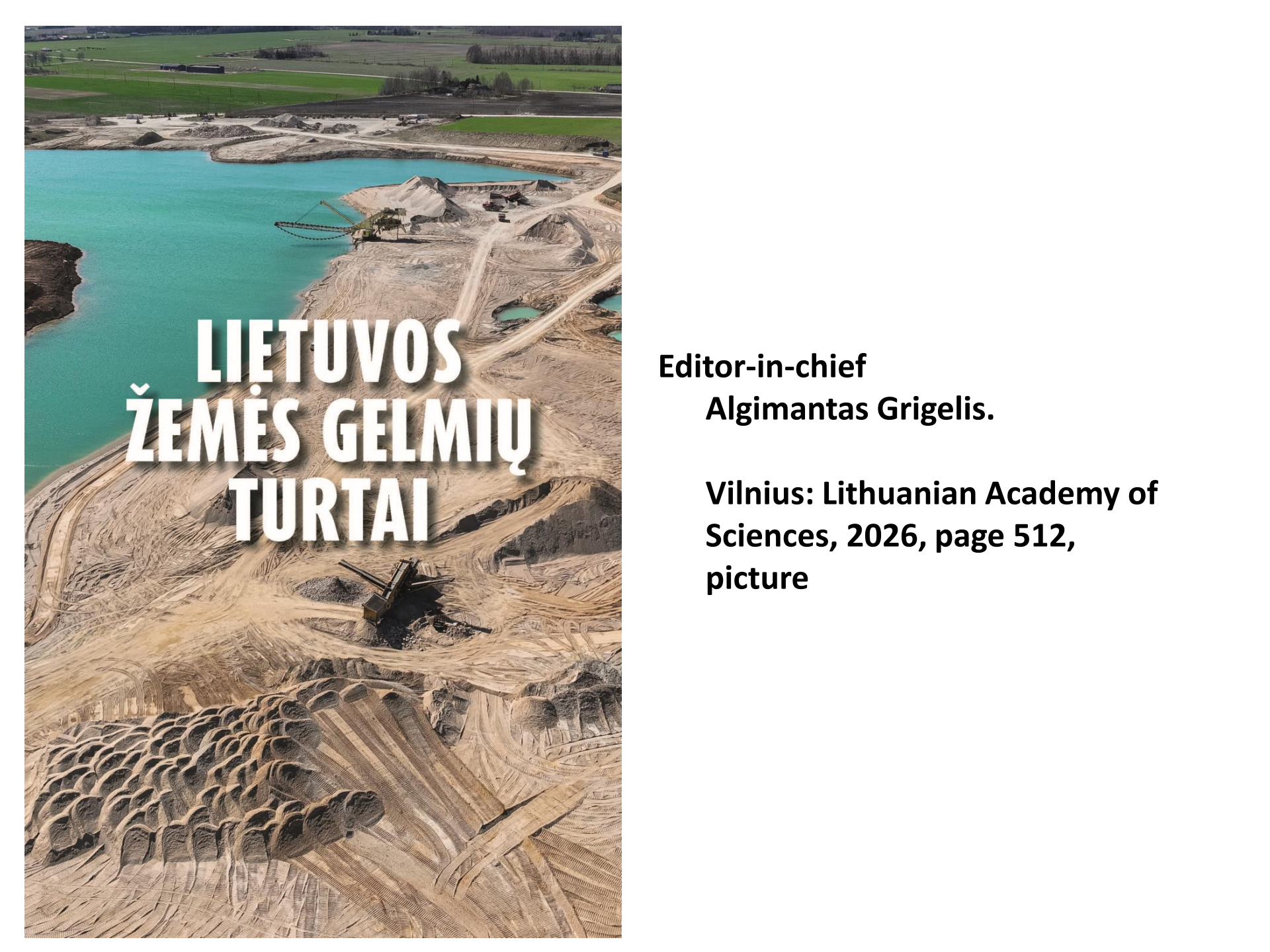


Lithuania's underground resources: resources, benefits, prospects



in the monograph
**THE UNDERGROUND RESOURCES OF
LITHUANIA**



LIETUVOS ŽEMĖS GELMIŲ TURTAI

**Editor-in-chief
Algimantas Grigelis.**

**Vilnius: Lithuanian Academy of
Sciences, 2026, page 512,
picture**



Authors (from the left): Dr. habil. Valentinas Baltrūnas, Geologist Ignas Vaičeliūnas, Dr. Ginutis Juozapavičius, Dr. Anicetas Štuopis, Academician Jūras Banys, Academician Algimantas Grigelis, Dr. Saulius Gadeikis, Geologist Saulius Gegieckas, Academician Gediminas Motuza Matuzevičius.
May 29, 2025, photo by Virginija Valuckienė.

Everything that surrounds us is in one way or another related to the resources of the earth's depths: a kitchen spoon and food, a mobile phone and a computer, buildings and roads, transport and toys - the raw materials for all these things are taken from the depths of the earth.



Mineral resources are natural materials located deep within the earth that can be used in production or for other purposes.

NAUDINGOSIOS IŠKASENOS tai žemės
gelmėse esančios gamtinės medžiagos,
kurias galima naudoti gamyboje ar kitoms
reikmėms



The depths of the Lithuanian Earth contain three groups of minerals: non-metallic, ores and groundwater.

- Non-metallic minerals - peat, sapropel, amber, oil, gas rock salt, anhydrite, dolomite, gypsum, glauconite, limestone, chalk marl, quartz monomineral sand, clay, freshwater limestone, sand and gravel.
- Of the ores, only a rich iron deposit was discovered in the crystalline foundation, along with the ore, the rare-earth elements (REE) were found.
- Groundwater, depending on the amount of dissolved salts, is fresh, mineral of various concentrations and brine.

Lithuanian underground resources: useful properties of the lithosphere

- Engineering geology is a branch of geological science that studies the structure, properties, dynamics and interaction of the geological environment with engineering structures, as well as analyzes the possibilities of its rational use in human engineering activities.
- in other words, engineering geologists find out what rocks and soils lie beneath our feet, what their properties are, how they change and how to use them safely and rationally when designing and building various structures.
- Engineering geological monitoring



Protection of the Earth's Depths

- Protection of underground resources is actions and measures aimed at protecting the valuable properties of the subsurface from physical, chemical, biological or other negative effects resulting from natural processes or human activities, fully or partially restoring these properties, and rationally and sustainably using underground resources.
- Its relevance is evidenced by a rather large number of facts about developed mineral deposits, the establishment of environmentally polluting enterprises in watershed protection zones, groundwater polluted by operating and reclaimed landfills, and the design of large energy facilities near tectonic faults.

Protection of geo-heritage – an important component of information on Lithuania's natural resources.

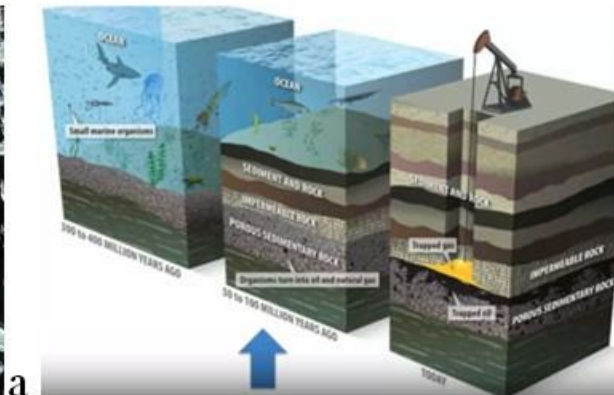
- Geological heritage sites include geological features (exceptionally large boulders, cliffs, sinkholes and caves, typical or unique outcrops of scientific value, and fossil and mineral sites), geomorphological features (landforms of exceptional size and appearance, such as hills, ridges, depressions, ravines, etc.), hydrogeological features (springs and sources with exceptional discharge rates or unique properties), and hydrographic features (exceptionally large rapids, oxbow lakes, islands, waterfalls, and other elements of the hydrographic network).
- Currently, there are 273 state-protected geo-heritage sites in Lithuania—including 130 natural monuments—as well as 53 municipality-protected sites (State Service for Protected Areas, 2025).

Harmonious and sustainable development - unfortunately

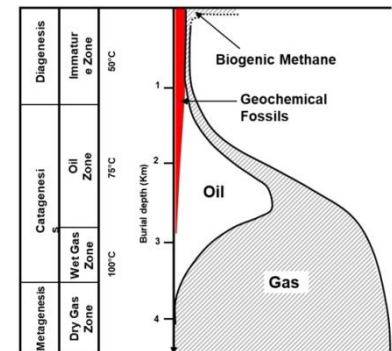
- The public has a negative opinion about the exploitation of any land resources,
- but they want a quick improvement in the economic and social situation. Without exception, everyone expects good roads, wide streets, good and fast communication,
- but no one wants the gravel and rubble for these roads to be dug somewhere near their place of residence or favorite place

Chapter 4 – Hydrocarbons

- These were marine organisms that died and were buried; rapidly covered by other sediments (in geological terms) and sinking to great depths, they decomposed under high temperatures (70–100°C) into simpler liquid hydrocarbons—oil—or, at even higher temperatures, into the simplest form: gas.
- Some of the oil and gas remained within the rocks where they originated—forming shale oil and gas.
- Some migrated under pressure to fill the voids in porous rock layers capped by impermeable rock, thereby creating conventional oil and gas reservoirs.
- Others, encountering no obstacles, migrated to the Earth's surface, where they oxidized, burned off, and dissipated into the atmosphere.



b



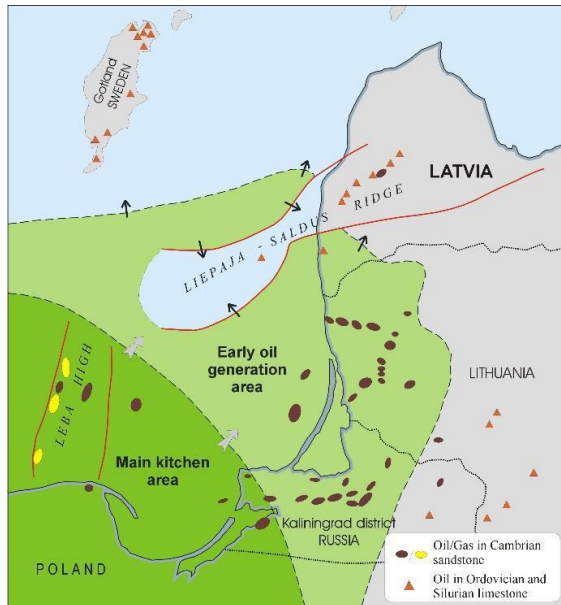
Hydrocarbon Generation as a function of temperature and depth
(from Mouchet and Mitchell, 1989)

In Lithuania, systematic oil exploration, which began in 1958, was successful.

It was established that in the Baltic synclis during the Cambrian-Ordovician and Silurian periods, there were favorable conditions for generating liquid hydrocarbons, i.e. oil.

Therefore, we have traditional oil deposits in the Cambrian reservoir from which production is carried out.

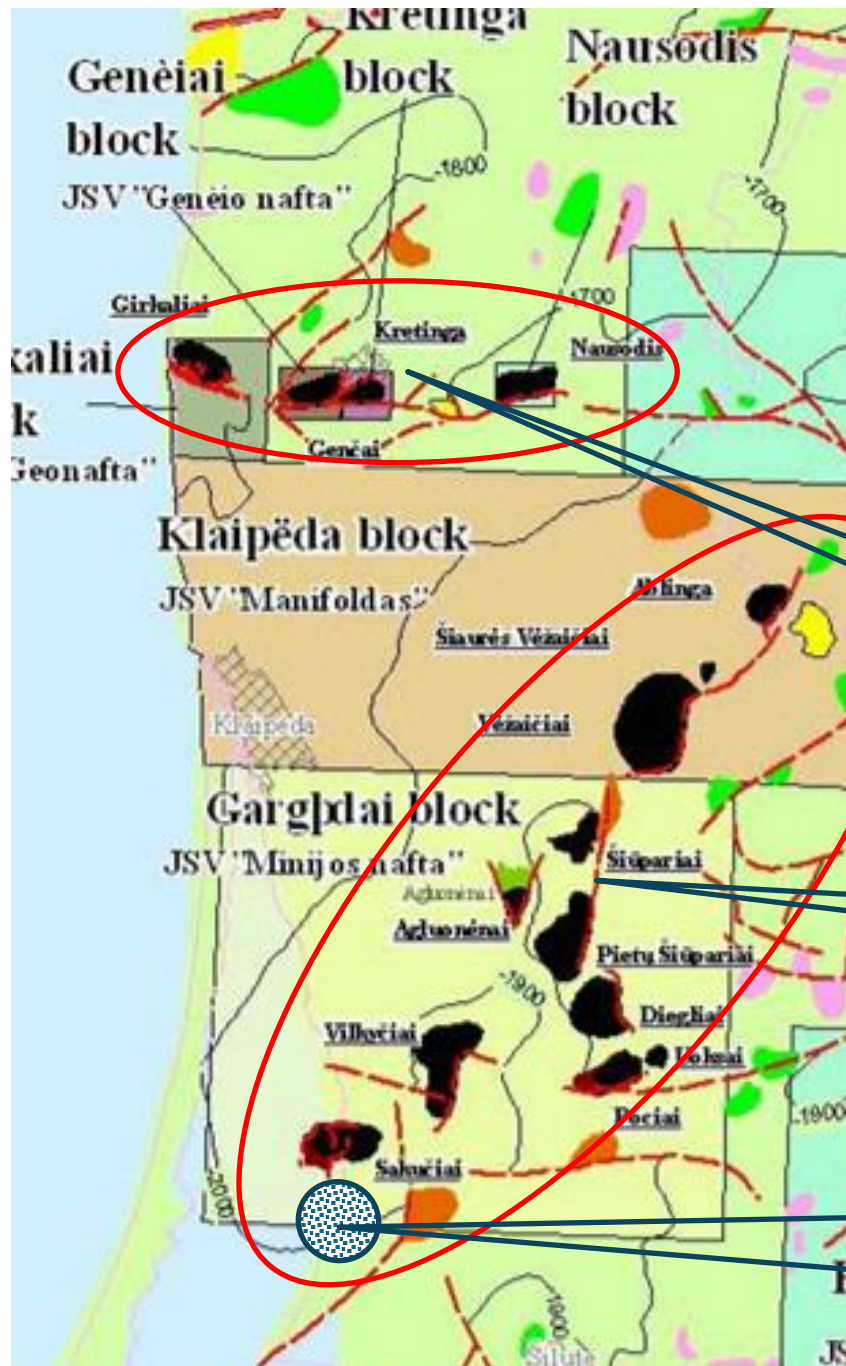
We have shale oil in the Ordovician and Silurian clayey rocks.



Oil production map

Onshore, traditional hydrocarbons are produced from Cambrian sandstones in the **Telsiai Volas** and **Gargždai Uplift Zone**.

In the southern part of the latter the Kintai structure is ready for drilling.

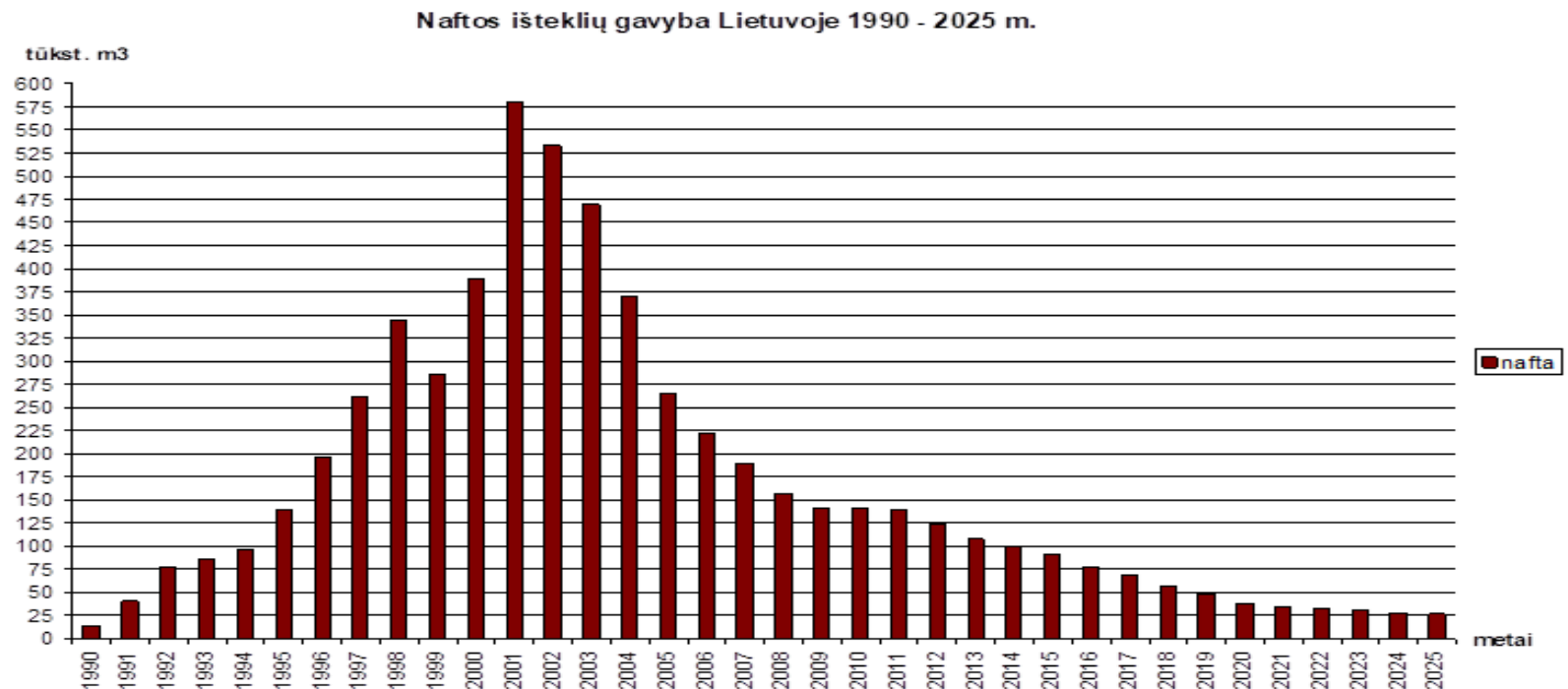


Telšiai Volas (scarp)

Gargždai Uplift Zone

Kintai structure has been studied with 2D and 3D seismic work. It is ready for drilling.

The peak of production was in 1997-2005, when production exceeded 250,000 m³ per year - approximately 12% of Lithuania's demand. The highest production - close to 600,000 m³ - was in 2001. Later it steadily decreased.



Onshore production is declining.

What are the options for the increase of production?

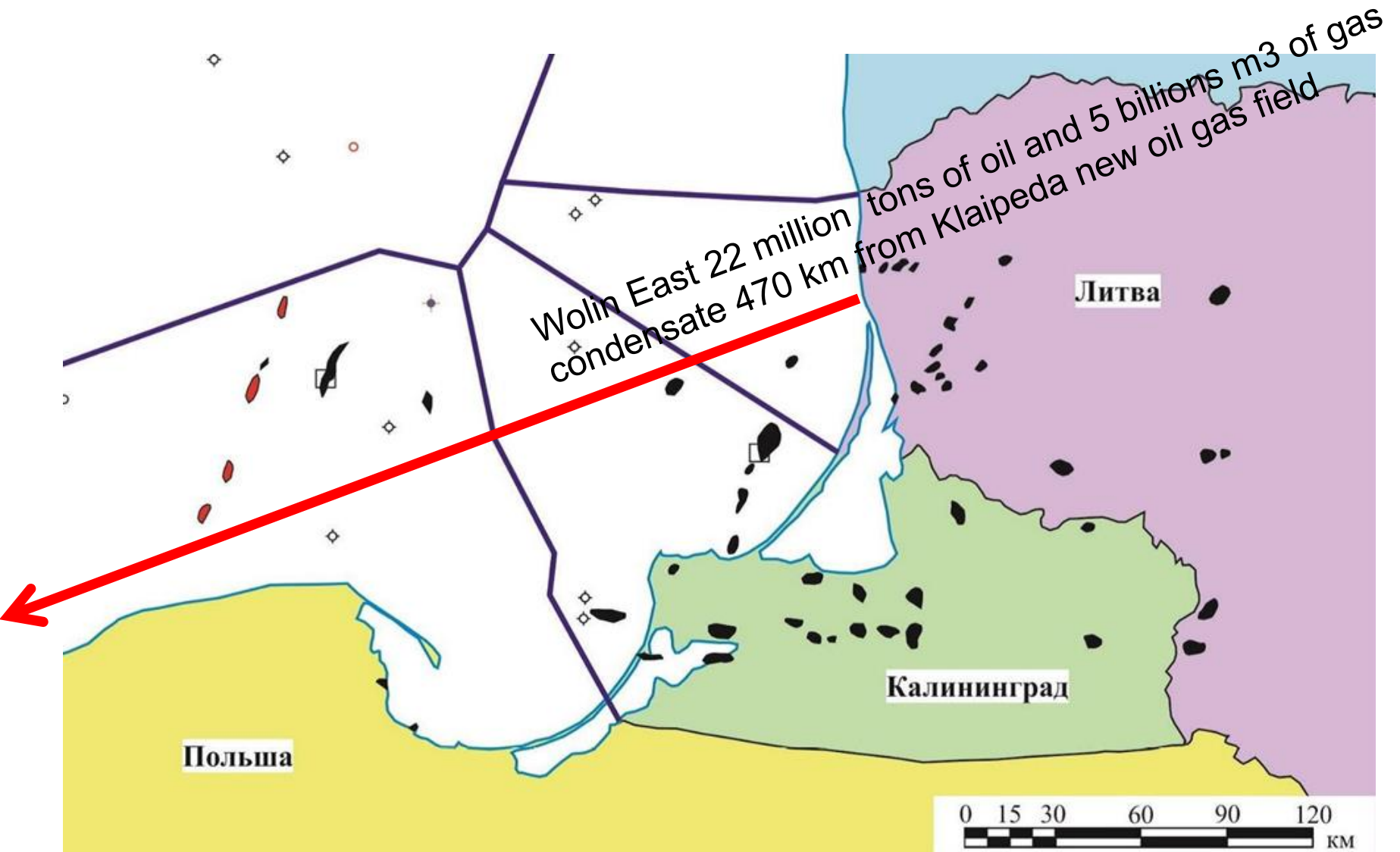
- **Geological oil resources**

- In the Baltic Sea area there are about 100-160 million tons.
- In the Kintai structure – 4.5 million m³,
- In the Gargždai uplift zone – about 125 million m³.

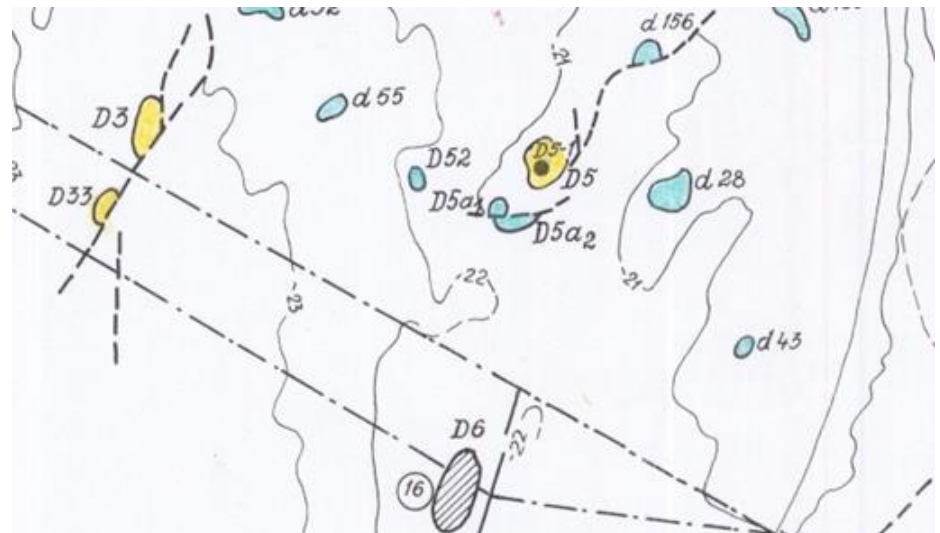
- **Economically recoverable resources**

- In the Baltic Sea area 50-80 million tons.
- In the Kintai structure – 1.5 million m³,
- In the Gargždai uplift zone, in order to produce oil, CO₂ gas would have to be pumped into the layer. Unfortunately, Lithuanian legislation prohibits this.

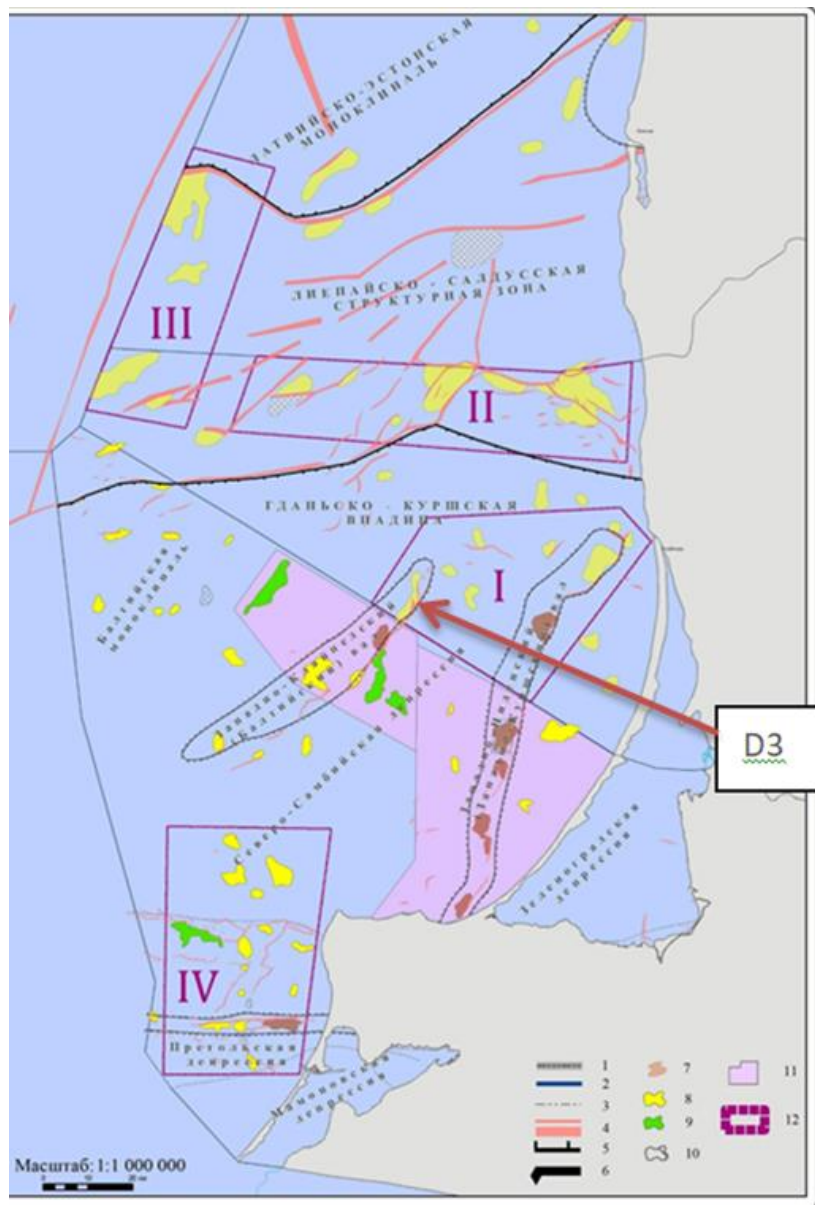
Oil and gas fields in the Baltic syncline



- Russian shelf oil fields:
 - ✓ D6 – 10 million tons, production since 2004
 - ✓ D33 – 21.2 million tons
 - ✓ D6 Južnoje – 3.01 million tons
 - ✓ D29 – 2.1 million tons
 - ✓ D41 – 2 million tons, production since 2019.
- Lithuanian shelf oil fields:
 - ✓ One well in D5 has been drilled, tested **5.7 m³/day** of oil flow from Cambrian sandstones. Unfortunately, this structure has not been studied further.
 - ✓ The structure D3 may be similar to D33, with similar resources or even form a single field.



Can we increase oil production? – Yes. Lukoil Kaliningradmorneftj produces more than 0.5 million tons, plans to increase it to 2 million tons per year in the future. Increase in the D33 field



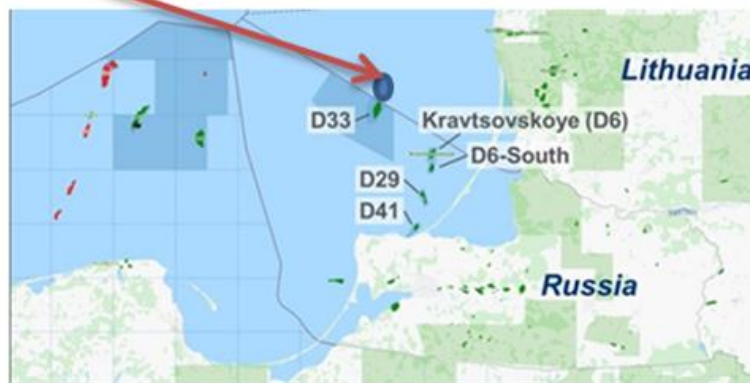
Paveikslai iš Otmas AA ir kt. Naftos perspektyvos Baltijos jūros akvatorijoje rusų k.

Kompanija „LUKOIL Kaliningradmorneftj“, 2018 metais planuoja išgauti 569,6 tūkstančius tonų, perspektyvoje (išvysčius gavybą jūroje) iki 2 milijonų tonų

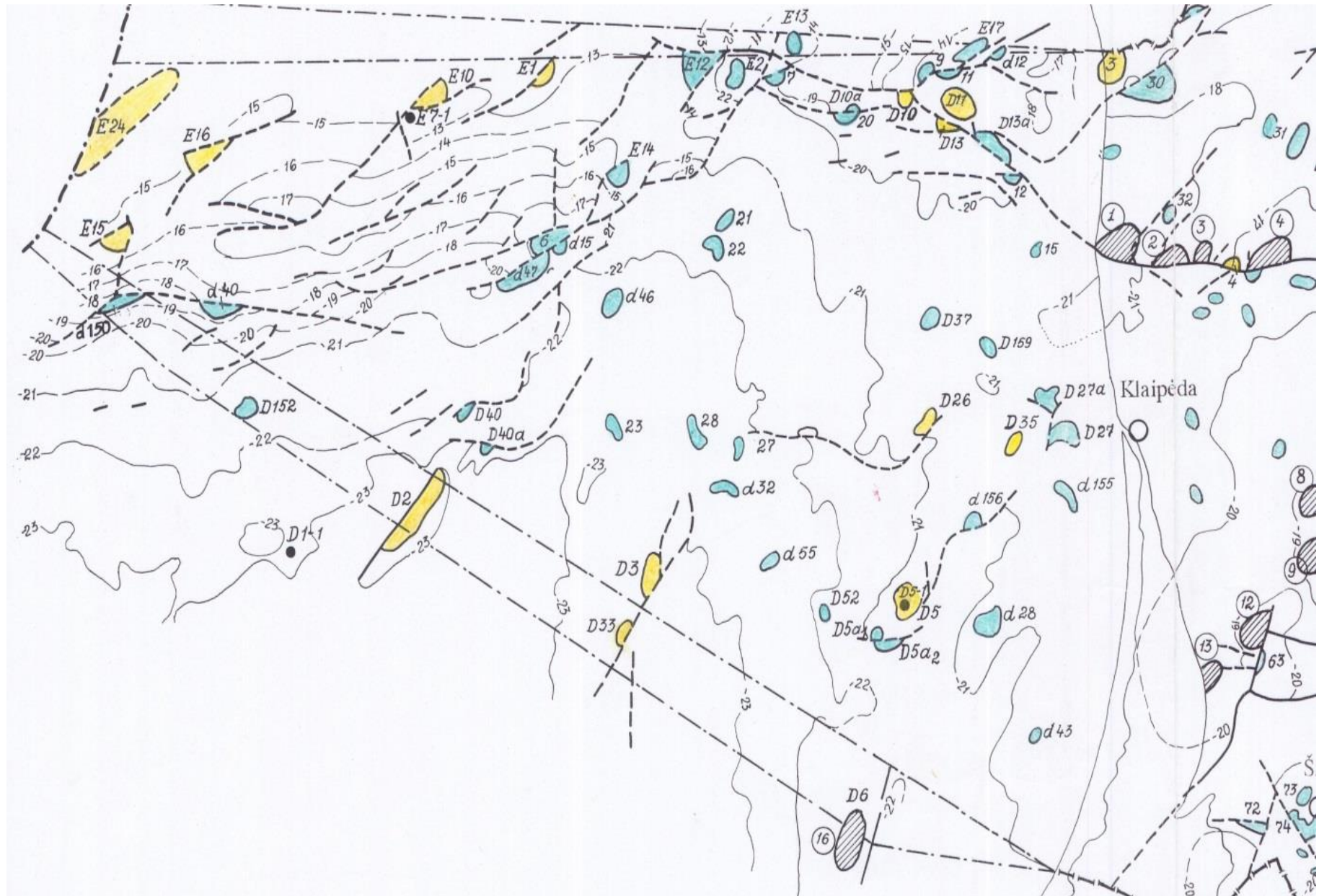
D6 (Kravcovskoje) geologiniai/išgaunami naftos ištekliai – 21,5/ 9,1 mln. t, gavyba vykdoma nuo 2004 m.

D41 naftos ištekliai: geologiniai – išgaunami 3,9/ 2,0 mln. tonų. Gavyba nuo 2019 m.

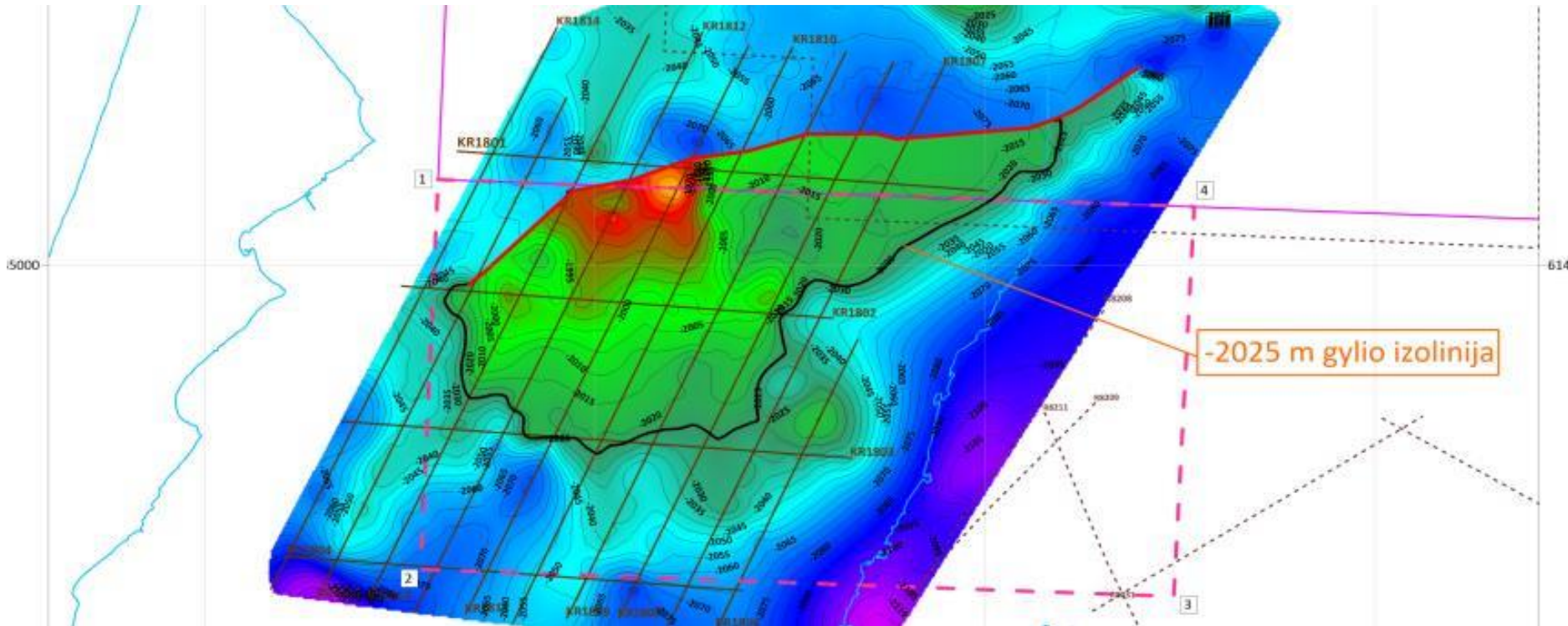
D33 pagal išteklis yra didžiausias telkinys, rastas Baltijos jūroje. Kompanijos „Lukoil“ vertinimu išgaunami ištekliai – 21,2 mln. t.



Petrobaltic's discovered promising oil structures

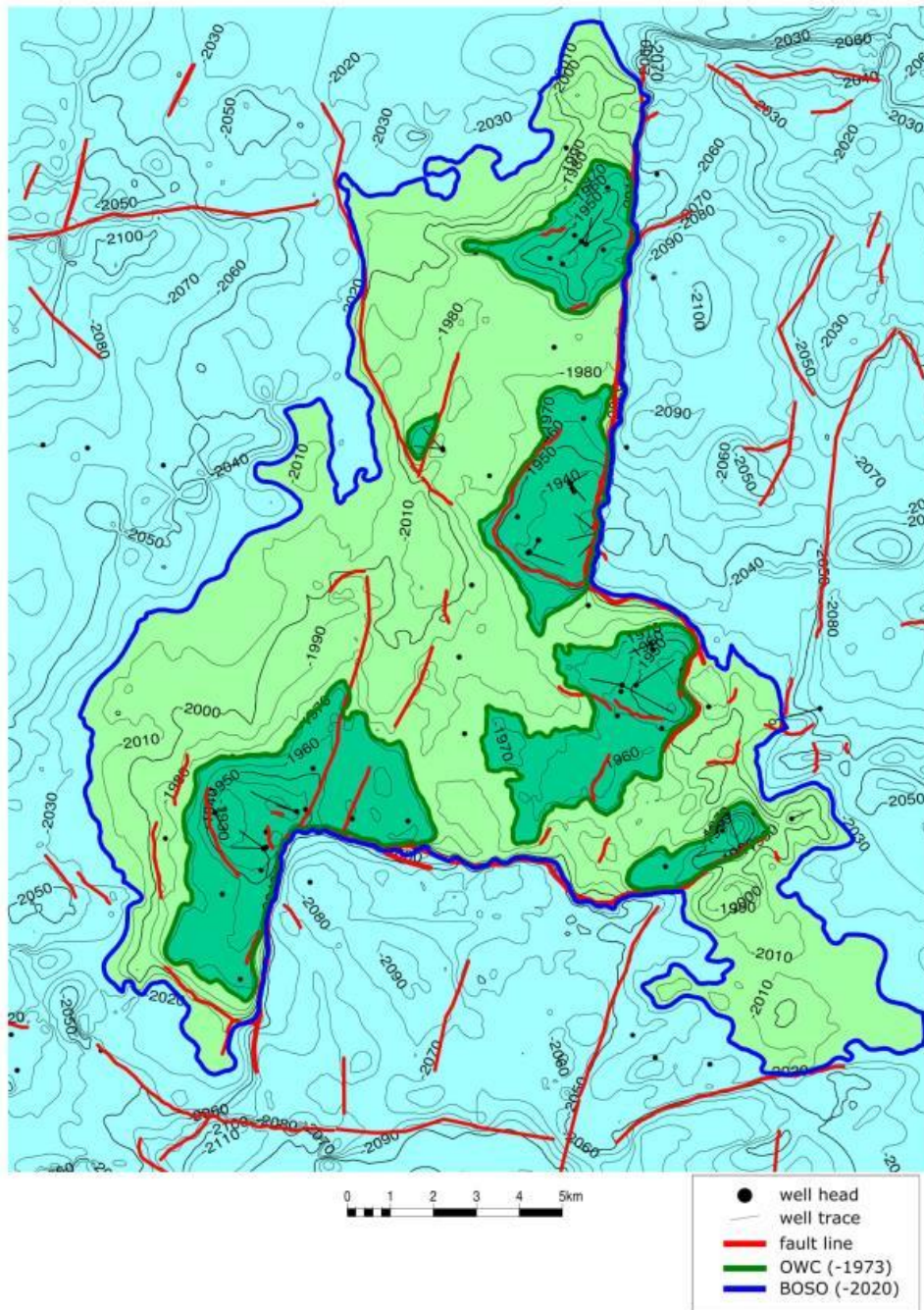


Kintai structure is ready for drilling, but due to the opposition of local residents and some officials, drilling is not taking place. Geological/recoverable resources in the structure are estimated at 4.5/1.5 mln. m³.



At current oil prices, state revenue in the form of royalties alone would be about 70 million euros.

Top reservoir depth



Transition zone in Gargždai Uplifts

- Dark green fields – the main oil resources located above the average depth of the VNK (1973 m).
 - Their total area is 51 km².
 - Contains 12.7 mln. m³ of oil (in situ).
- Light green field – a residual oil field in the transition zone in the interval [1973 m – 2020 m].
 - Its area reaches 250 km².
 - Contained 125.6 mln. m³ of oil. The production of these resources requires the use of tertiary extraction methods, such as CO₂ injection.

If we could use oil resources

- If oil exploration and production in the Baltic Sea were allowed, production could return to the level of 2000 or even higher.
- Offshore production could meet 5% of the demand of the Mažeikiai refinery, and even a quarter of the amount of oil products used in Lithuania.
- Structure D3 in the Lithuanian economic zone potentially has the same oil resources as structure D33 on the Russian side, where oil was found and is being prepared for production. The resources of the D33 field are estimated to be very large for this oil-rich region and are economically valuable for offshore production.
- 21,200 thousand tons is approximately 148.4 million barrels. Their value, calculated at only 60 US dollars per barrel, would be 8 billion 904 million US dollars. In Lithuania, the hydrocarbon resource tax is 12 percent of the produced and sold amount, so from 8,904 million. would be 1,068 million. US dollars – about 1 billion euros. This is a serious asset.

No cost to the state.

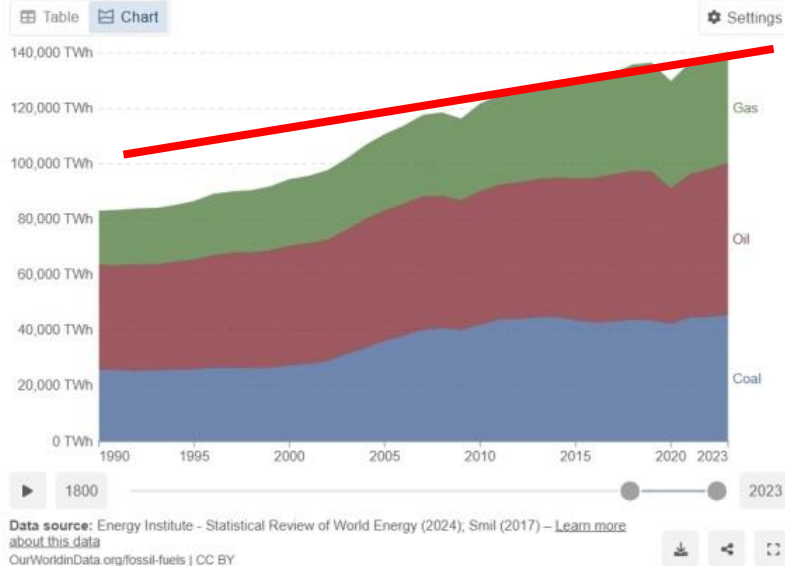
It was \$60/bbl. Now it's more - \$100/bbl.



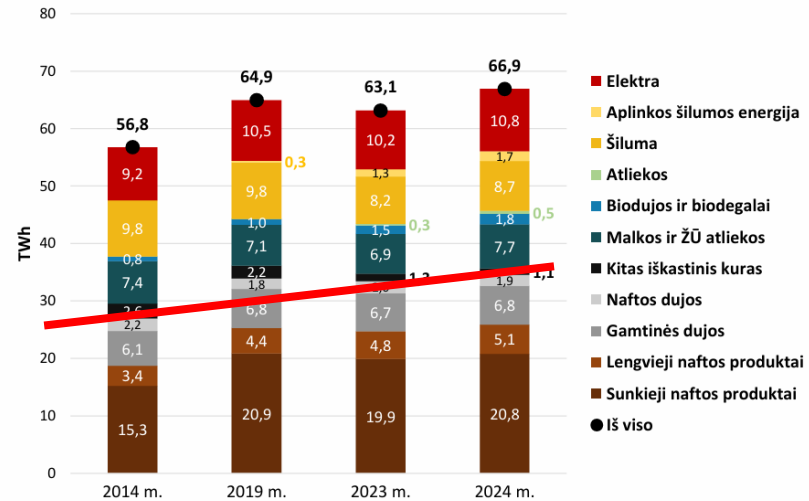
We don't need fossil fuels.

Global fossil fuel consumption

Measured in terawatt-hours of primary energy consumption.



Galutinės energijos rūšių derinys Lietuvoje.



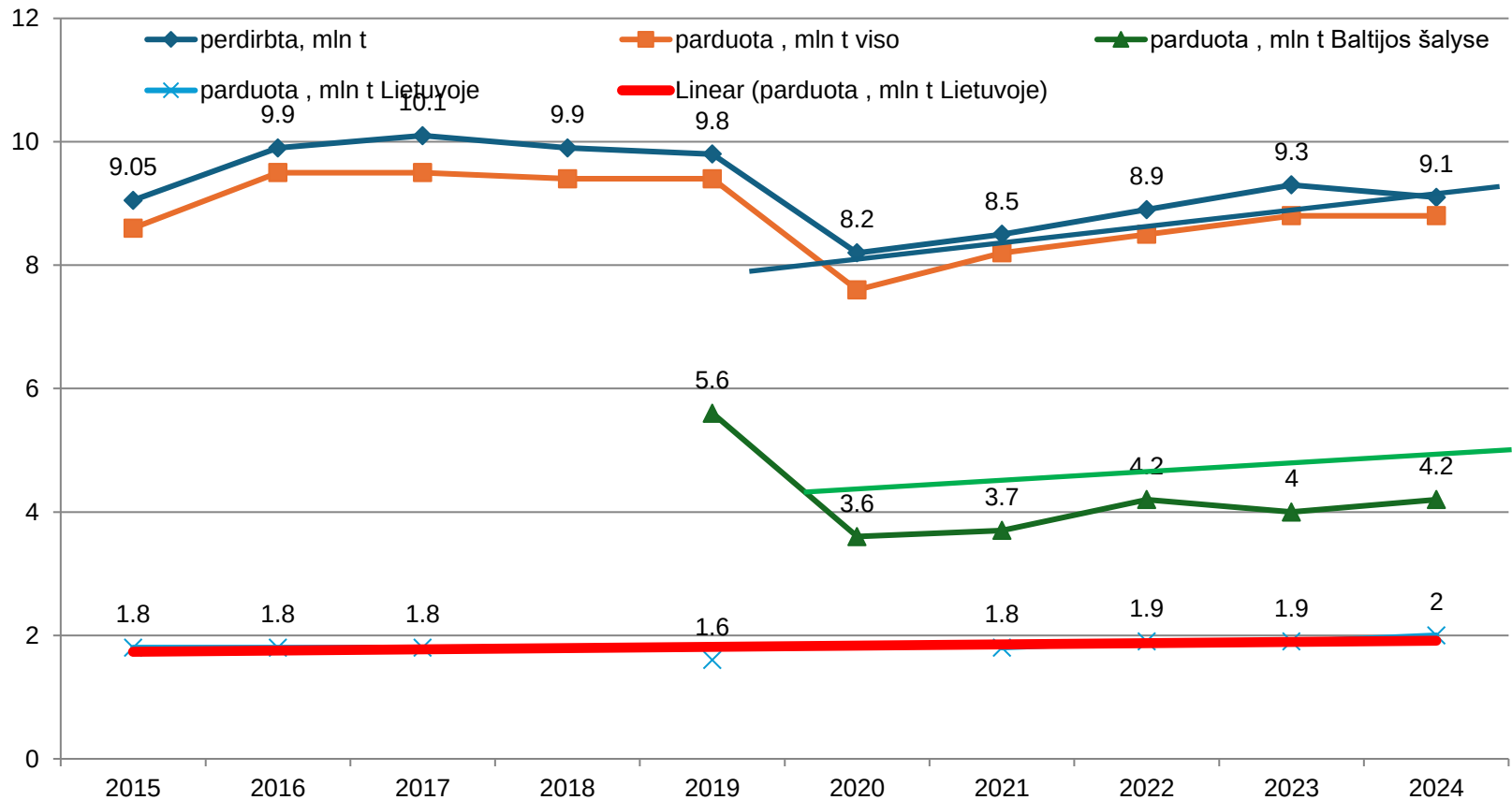
Duomenų šaltinis: Valstybės duomenų agentūra.

According to the Lithuanian Energy Agency, in 2014, 29.6TWh was obtained from fossil fuels, in 2024 – 35.7TWh = **21% more**. Fuel (diesel, gasoline and liquefied petroleum gas) consumed 2,163 thousand tons in 2023, in 2024 2,270 thousand. t. = **5% more**. The oil refinery operates stably - each year it processes about 9 million tons of crude oil purchased from Saudi Arabia, Norway, the USA and other countries.

Orlean Lietuva oil refining and sales, million tons.

2024 year. 9,1milions tons - refining; 4,2 - sold in the Baltic States;
2 – sold in Lithuania

Source: company annual reports



Opinions

“The use of hydrocarbon resources (oil) shall be carried out in accordance with the best environmental and risk management practices of the European Union, taking into account environmental pollution, climate change and other problems. To provide for the regulation of the development of **oil resources in the offshore part, ...**” GENERAL PLAN OF THE TERRITORY OF THE REPUBLIC OF LITHUANIA until 2030. (Resolution No. 789 of the Government of the Republic of Lithuania of 2021)

“The main weakness of the Lithuanian energy sector is **dependence on imported energy resources, primarily oil and natural gas...**” National Energy Independence Strategy” (Resolution No. XIV-2856 of the Seimas of the Republic of Lithuania of 27 June 2024)“

Deputy Minister of the Environment Akvilė Gargasaitė. 2026-03-23

Taking into account the sensitive ecological state of the Baltic Sea and the goal of reducing environmental impact set out in the Government's program, we inform you that **oil production works in the sea area are currently not planned.**

Just one note on the “green course” for Mrs. Akvile Gargasaitė.

One tanker brought 100,000 tons of oil to the Butinge terminal. 13,000 km to the Middle East.

For such a trip, 1,200 tons of fuel oil are consumed, about 4,000 tons of CO₂ are released into the atmosphere.

100 trips per year 400,000 tons of CO₂.

If 5% of the oil processed in Mažeikiai were replaced with Lithuanian oil (from Kintai, from the Baltic Sea), **20,000 tons of CO₂ less would enter the atmosphere.**

Oil search, exploration and production work has provided exceptional knowledge about the depths of Lithuania and their resources, revealing various possibilities for using the depths

- rock composition and properties, brines in deep horizons

- heat of the depths and the possibility of using them,

- cavities - suitable for gas storage, carbon dioxide storage

brines located in deep (Devonian, Cambrian) reservuors

- Contains increased levels of iodine and bromine close to or even exceeding industrial conditions
- Suitable for treatment and rehabilitation purposes
- Suitable for aquaculture



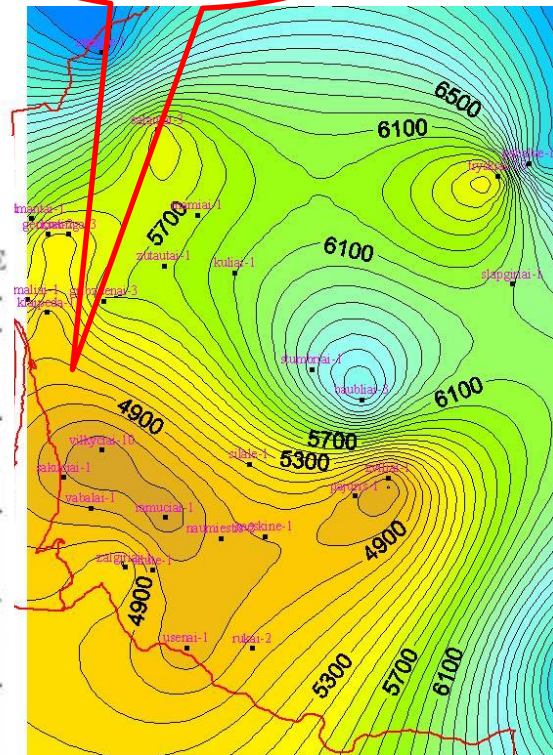
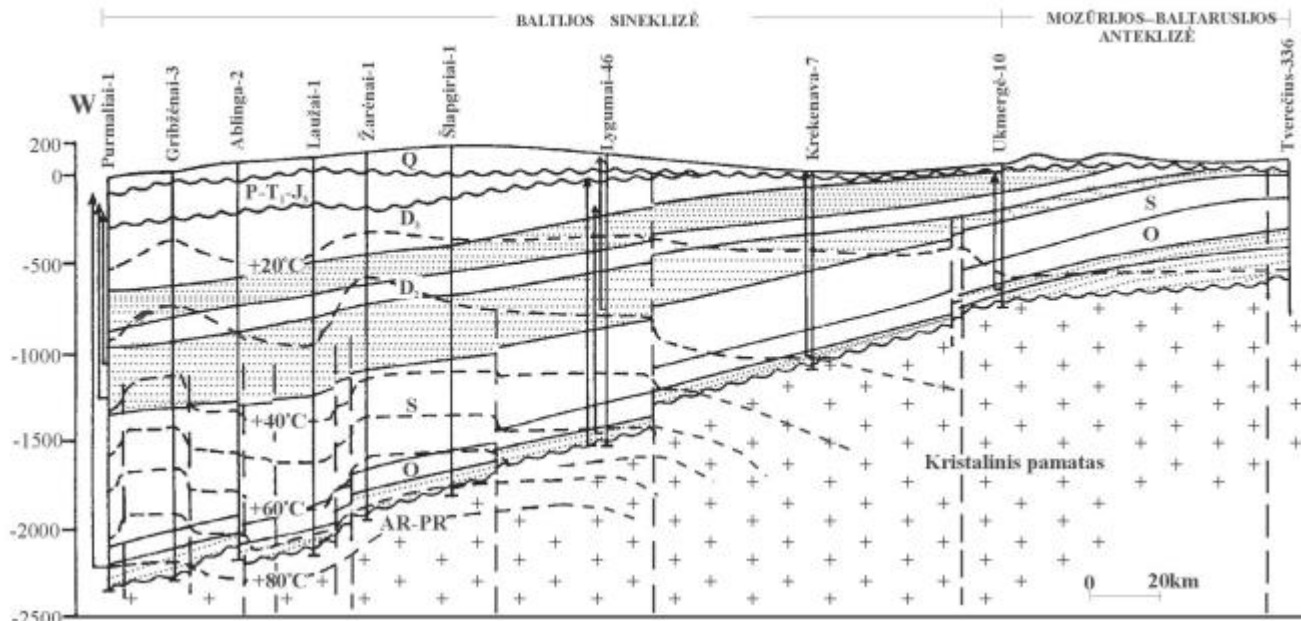
heat of the depths

From heating buildings and swimming pools to electricity generation and energy storage/balancing.

on the left the temperature from Klaipėda to Tverėčius,

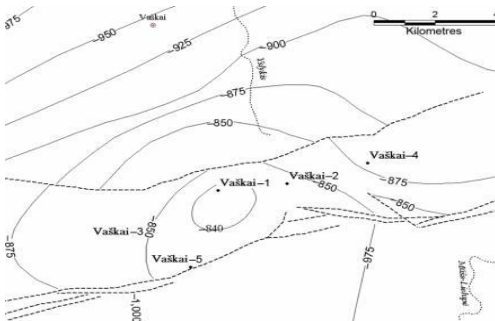
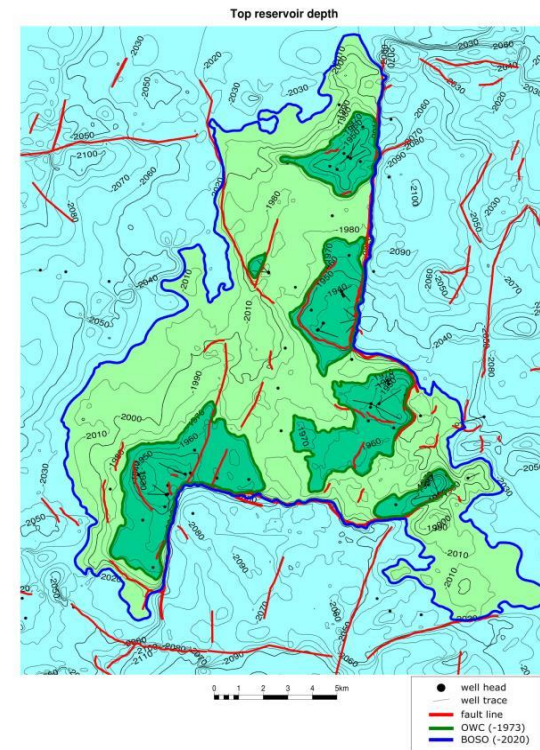
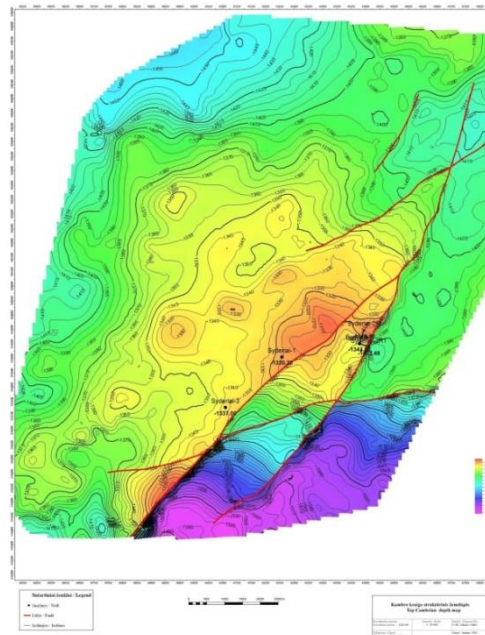
on the right the temperature depth from the ground +150 degrees

Šiūpariai site Cm
at 1975 m +82°C.
+150°C <5000m



CO₂ storage sites

- The most suitable for CO₂ storage sites:
 - Vaškai – capacity >8.8 mln. t (new wells are needed).
 - Syderiai – capacity 49.1 mln. t (wells can be restored/adapted).
 - Gargždai uplift zone up to 100 mln. t (wells can be adapted).
- This gives a total of 157.9 mln. t
 - Or > 25 years of planned maximum collection.



structures suitable for CO₂ storage are also suitable for natural gas storage

- The closed Vaškai structure contains 39.6 million m³ of pores. The working storage capacity can be 1.5 billion m³,
- When filling the Syderiai structure to the isohypse of -1350 m, the working storage capacity is also 1.5 billion m³.
- The Gargždai uplift zone is limited by the isohypse of -2020m and has 146.6 million m³ of pores. The working storage capacity is about 9 billion m³.
- In Lithuania, the annual use of natural gas is about 2 billion m³. We have the ability to store such a quantity in Lithuania.
- Our own gas storage facility, together with „Independence“, significantly would increase the country's energy independence and budget revenues.



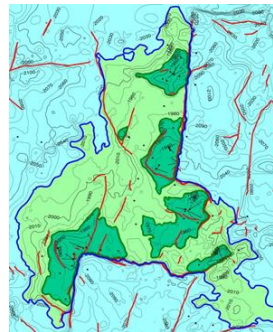
CO2. For comparison – two chains

1. From Industry to KN Energy ≈ 300 km, stored in the port, loading onto ships to Oygarden ≈ 1500 km, unloading to temporary storage, 100 km by pipeline to the injection well.



Norway,
Northern Lights

2. From Industry to Vilkyčiai ≈ 300 km, unloading to temporary storage, 0.1-10 km pipeline to injection well



Lithuania,
Gargždai Uplift Zone

Which is better – a long or short chain?

Thanks.

First of all, a big thank you to Academician Algimantas Grigelis, the initiator and Editor-in-chief of the monograph, who suggested that I write about oil

Thanks to the General Manager of Minijos Nafta, Tomas M. Haselton, who allowed the use of the company's materials and encouraged the writing of the book.

A big thank you to Professor Mayur Pal for allowing me to present the publication to you at this conference.

Thank you to Dr. Ginutis Juozapavičius and to Dr. Saulius Gadeikis, whose prepared materials I used in this presentation.

Thank you to everyone who listened.

Ignas Vaičeliūnas, Chief Geologist, UAB "Minijos Nafta,, iva@minijosnafta.lt

The electronic version of the book and Summary in English is available

<https://www.lma.lt/news/3183/38/Pazinkime-savo-zeme-naujas-zvilgsnis-i-Lietuvos-gelmiu-turtus>