BALTIC CARBON FORUM 2021

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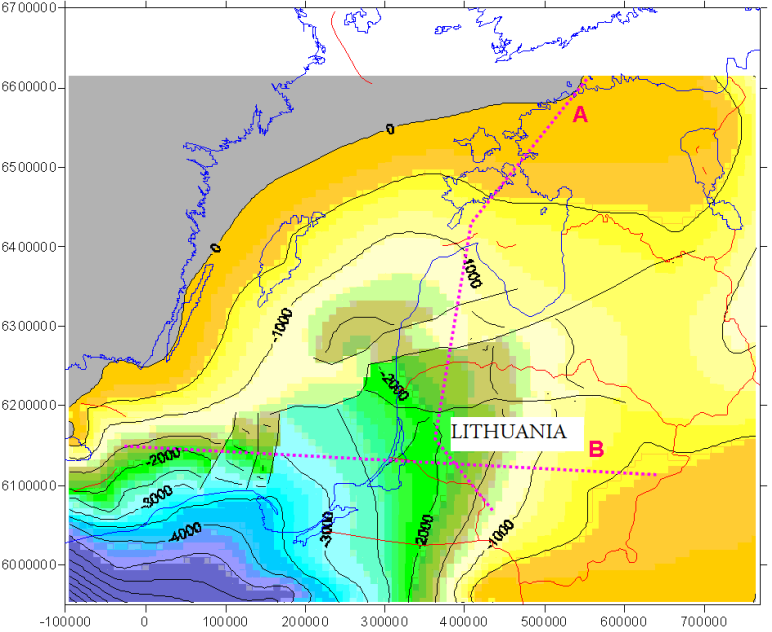
Nature Research Centre

Prospects of Geological Storage of CO2 in Lithuania

1. GEOLOGICAL PROSPECTS

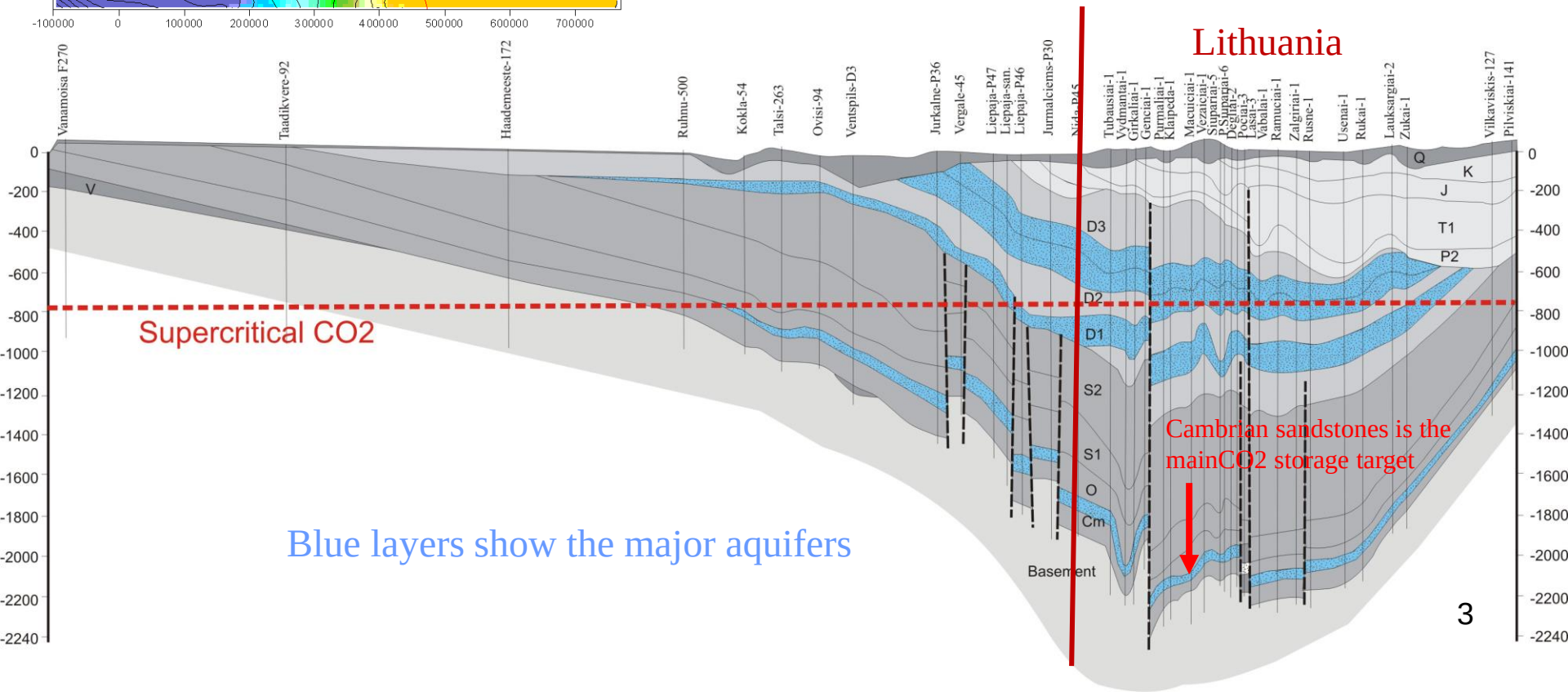
BALTIC BASIN

Depths of the bottom of the sedimentary cover



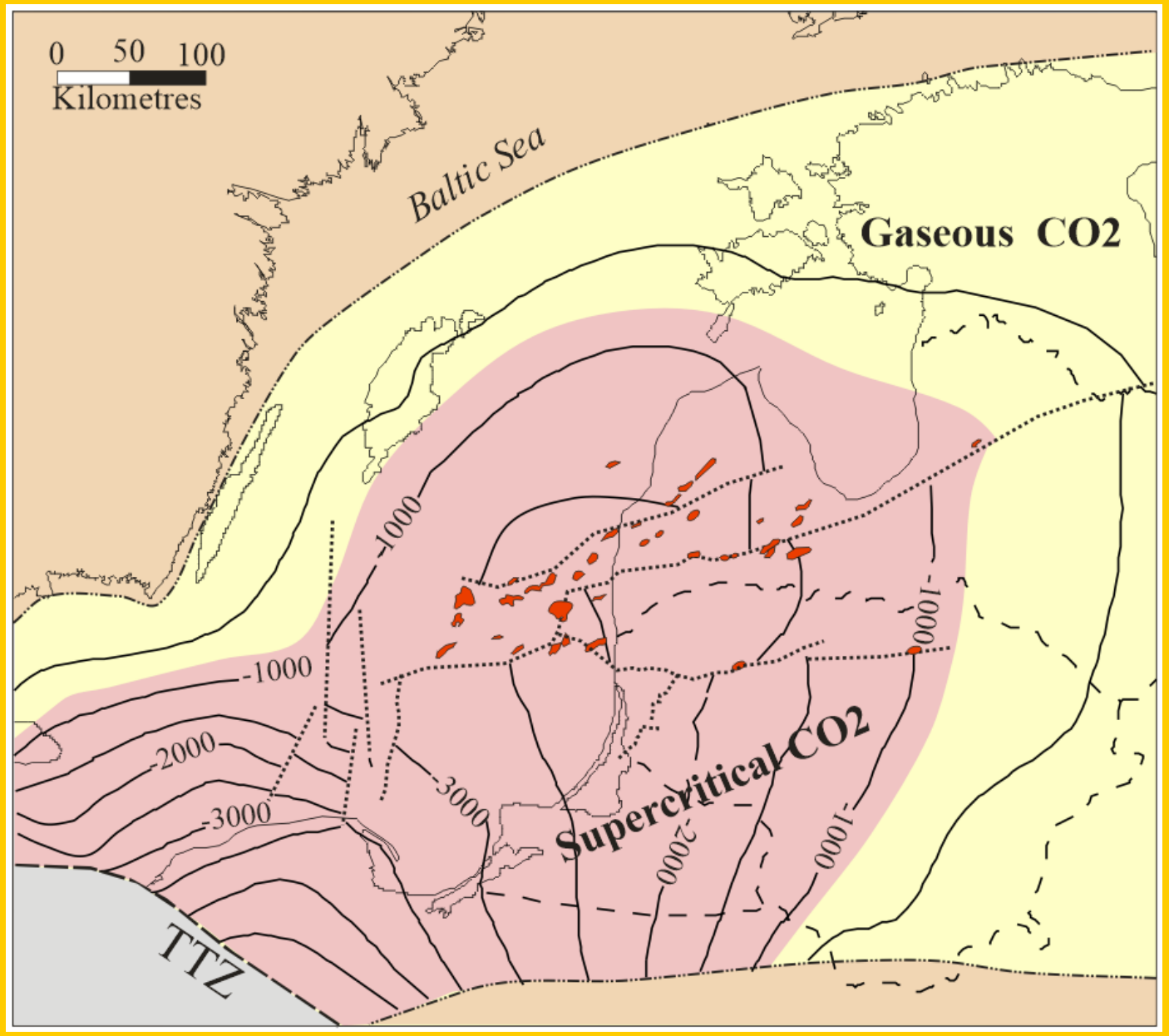
Geological cross section North-South (Estonia-Latvia-Lithuania)

(line A on the map)

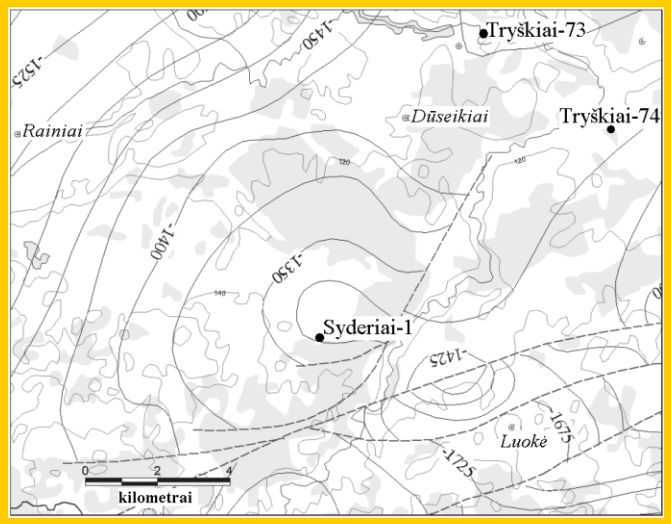


CO2 phase map of Cambrian reservoir

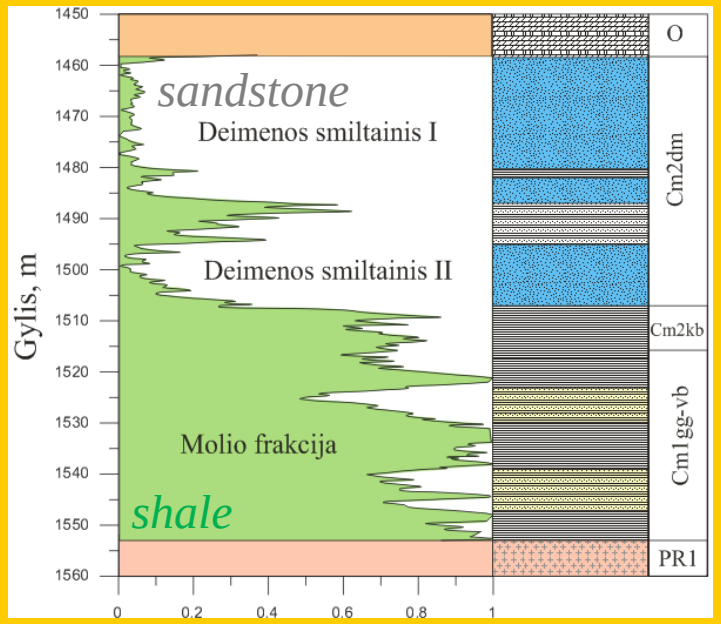
Depths of the base and largest local structures are indicated

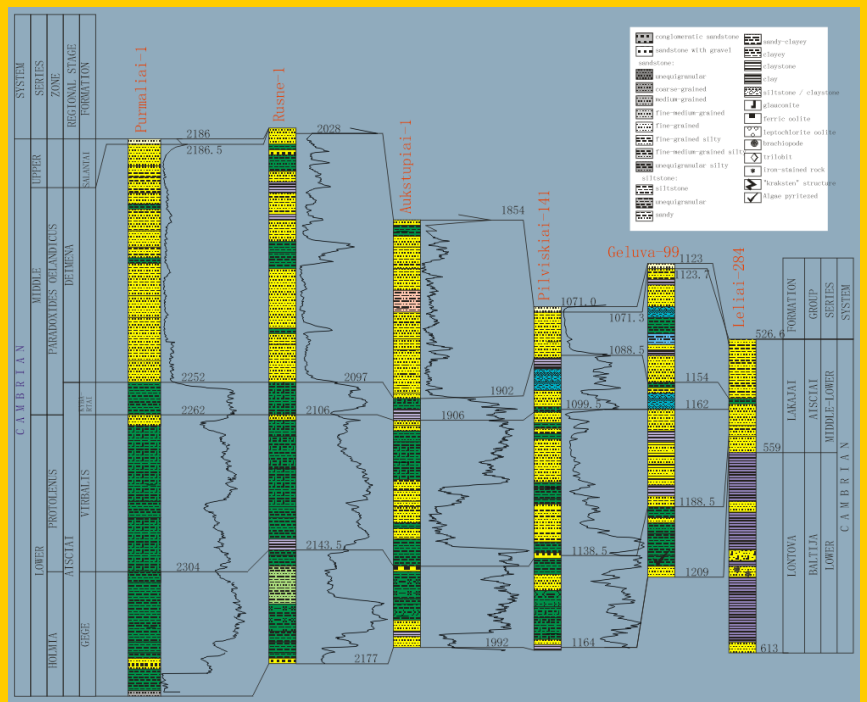


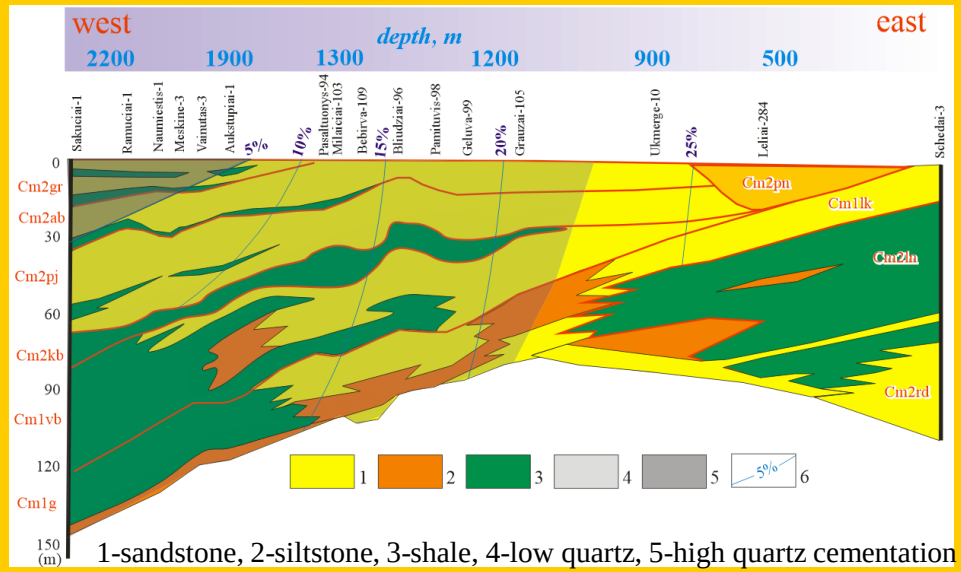
Depth of top of Cambrian
Syderiai structure
CO2 storage capacity 8.8 Mt



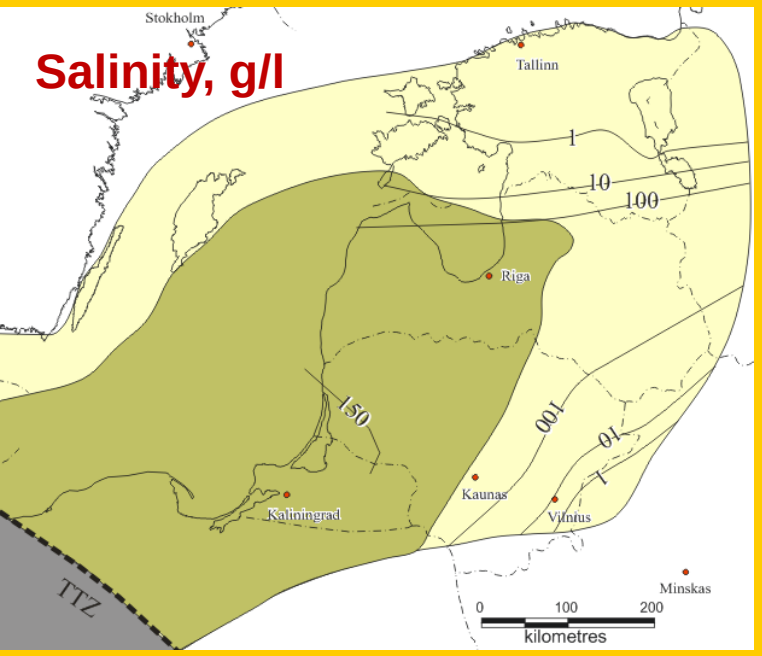
Well Syderiai-1

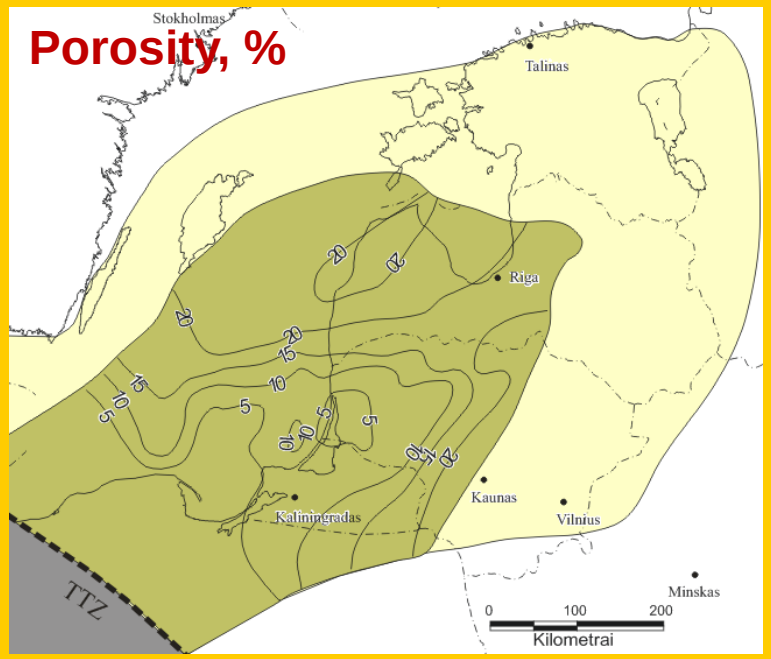


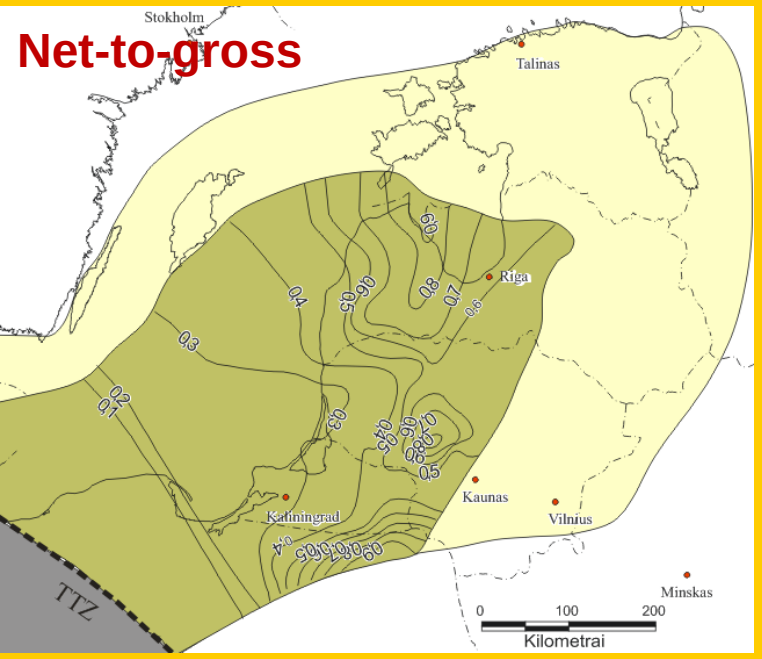




Lithology of Cambrian succession.
Porosity of sandstones is indicated







Characteristics of Cambrian reservoir

2. POLITICAL ENVIRONMENT

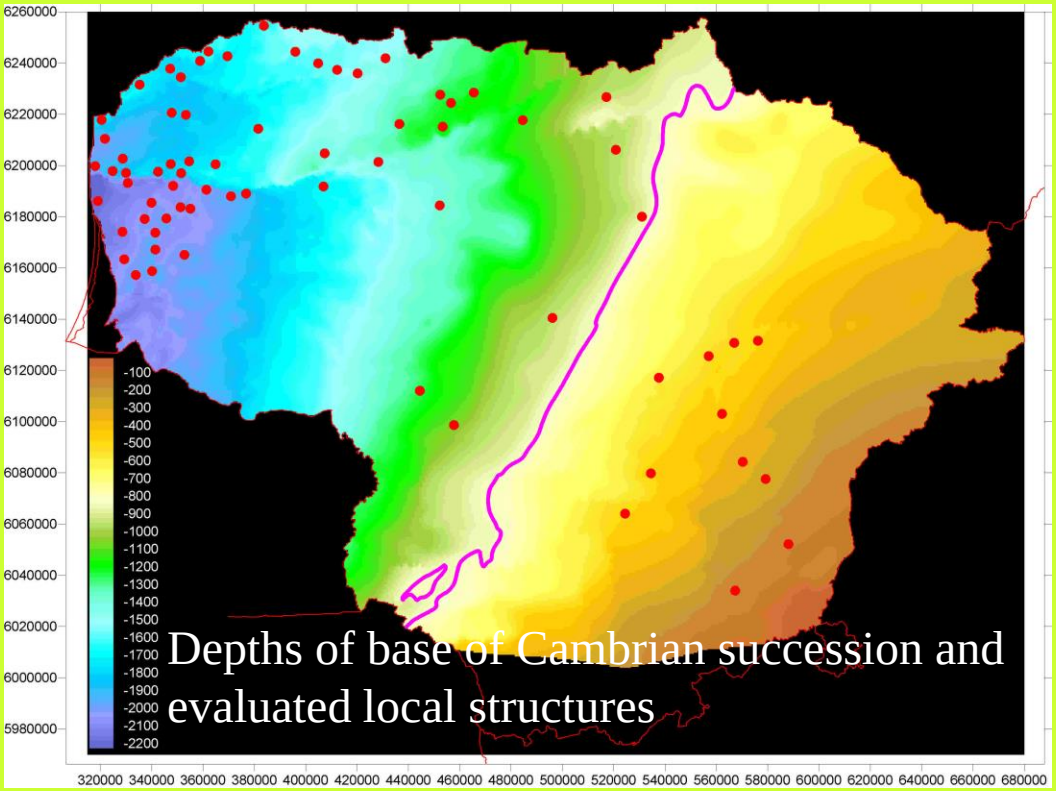
Text book vs region-specific geological risks

CO_2 geological storage legislation

2011.06.28 – **adaptation** of EU Directive 2009/21/EB by LT Parliament
2019.10.15 – **prohibition** of geological CO_2 storage, document Nr. XIII-2481

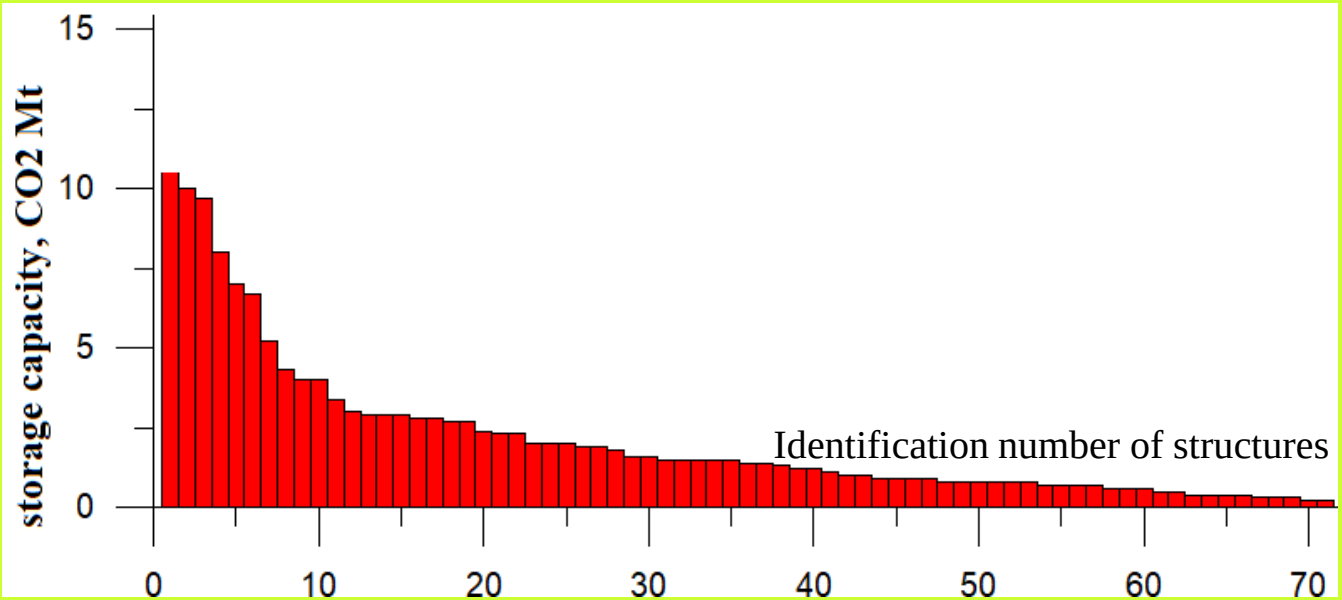
Major risks pointed by Ministry of Environment to justify prohibition of CO_2 geological storage in Lithuania

- Too small size of closed structures to store large volumes of CO_2
- Vertical movements of the surface due to CO_2 injection
- Induced seismicity;
- Salinification of potable water aquifers due to vertical water flow along reactivated faults;
- Other risks (hydrostatic pressure variations in reservoir, mobilization of methane, *etc*.);
- Conflict of interests (*e.g.* CO_2 contamination of geothermal aquifers)

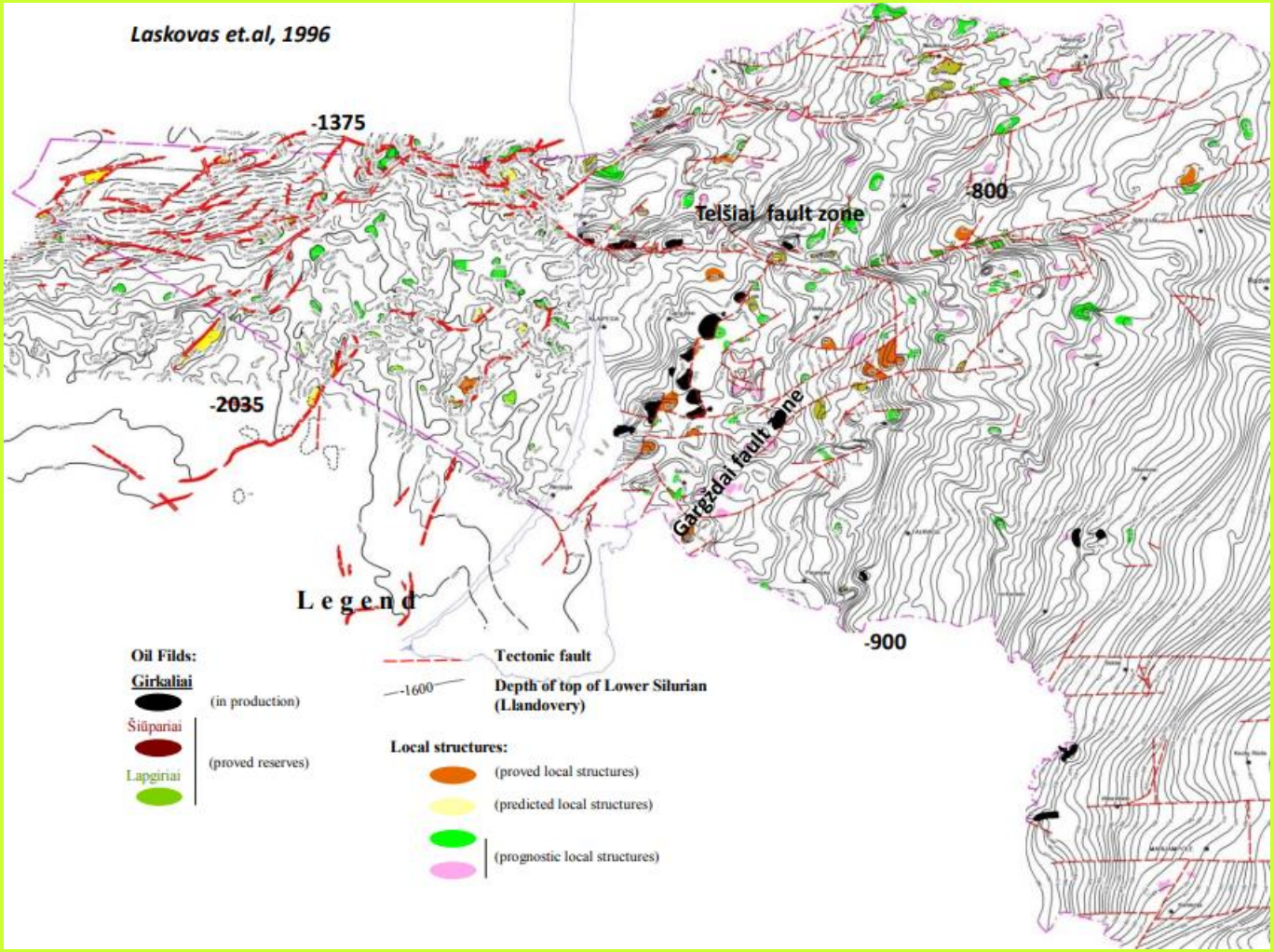


Official argument **1**:
Too small size of closed structures to store large volumes of emitted CO2

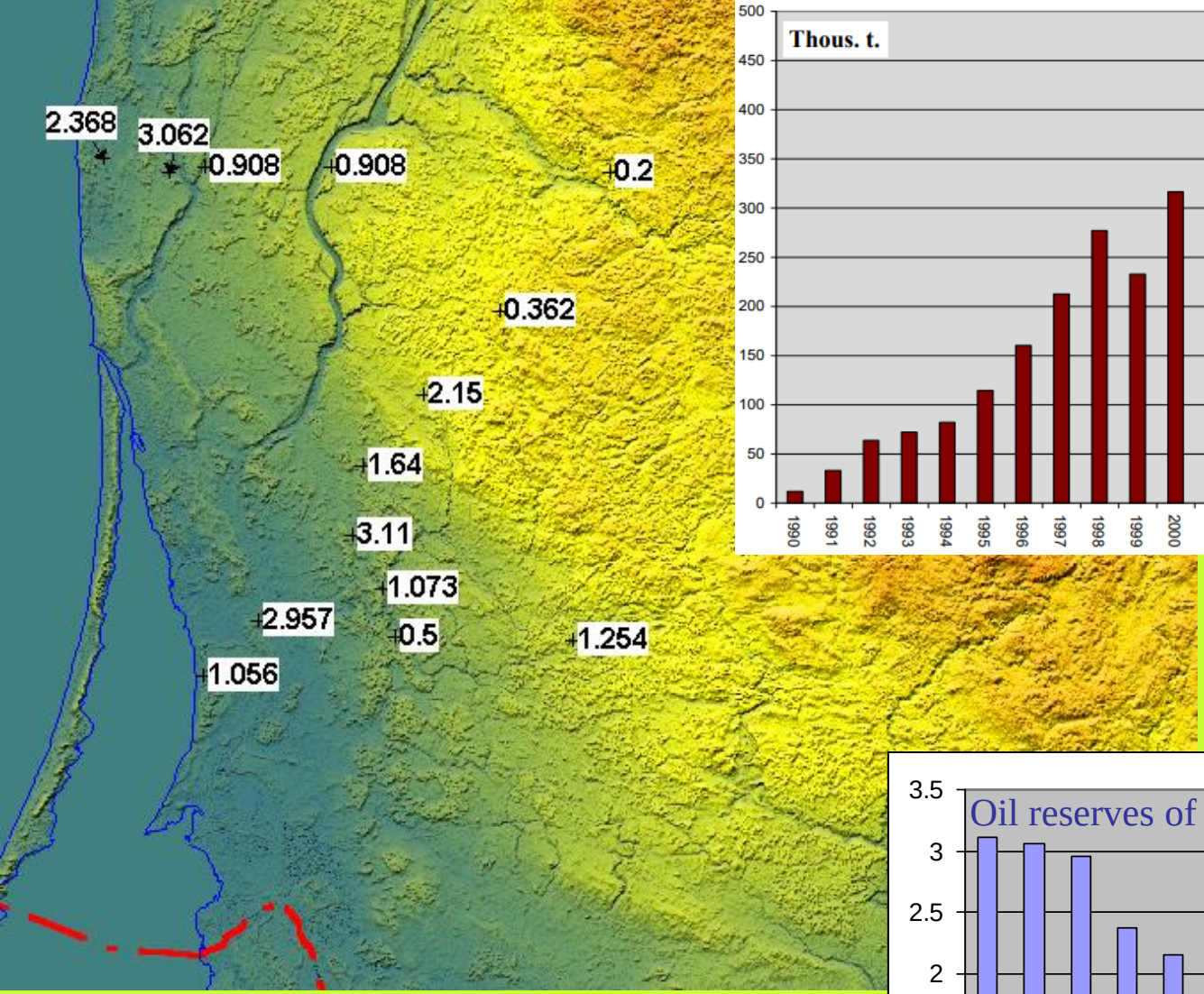
Sources listed in ETS emit 5.61 Mt/y of CO2

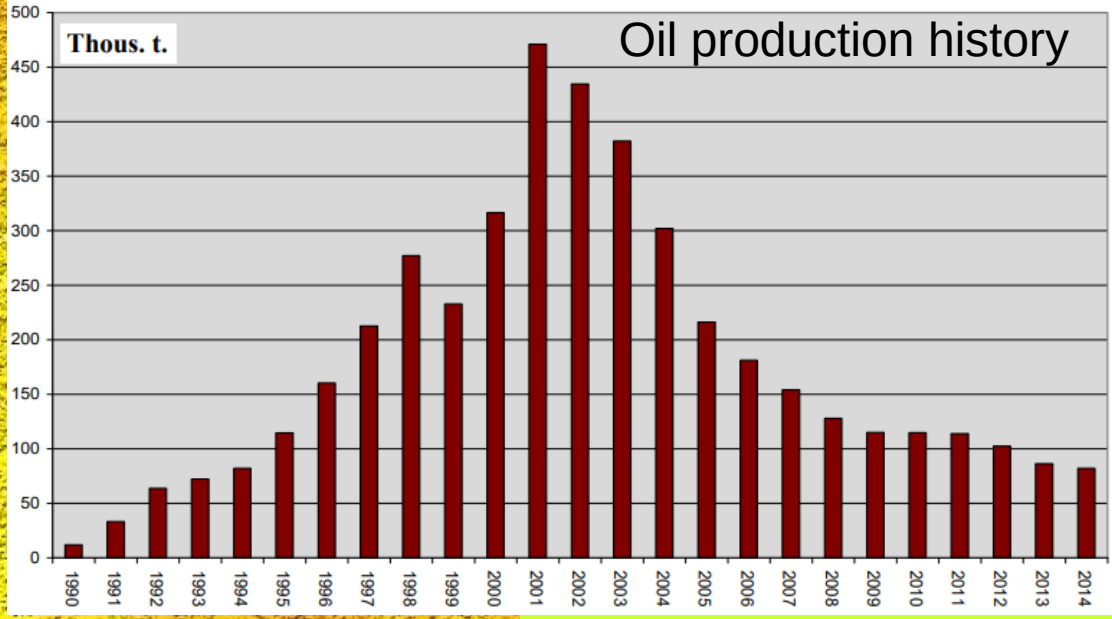


Map of Cambrian closed structures



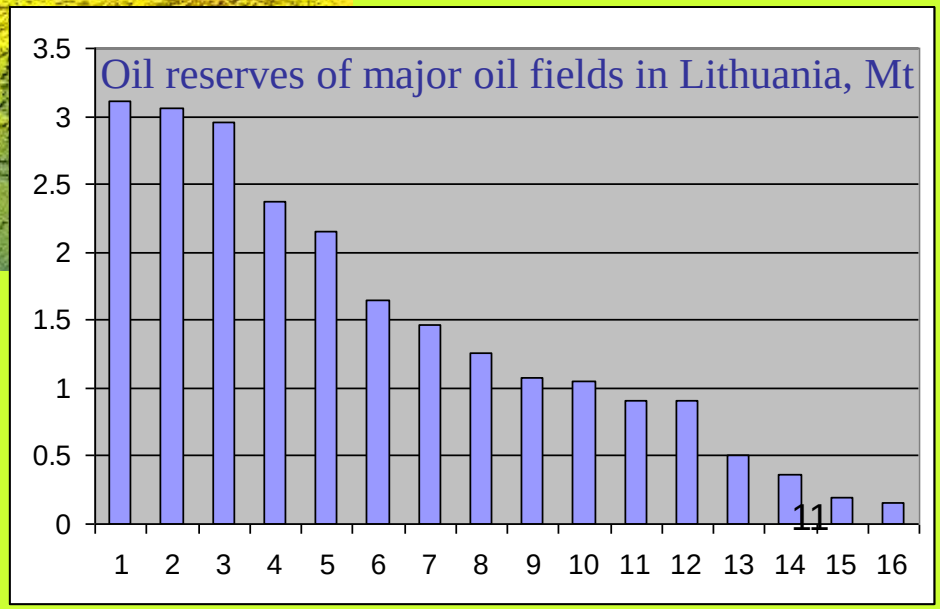
Storage capacity of Cambrian structures is very low (small size, low reservoir quality, limited thickness (~70 m). The two largest structures can store 8.8 and 11 Mt of CO2





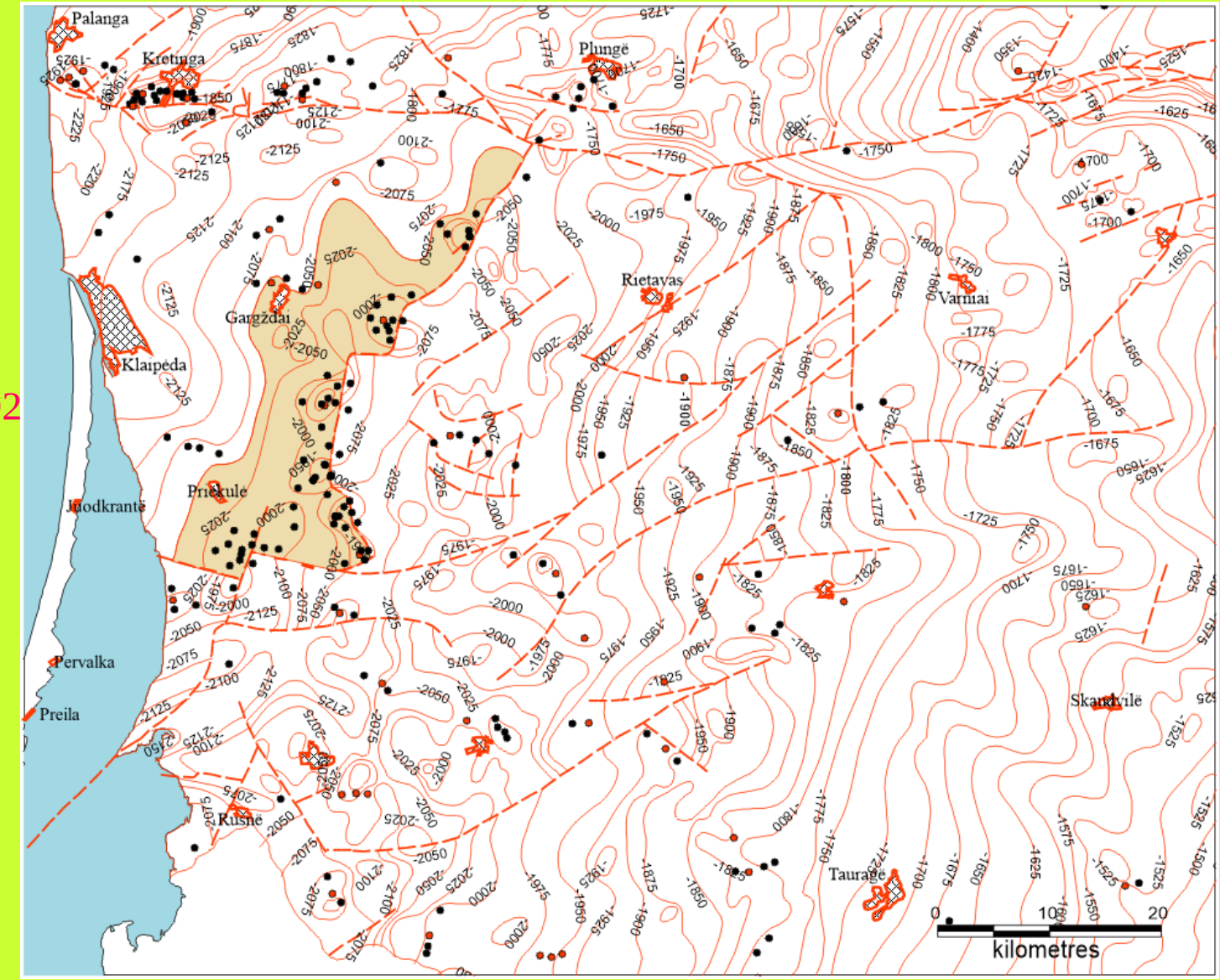
oil fields of Cambrian reservoir (oil reservs, Mt)

Total storage capacity 5.6 Mt



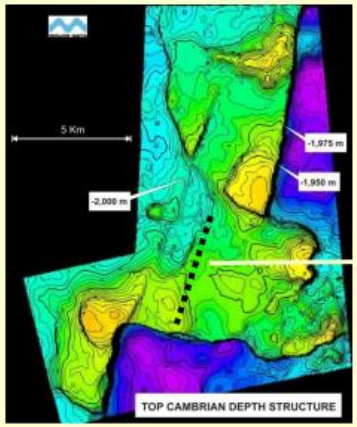
but…..

about 100 Mt of CO2 can be stored in Gargždai elevation

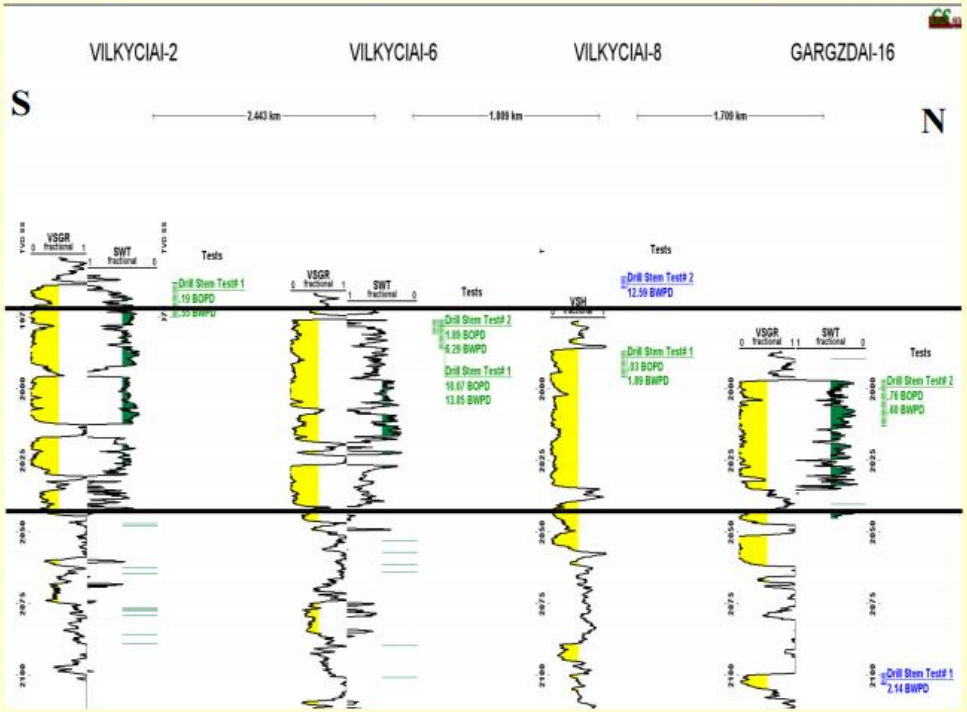


Structural map of top of Cambrian. Shaded area shows Gargždai zone of oil fields. Well clusters mark oil fields. Storage capacity is estimated as large as 100 Mt (25 years of CO2 emissions from large >100,000 Mt stationary sources in Lithuania). It can be combined with the economic (EOR) benefit

THICK RESIDUAL OIL ZONE EXISTS IN LITHUANIA



CROSS-SECTION BELOW; ALL RESERVOIRS BELOW OWC



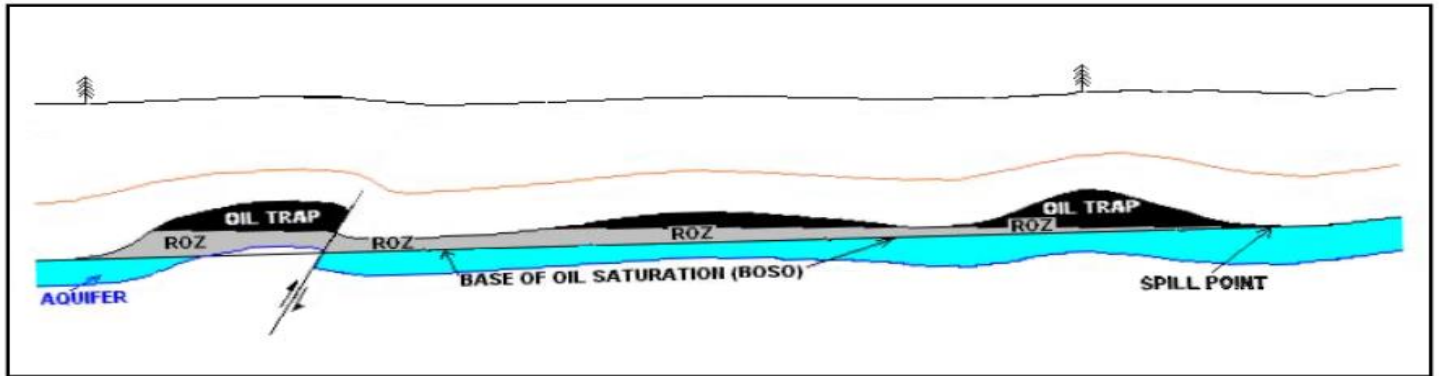
OIL-WATER-CONTACT –1,973

65 m RESIDUAL OIL ZONE (ROZ)

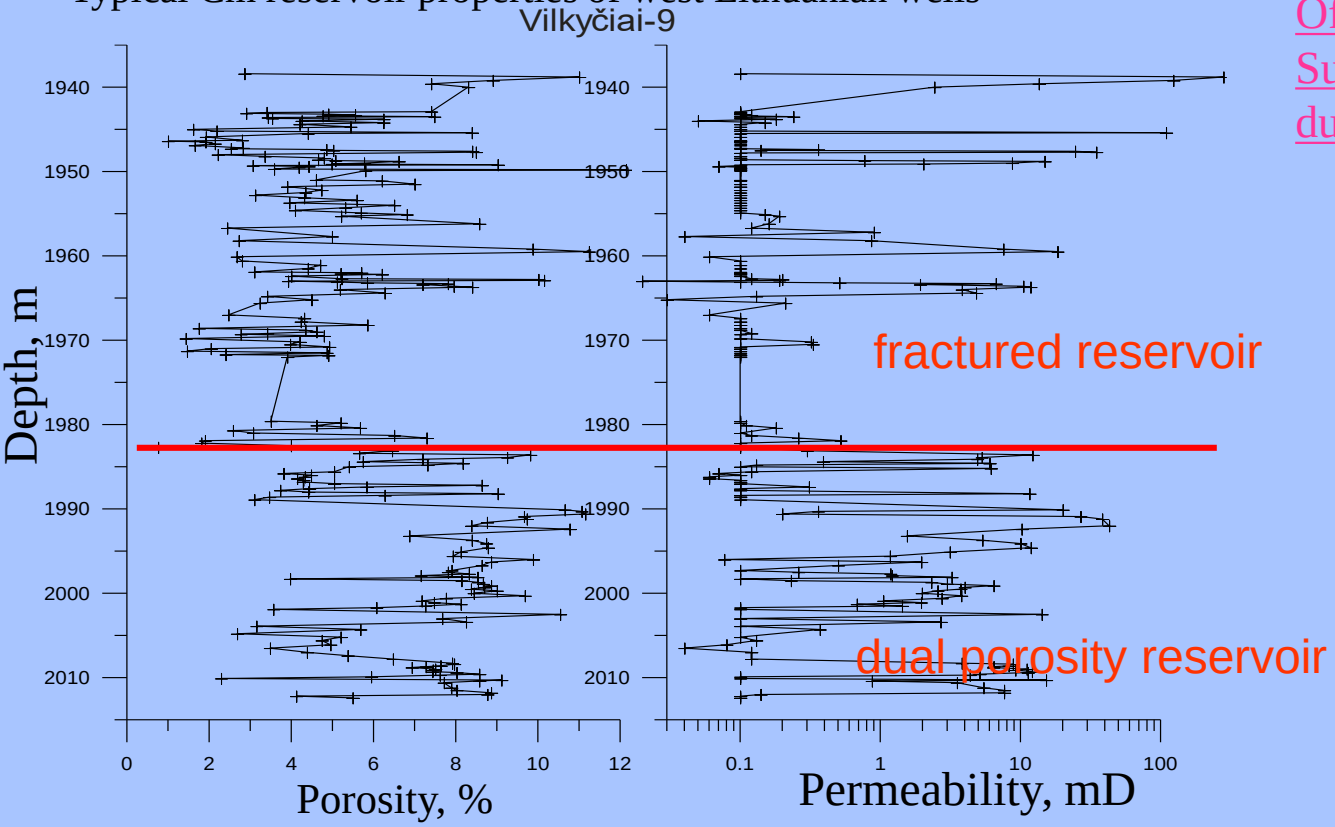
BASE of OIL SATURATION ("BOSO") –2,040

December, 2013

Extraction of incremental oil from residual zone

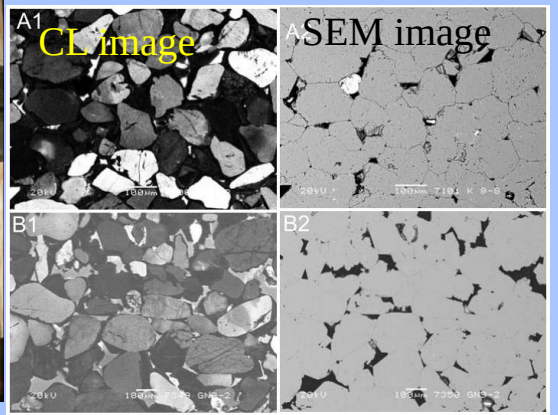


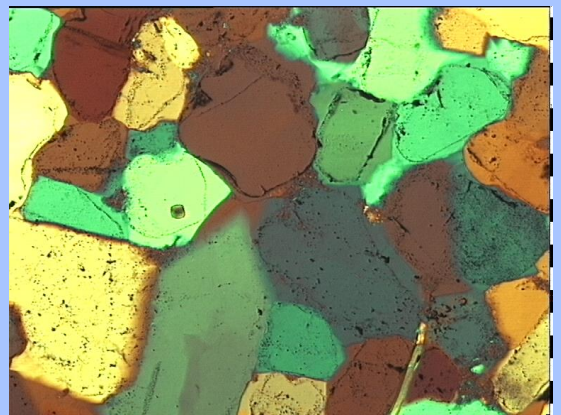
Typical Cm reservoir properties of west Lithuanian wells



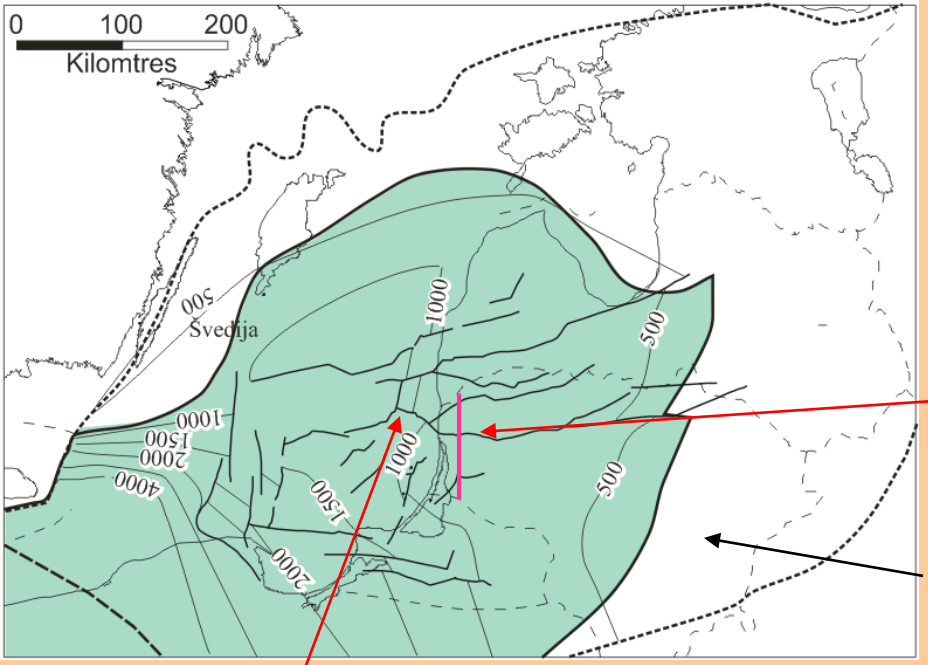
Official argument 2: Surface vertical movements due to CO2 injection

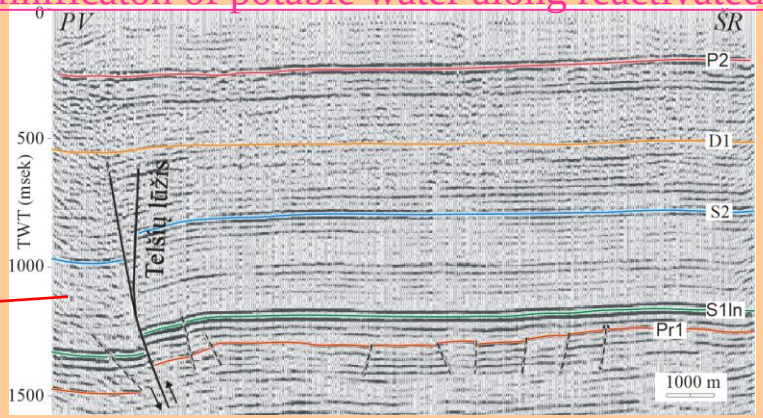
Reservoir properties are **too low** to maintain high-rate CO2 injection to jeopardies surface movements jeopardies surface



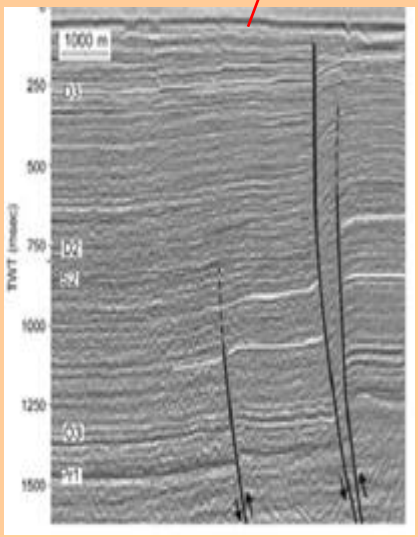


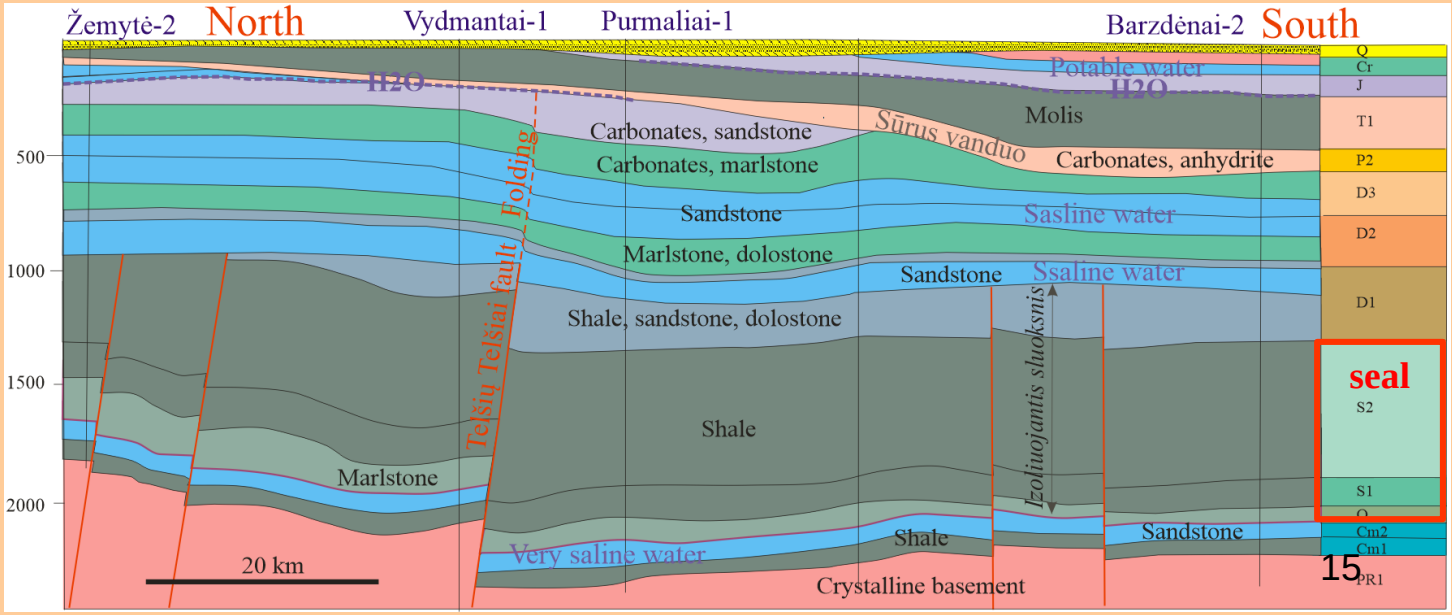
Official argument 3:
Salinificaton of potable water along reactivated faults





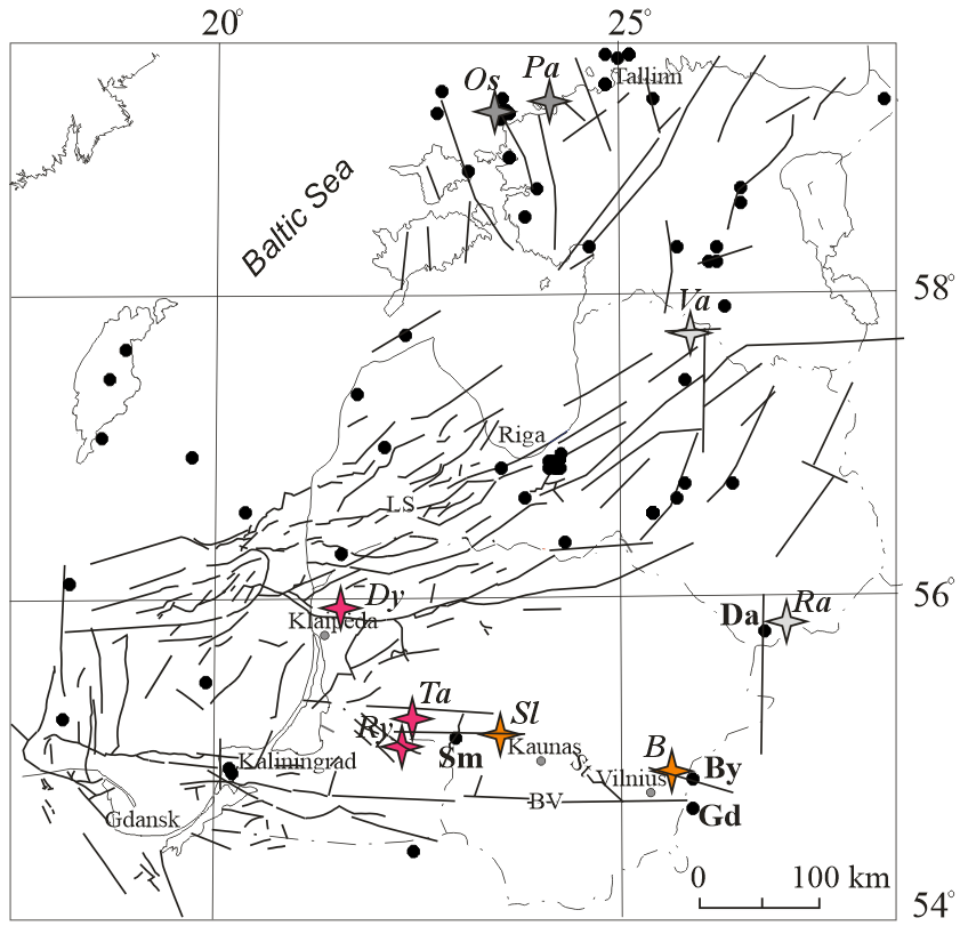
The thickness of the Ordovician-Silurian seal (mudstones). Faults penetrate Lower Palaeozoic deposits, rarely the whole Palaeozoic package. No oil shows were reported from the Devonian deposits, except one case in E6 structure (Latvian offshore). No mineral water anomalies either





Geological profile

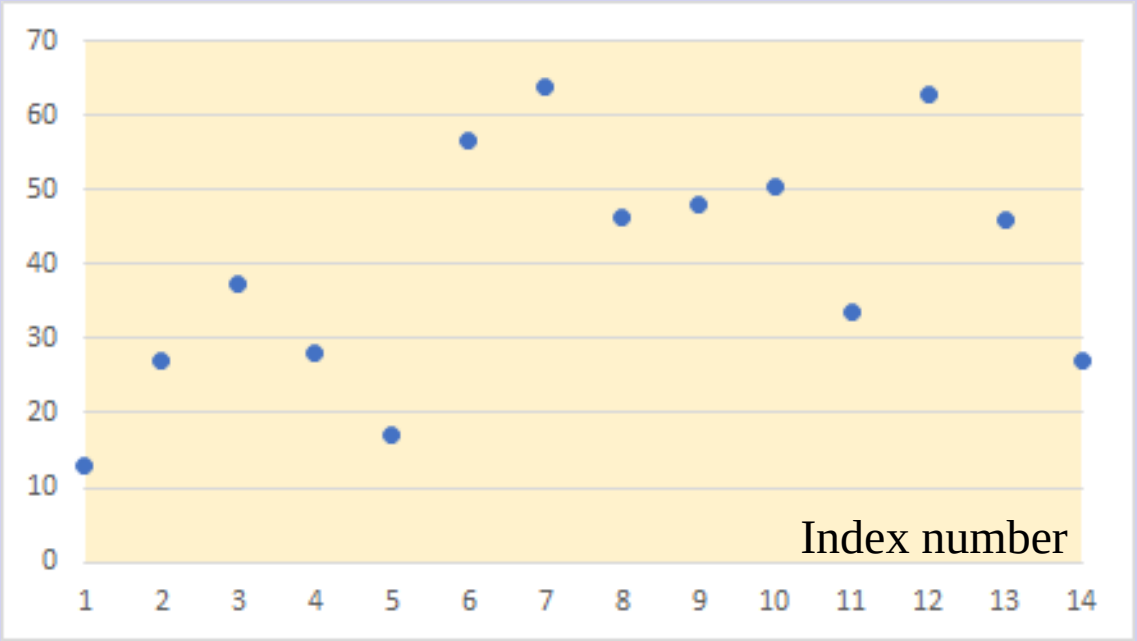
Oficial argument **4**: induced seismicity



Map of recent (dots) and prehistorical (glacial isostasy induced) earthquakes and faults recorded in the sedimentary cover. No recent earthquake was recorded in Lithuania (except doubtful Smalininkai seismic event of 1313)

No devastating historical earthquakes were recorded (**Mmax=5.3**). Prehistorical earthquakes evaluated **M=6.5**. CO2 injection is unable to reactivate faults due to too low present tectonic forces. In any case, faults are avoided in CO2 storage sites

Official argument 5: Mobilisation of methane

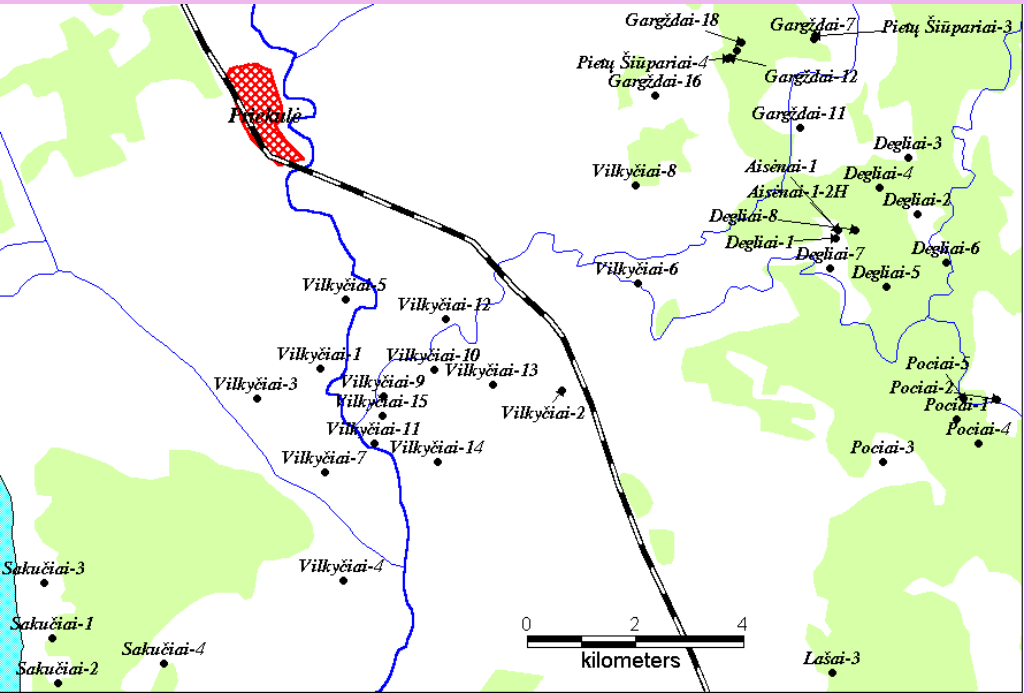


Gas-oil-ratio plot showing gas volume in Cambrian oil, m3/t

Gas-oil-ratio is very low in Lithuanian oil minimizing any potential risk of methane mobilization by CO2 injection in oil fields

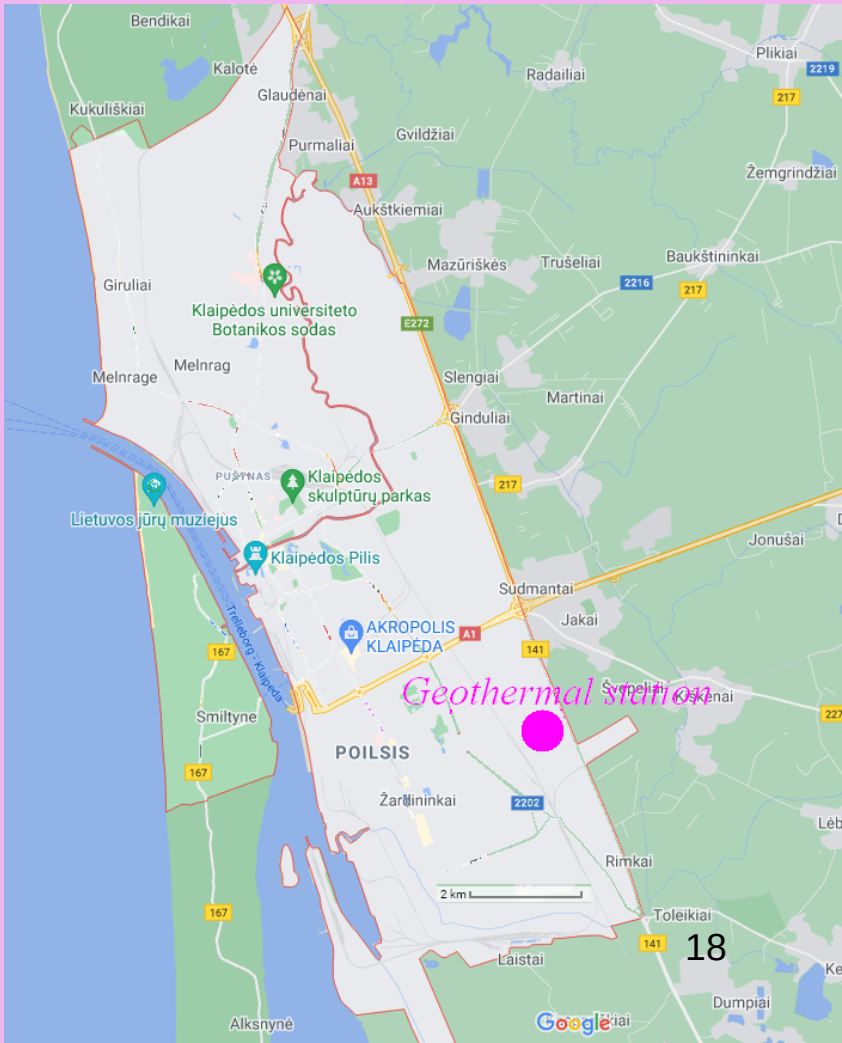
Any conflict of CO2 storage and district heating geothermal stations is impossible in **principle**. CO2 storage sites are planned as far away from cities and towns as possible, while geothmeral district heating station are installed within the city limits.
Moreover, application of CO2 may promote geothermal **electricity** demo experiments

Oil fields are located far away from the towns, only small settlements



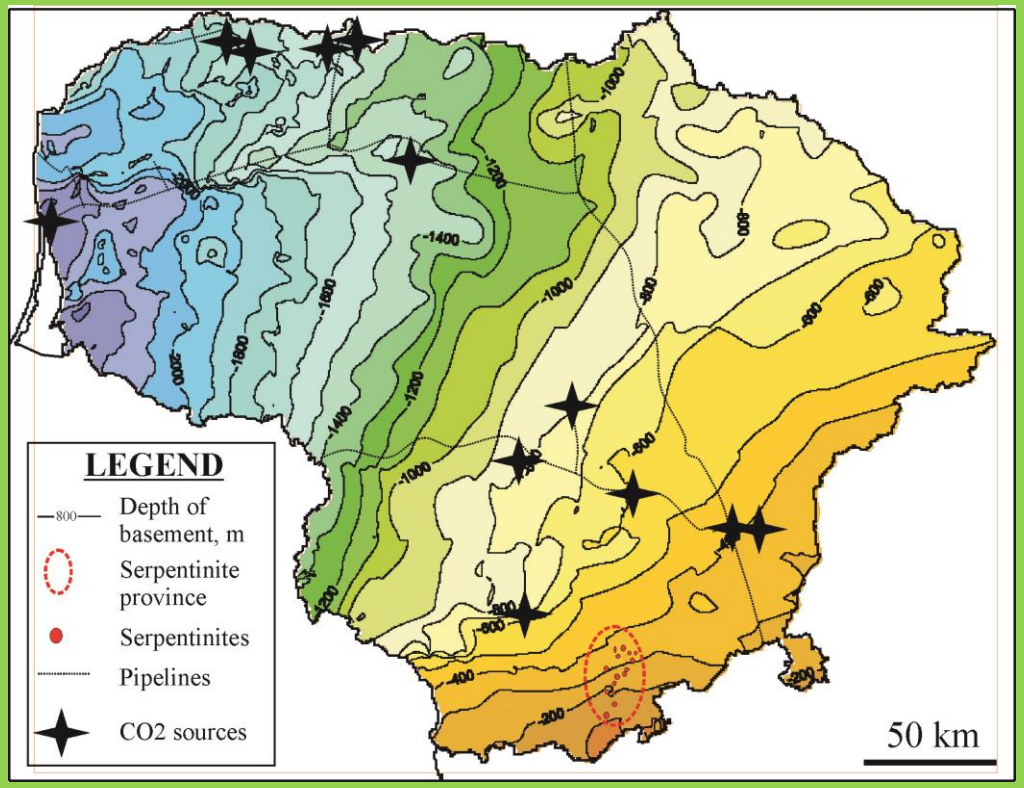
Oficial argument 5:
Conflict of interests, e.g. extraction of the geothermal energy for district heating

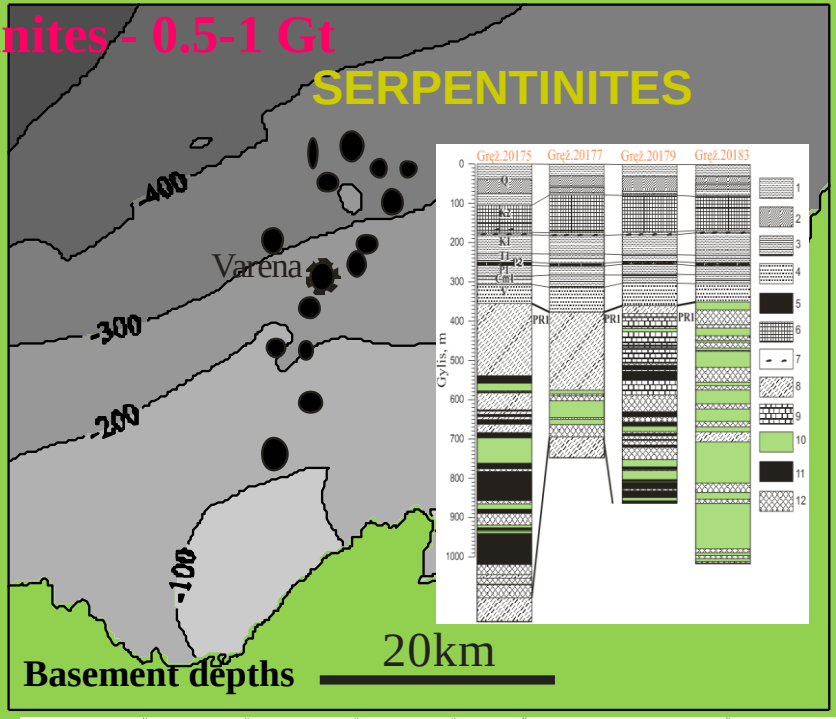
Klaipeda geothermal station is located within the limits of Klaipeda city

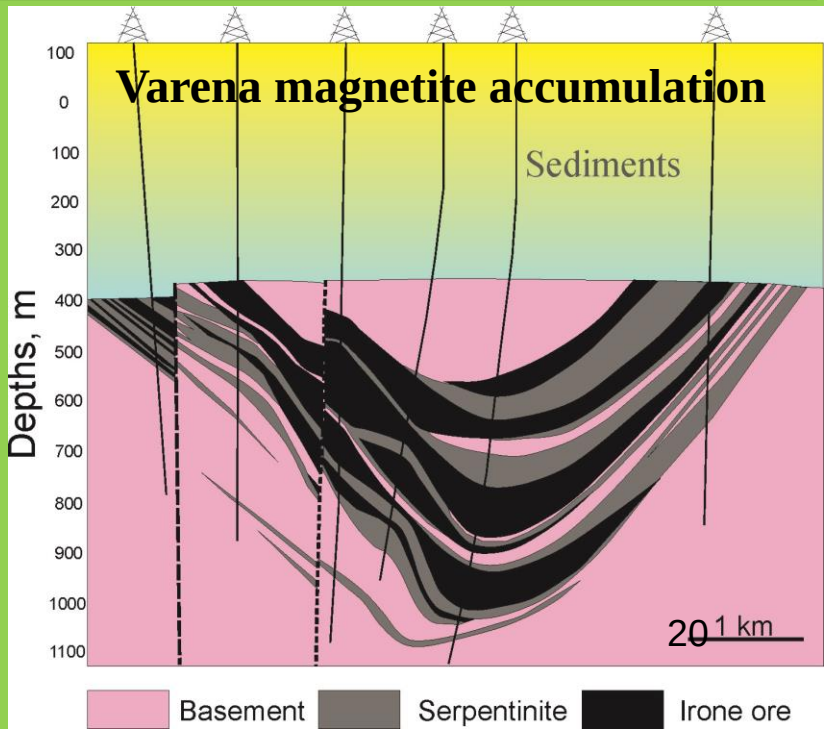


3. Mineral carbonation alternative is kept in mind

LITHUANIA CO_2 storage potential in serpentinites - 0.5-1 Gt







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GHGT-10

Carbonation of serpentinite rock from Lithuania and Finland

Inga Stasiulaitiene[a], Johan Fagerlund[b], Experience Nduagu[b,c], Gintaras Denafas[a], Ron Zevenhoven[b*]

Any indications of environmental risk in west Lithuania?

Risk indices	Was it recorded in west Lithuania?
Natural hydrochemical anomalies in potable water aquifers	No
Hydrochemical anomalies in saline aquifers	No
Presence of gas methane in Devonian aquifers	No (N and CO2 instead)
Historical and recent earthquakes	No
Seismic events related to oil exploitation	No (one low-magnitude event recorded in 2015 is under question)
Faults reaching potable water aquifers	No
Saline water anomalies in old oil wells	No
Oil shows in Devonian aquifers	No

CONCLUSIONS

Gargzdai zone of oil fields (elevation) is considered as a prospective structure for **industry-scale** CO2 storage in Cambrian reservoir, also is an attractive object for **developing** EOR technology (oil production from ROZ)

Positive political climate concerning CO2 geological storage has dramatically changed to absolutely negative position even in terms of demo research activities since 2018

All provided arguments to support banning of CO2 geological storage are based on text-book statements ignoring the region-specific geological conditions

The change of the negative to positive policy can be still expected in near future

The desktop studies are considered only, so far

PR activities should be increased to promote CO2 geological storage acceptance

Thank you!