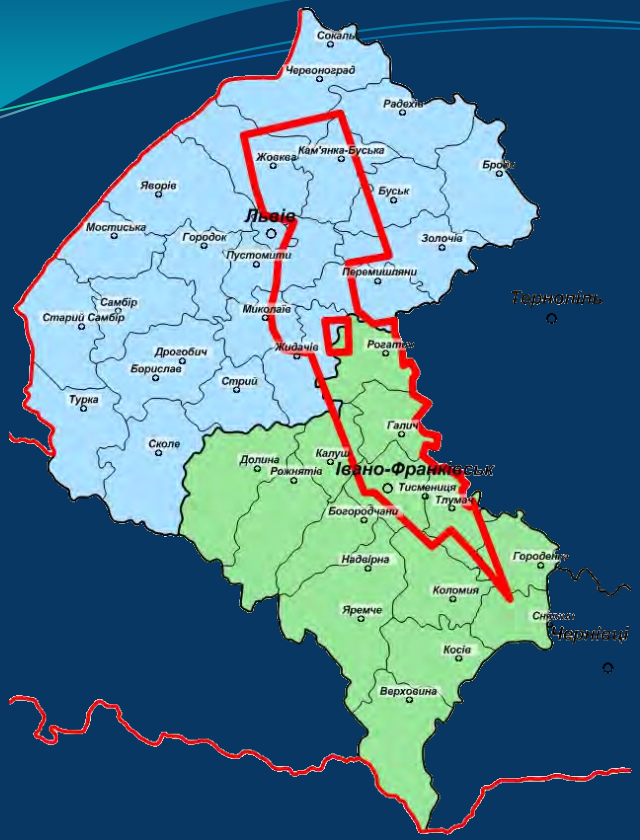
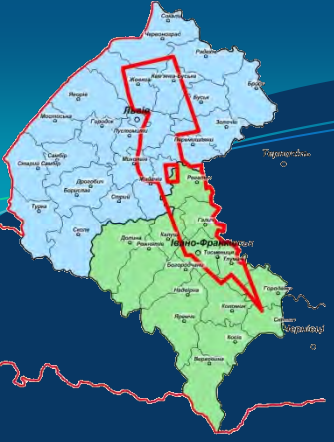


Western region

Geological, hydrogeological, technological and social aspects of natural gas production from silurian shale rocks

Ivano-Frankivsk National Technical University of Oil and Gas
Oleksandr Petrovskyy, Tetyana Fedchenko, Oksana Onishchuk



CONTENTS

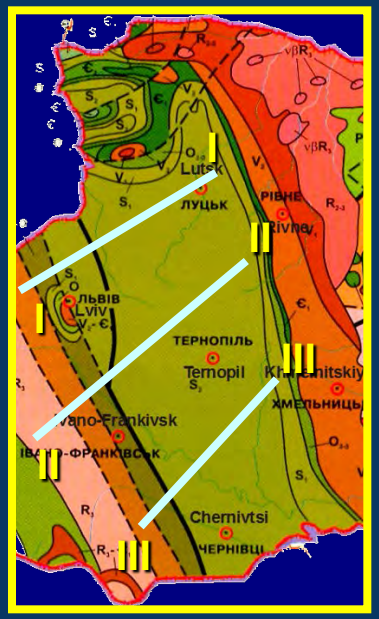
1. Geological structure of Eastern Europe platform western end and characteristic of gas potential silurian shales.
2. Hydrogeological characteristic of Eastern Europe platform western end.

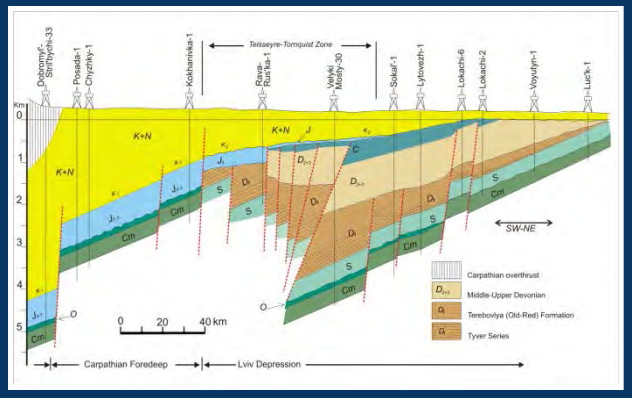
   Main supplies of fresh water and consumption volumes in Lviv and Ivano-Frankivsk oblast.
3. Main stages of natural gas fields exploration and development from shale rocks.
4. Technical and social aspects of natural gas fields exploration and development from shale rocks in Ivano-Frankivsk oblast.

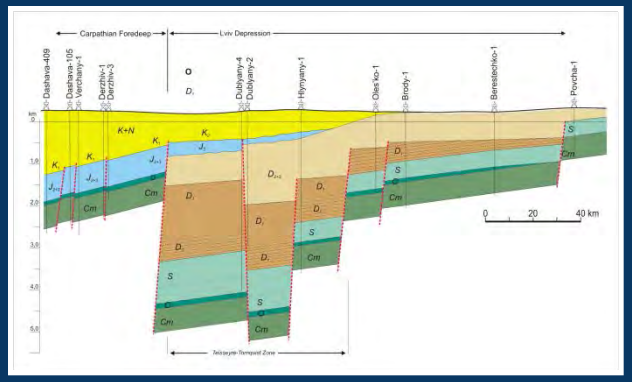
ADMINISTRATIVE IDENTITY

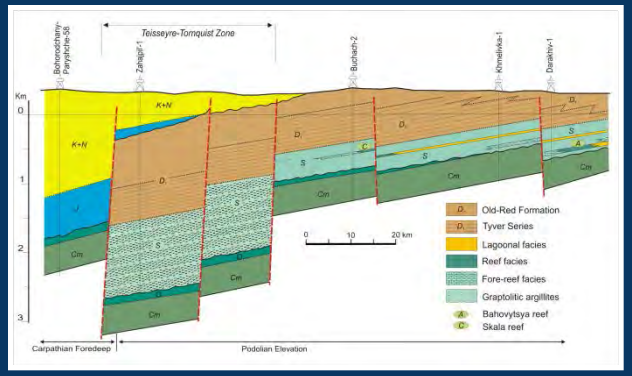
Lviv and Ivano-Frankivsk oblast

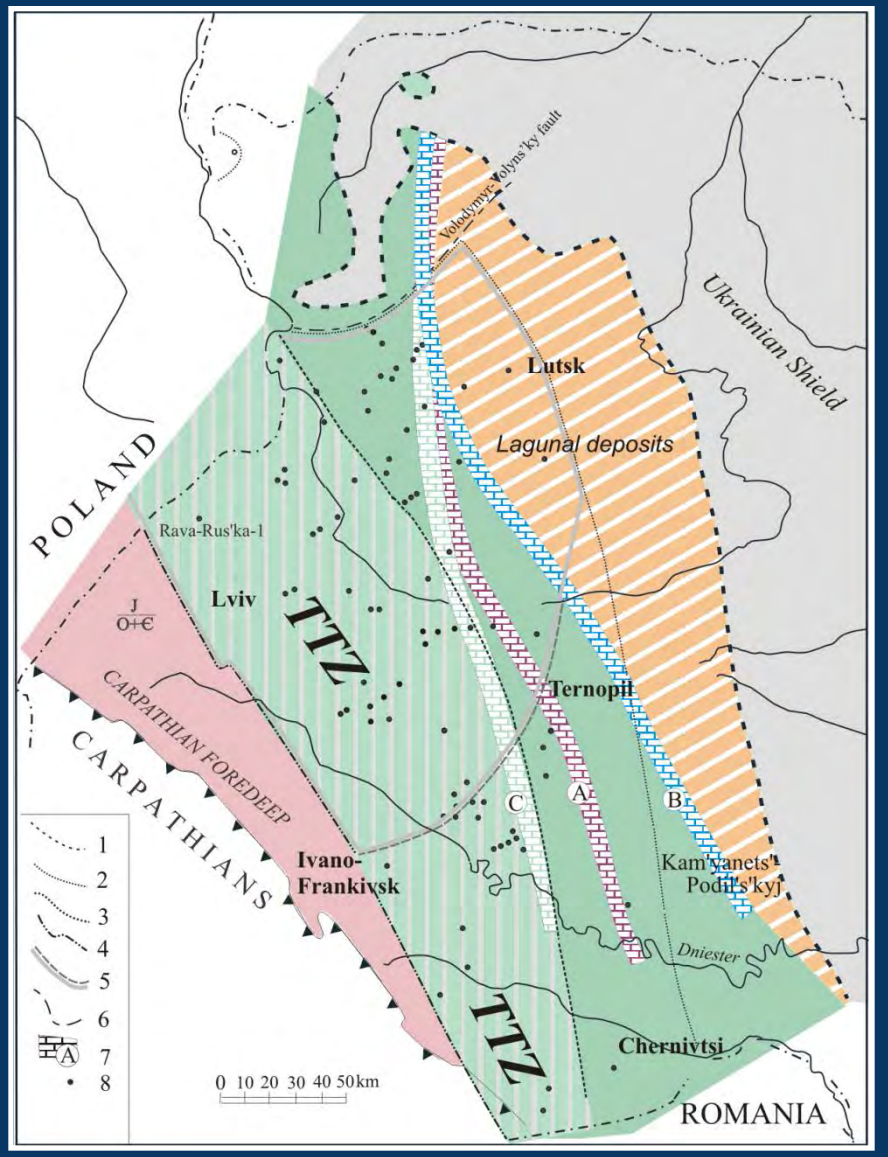
GEOLOGICAL STRUCTURE











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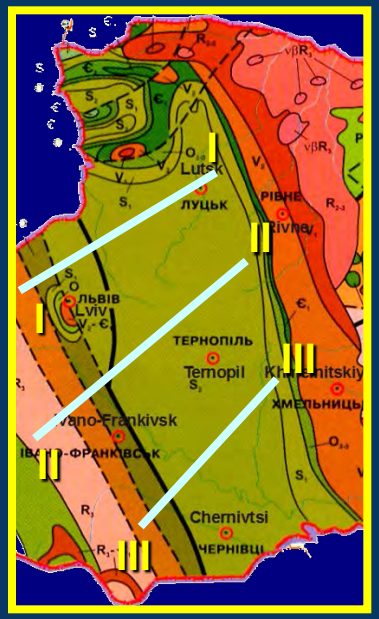

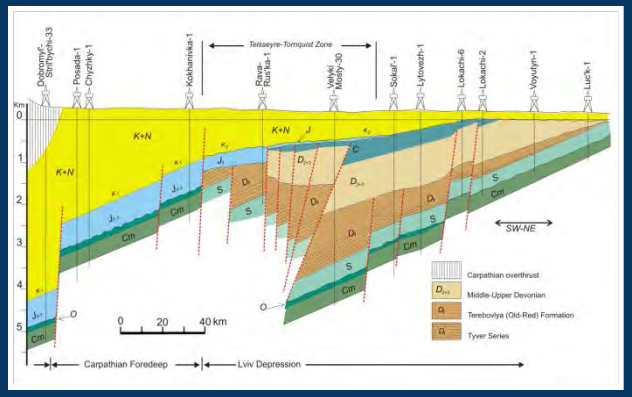

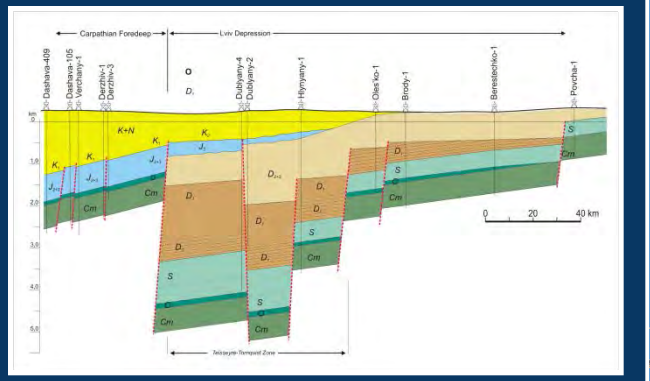

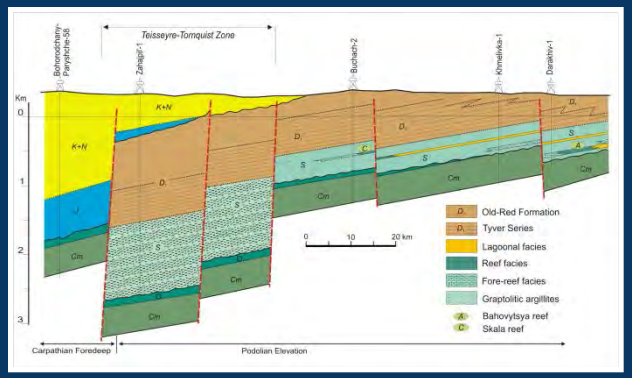

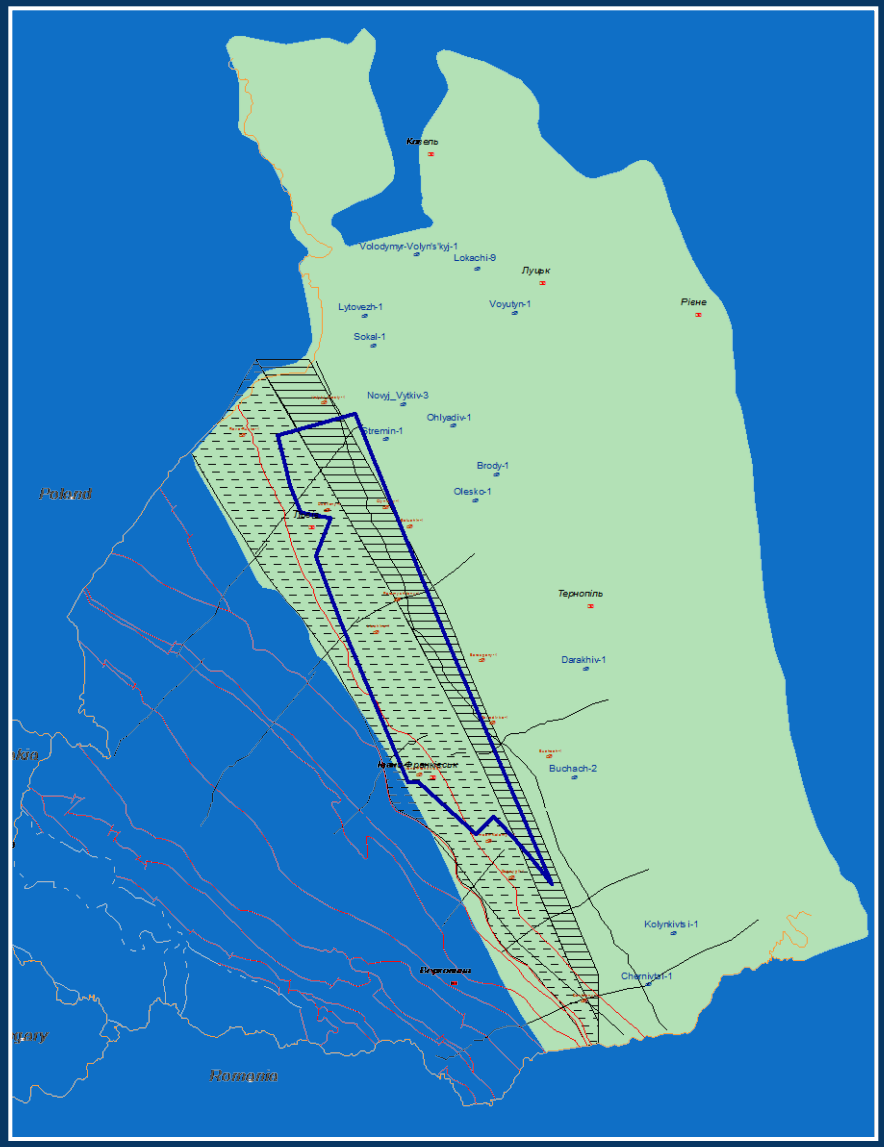

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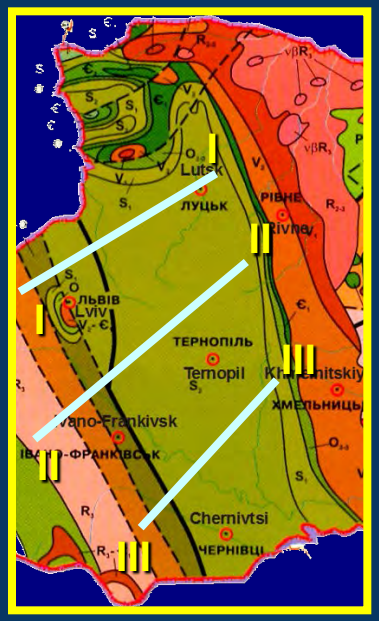
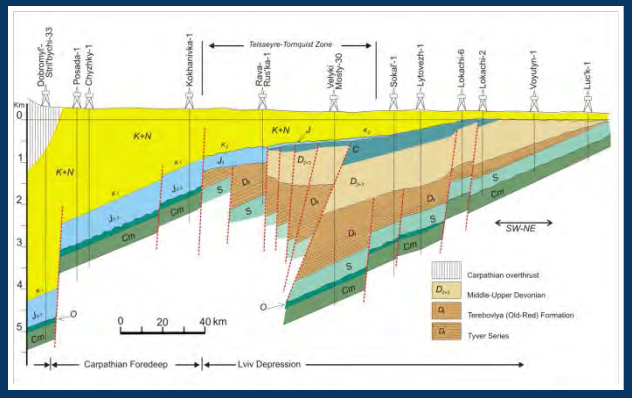
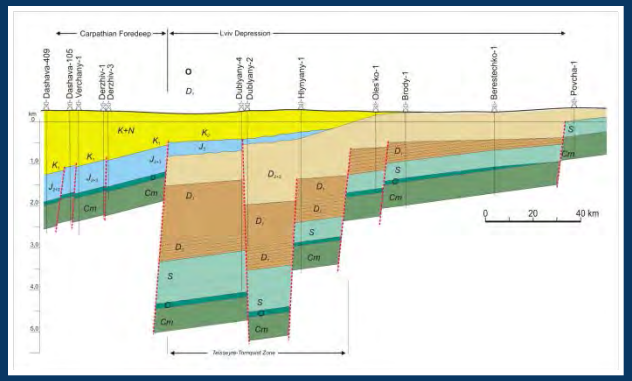
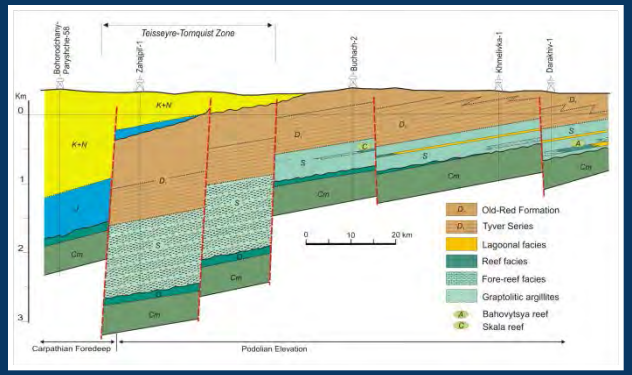
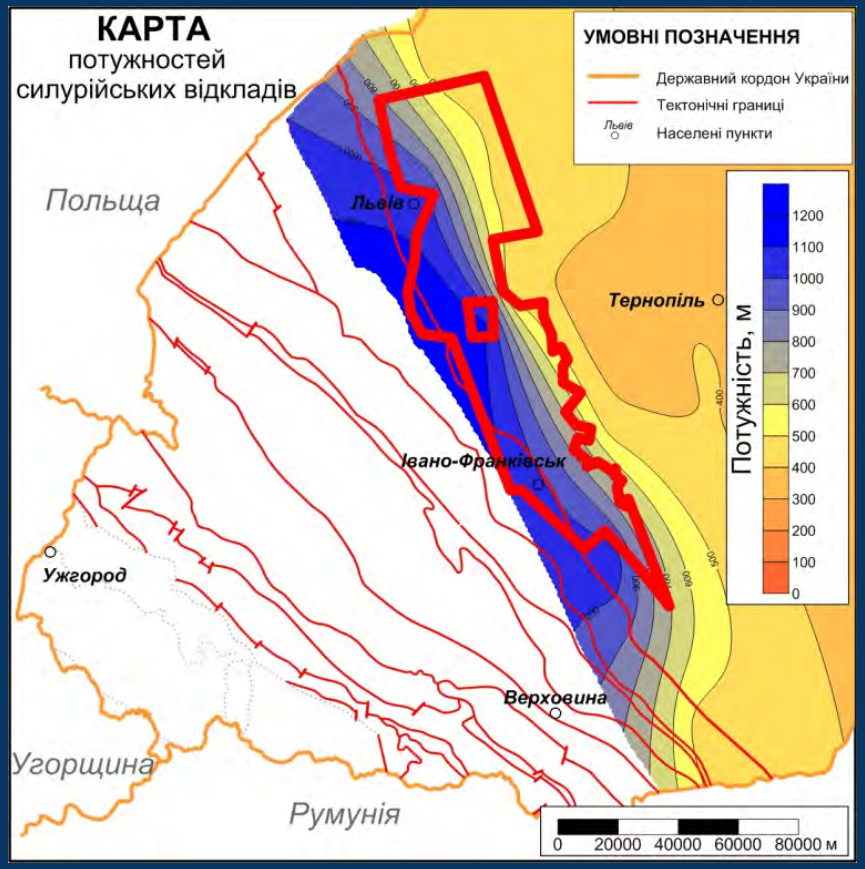






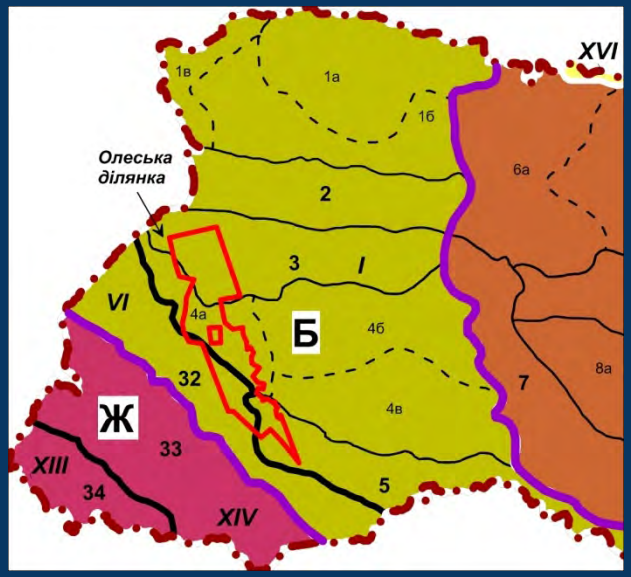




Силурійські відклади
Глибина до покрівлі – 2000 м
Товщина – 600-1200 м

HYDROGEOLOGICAL CHARACTERISTIC

Hydrogeological zoning of Western Ukraine

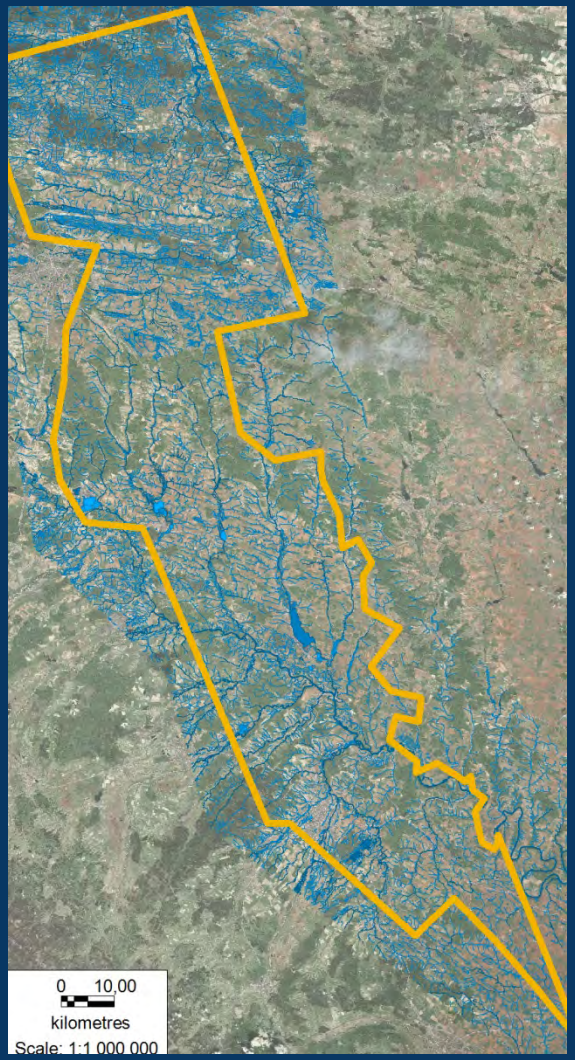


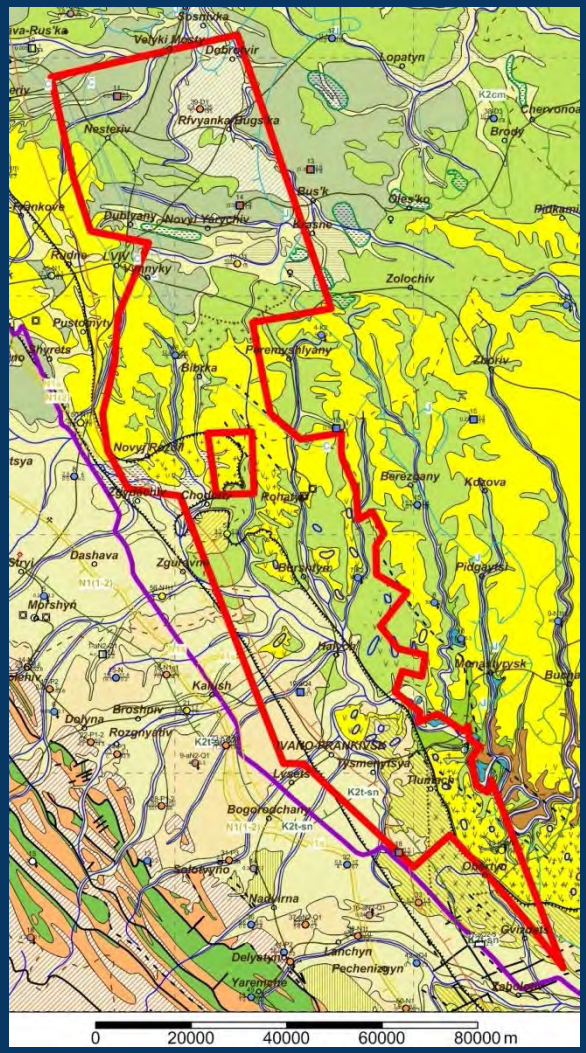
УМОВНІ ПОЗНАЧЕННЯ

- **Б, Ж** - межі основних басейнів підземних вод за каталогом БД
- ***I - XIV*** - межі басейнів підземних вод II порядку
- ***1 - 36*** - межі гідрогеологічних районів
- ***а - в*** - межі гідрогеологічних підрайонів

Main source – surface water

Surface and subsurface water of Olesk area

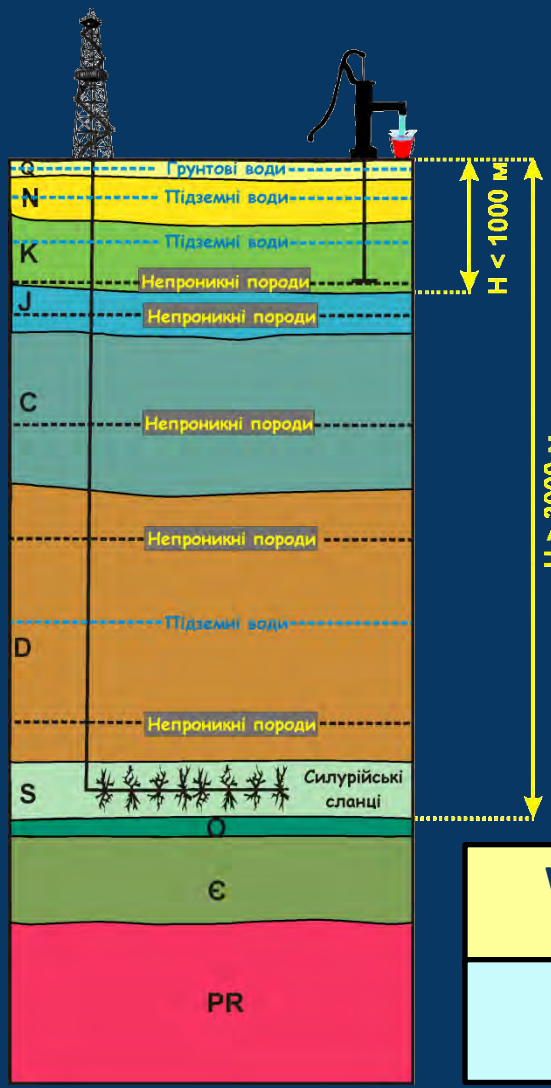




ECOLOGICAL RISKS OF WATER POLLUTION

<u>ECOLOGICAL RISKS</u> of hydraulic fracture are associated with:
- pollution of ground waters;
- pollution of surface water due to overflowing of fracturing fluid.

Typical geological record of Olesk area



Main aquifers used for water intake are embedded at a depth of *<u>1000 m .</u>*

Upside silurian shales are embedded *<u>2000 m</u>* deeper than fresh aquifers and superposed by thick formations (1000-2000 m) of impermeable rocks.

Well design

Well design ensures <u>reliable isolation of aquifers</u> against technological fluids along whole wellbore.

Compliance control of drilling process conditions is required to avoid ecological risks.

Water consumptions – U.S. experience

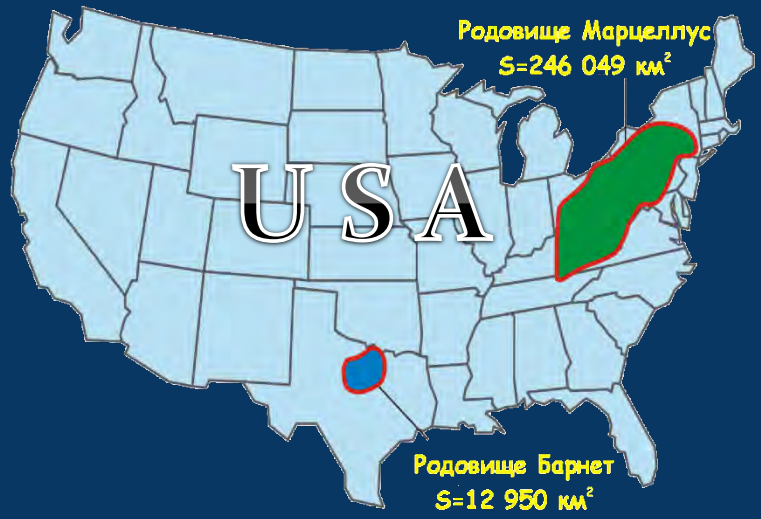
Water intake sources for well drilling in U.S. (*each part depends on hydrogeological situation in the region*):

- Surface waters
- Ground waters
- Municipal and private water reservoirs
- Re-use of return water after purification

Upside Olesk area
S=6 324 km²

Fields area ratio

The biggest fields of shale gas in U.S.



AVERAGE ANNUAL WATER VOLUME, REQUIRED FOR DEVELOPMENT*

BARNETT field
(15 000 wells):

5,3 mln. m³ (< 2% of overall water intake of Texas)

MARCELLUS field:

75 mln. m³ (0,8% of overall water intake of New York, West Virginia and Pennsylvania)

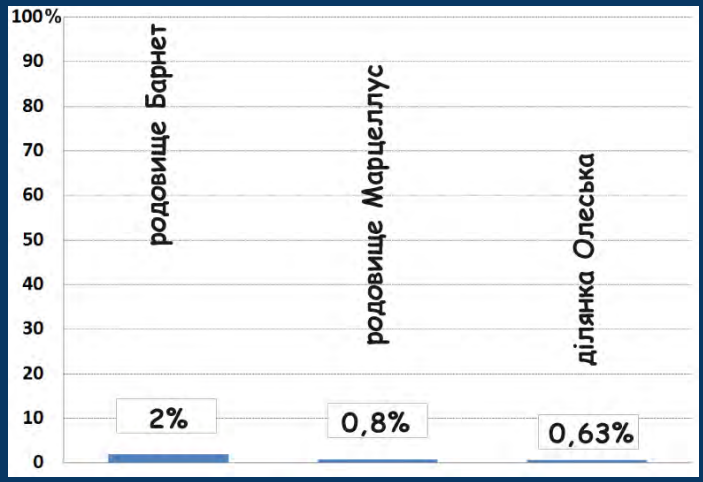
FORECASTED
AVERAGE ANNUAL WATER VOLUME, REQUIRED FOR DEVELOPMENT

Olesk areas:
2,26 mln. m³
(**0,63%** of overall water intake of Lviv and Ivano-Frankivsk oblast)

Source* http://fracfocus.org/

Average annual water volume for shale gas field development in 1 km² area

Water part for shale gas field development related to overall water intake of the territory



By setting up technology and methodology for field development, **water consumptions** per well **are decreasing!!!**

UTILIZATION OF WATER RESOURCES

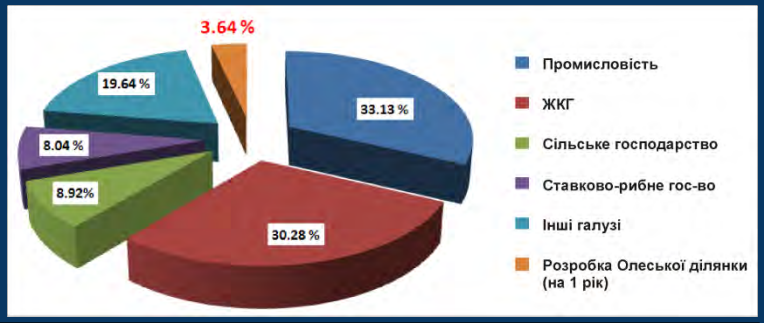
Surface and subsurface water resources

Water resources supply per capita:

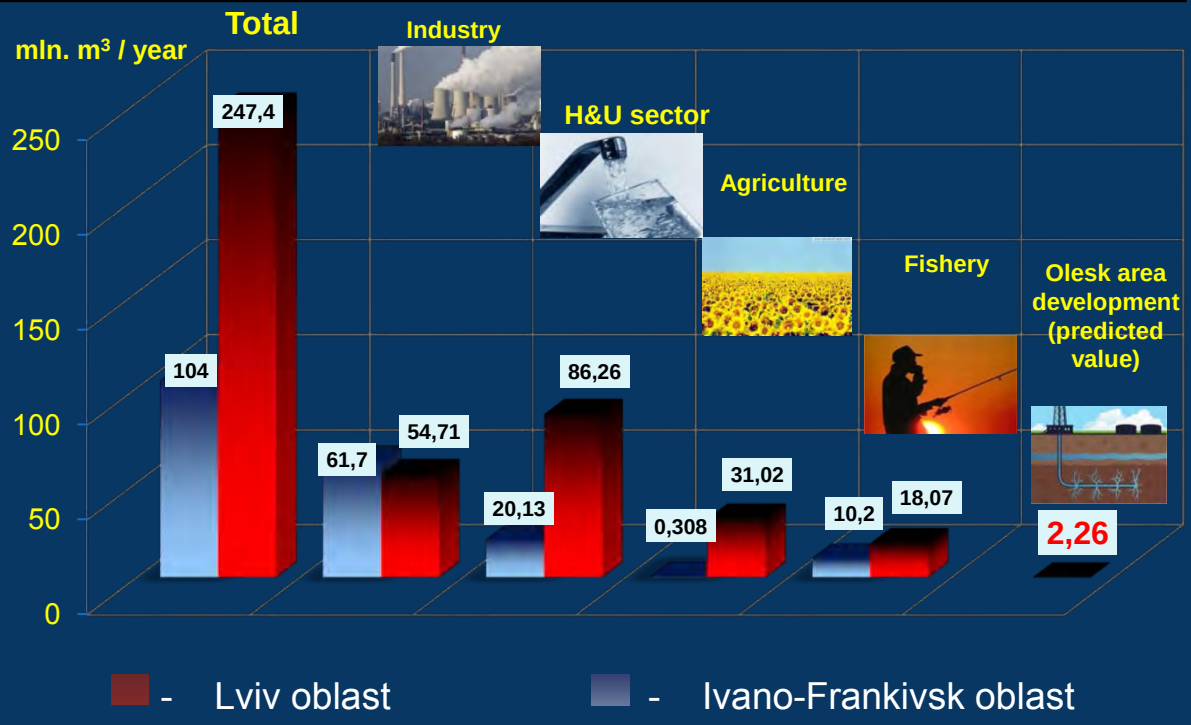
3,22 ths m³/ year (Ivano-Frankivsk oblast)

1,82 ths m³/ year (Lviv oblast)

Percentage of water resources utilization by different business facilities



Water utilization by business facilities



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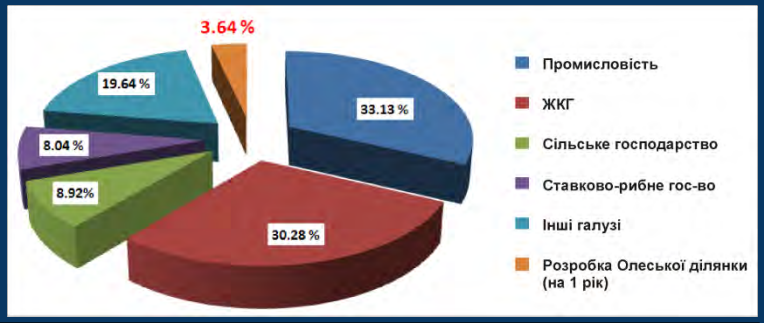

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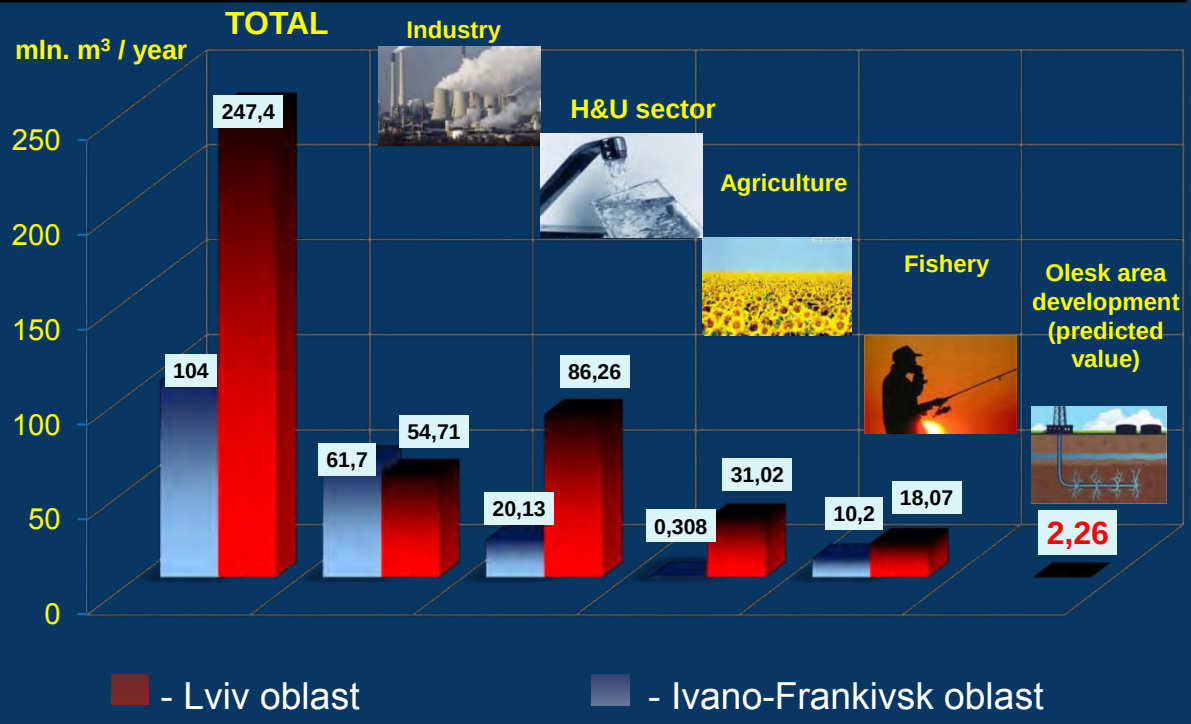
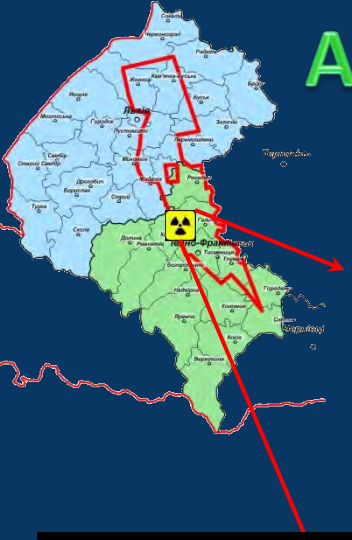
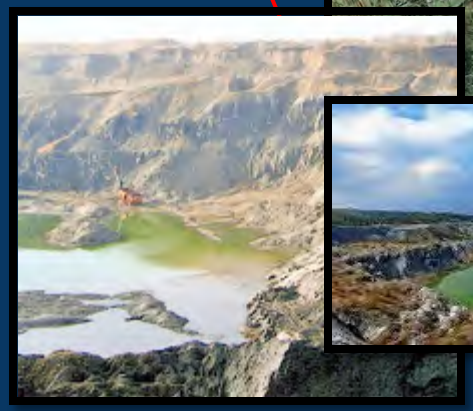


ALTERNATIVE PATHS OF WATER SUPPLY IN IVANO-FRANKIVSK OBLAST

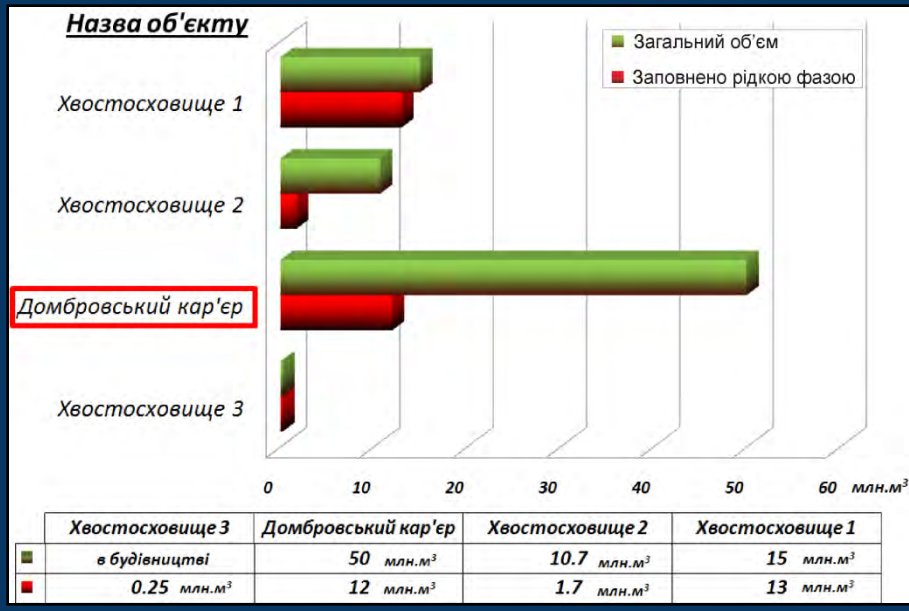




INDUSTRIAL WATER FACILITIES OF KALUSH-HOLYN' POTASSIUM SALT DEPOSITS:

Dombrovskyy opencast, slope mines of potassium salt underground mining, tailing ponds of chemical plant

Characteristic of artificial reservoirs of Kalush-Holyn' potassium salt deposit



	Хвостосховище 3	Домбровський кар'єр	Хвостосховище 2	Хвостосховище 1
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	0.25 млн.м³	12 млн.м³	1.7 млн.м³	13 млн.м³

MAIN ECOLOGICAL HAZARDS:

- Saline contamination of surface and subsurface waters, soils;
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Is enough for 11 years and 11 months of Olesk area development

Annual growth of brines in Dombrovskyy opencast due to atmospheric precipitations and water inlet from aquifer is equal to ***4 mln. m³***.

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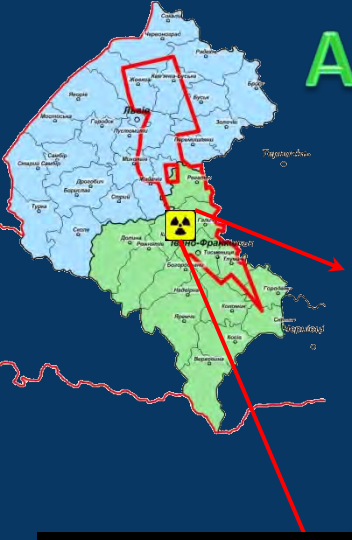

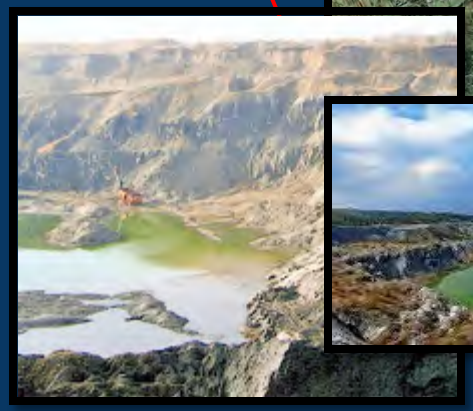

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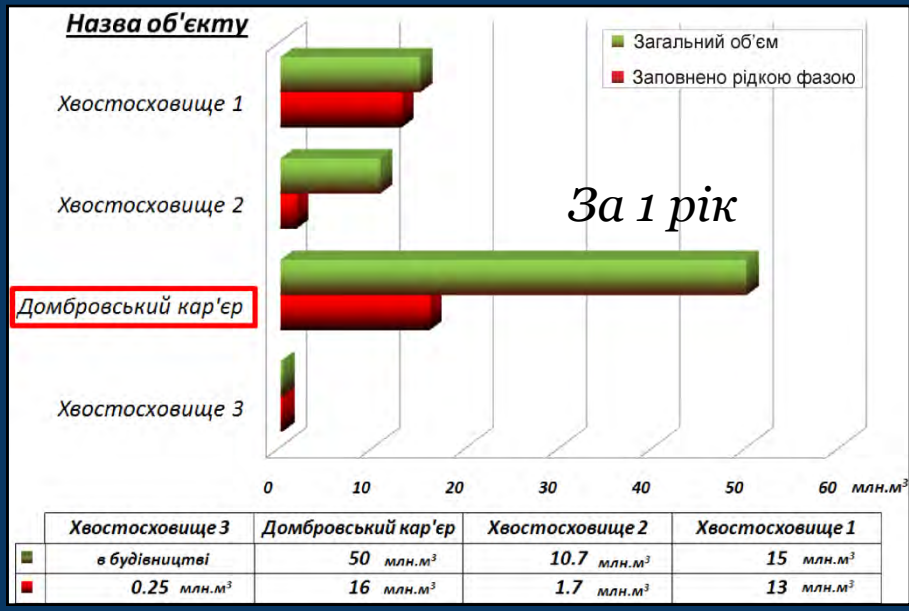

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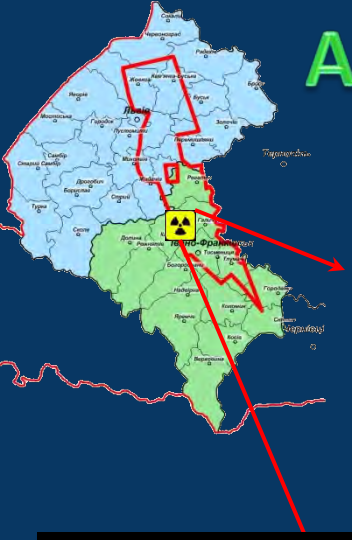

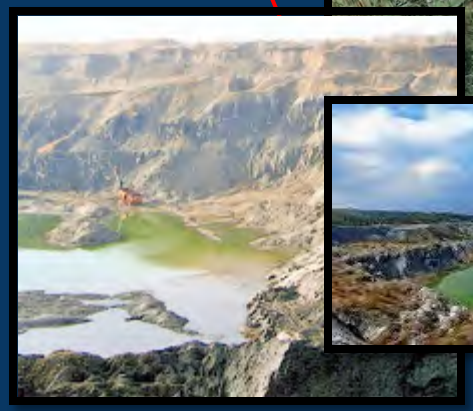

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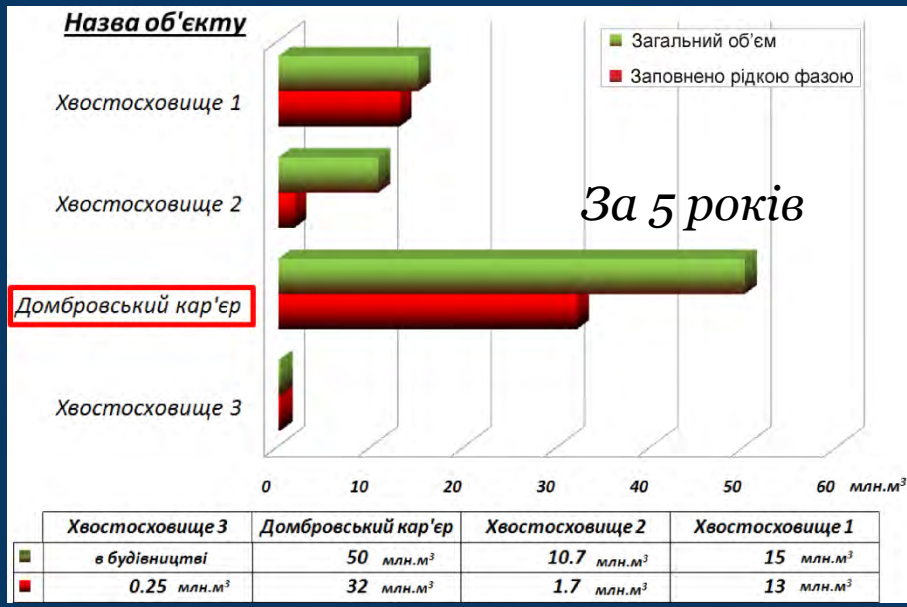

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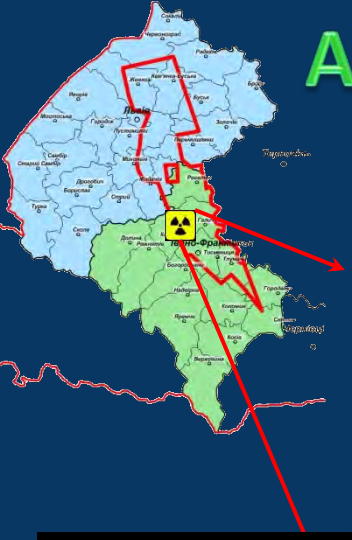

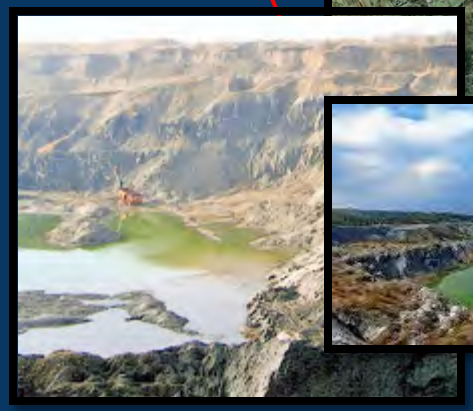

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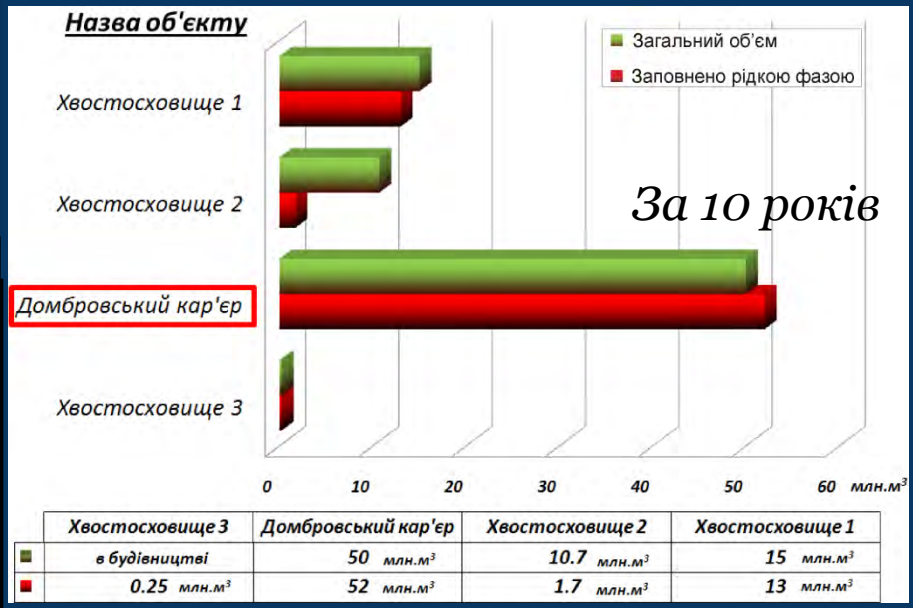

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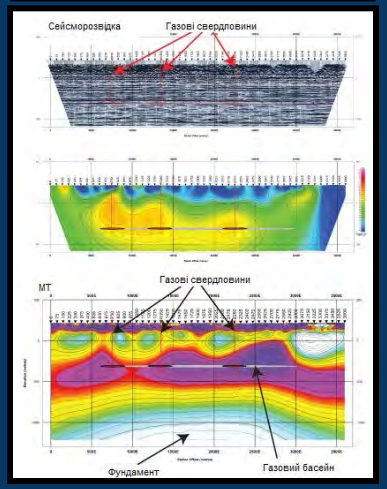
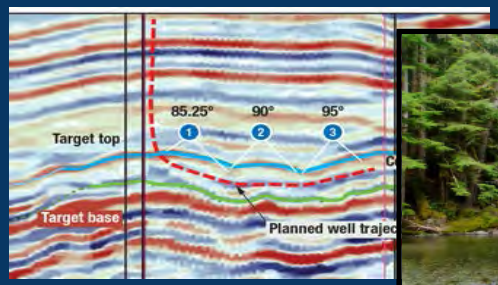
EXPLORATION AND DEVELOPMENT OF NATURAL GAS FIELDS FROM SHALE ROCKS

1. Geophysical logging, including 3D seismic exploration

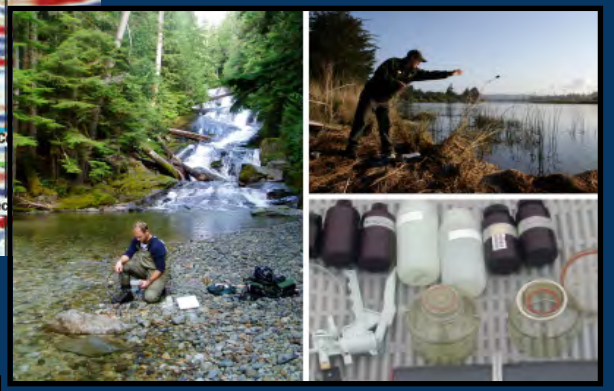
2. Geologic-geophysical simulation



3. Optimization of prospect well location



4. Ecological monitoring of environment prior to drilling start

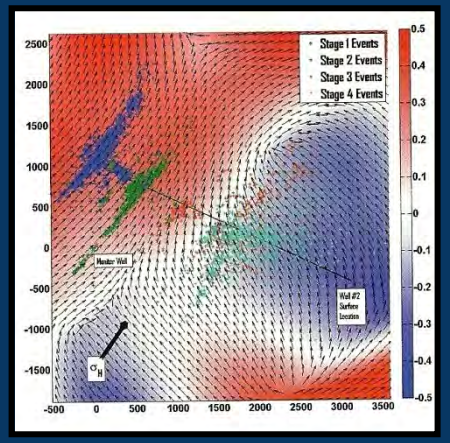


5. Prospect drilling and well testing

6. Petrophysical investigations and core analysis

7. Production drilling

8. Geophysical monitoring of hydraulic fracturing



POSITIVE ASPECTS OF SHALE GAS PRODUCTION IN IVANO-FRANKIVSK OBLAST

Natural gas development from shale rocks allows to provide a set of social and economical decisions:

1. Provide own gas resources for region inhabitants.
2. Provide a volume of additional workplaces.
3. Provide significant revenues for budgets of different levels.
4. Provide the development of high level oil&gas education, science and technologies in western region.

Technical and ecological warnings:

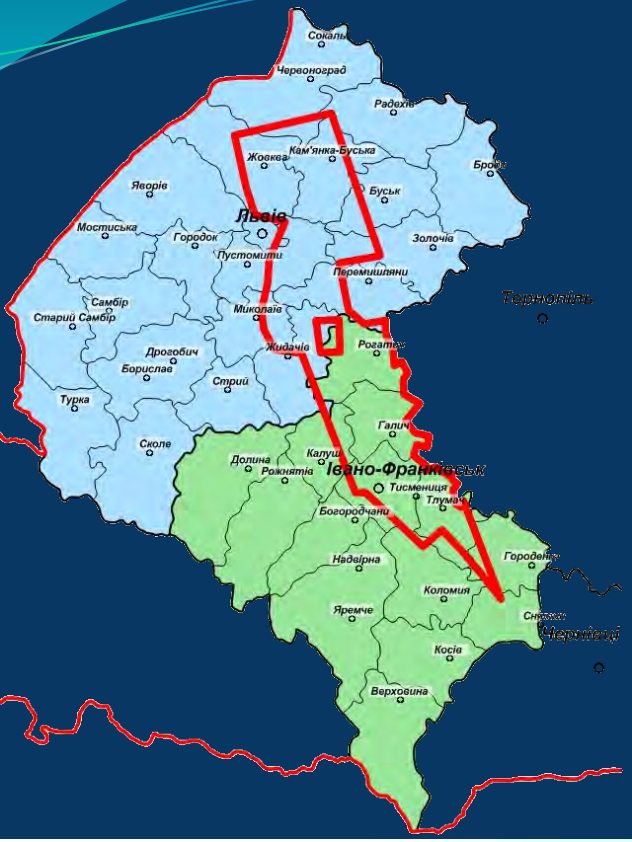
1. Advanced powerful drilling rigs that provide maximum drilling efficiency are required.
2. Remote control of shale stratums hydraulic fracturing has to be provided.
3. Efficient well abandonment by cementing both wellbore and borehole environment where the hydraulic fracturing is performed.

POSITIVE ASPECTS OF SHALE GAS PRODUCTION IN IVANO-FRANKIVSK OBLAST

Ivano-Frankivsk National Technical University of Oil and Gas (IFNTUOG) – single higher education institution in Ukraine, where specialists for whole oil and gas industry are trained.

Faculties that cover training of engineers for all stages of exploration and development of natural gas from shale rocks:

- **Faculty of geological prospecting**
- **Ecological engineering faculty**
- **Faculty of oil and gas production**
- **Faculty of oil and gas pipelines**
- **Mechanical engineering faculty**
- **Mechanical and technological faculty**



Western region

Geological, hydrogeological, technological and social aspects of natural gas production from silurian shale rocks

Ivano-Frankivsk National Technical University of Oil and Gas
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Thank you for attention!