



**REPP-CO₂: Pilot Project of CO₂
Geological Storage in the Czech Republic**



A 5 - Monitoring

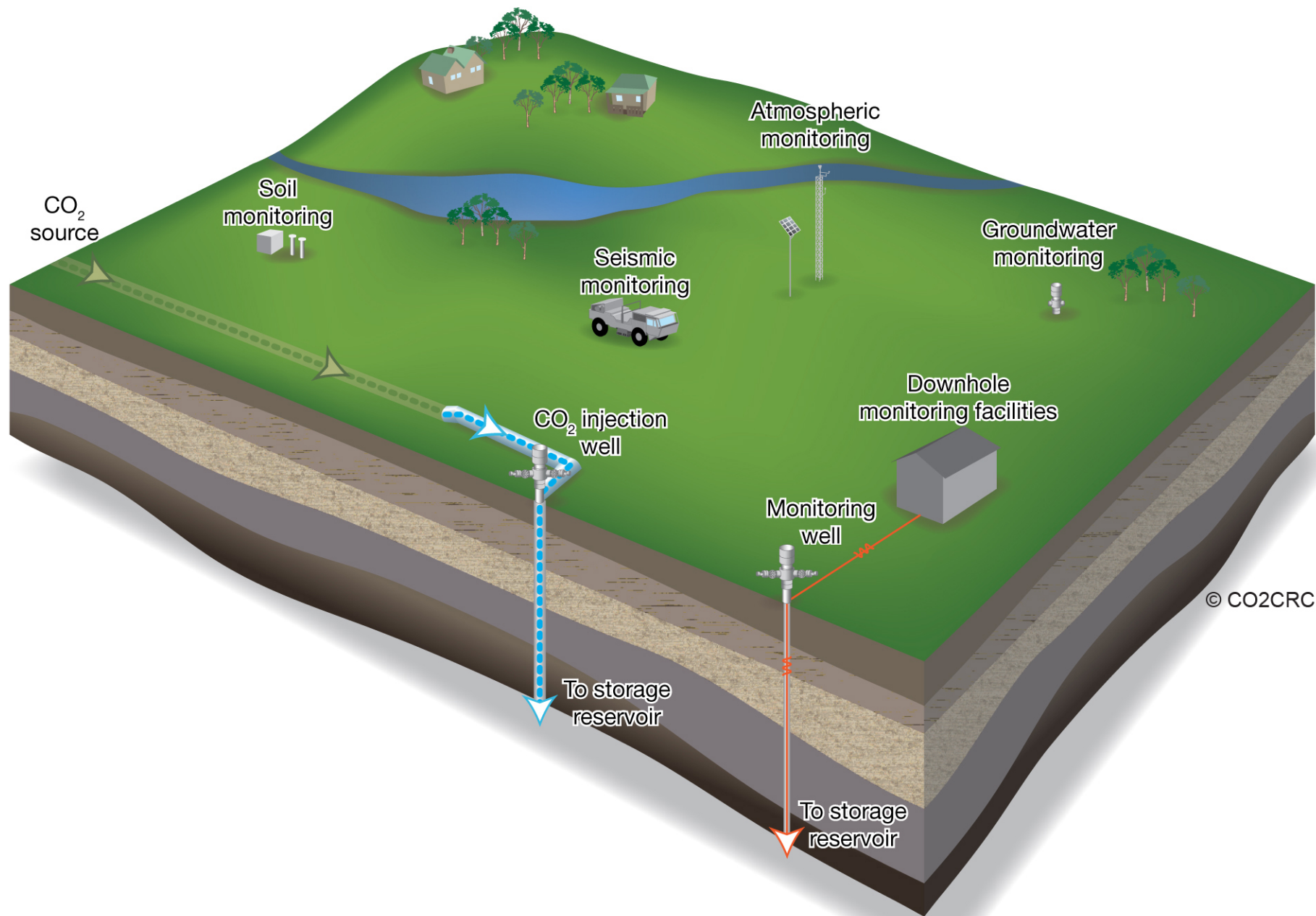
Jiří Sedlák et al., Prague, November, 2016

MONITORING



CO₂ storage regulations requires that storage operations are rigorously monitored in order to:

- verify the amount, composition and p-T conditons of injected CO₂
- understand how the CO₂ is behaving once underground
- provide early warning if things are not going as planned
- to have assurance of long-term storage integrity
- to measure any leakage that might occur



Monitoring Phases:

- (1) Pre - injection
- (2) Operational
- (3) Closure
- (4) Post - closure

Methods of CO₂ monitoring

- (1) Direct or indirect
- (2) Qualitative or quantitative
- (3) Local or areal
- (4) Deep-focussed or shallow-focussed

1. **Shallow monitoring** systems are designed to detect and measure CO₂ that has migrated into shallow geological formations, to the soil or leaked to the atmosphere. Shallow focussed methods can be (1) airborne, (2) deployed at the surface, or can be run from (3) shallow wellbores.

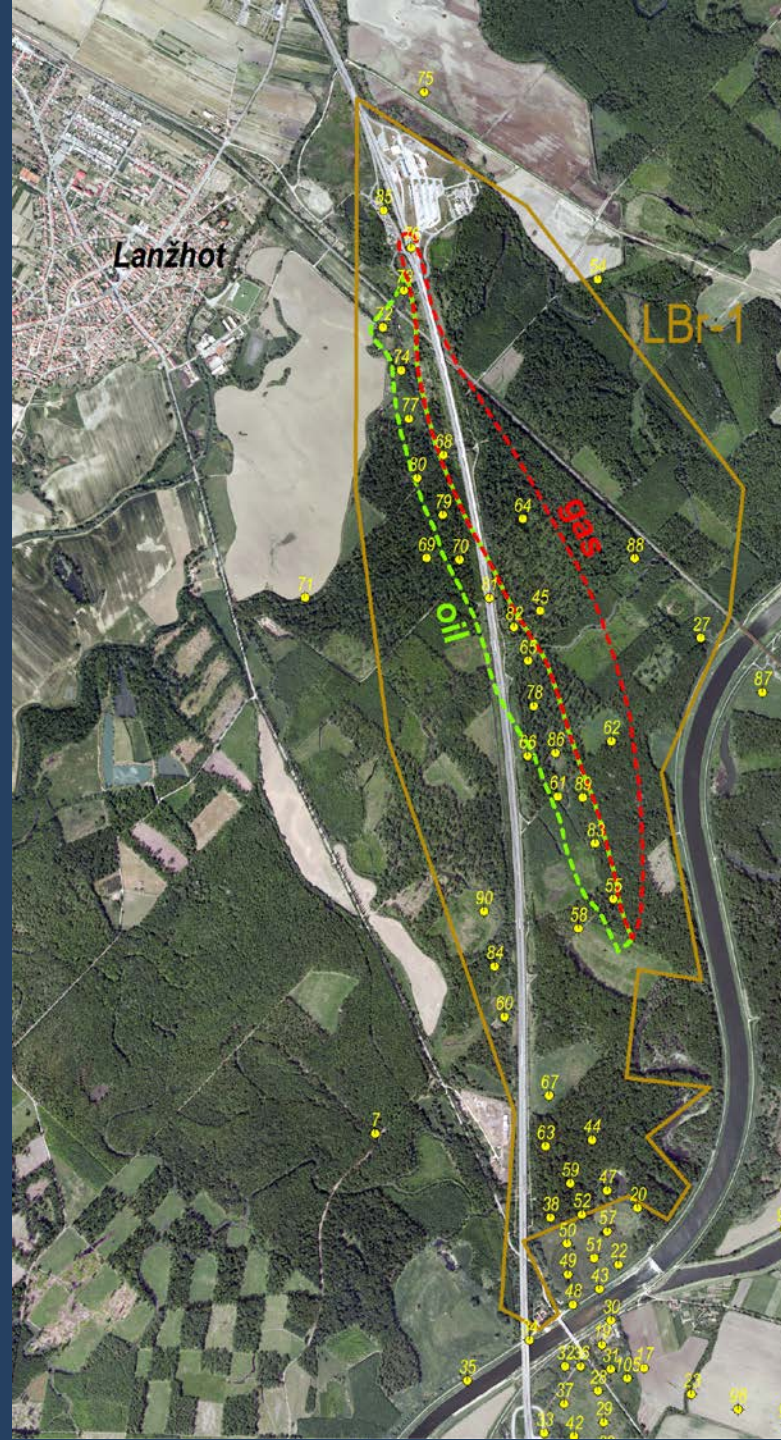
2. **Deep-focussed** monitoring is run from the surface or from wellbores. It is aimed at identifying and characterising changes that occur within the storage reservoir as injection proceeds, including the movement of CO₂ within the storage reservoir and its immediate surroundings.

MONITORING tasks - Storage site LBr-1:

- **TASK 1:**
to do applicability assessment of suitable monitoring methods
- **TASK 2:**
to realize initial base-line monitoring measurements on site
within duration of pilot project
- **TASK 3:**
to work out final monitoring plan for Storage site LBr-1

Matice použitelnosti monitorovacích metod vytvořená pomocí programu BGS:
Interactive Design of Monitoring Programmes for the Geological Storage of CO₂

metody	cíl monitorování					
	oblak CO2	integrita krycí horniny	únik CO2	migrace mimo úložiště	kvantifikace	seismicita
4D (opakovaná 3D) seismika	xxx	xxx	x	xxx	xxx	
2D seismika	xx	xx	x	xx	xx	
seismika mezi vrtů (tomografie)	xxx	x		x	xxx	
vrtná seismika (VSP)	xx	x		x	xx	
vícetřídňová seismika	xxx	xxx		xxx	xxx	xx
stopovače (tracer)	x	xxx	xxx	xxx	x	
karotážní měření	x	xxxx		xxx	xxx	
měření tlaku ve vrtu	x	xxx		x	xxx	xxx
měření teploty ve vrtu	x	xxx		x	xxx	xxx
chemismus fluid ve vrtu	x	xx	xxx	xx	xx	
měření pH ve vrtu	x		xx	xx	xx	
monitoring mikroseismů	x	x				xx
povrchová gravimetrie				xx	xx	
měření koncentrace půdních plynů		x	xx		x	x
inSAR (satelitní interferometr)		x				x
infračervený laser			x			
Eddy kovariance (atmosf. CO2)		x	x			
infračervený analyzátor plynů		x	x			
povrchový tok plynů		x	x			
letecká spektrometrie (chlorofyl)		x	x			
geochemie fluid			x			
mikrobiologický monitoring			x			
sklonoměr (tiltmeters)						x

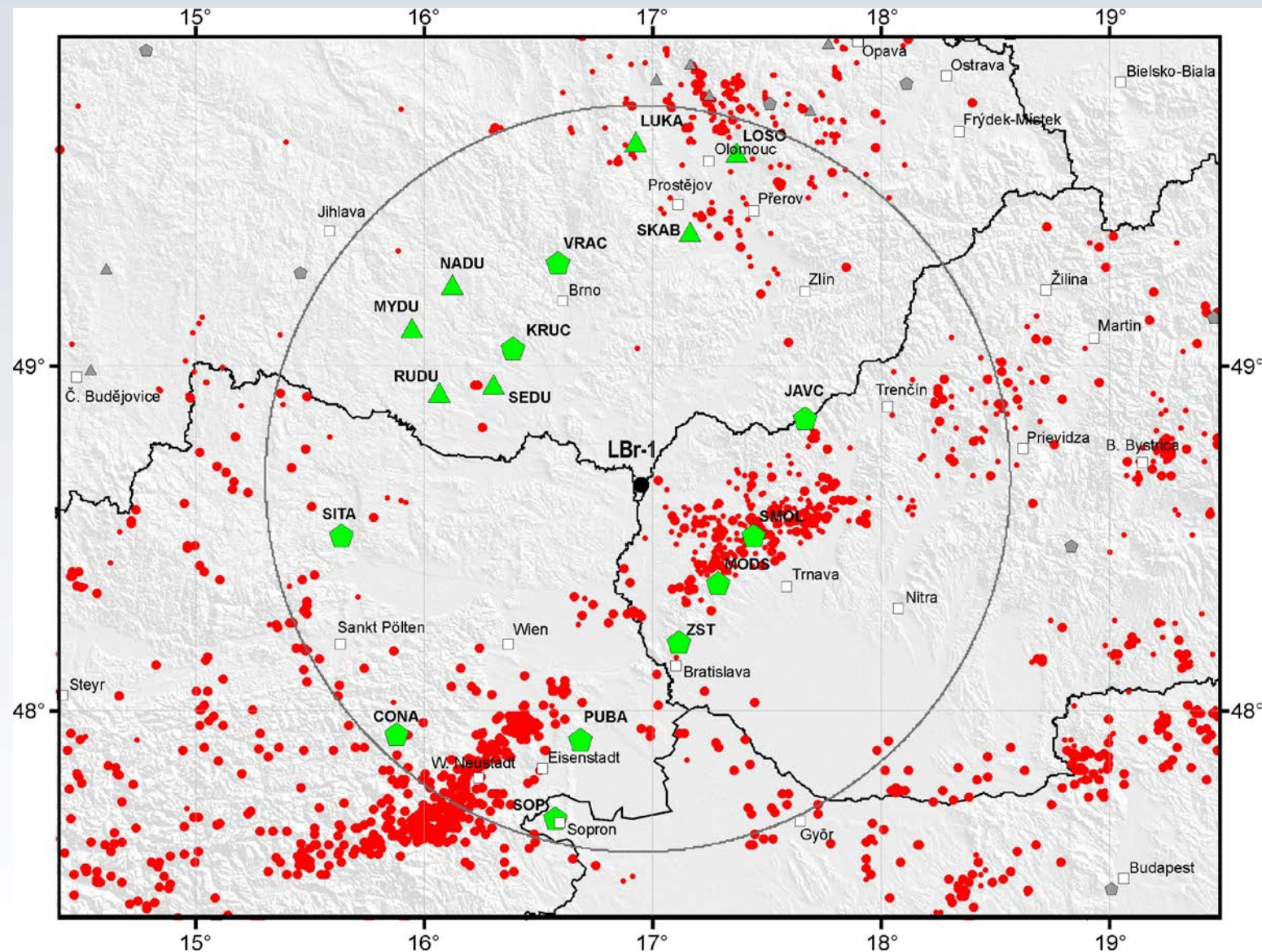


BASELINE MONITORING MEASUREMENTS ON SITE LBr-1

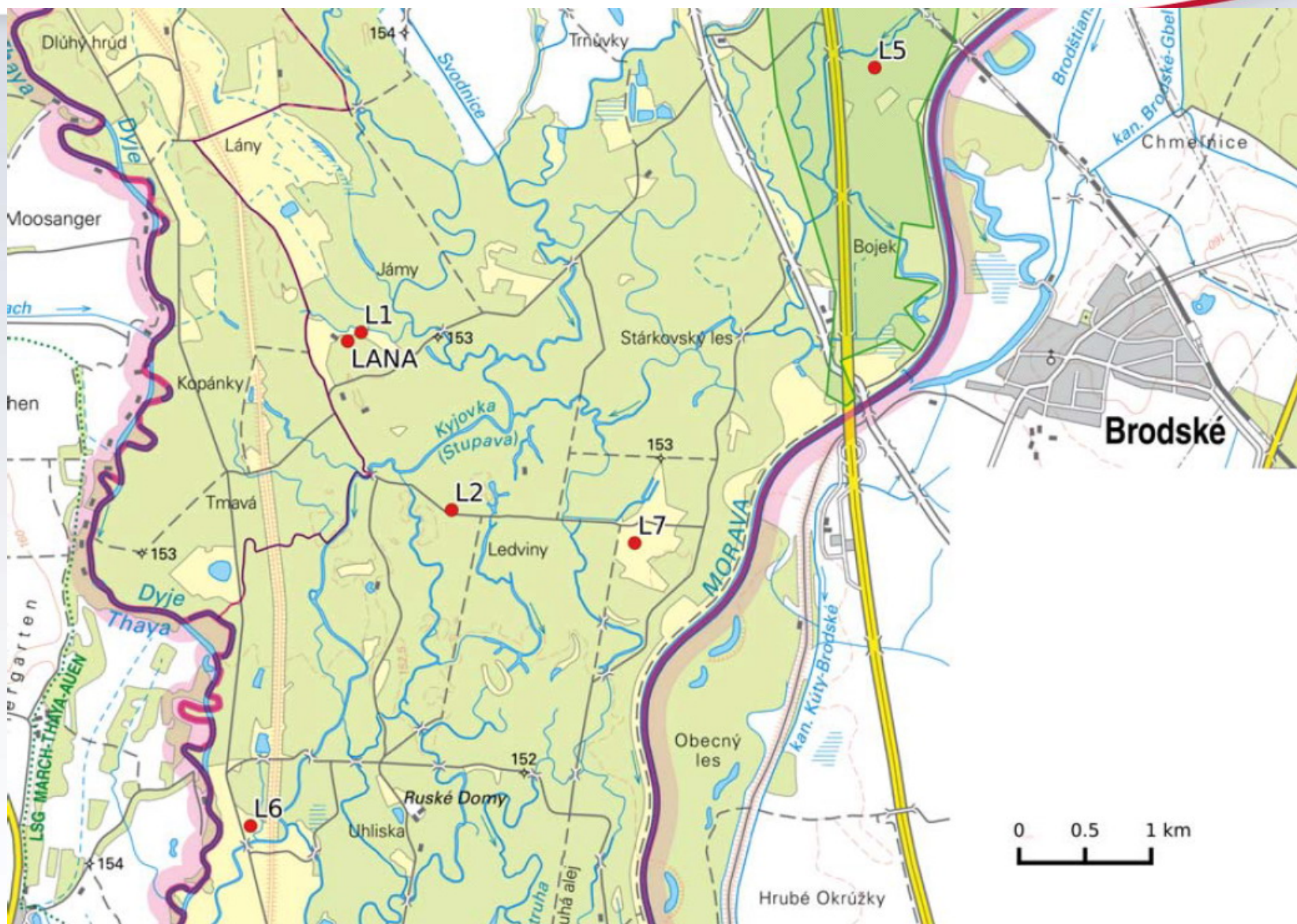
Methods:

- **seismological monitoring** - by **UFZ** (Masaryk University Brno)
- **gravimetric monitoring** - by **Miligal** (small geophysical company)
- **atmogeochemical monitoring** - by **CGS** (Czech Geological Survey)

Regional seismic stations and seismicity in surrounding of LBr-1



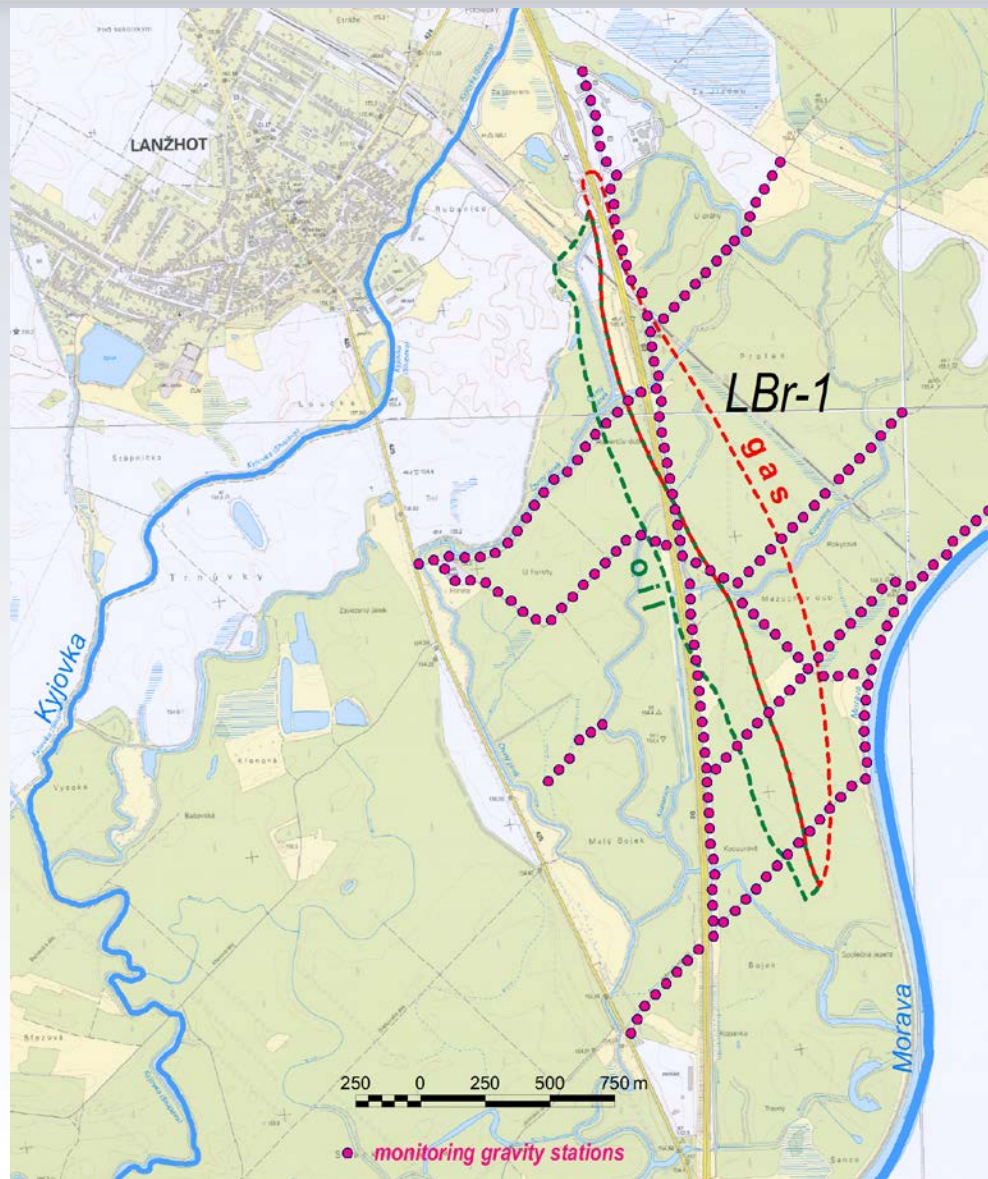
Location of baseline seismologic stations



- A) Strong earthquakes are unlikely to occur in the vicinity of LBr-1
- B) Geology on site LBr-1 is non-favourable. High seismic noise and probably high attenuation of seismic signal makes local registration surface seismology registration relatively ineffective
- C) Final seismologic solution would have to be based on borehole arrays



Local seismological station LANA was installed in a distance of several kilometres from LBr-1. The RefTec 130 device equipped with PE-6 geophone was used for registration of baseline seismicity.



Repeated gravity measurements were done during april and during september 2016.

There were 200 gravity points measured and the measurements are being presently numerically processed.

The results should indicate seasonal local changes of gravity acceleration due to variation of underground water level.

New quartz digital gravity meter **Autograv CG-5**
was bought from Scintrex Ltd (Canada)





BR62 (blow-out well), typical landscape and vegetation

- ▲ Soil type map with atmogeochemical gas measurements
- ⬆ Blue dots show places with more detailed continuous measurements



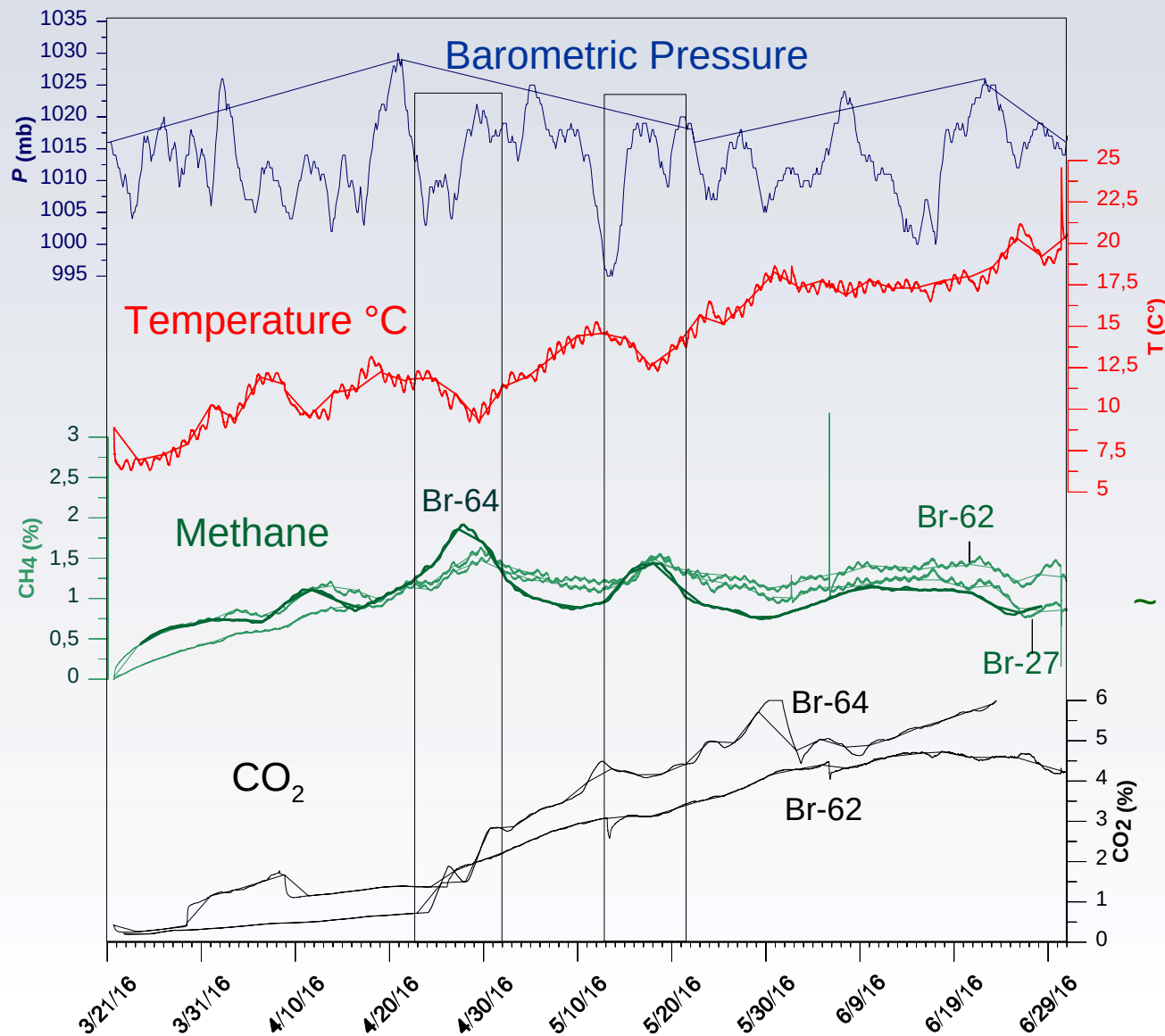
Ecoprobe 5



New Automatic stations **Idrogeosol**
installed on BR 62, 64 and 27 sites

Buried underground, water friendly

1. *Based on total 36 sites measured by portable **Ecoprobe 5** analysis of soil air **5 new locations for Automatic atmogegeochemical stations Idrogeosol** were selected*
2. ***Continuous baseline monitoring measurements** of natural background values (prior to CO₂ storage) has been carried out from March to November 2016 using new Automatic stations **Idrogeosol** (bought for REPP-CO₂ from Italy)*
3. ***CO₂ content:** ~ 2.8-5.9% (seasonal variability)
CH₄ content: ~ 0.8-1.2% (daily variability, seasonal stability)*



Activity 5 - Monitoring – SUMMARY:

- (1) Monitoring methods applicability analysis was done
- (2) Selected base-line monitoring measurements were realized
- (3) Final monitoring plan for storage site LBr-1 is being completed

Thank you for your
attention