

**International Scientific and Practical Symposium
"LOW-CARBON OPEN INNOVATION for REGIONS of UKRAINE" (LCOIR-UA-2012)**

The geological storage CO₂ in Italy

Sergio Persoglia

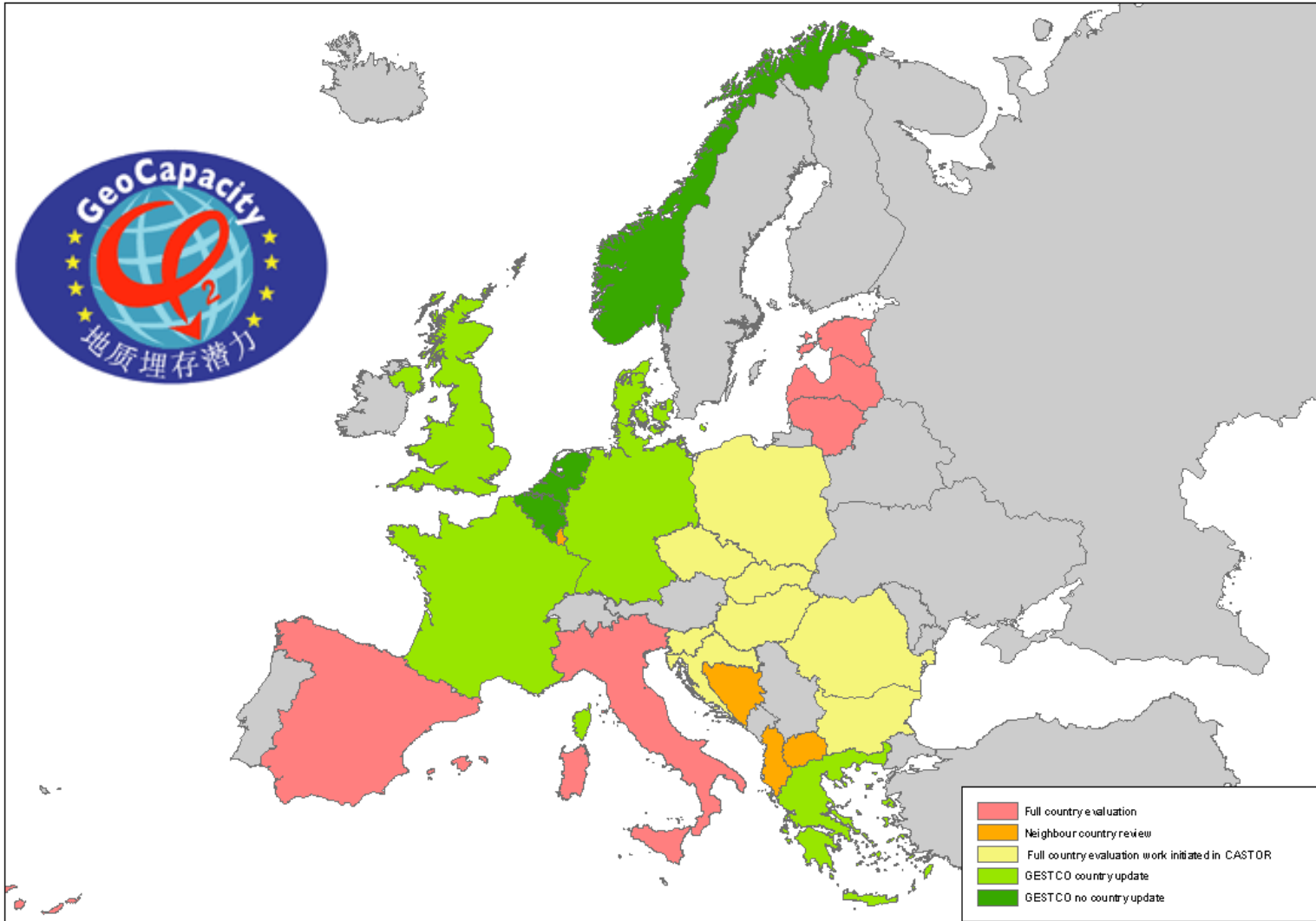


Istituto nazionale di Oceanografia e di Geofisica Sperimentale

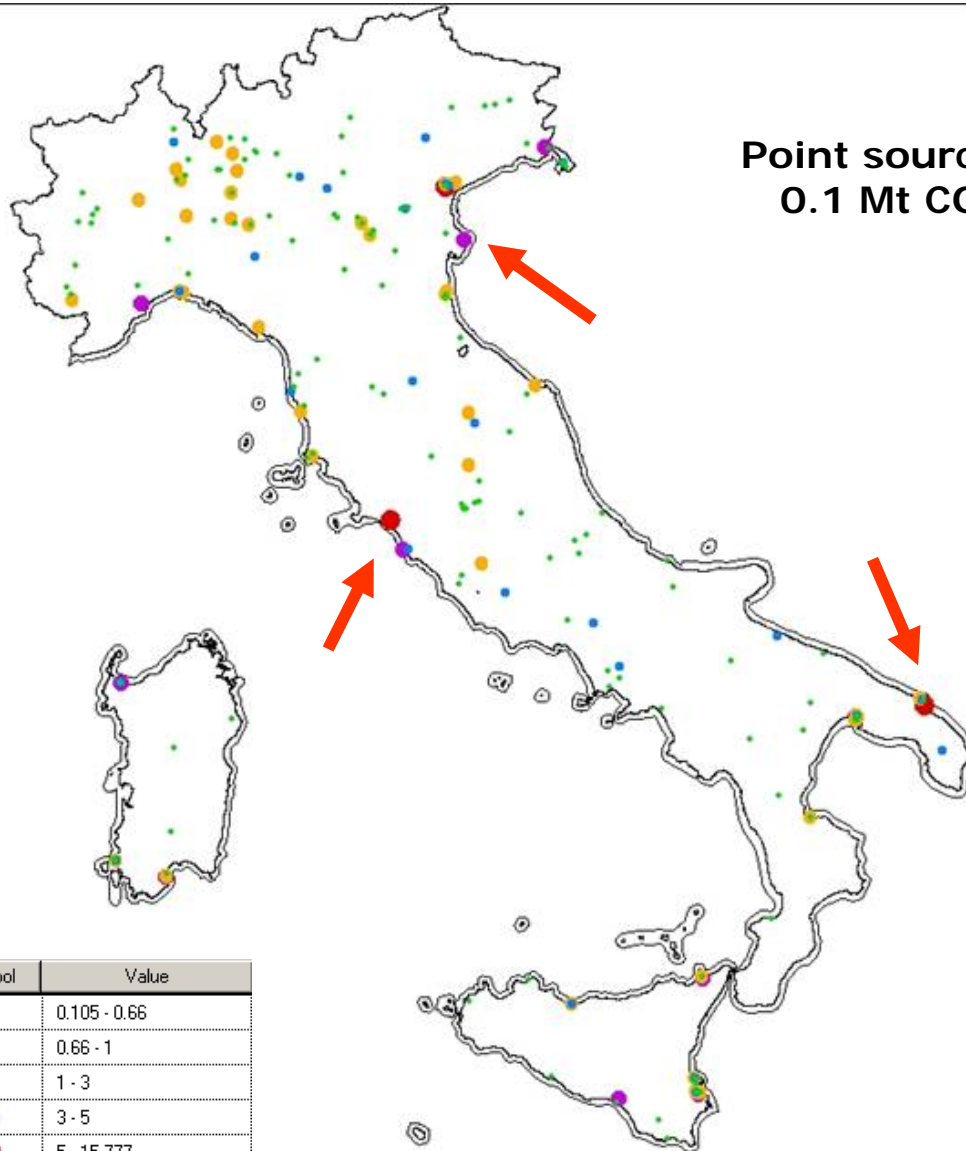


Secretary General

GeoCapacity project



GeoCapacity project








Point sources emitting more than
0.1 Mt CO₂ /yr (INES- APAT)

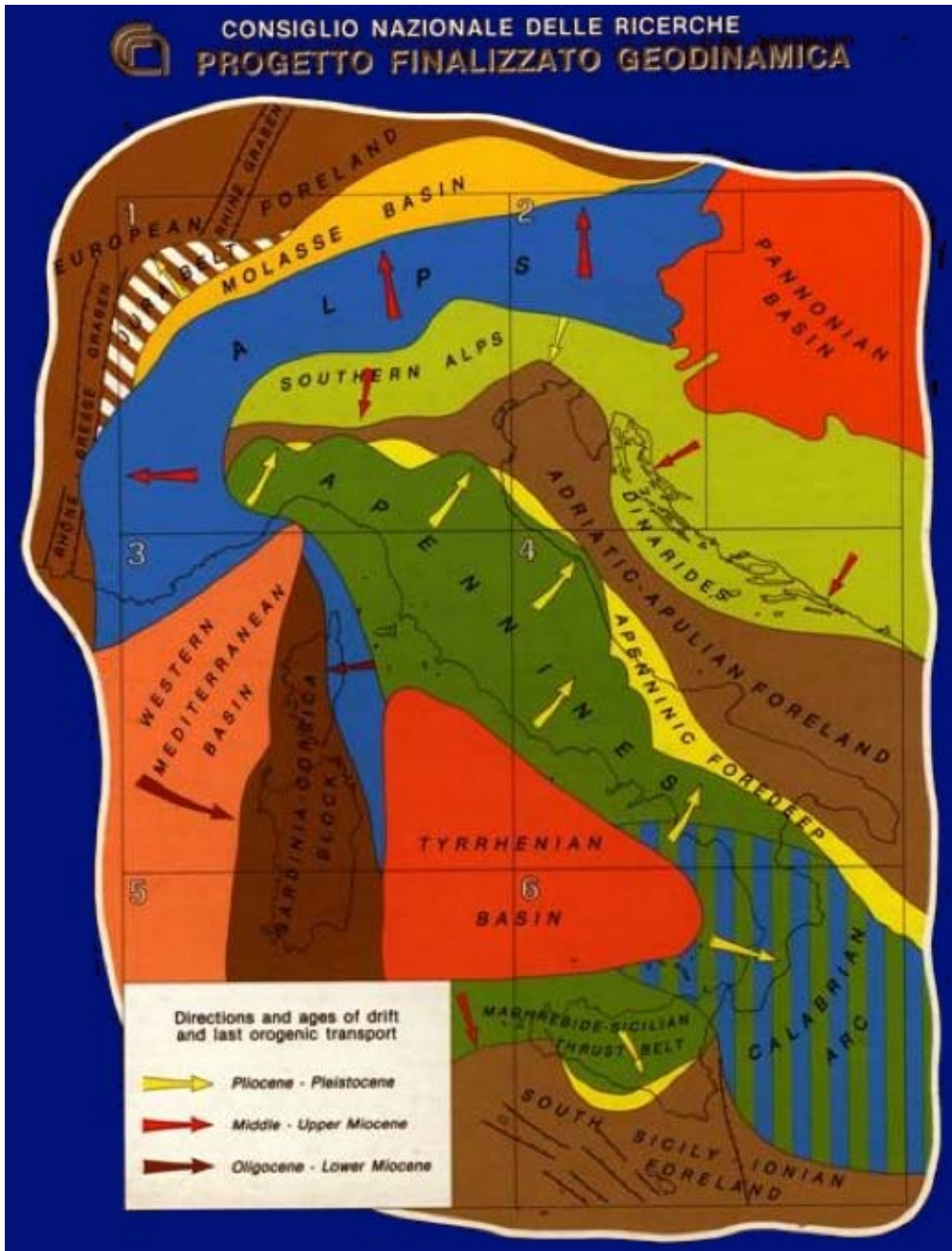
**ITALIAN INDUSTRIAL CO₂
EMISSIONS: 212 Mt/yr
(2007)**

**Three major emission points
(power plants):**

1. Venice (Northern Italy):
about 5.5 Mt/yr
2. Montalto di Castro (Central
Italy): about 6 Mt/yr
3. Brindisi (Southern Italy):
about 16 Mt/yr

Symbol	Value
	0.105 - 0.66
	0.66 - 1
	1 - 3
	3 - 5
	5 - 15.777

GeoCapacity project



THE MAIN STRUCTURAL DOMAINS

Appenninic chain front
aquifers confined in structural traps

Appenninic foredeep
aquifers in terrigenous formation

Apulian foreland
aquifers in carbonates

GeoCapacity project

1805 boreholes

(stratigraphy, logs, core description)

1753 seismic profiles

Data acquired by several oil companies (e.g. AGIP, ENI, Montedison) since the '50s and made available by the Ministry of the Economic Development in the framework of the project "Visibility of data related to the petroleum exploration in Italy"

www.videpi.com

45° N

43° N

41° N

39° N

37° N

500 km

6°E

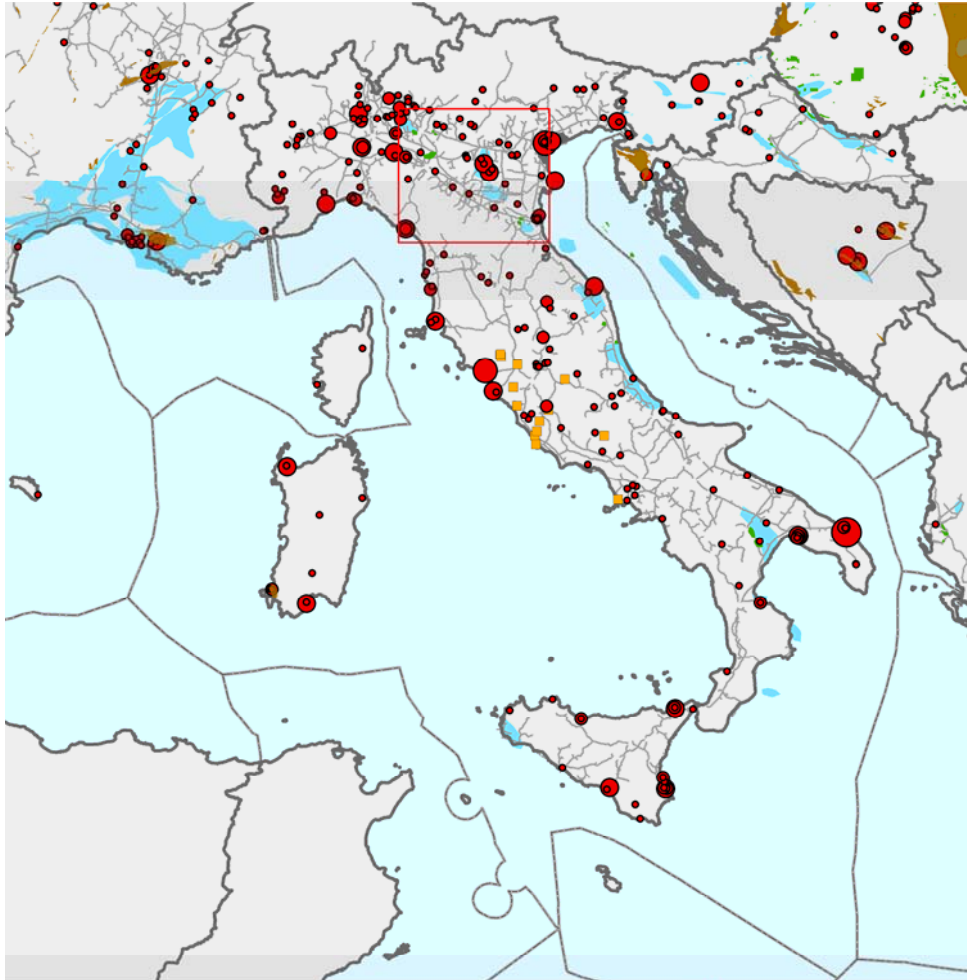
10°E

14°E

18°E

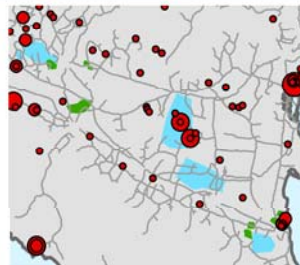
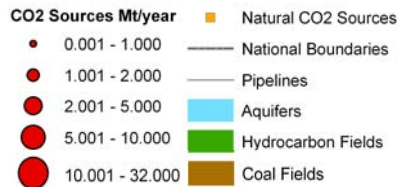


GeoCapacity project

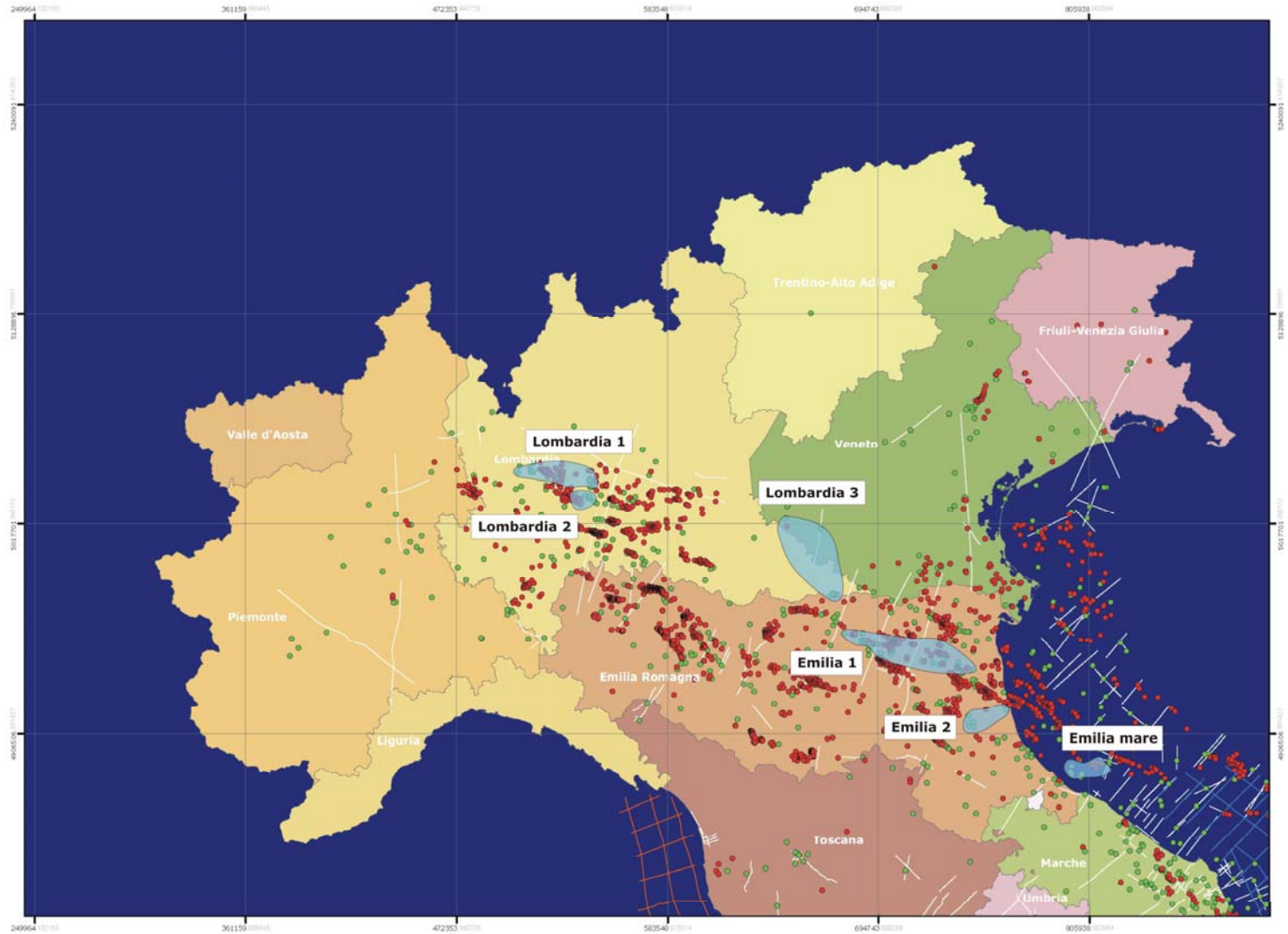


- Point sources
- Aquifers
- Depleted hydrocarbon fields
- Coal fields

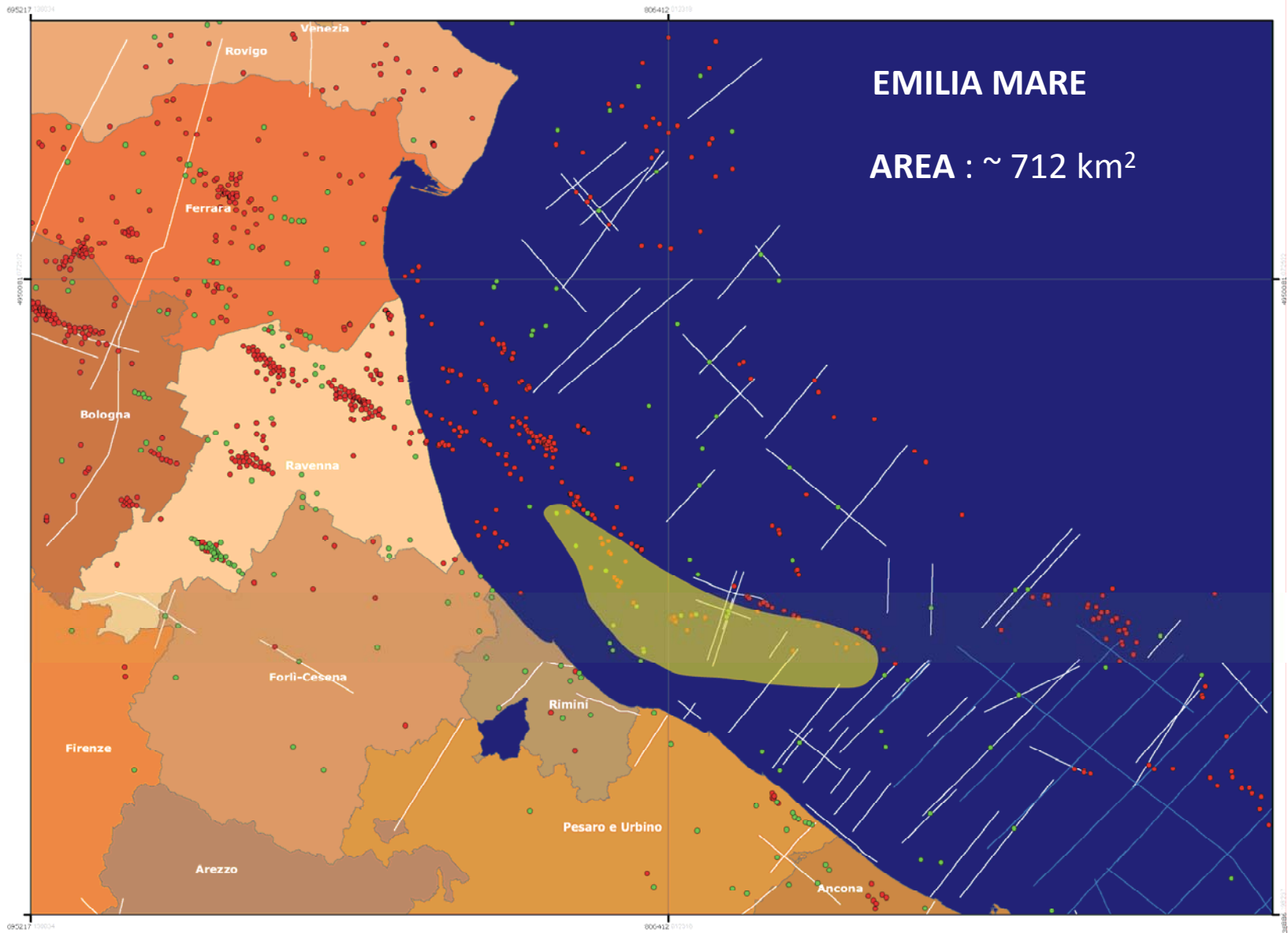
GeoCapacity maps of Sources & Sinks



GeoCapacity project



GeoCapacity project



GeoCapacity project



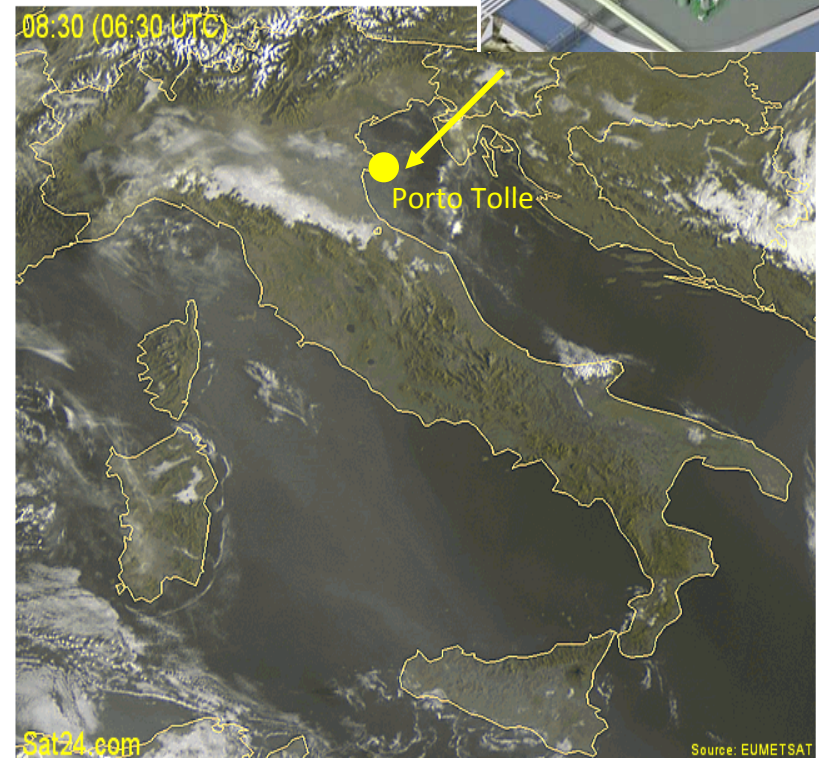


L'ENERGIA CHE TI ASCOLTA.

High level overview of the Porto Tolle project

Project goal

To retrofit one 660 MW_e coal fired unit, of Porto Tolle power station, with CO₂ post combustion capture equipment and start CO₂ underground storage in an off-shore saline aquifer by 2015 (injection rate 1Mt/y for 10 year)



GeoCapacity project

CO ₂ storage capacity	Pyramid class	Conservative estimate (Mt)	Estimate in database (Mt)
Storage capacity in AQUIFERS	Effective	4795 (S.eff: 2%)	9590 (S.eff: 4%)
Storage capacity in HYDROCARBON FIELDS	theoretical	1810	3426.5
Storage capacity in COAL FIELDS	N/A	71	265
Total storage capacity estimate		6676	13281.5



$$M_{CO_2e} = A \times h \times \phi \times \rho_{CO_2r} \times S_{eff}$$

M_{CO_2e} : effective storage capacity

A : aquifer area

h : aquifer thickness

ϕ : reservoir porosity

ρ_{CO_2r} : CO₂ density at the reservoir conditions

S_{eff} : storage efficiency (1 to 5%-Eu GeoCapacity)

❖ Recent updates bring this value to 12 Gt

Enel workflow strategy - 1

Capture

Lab scale

Research center - Brindisi



Flue gas 2 Nm³/h
CO₂ 0.4 kg/h

- Process evaluation
- Analytical protocols development

Pilot scale

Power plant - Brindisi

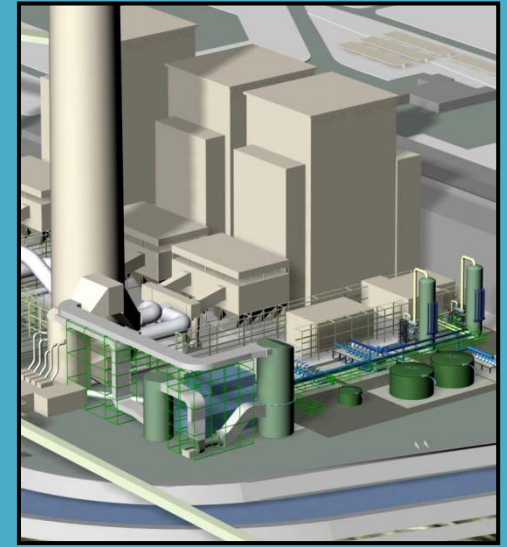


Flue gas 10'000 Nm³/h
CO₂ 2'500 kg/h

- Performance evaluation
- Emission analysis
- Tests on innovative process

Demo scale

Power plant - P.to Tolle



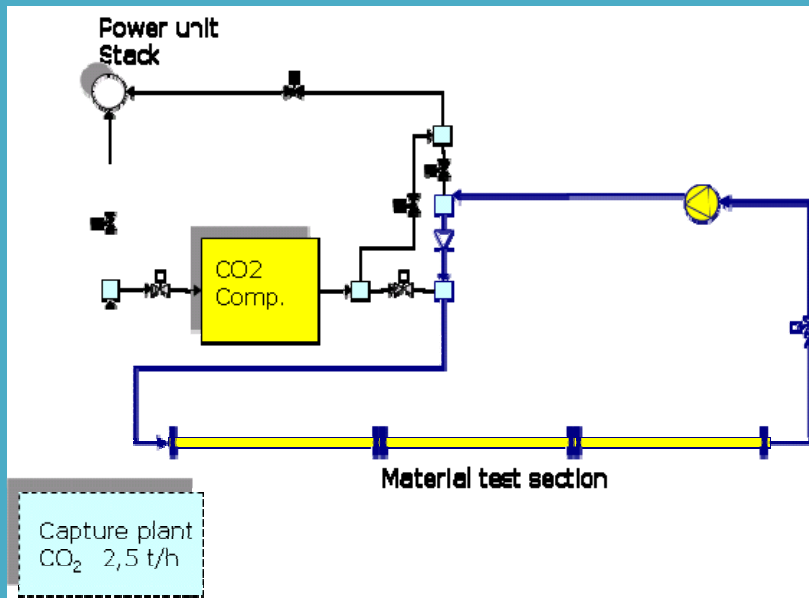
Flue gas 810'000 Nm³/h
CO₂ 180'000 kg/h

- Technology scale up

Enel workflow strategy - 2 Transport

Pilot scale

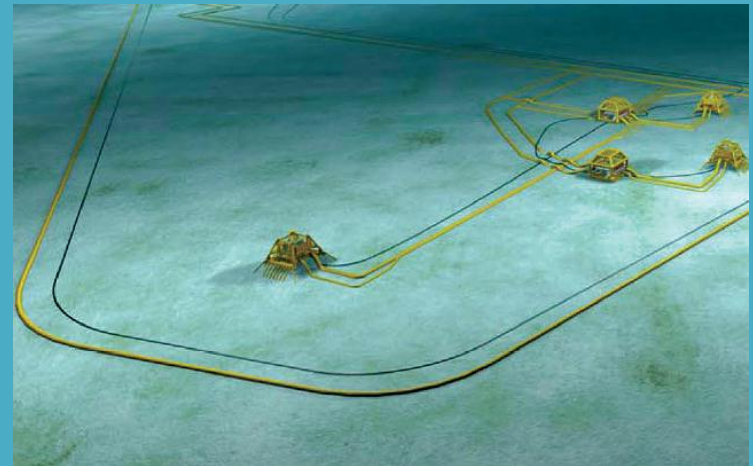
Power plant - Brindisi



- Validate design models (both stationary and dynamic) of the CO₂ transport line
- Optimize operating procedures
- Study corrosion problems related to the presence of impurities in the CO₂ stream

Demo scale

Power plant - P.to Tolle

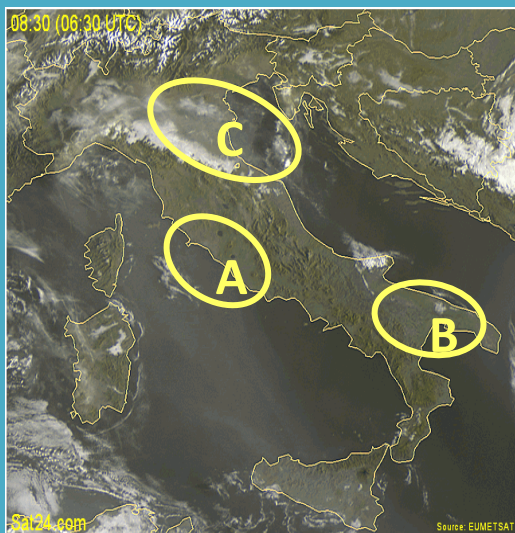


- Subsea pipeline ~100 km

Enel workflow strategy - 3 Storage

Basin scale

Italy

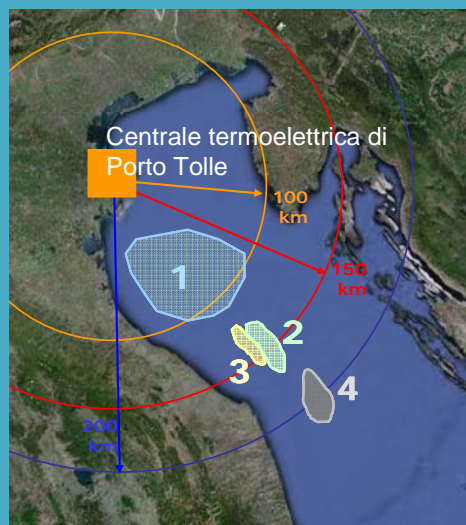


Estimation of the CO₂ geological storage potential in Italy, focusing on the areas next to main CO₂ source.

- Cesi Ricerca project
- GeoCapacity EU project - OGS

Regional scale

Northern Adriatic sea

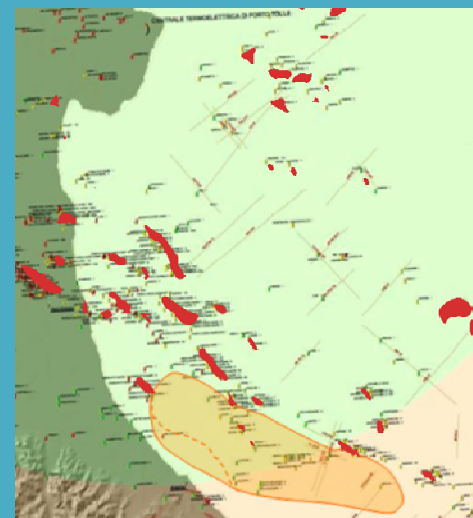


The correlation between the borehole information and the available seismic lines led to the mapping of the reservoir and caprock depth.

- Public data

Local scale

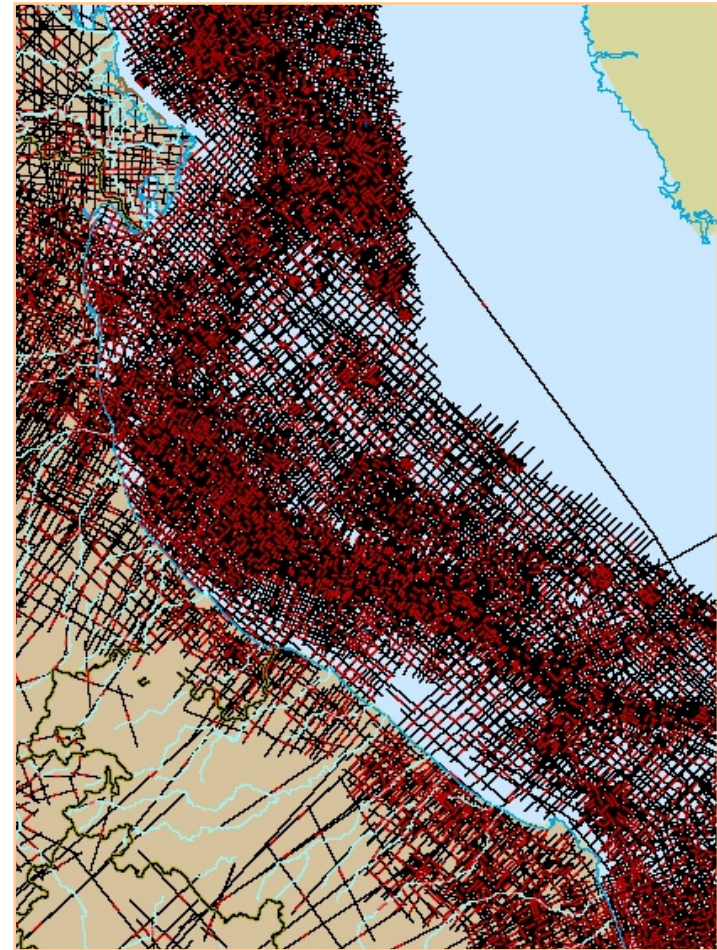
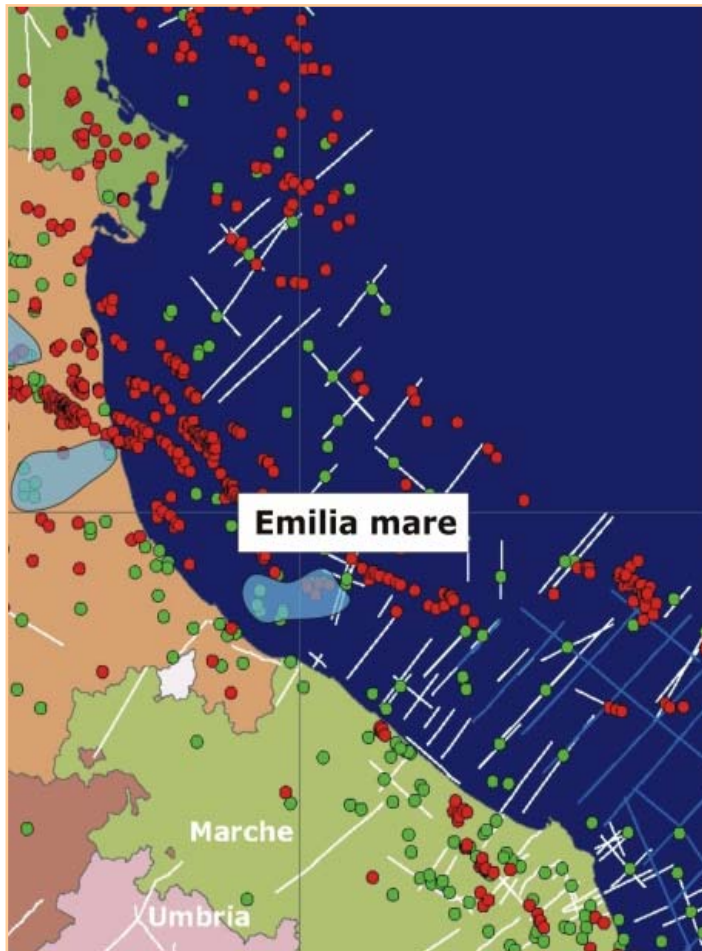
Storage structures



A characterization of the selected area was performed revealing that it is constituted by several structures.

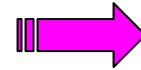
- Property data
- Field data

Enel workflow strategy – Site characterisation

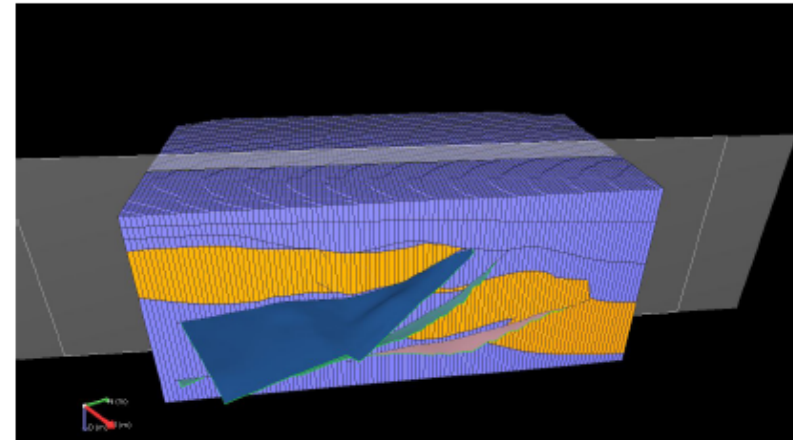
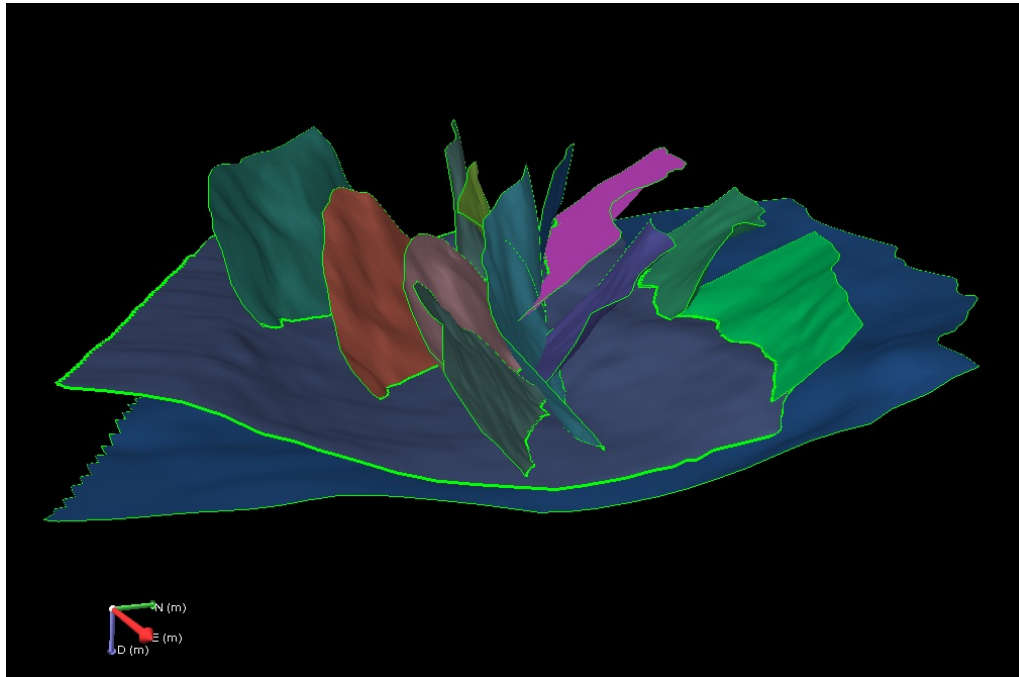


Enel workflow strategy – Site characterisation

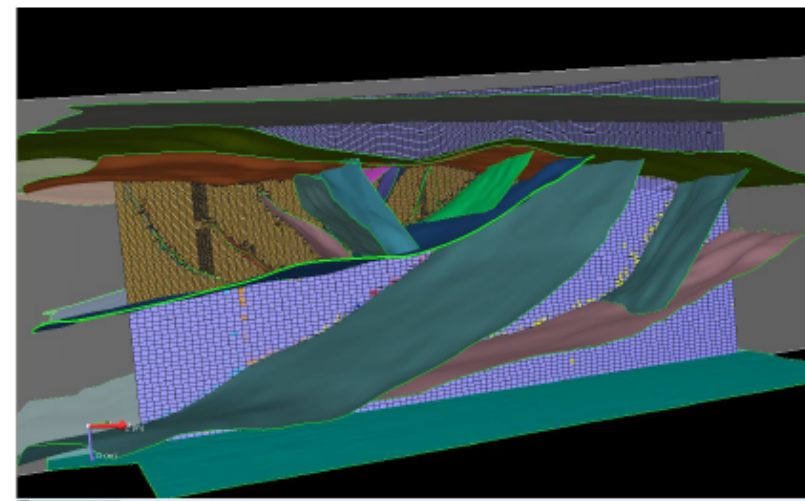
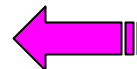
1. Geological and structural model



2. Volumetric gridding

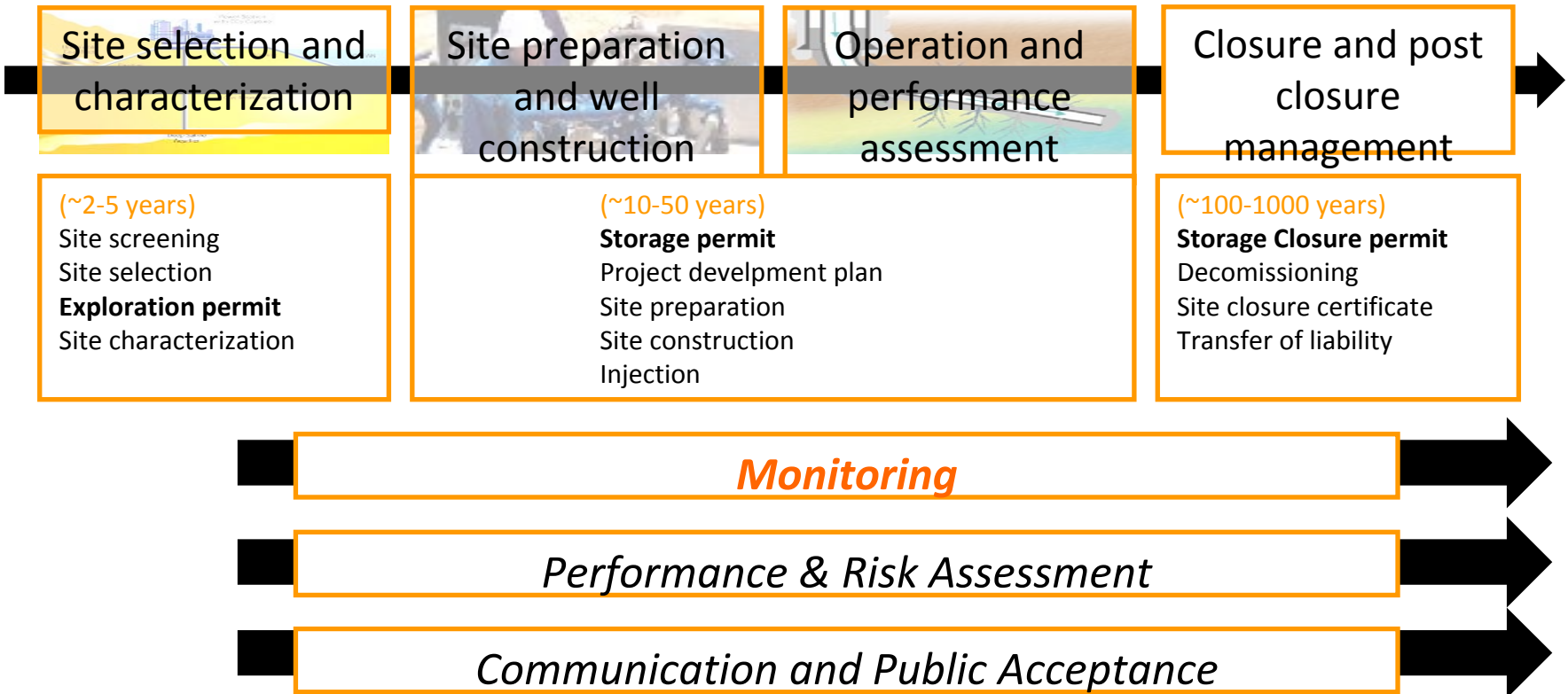


3. Volumetric gridding populated with petrophysical properties

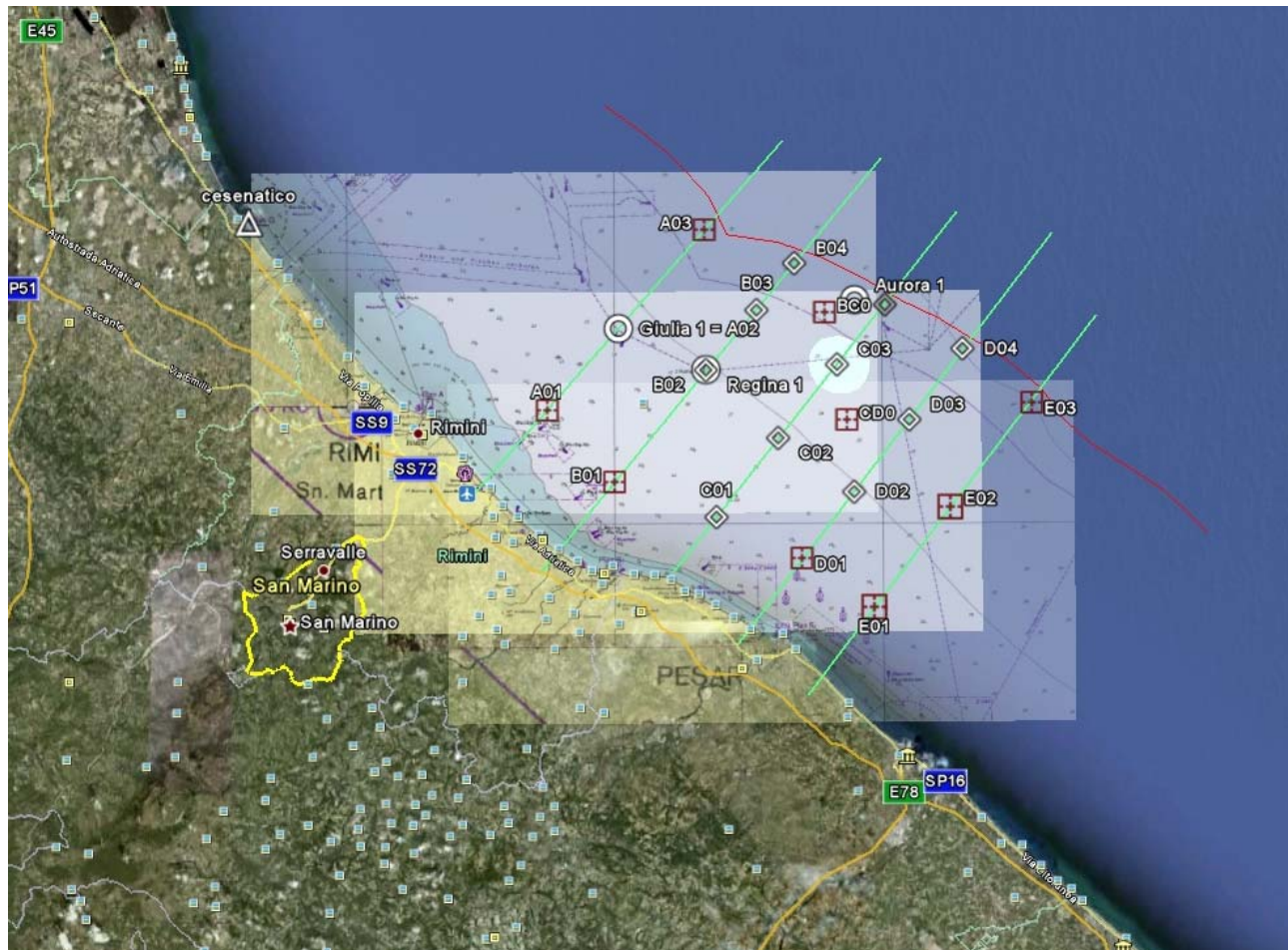


Dynamic modeling (e.g. fluidodynamic, geomechanics, geochemistry)

Enel workflow strategy – timing



Enel project - Baseline surveys



Based on request of European Directive on CO₂ geological storage, the CO₂ baseline before injection has been evaluated.



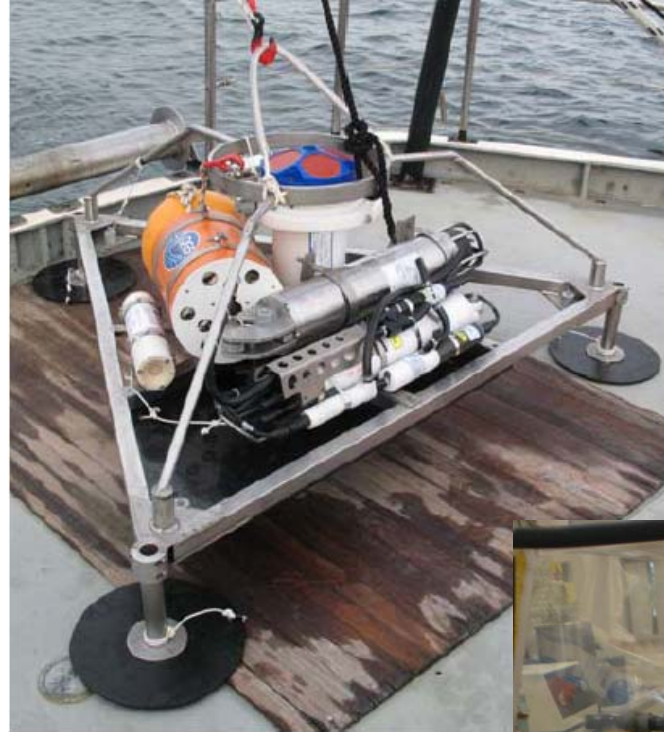
L'ENERGIA CHE TI ASCOLTA.

Enel project - Baseline surveys

The baseline study covers a $\sim 400 \text{ km}^2$ area around the more probable injection locations in water depths ranging from 13 to 40 m.

Measurements include:

chemical, biological and physical analyses of both the water column and the near-surface sediments during four different periods of the year to define the ranges of baseline values in the area, both spatially and temporally.



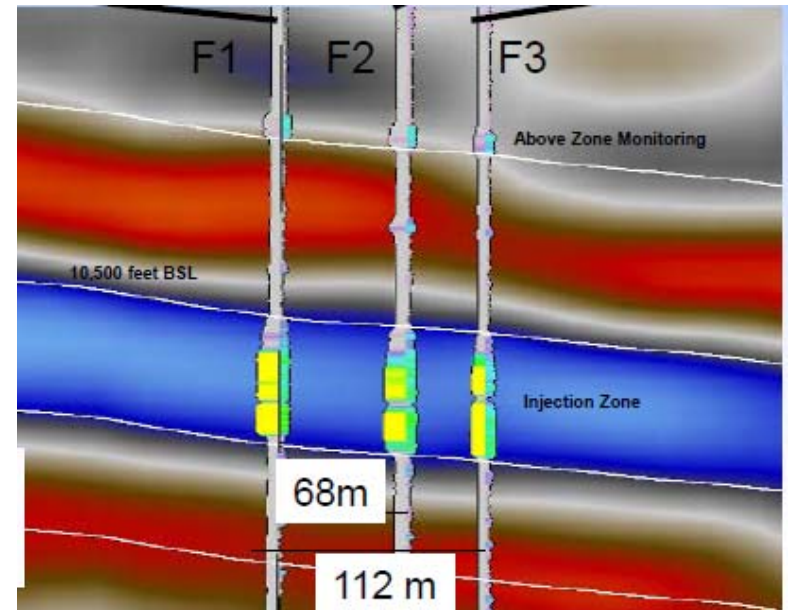


L'ENERGIA CHE TI ASCOLTA.

Enel project – Seismic monitoring plan

It consists of a chain of actions involving:

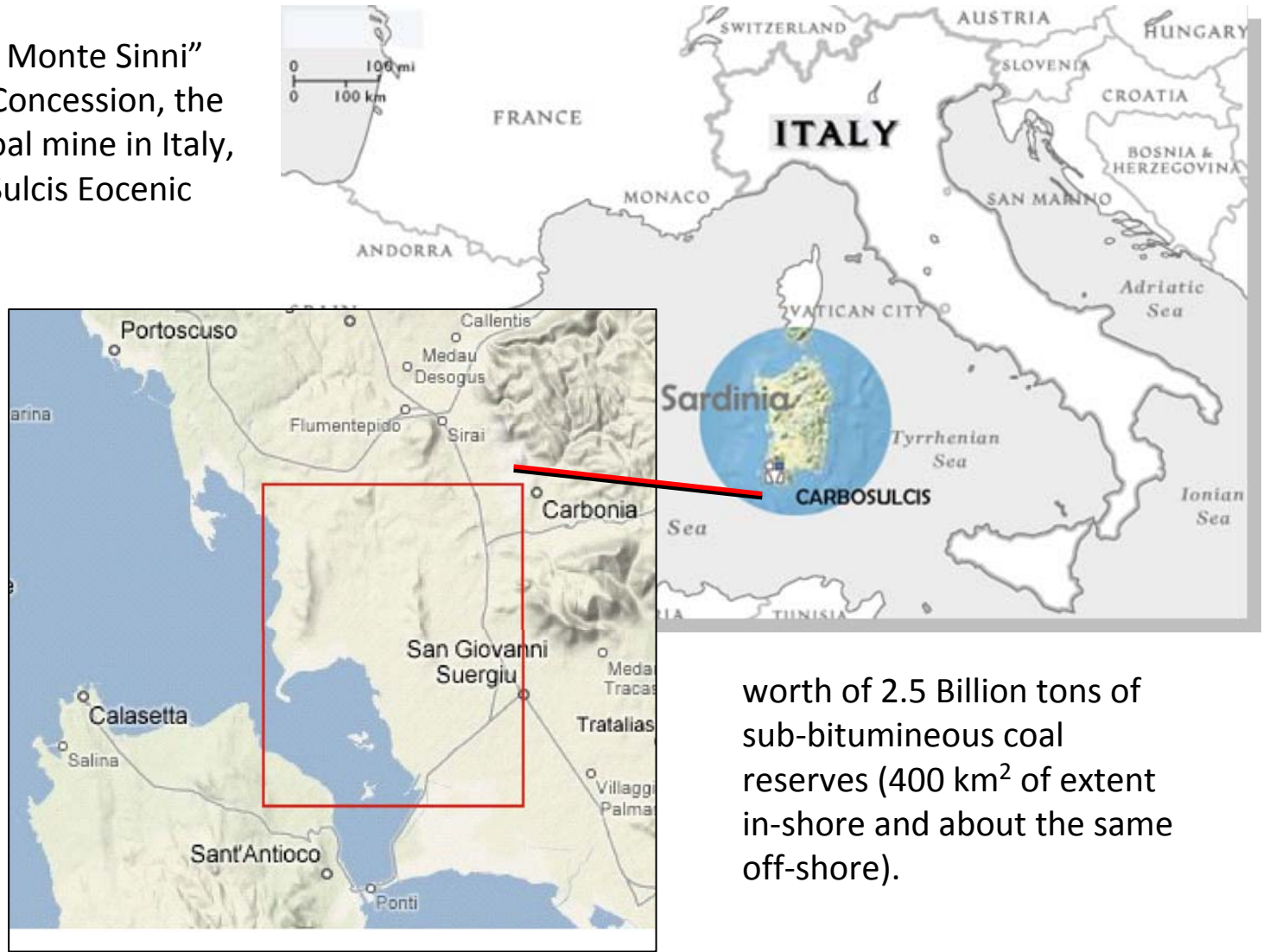
- ✓ Building a model of the physical properties in the rock formations from the surface to the aquifer/reservoir;
- ✓ evaluation of the change in seismic properties varying CO₂ saturation;
- ✓ calculation of synthetic seismograms and topographic modelling;
- ✓ evaluation of delectability of the injected CO₂, both in the hosting formation (CO₂ plume) and in the overlying formations (possible leakages);
- ✓ plan of the most effective seismic acquisition pattern in terms of cost/benefits and lower impact on the investigated areas (planning optimization).



The “Carbosulcis” project

Carbosulcis S.p.A. is a coal mining company based in SW Sardinia, Italy, managed by the Sardinian Government since 1996.

The “Miniera Monte Sinni” Coal Mining Concession, the only active coal mine in Italy, exploits the Sulcis Eocene Coal Basin,



worth of 2.5 Billion tons of sub-bituminous coal reserves (400 km² of extent in-shore and about the same off-shore).

The “Carbosulcis” project



- The amount of underground coal reserves in the 55 km² mine concession is over 60 M tons.
- The potential yearly u/g longwall production of the mine is 1.5 M tons of salable coal.
- The Company employs 600 units in total in u/g and surface activities.
- More than 30 km of galleries are excavated underground
- About 15 km of main galleries in the underground workings
- Access from surface by a 3 km long decline and two shafts
- Mine depth comprised between 350 and 500 m underground
- The ENEL Power Plant of Portovesme burns the coal produced and it is located 3 km from the mine.

The “Carbosulcis” project

BRGM – Orléans
IFPEN – Paris
Imperial College – London
OGS – Trieste
TNO – Utrecht
La Sapienza – Roma



GEOTEC - Campobasso

CO₂ GEOLOGICAL STORAGE PERFORMANCE ASSESSMENT AT THE SULCIS BASIN

By the consortium

WP1A: Data Room Evaluation
WP2A: Seismic Data Acquisition and Interpretation
WP3A: Reservoir Geology and Geological Model
WP4A: Reservoir Characterisation
WP5A: Reservoir Performance Prediction

By Carbosulcis

WP1B: Data Room Evaluation
WP2B: Drilling and Coring
WP3B: Well Logging
WP4B: Well Testing, Completion



The "Carbosulcis" project

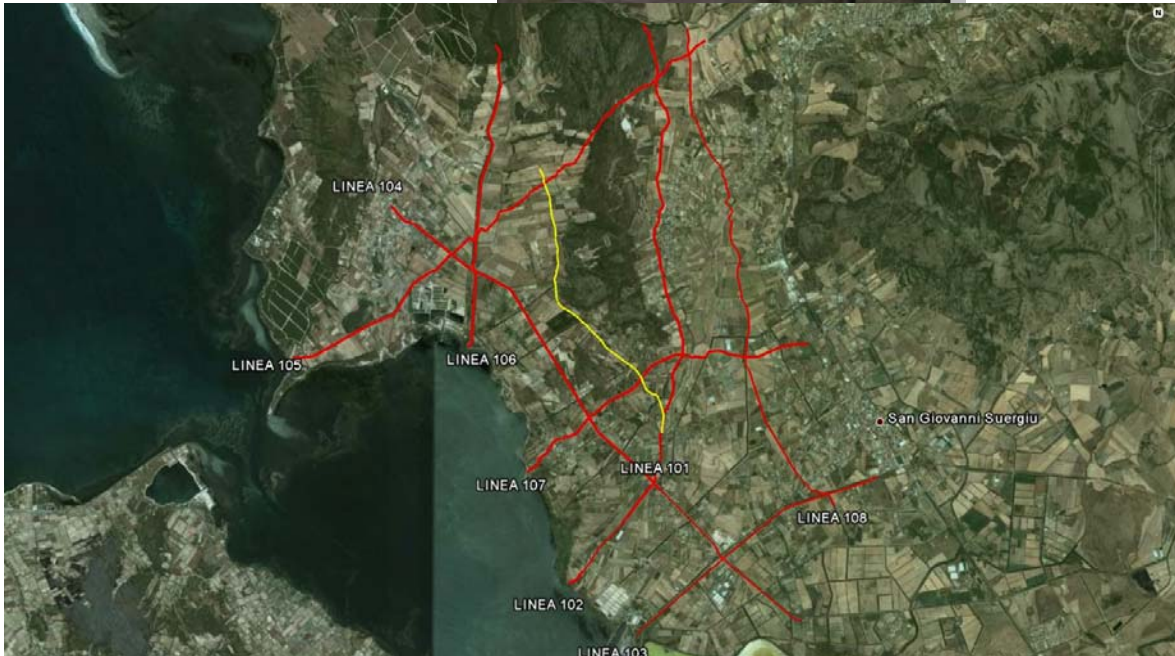
STAGES		FORMATIONS	MAJOR LITHOLOGIES	DEPOSITIONAL ENVIRONMENT	
CAENOZOIC	MIOCENE	Volcano-sedimentary complex	Pyroclastics rhyolitic ignimbrites andesitic basalts	Volcanics interbedded within continental terrigenous successions	Not studied
	OLIGOCENE	Cixerri Fm. <small>Up to 300m</small>	Polygenic conglomerates sandstones siltstones claystones	Alluvial fans braided plains	Alluvial fans
		Produttivo Fm. <small>30-70 m</small>	Siltst. Sandst. Cgl coal freshwater limest maris claystones	Fluvial channels palustrine lacustrine paralic lagoonal	Fluvial channels supralittoral paludal-lagoonal littoral
		Miliolitic Limestone Fm. <small>30-40m</small>	Bio-calcarenites maris	Hypersaline & mesohaline lagoons	Sublittoral
	Palaeocene	Basal Conglom.	Conglomerates	Transgressive lag	
Mesozoic	Dolomite				
PALAEOZOIC BASAMENT	PERMO-TRIASSIC		Folded metasedimentary formations	Not studied	

- Lithology: Miliolitic limestone on the bed of "Produttivo" (coal bearing) formation, with secondary porosity caused by fractures and karst phenomena
- Thickness of caprock in considered area: 600-800 m
- Structural traps: reservoir compartmentation through not active faults
- No evidences so far of communications between aquifer and shallow formations
- Composition of aquifer water is very different from the one of shallow water tables (Fossil water table)

The "Carbosulcis" project

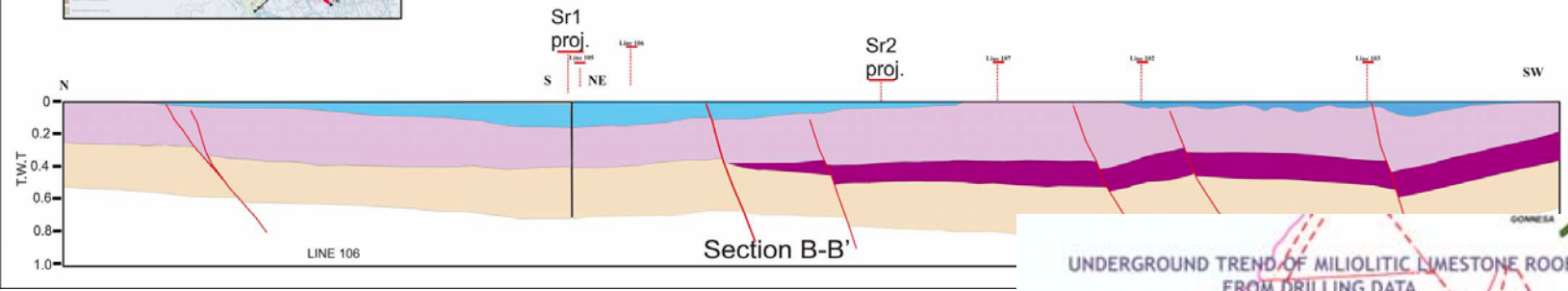
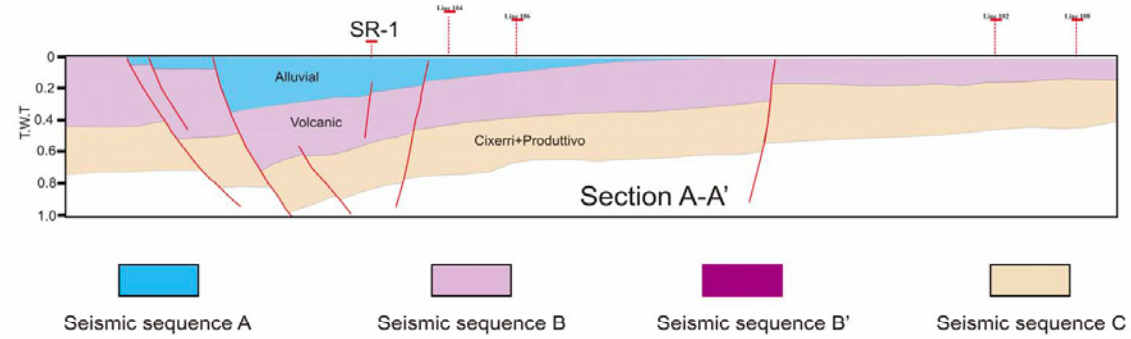
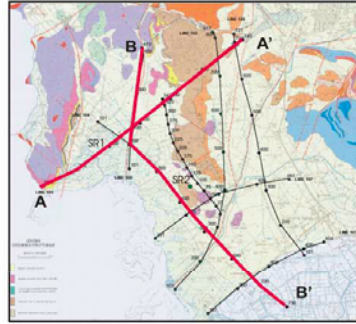


- Two 450 m-each deep pre-drills holes for SR1 and SR2 core drills completed;
- Over 30 km of Seismic profiles carried out on May-June 2008;
- Drilling activities started in September 2008
- Since then n.2 drilling wells were drilled and cored (960m depth and 890m depth)

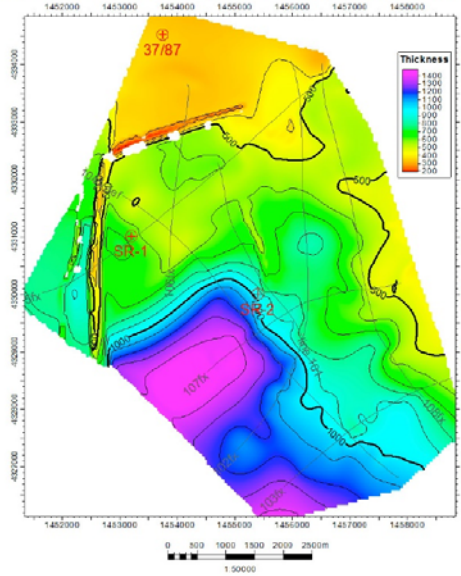


- New drilling campaign in preparation, consisting of 2 new wells with logging, well testing, and VSP surveys

The "Carbosulcis" project



Thickness (meters) Volcano-sedimentary complex



Thickness (meter) Cixerri

