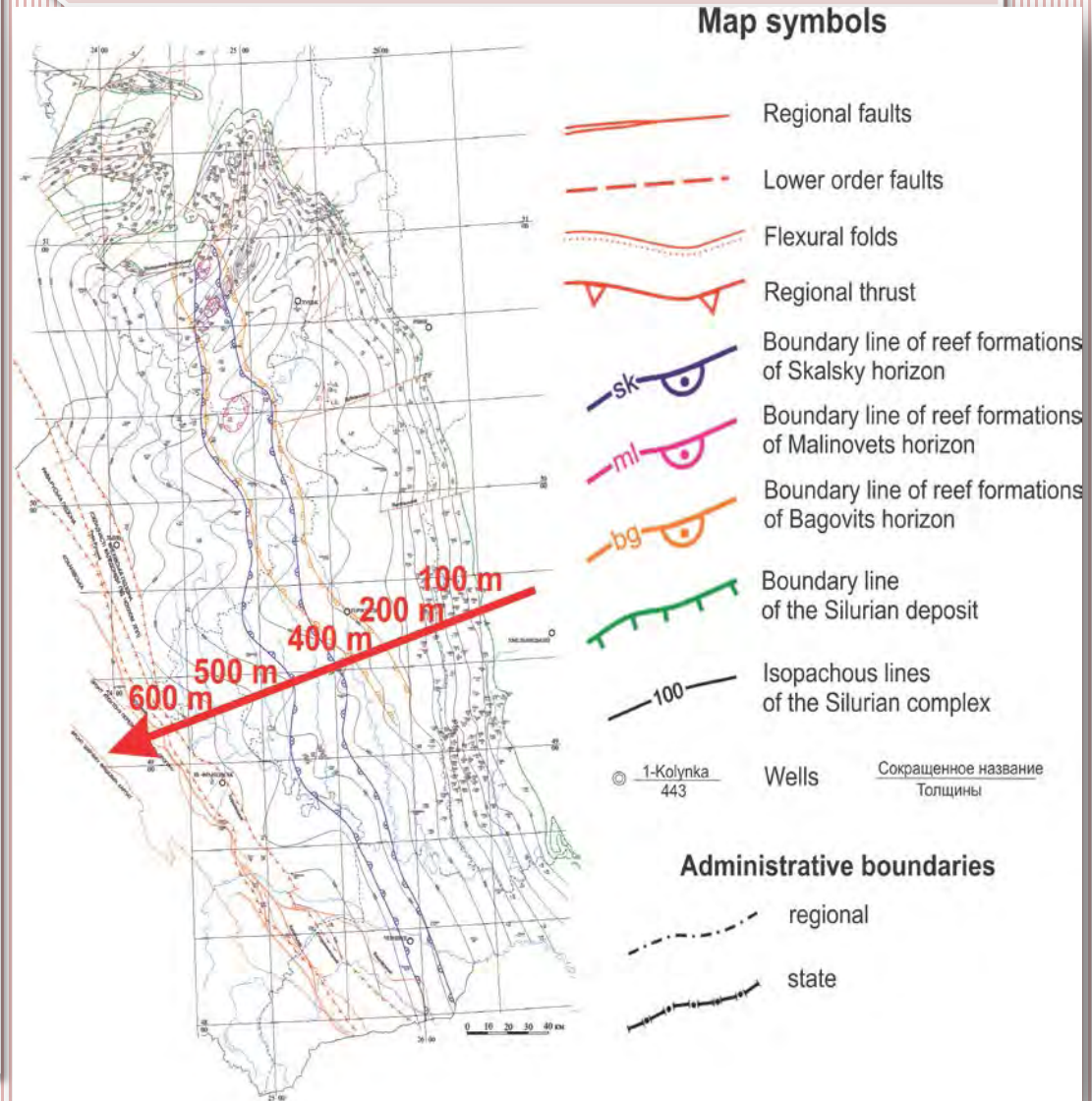
- area — approx. 18.5 ths. km<sup>2</sup>
- thickness — more than 1000 m
- depth of occurrence — up to 3000-5000 m

### Lviv Paleozoic downfold

Ludlow layer of the Silurian strata:

- area — tens of thousands km<sup>2</sup>
- thickness — 400-600 m
- depth of occurrence — 2000-3000 m

## Thickness variation of the Silurian formation





# PROJECT OF SHALE GAS AND TIGHT GAS RECOVERY



**Oleska field, shale gas formations**



**Yuzovska field, tight gas reservoirs**

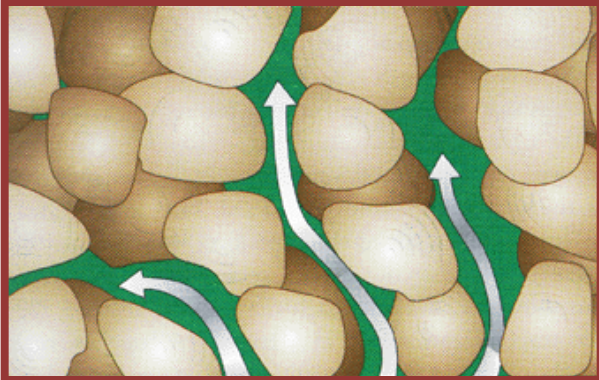
<u>Index</u>	<u>Oleska field</u>	<u>Yuzovska field</u>
Pessimistic scenario	3 – 5 bcm/year	10 bcm/year and more
Baseline scenario	approx. 10 bcm/year	approx. 15 – 20 bcm/year
Optimistic scenario	15 – 20 bcm/year	30 – 40 bcm/year
Possible unconventional gas resources	1 – 2 trillion. m <sup>3</sup>	1 – 3 trillion. m <sup>3</sup>

*Prognostic variants of shale gas production*

# SHALE GAS AND COAL-BED METHANE PRODUCTION

## TYPES OF UNCONVENTIONAL GAS

### Gas in consolidated rocks



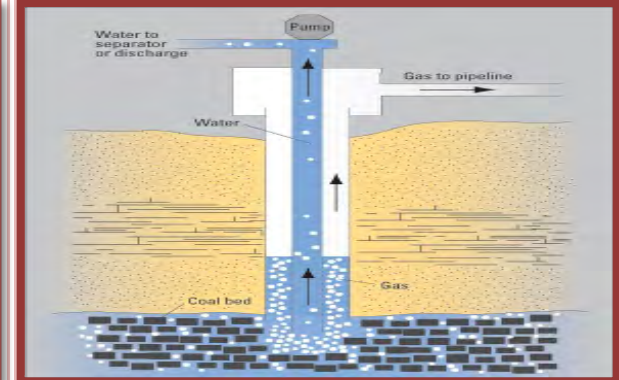
- Penetrates the consolidated sandstones
- Low porosity – small space between the grains of rock
- Low permeability – gas can't freely migrate through the rock

### Shale gas



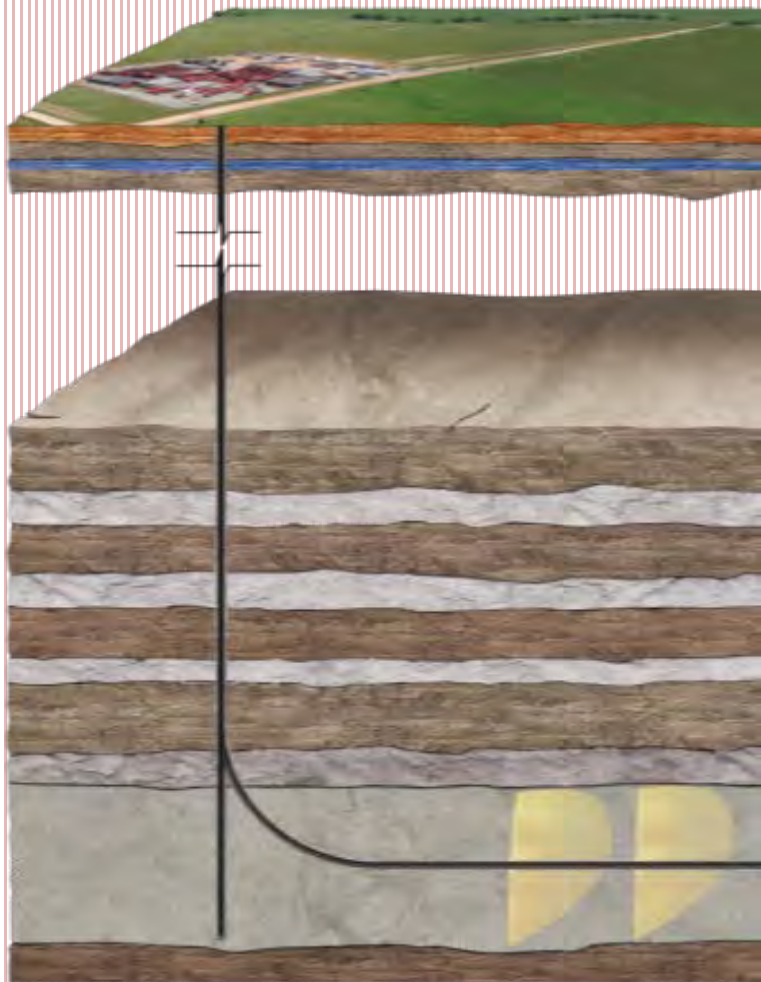
- Located between shale streaks
- Low porosity and ultra-low permeability
- Hydraulic fracturing is needed to release gas

### Coalbed methane



- Natural gas in coal layers
- Low permeability
- Mining due to natural fracturing of coal
- Low production rate

## HYDRAULIC FRACTURING



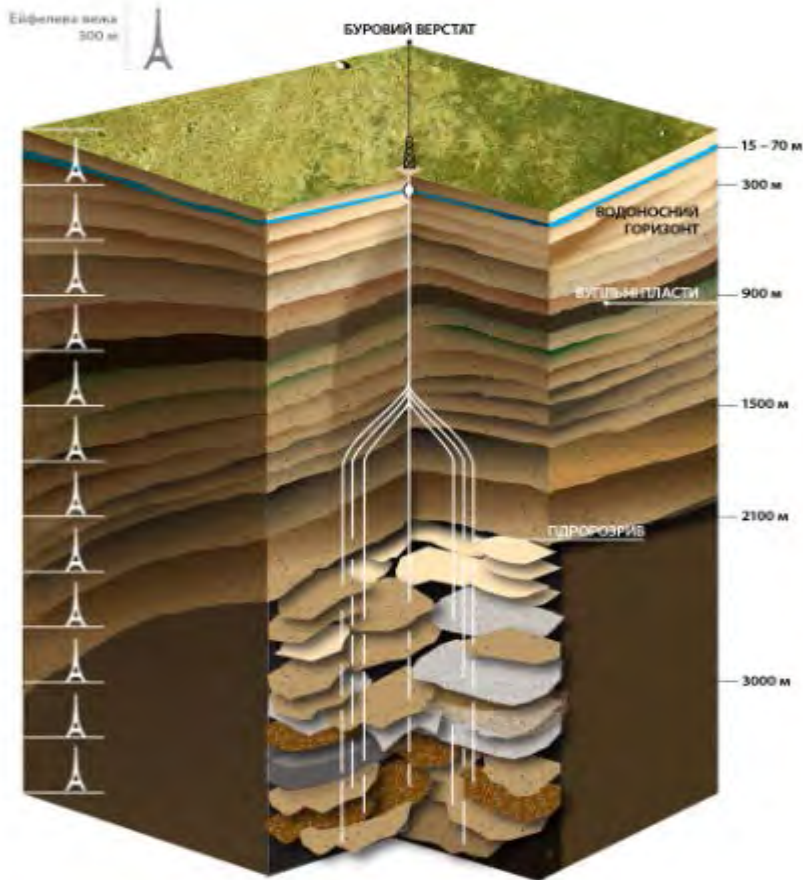
- Proven technology
- Use of liquid to form cracks in rock so that gas could flux into the well
- Composition – 99% of water and sand; and 1% of chemical impurities
- The particles of sand-proppant keep the rock opened after HF

### Hydraulic fracturing is used to:

- Increase the production rate
- Increase the volume of extracted gas

## PREVENTION OF EXPOSURE ON AQUIFERS

Scheme of "bush" wells  
(Source: Royal Dutch Shell plc)



Layers that contain gas of consolidated rocks occur several thousand metres deeper than freshwater-bearing horizons.

Kilometres of various subsurface formations lie between these horizons and fissures, which were formed after fracturing. Best experience in water management lies in water use reducing, maximizing of water reuse and purification according to Ukrainian laws and international standards.

Water reuse reduces water management by 50%. This allows to optimize liquid waste volume and withdrawal for hydraulic fracturing.

## FIRST EXPLORATION WELL – BELIAEVSKAYA-400



- ❑ Drilling site – 300 x 220 m
- ❑ Concreted road laid to the site – 3700 m
- ❑ Project drilling depth – 5250 m
- ❑ Spudding-in – 25 October 2012
- ❑ Expected time of drilling – 6 months.
- ❑ Best international standards for safety and environmental protection

# SUMMARY

**1. Currently Ukraine implements economic-geological evaluation of mineral deposits on the basis of the United Nations Framework Classification 1997 and applies it at the legislative level. At present the works on comparison between Ukrainian Classification of mineral reserves and resources (UNFC-1997) and UNFC-2009 as also CRIRSCO and SPE (PRMS) Classifications.**

**Ukrainian Classification of mineral reserves and resources is fully comparable with the CRIRSCO Classification (solid minerals) and preliminary with SPE-PRMS (hydrocarbons) Classification. This will allow to transform the reserves of mineral deposits from national classification system of Ukraine into the world's most common Classification systems of multinational companies.**

## SUMMARY

2. Ukraine has major deficits in energy products, what determines a considerable proportion of their imports. At the same time Ukraine has prospective territories for hydrocarbon upgrading, what determines the potential for profitable investment in new fields discoveries, as well as opportunities of additional hydrocarbon extraction within abandoned deposits in virtue of modern technologies use.

3. Ukraine has significant coal-bed methane reserves that are accounted for the State balance. The problem is the lack of modern technological methods of its recovery and use.

4. Ukraine has significant gas reserves in shale formations and in consolidated rocks, what determines the desirability of corresponding investment projects development on favorable terms for an investor.

**THANK YOU FOR  
YOUR ATTENTION**