ASSESSMENT OF TRANS-BOUNDARY EFFECTS AT LBr-1 CO_2 STORAGE PILOT SITE AND REGULATORY SOLUTIONS

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- Possible leakage through boreholes
- Spill points

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Introduction

National transpositions of the EU CCS Directive do not fully address trans-boundary issues

Case study – LBr-1 site located close to the Czech-Slovak border

Main objective – evaluate any trans-boundary issues that might arise from CO_2 storage at LBr-1, identify difficult-to-handle aspects and suggest solutions

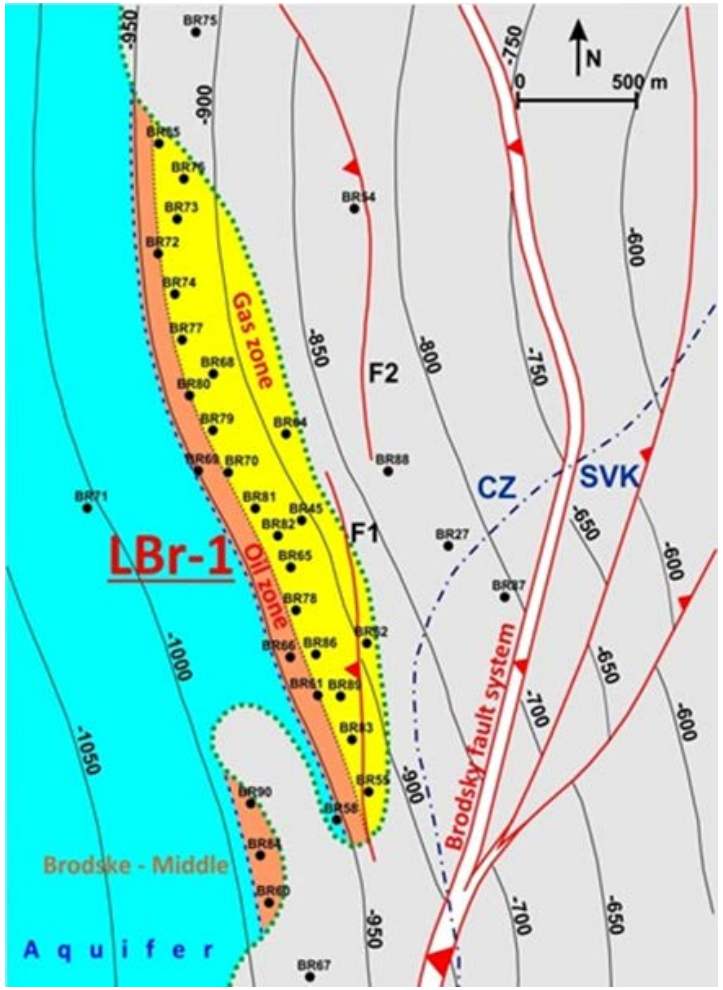
Location of LBr-1 and satellite image with reservoir area

Brief geological description of the storage complex

Storage structure = originally hydrocarbon-bearing reservoir horizon (Láb horizon), comprises the Middle-Badenian (Serravallian/Langhian - Middle Miocene) sands; 4 partial layers, thickness up to 30 m; depth ~ 1.000 m

Caprock – Middle-Badenian shales

Combination of a lithological and tectonic trap; pinch out at the East/North-East edge of the field, still on the territory of the Czech Republic; faults of the Brodsky fault system confine the field in the South / South-East



LBr-1 field history

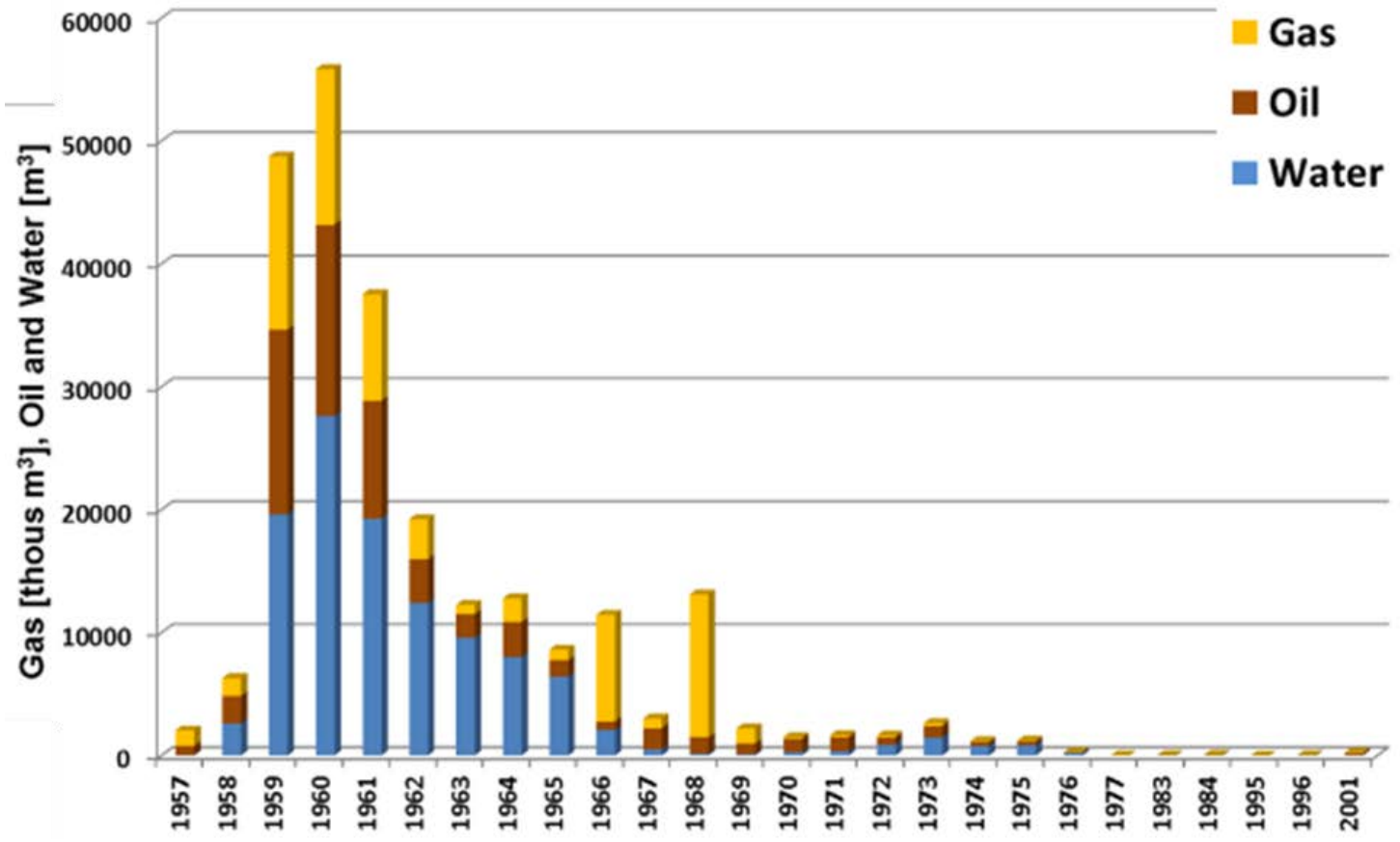
Discovered in 1957

Main production in 1959 - 1969; occasional production till 2001

Total cumulative production 61,900 m^3 of oil and 68.7 mil. m^3 of gas

Now completely abandoned

Possibly good candidate for a CO_2 storage pilot



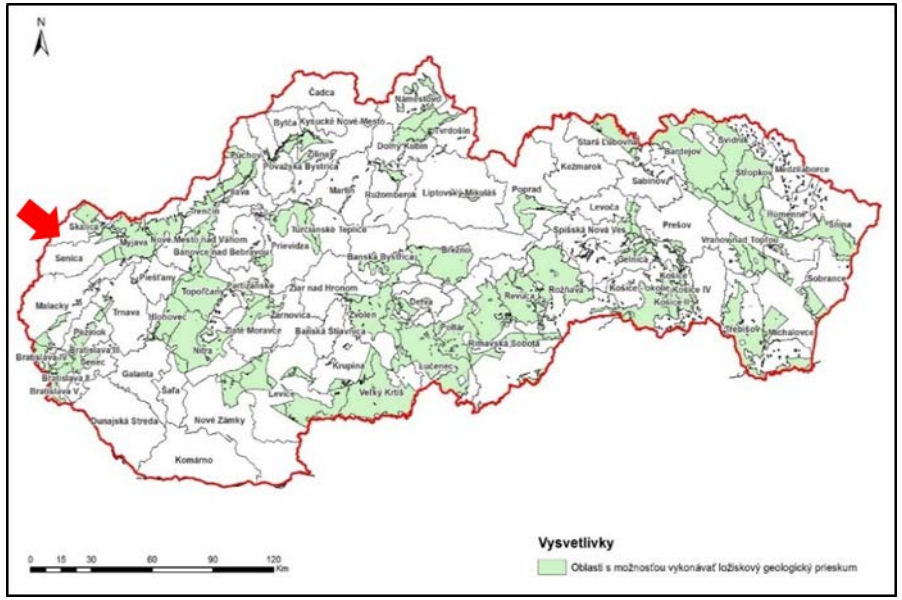
Legislation and regulatory issues

Comparison of legislative and regulatory framework in CZ / SK

Several barriers identified in both countries – missing implementing regulations, unclear transfer from producing field to CO_2 storage

Hostile regulatory environment in SK – CO_2 storage has the lowest priority among all subsurface uses

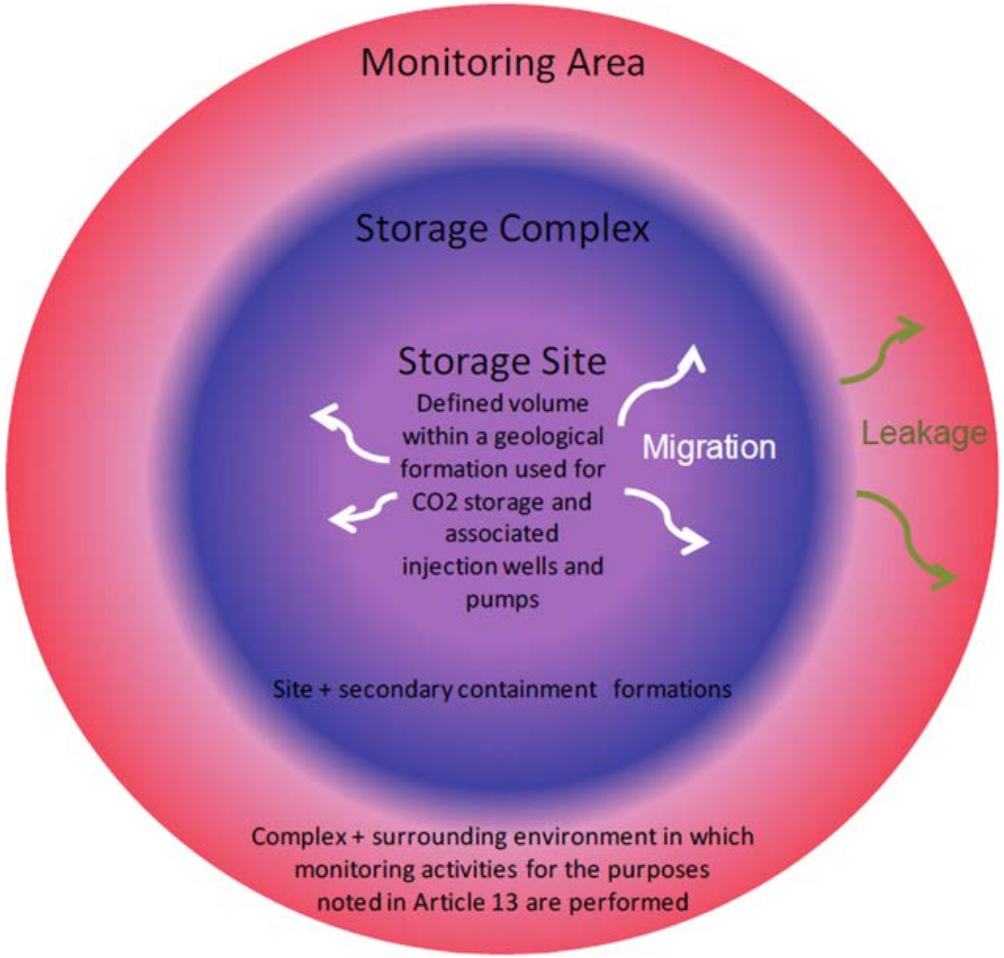
Implication – exploration for CO2 storage sites is forbidden on the Slovak side of the border → the storage site MUST NOT BE TRANS-BOUNDARY



Definition of storage complex

EU CCS Directive: Storage complex = the storage site and surrounding geological domain which can have an effect on overall storage integrity and security; that is, secondary containment formations.

The storage site itself means a defined volume area within a geological formation used for the geological storage of CO2 and associated surface and injection facilities



Schematic representation of the Storage Site, Storage Complex and Leakage as defined by the EU CCS Directive (adopted from ICF International, 2010)

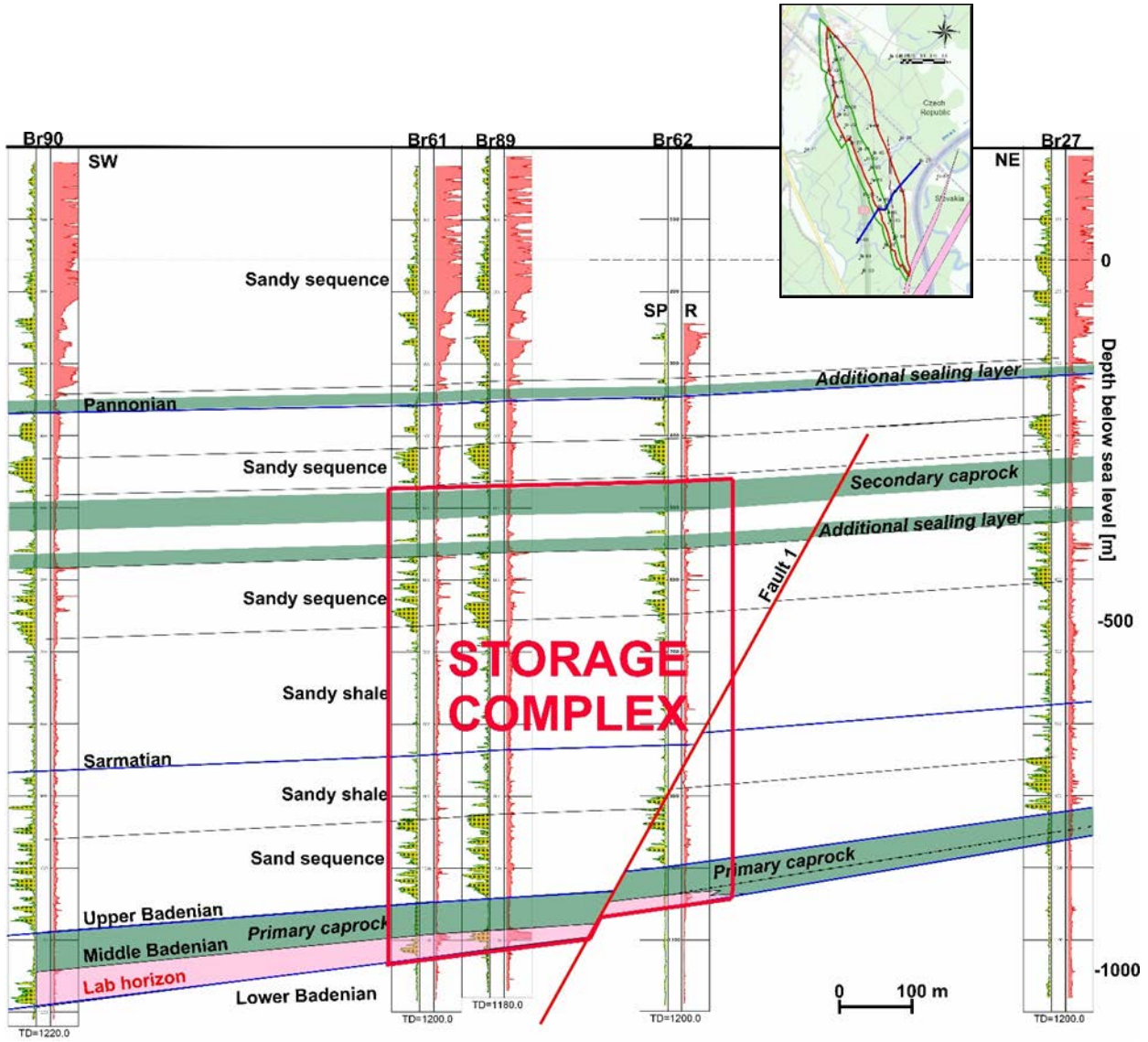
Definition of storage complex

Guidance Document 2: The storage complex includes:

- immediate surface and sub-surface facilities at the storage site;

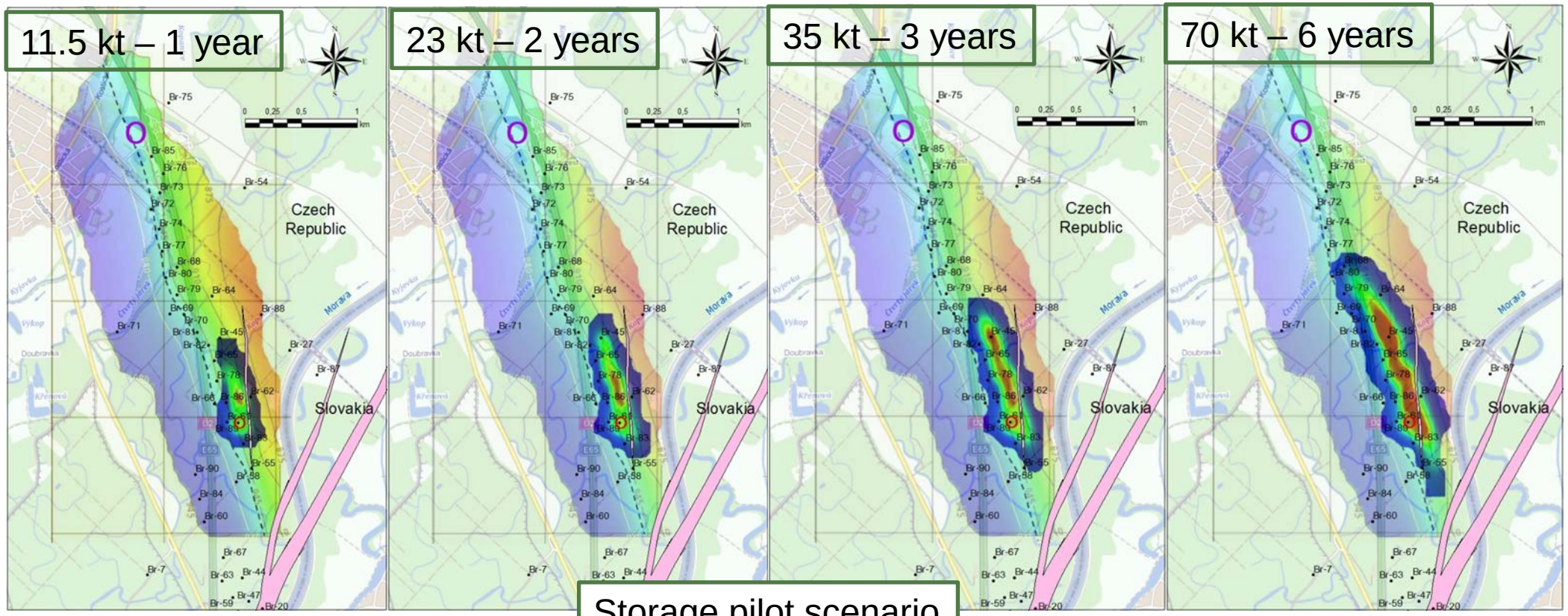
- only the targeted seal and reservoir, where the CO2 is physically injected into and is expected to migrate and be stored, i.e. the geological formations which comprise the physically invaded rock volume from the CO2 plume migration;

- secondary seal and reservoir that may contain the CO2, in case the CO2 plume migrates beyond the primary seal.

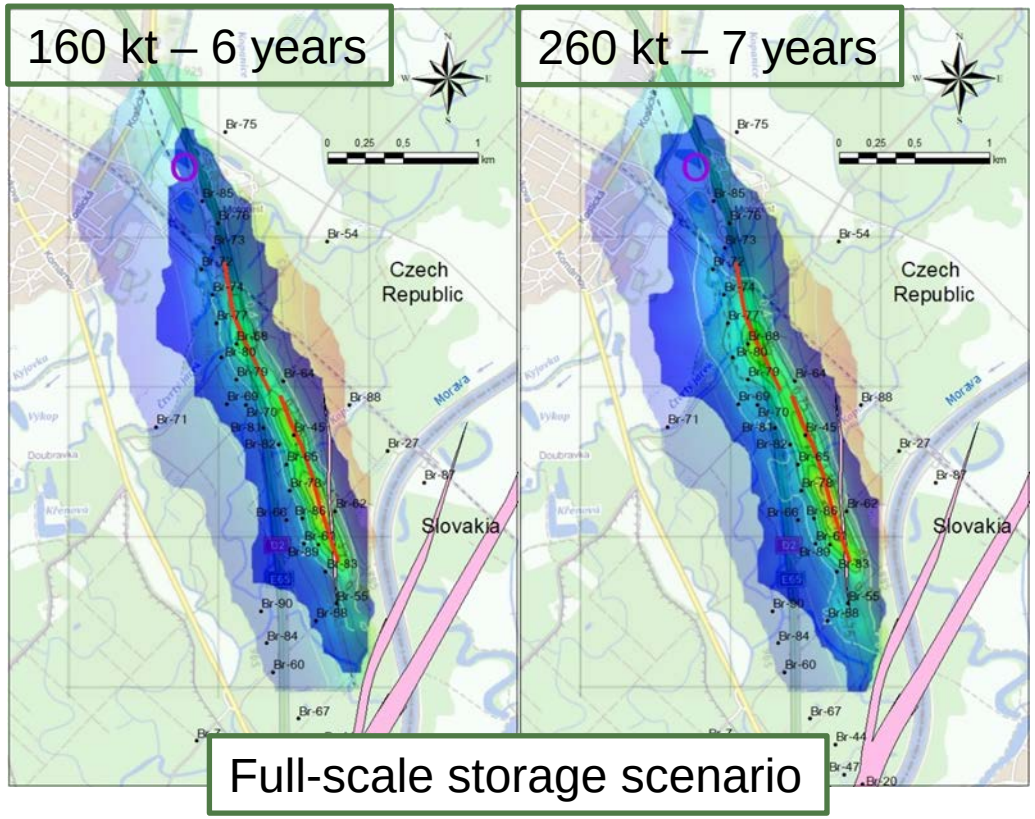


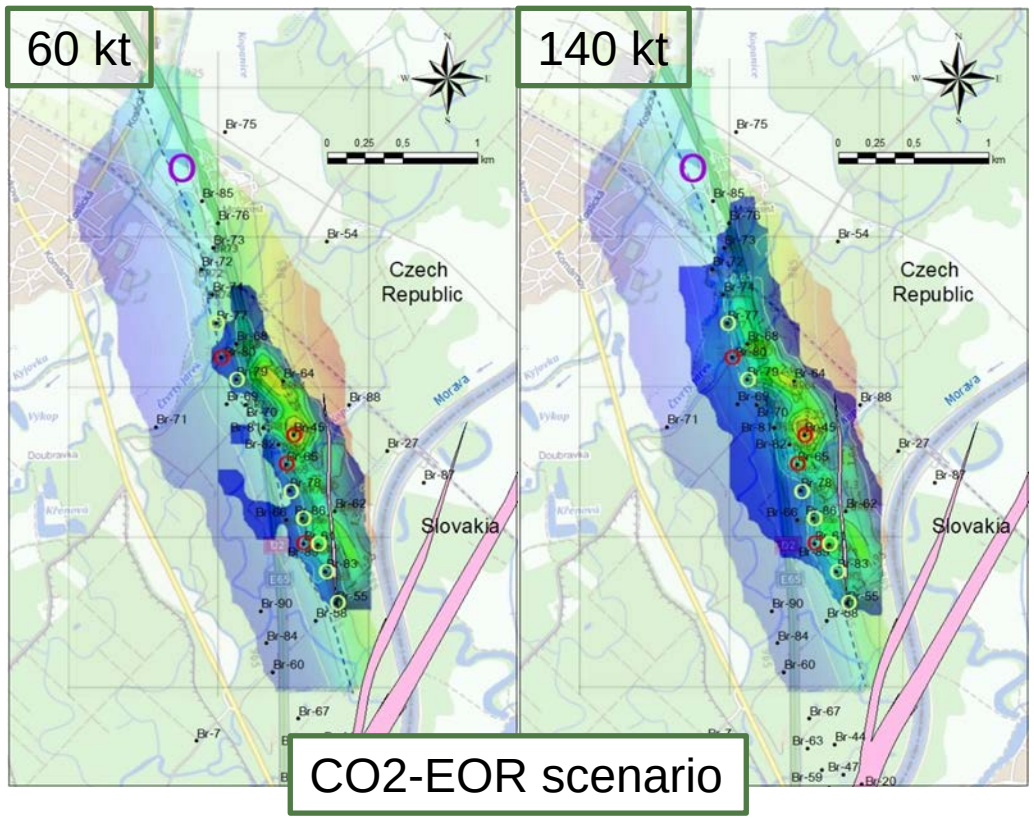
Plume extension

Plume extension approximately defines the ´physically invaded rock volume´ (= lateral extent of the storage complex).



Plume extension





Main results: - the storage complex is entirely located on the Czech Rep. territory
- full-scale storage scenario is limited by Northern spill-point

Trans-boundary issues – leakage through wells

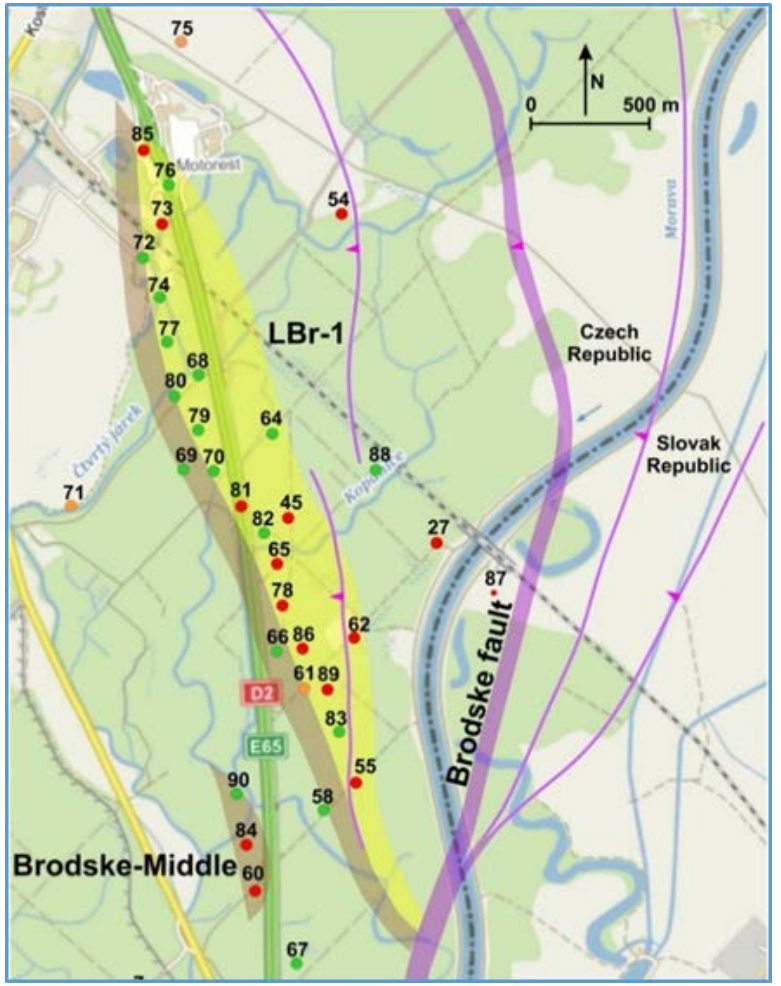
Possible trans-boundary issues assessed:

- Pressure footprint
- Possible leakage along faults
- Possible leakage through wells
- Migration of fluids due to exceeding spill points

31 wells at LBr-1; 25 penetrating the reservoir

Abandoned in 1957-2004, six wells re-abandoned in 2012-2015

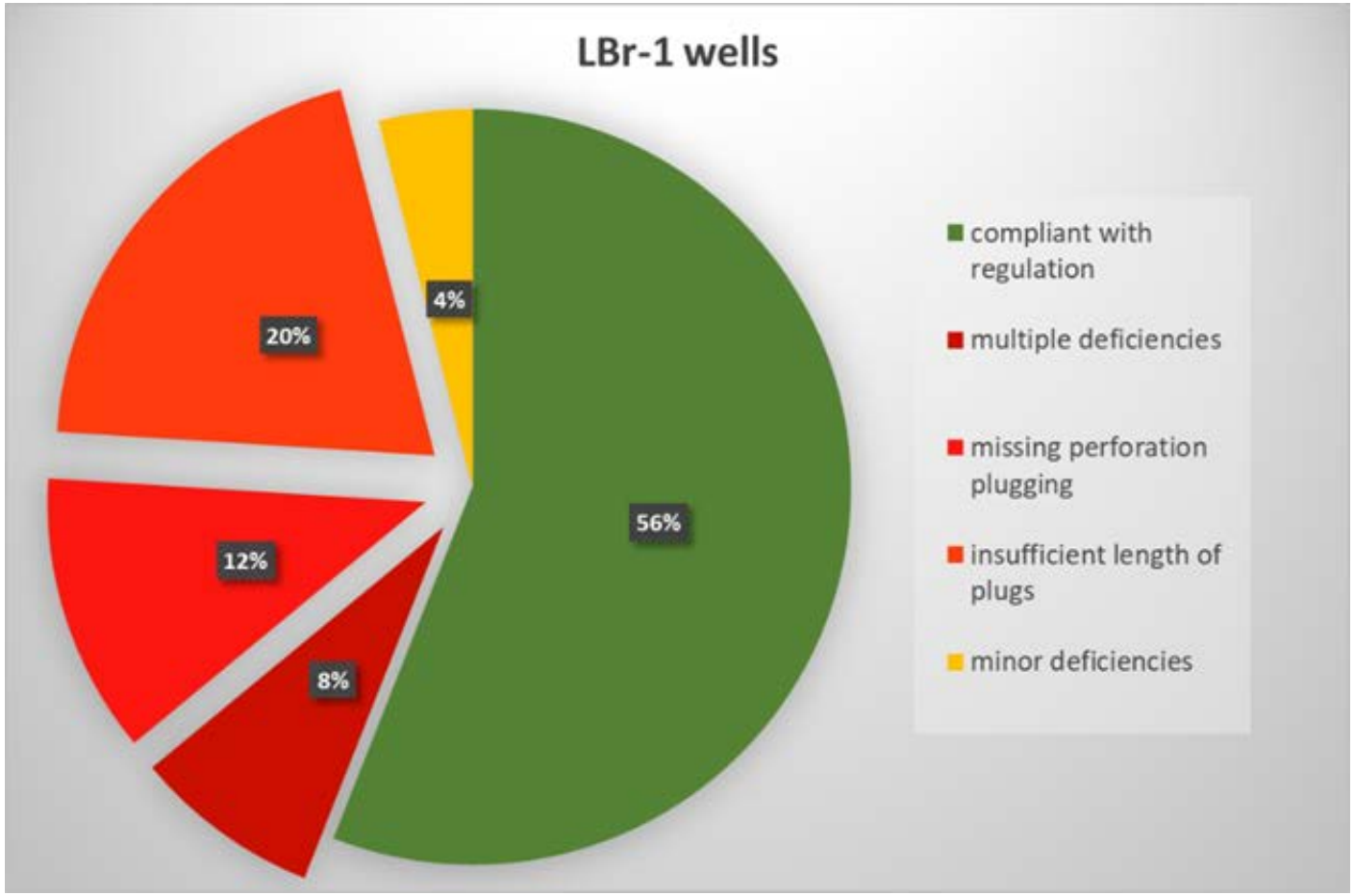
Comparison of the well abandonment status (based on archive data) with the currently valid Czech legislation – traffic lights used to visualize status.



Trans-boundary issues – leakage through wells

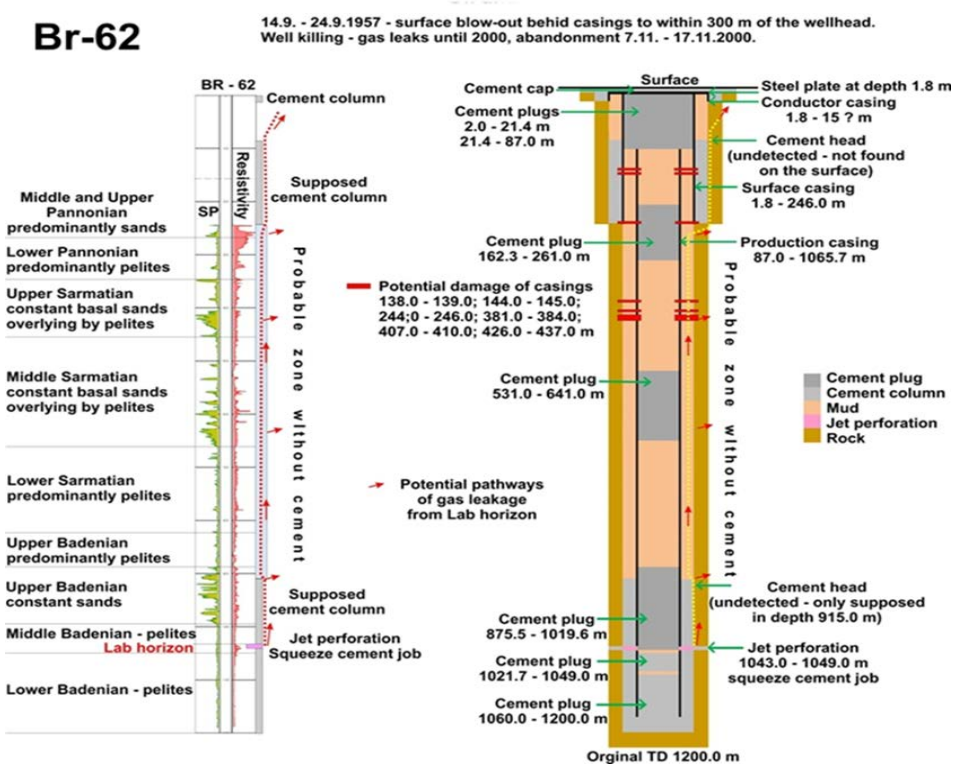
Assessment results:
- 56 % of wells compliant with current regulation
- 4 % with minor deficiencies
- 40 % with significant deficiencies

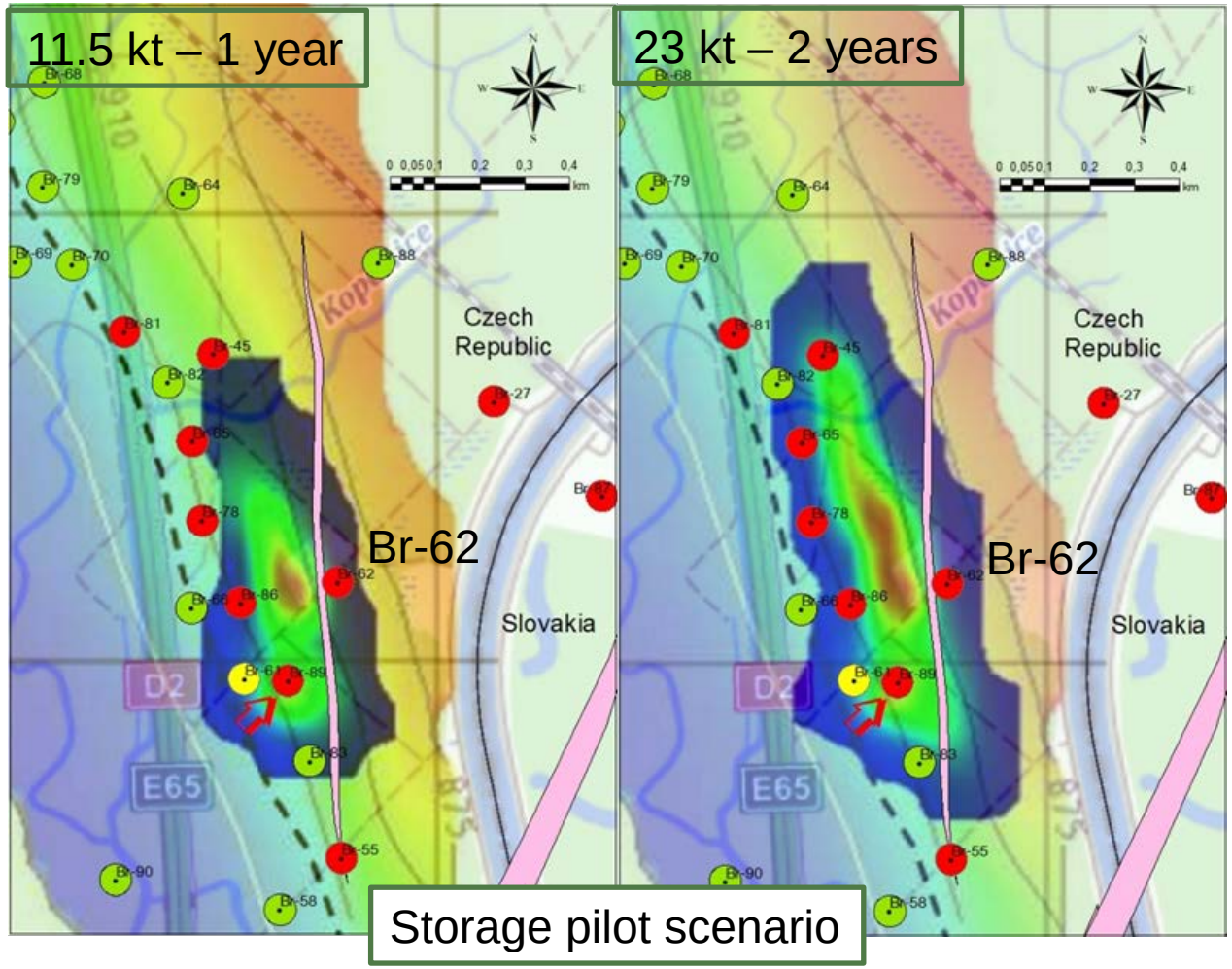
Issues of historical abandonment procedures:
- improper cementing of perforation intervals
- insufficient length of cement plugs



Trans-boundary issues – leakage through wells

Wells in the reach of CO_2 plume must be considered

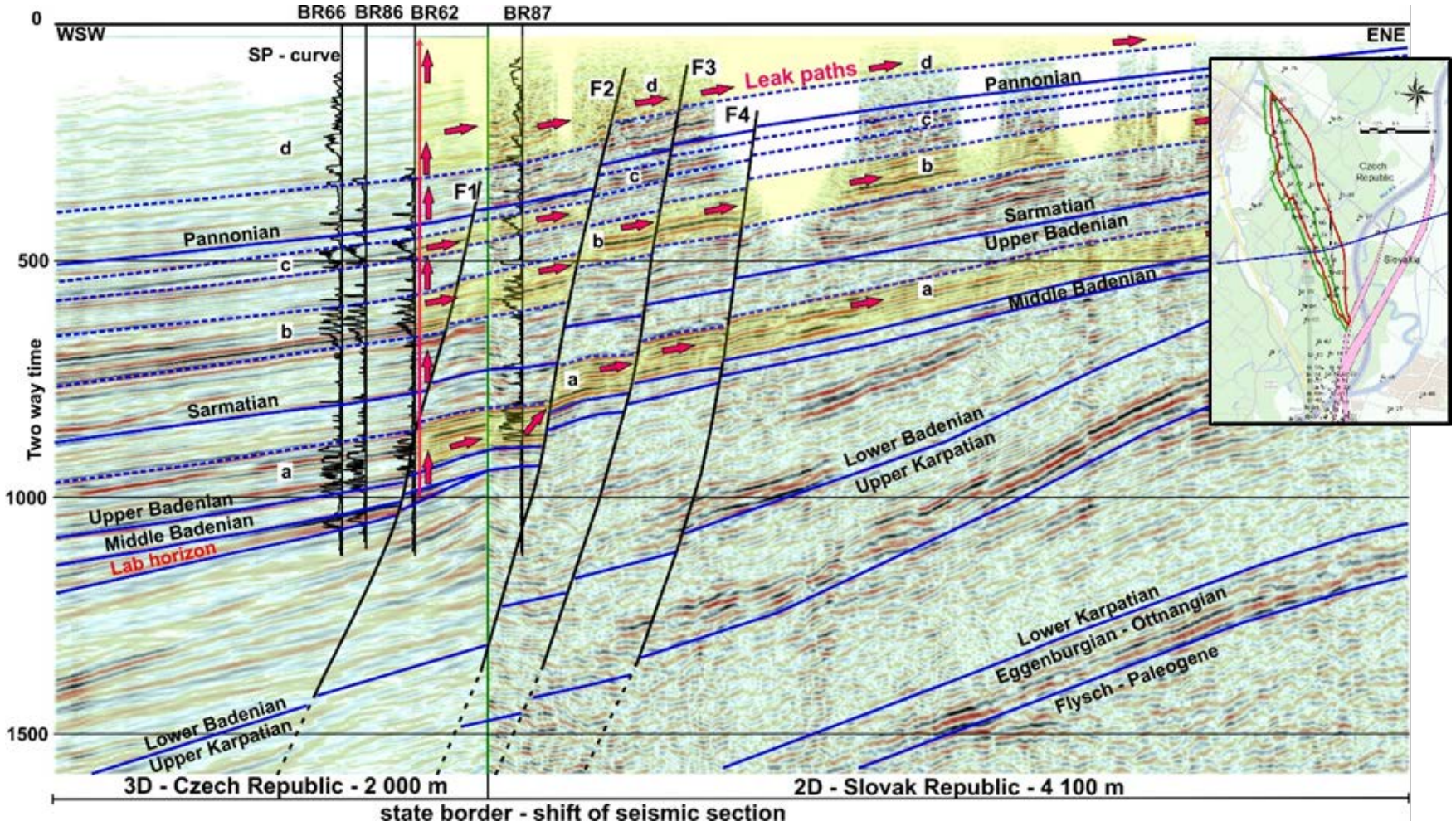




Trans-boundary issues – leakage through wells

Possible migration pathways

Leaked CO_2 would migrate in the territory of Slovakia due the dip of the layers and juxtaposition of layers at faults



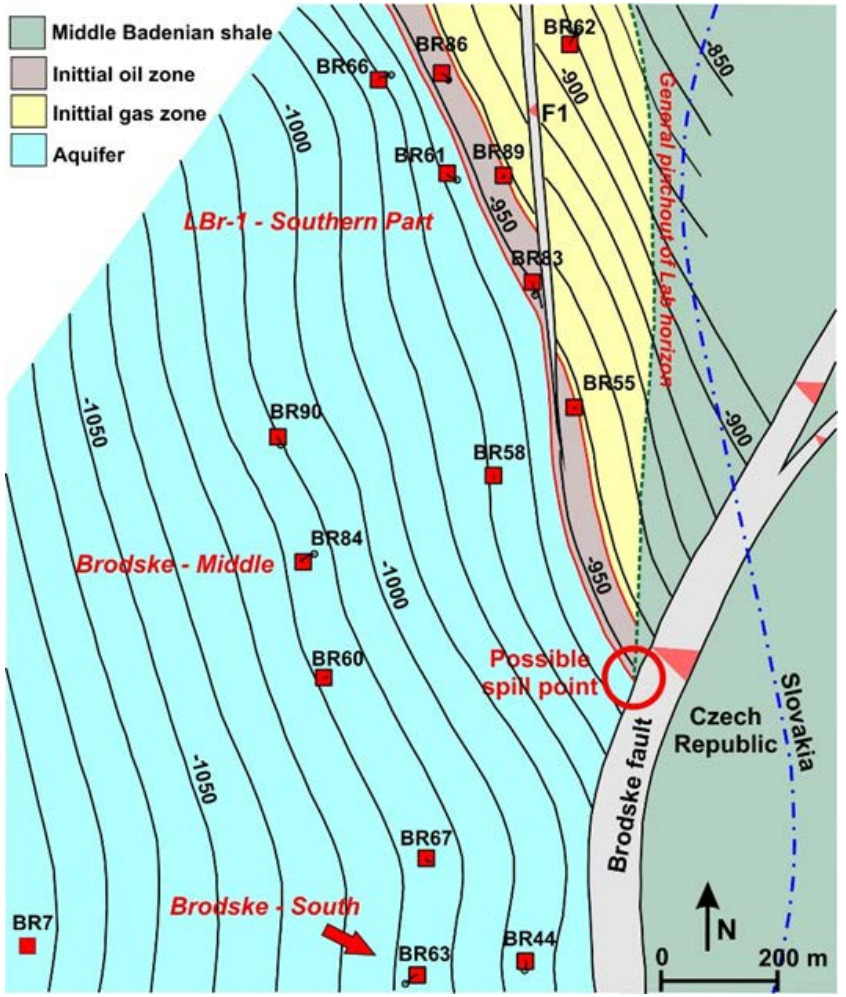
Trans-boundary issues – spill points

Southern spill point - the upper part of the Lab horizon is obviously bound by the pinch-out boundary.

The lowermost horizon is terminated by the Brodske fault in its deeper, aquifer part. No well has been drilled on the other side of the fault → uncertainty concerning the fault sealing role.

Analogue position at neighbouring field indicates possible fluid flow through the fault eastwards.

Conclusion: **Leakage through wells and along Southern spill point would represent an important trans-boundary issue.**



Conclusions

Regulatory barriers identified in both CZ and SK (e.g. incomplete regulatory framework); legislation and regulations must be adjusted in both countries to enable CO_2 storage.

Hostile legal environment in SK → the storage site must not be trans-boundary.

Detailed analysis of the extent of the storage complex at LBr-1 → storage site and storage complex are located entirely on CZ territory.

Possible CO_2 leakage through wells and along Southern spill point represent trans-boundary issues – CO_2 would migrate to Slovak territory.

Cooperation of regulatory authorities from both CZ and SK will be necessary to prepare and operate the storage site - risk assessment, monitoring and possible leakage mitigation measures are trans-boundary affairs → significant complicating factor for possible injection of CO_2 at LBr-1.

CO2 storage at LBr-1 still considered viable, especially in the basic pilot storage scenario (limited leakage risk). Trans-boundary issues → lower priority of the site → another site selected as No.1 candidate for the national storage pilot.

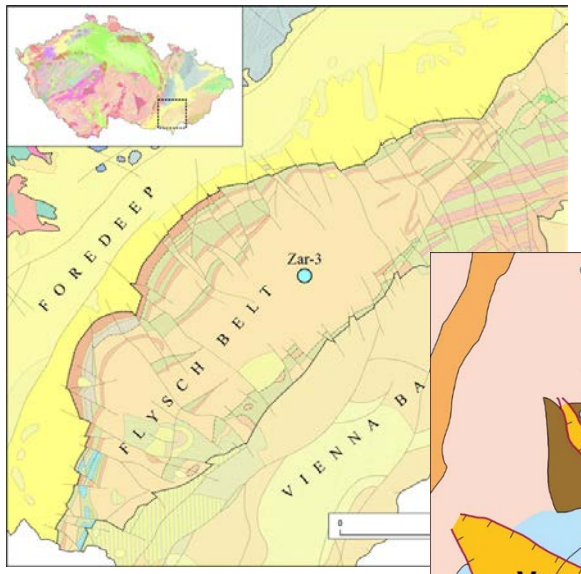
New initiative – CO2-SPICER

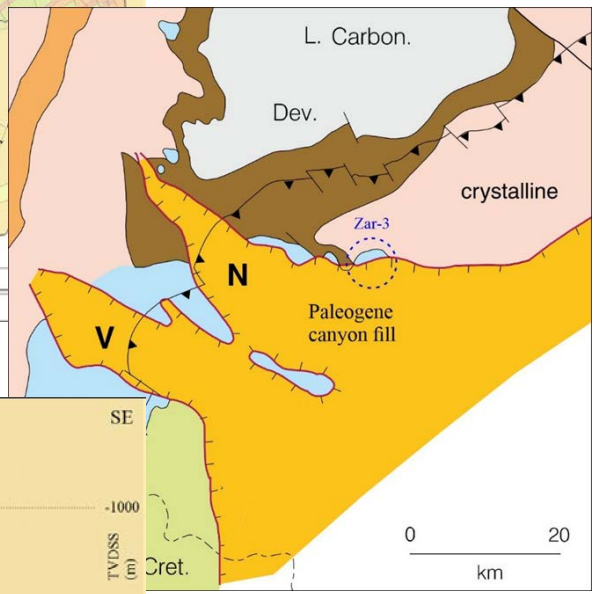
New Czech-Norwegian research project, 3.5 years duration (2020-2024)

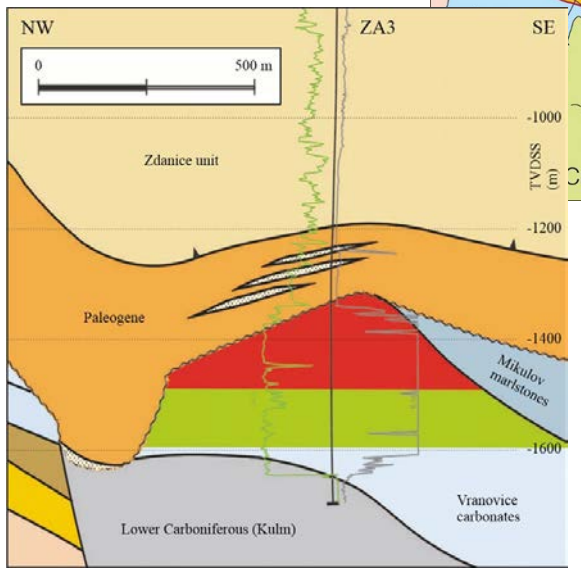
Main objective = assess a hydrocarbon field under operation (Zar-3) as a future pilot CO_2 storage site and prepare it to implementation-ready stage.

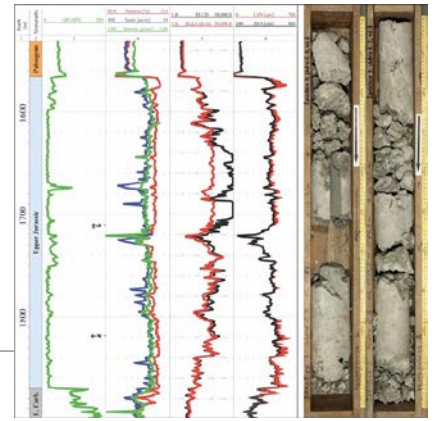
Location – Southern Moravia (SE Czech Republic); oil province – SE slopes of the Bohemian Massiff; geology – erosional carbonate relic on the slope of a paleocanyon.

Field operator (MND) on board – member of project consortium; all existing data will be available









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