**Istituto Nazionale
di Oceanografia
e di Geofisica
Sperimentale**

Università degli studi di Trieste

LAUREA MAGISTRALE IN GEOSCIENZE
Classe Scienze e Tecnologie Geologiche

Curriculum: Esplorazione Geologica

Anno accademico 2021 - 2022

Analisi di Bacino e
Stratigrafia Sequenziale (426SM)

Modulo 1.5 – Carbon and Energy Storage
Docente: **Michele Rebesco**

Modulo 1.5a
Carbon Capture and Storage (CCS)
Docente: **Valentina Volpi**

Modulo 1.5b
Energy storage
Docente: **Federica Donda**

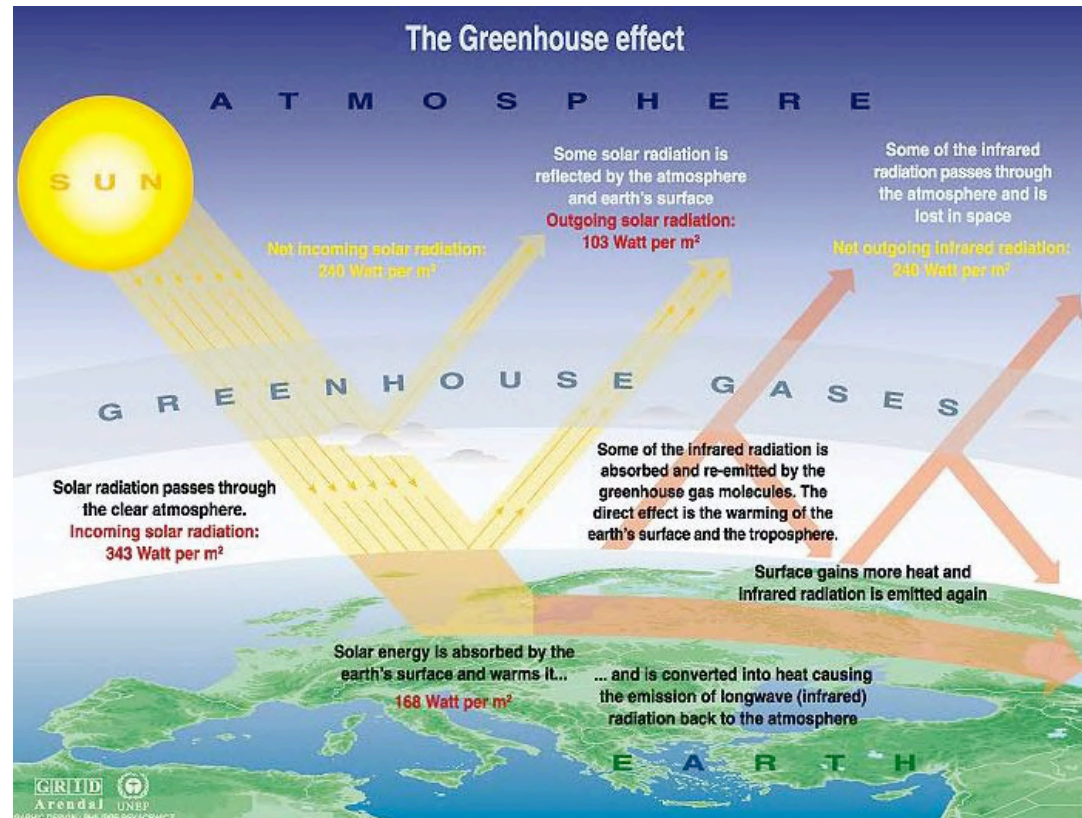# *Modulo 1.5a (CCS) Docente: Valentina Volpi*
OUTLINE

- Greenhouse gases
- Global warming
- Geological Carbon Capture & Storage
- Criteria for CO_2 storage
- Traps
- Reservoires
- Caprocks
- CCS projects
- Data Analysis
- Modelling
- Italian potential sites
- Monitoring
- Facilities and plants

Global warming and **climate change** are terms for the observed century-scale rise in the average temperature of the Earth's **climate system** and its related effects.

GREENHOUSE GASES

This process consists of the global warming due to the emission of gas (CO_2, water steam, methane...) in the atmosphere. Greenhouse gases allow sunlight to pass through the atmosphere while obstructing the passage to the space of the infrared radiation from the Earth's surface and lower atmosphere (the heat re-issued); in practice they behave like the glass of a greenhouse and help to regulate and maintain the temperature of the earth with today.

The Greenhouse effect

ATMOSPHERE

Some solar radiation is reflected by the atmosphere and earth's surface
Outgoing solar radiation: 103 Watt per m²

Net incoming solar radiation: 240 Watt per m²

Some of the infrared radiation passes through the atmosphere and is lost in space

Net outgoing infrared radiation: 240 Watt per m²

GREENHOUSE GASES

Solar radiation passes through the clear atmosphere.
Incoming solar radiation: 343 Watt per m²

Some of the infrared radiation is absorbed and re-emitted by the greenhouse gas molecules. The direct effect is the warming of the earth's surface and the troposphere.

Surface gains more heat and infrared radiation is emitted again

Solar energy is absorbed by the earth's surface and warms it...
168 Watt per m²

... and is converted into heat causing the emission of longwave (infrared) radiation back to the atmosphere

EARTH

GRID Arendal UNEP
GRAPHIC DESIGN: PHILIPPE REKACEWICZ

This is a natural process and allows that the temperature of the Earth be 33°C higher than what it would be without the presence of the gases.
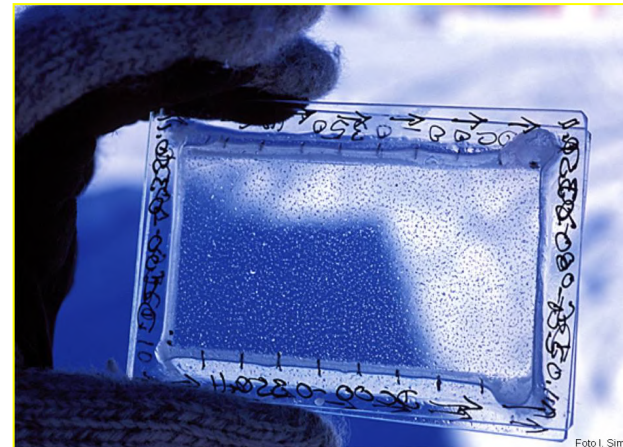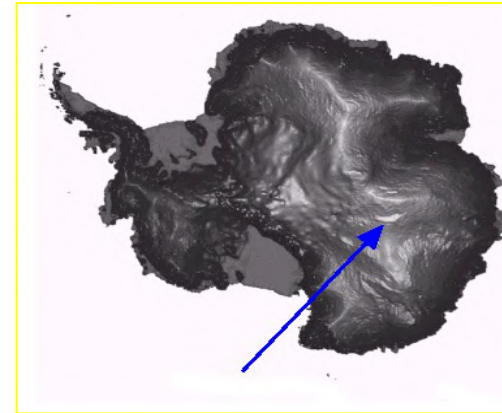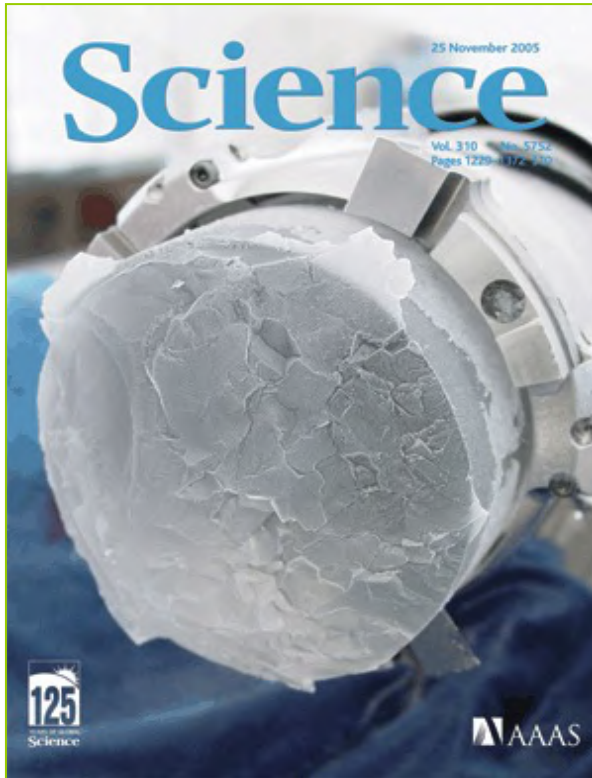
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OGS

CO$_2$ exchange between Earth and Atmosphere (Billiontons/years of Carbon)

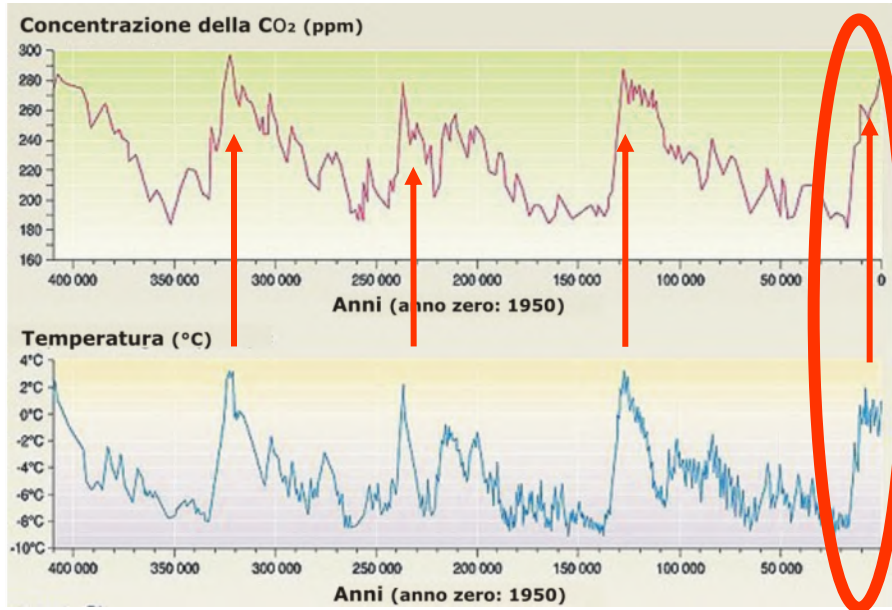**Total amount of emitted CO$_2$: 30 billion tons /year or 8.1 billiontons/years of carbon**
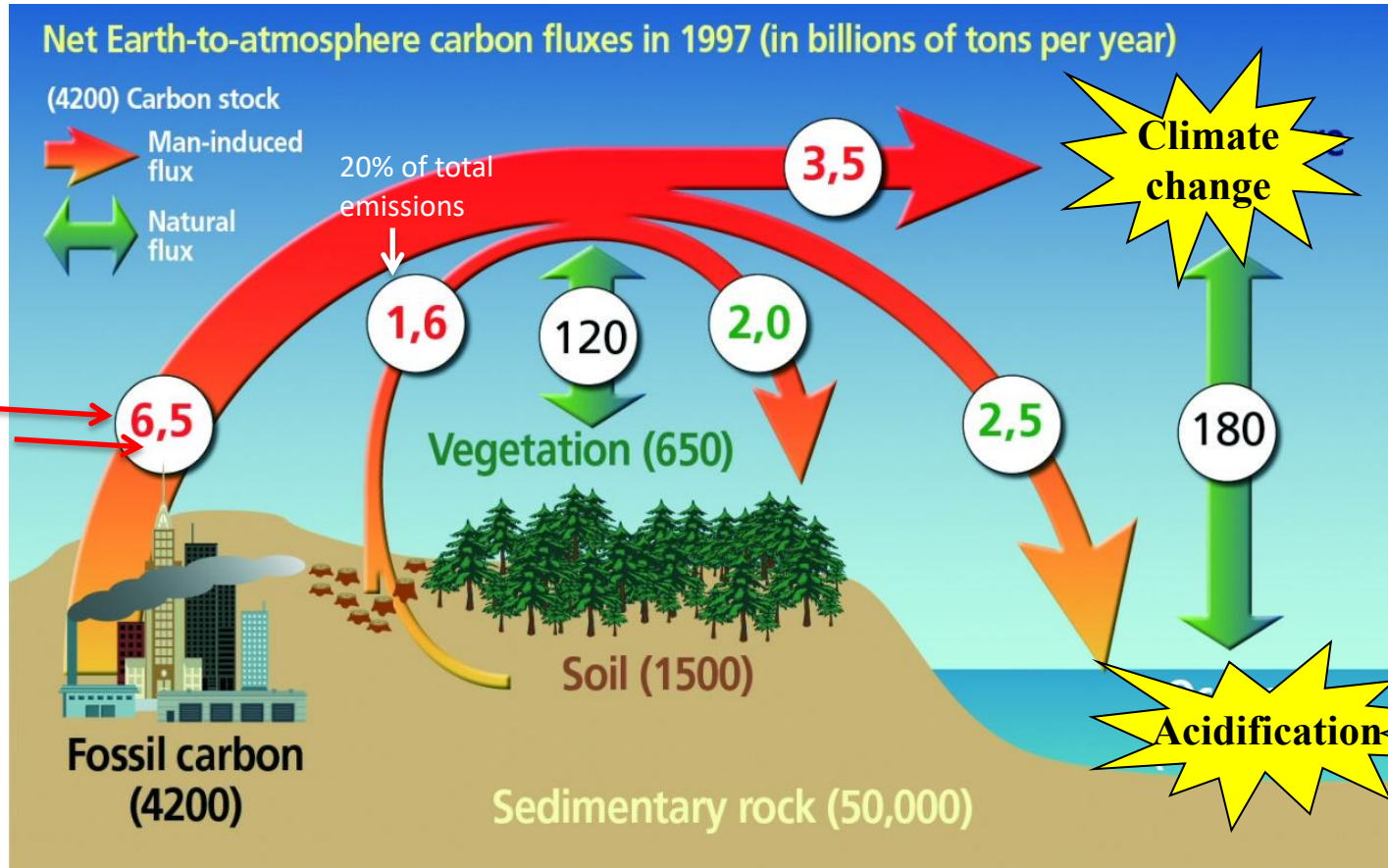
© BRGM im@gé

World emissions of CO$_2$ from the usage of fossil fuels:
6.5 Gt C/y (o 24 Gt CO$_2$/a)

Ice cores from Antarctica have allowed to reconstruct the temperature trend and the CO_2 concentration in the atmosphere for the the last 400.000

GLOBAL WARMING

Correlation between temperature increase and concentration of CO_2 in the atmosphere over the last 400,000 years (drilling of ice in Antarctica)

Concentration of CO_2 in 2020

31.5 Gt - 412.5 ppm (50% higher than when the

industrial revolution began)

IN 2021 (projected) : 40 Gt

IEA (2021), Global Energy Review 2021, IEA, Paris
https://www.iea.org/reports/global-energy-review-2021

CO_2 concentration in the atmosphere is increased by circa ~**40%** from 1750 (Rivoluzione Industriale; IPCC, 2014)
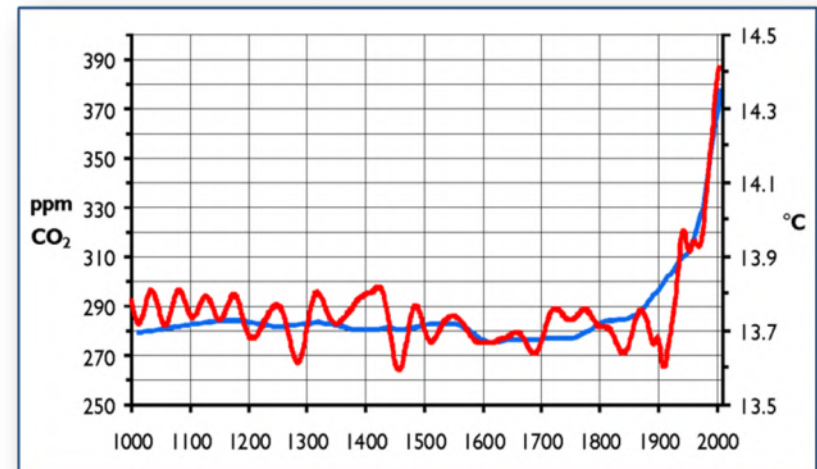
Global variation of the temperature (red) and the CO_2 present in the atmosphere (blu) in the last 1000 years.

CO$_2$ GEOLOGICAL STORAGE
CARBON CAPTURE AND STORAGE

.. one of the options to reduce the global CO$_2$ emissions by 2050

Three main phases:

1. Capture

2. Transport

3. Storage

© BRGM - BLCom
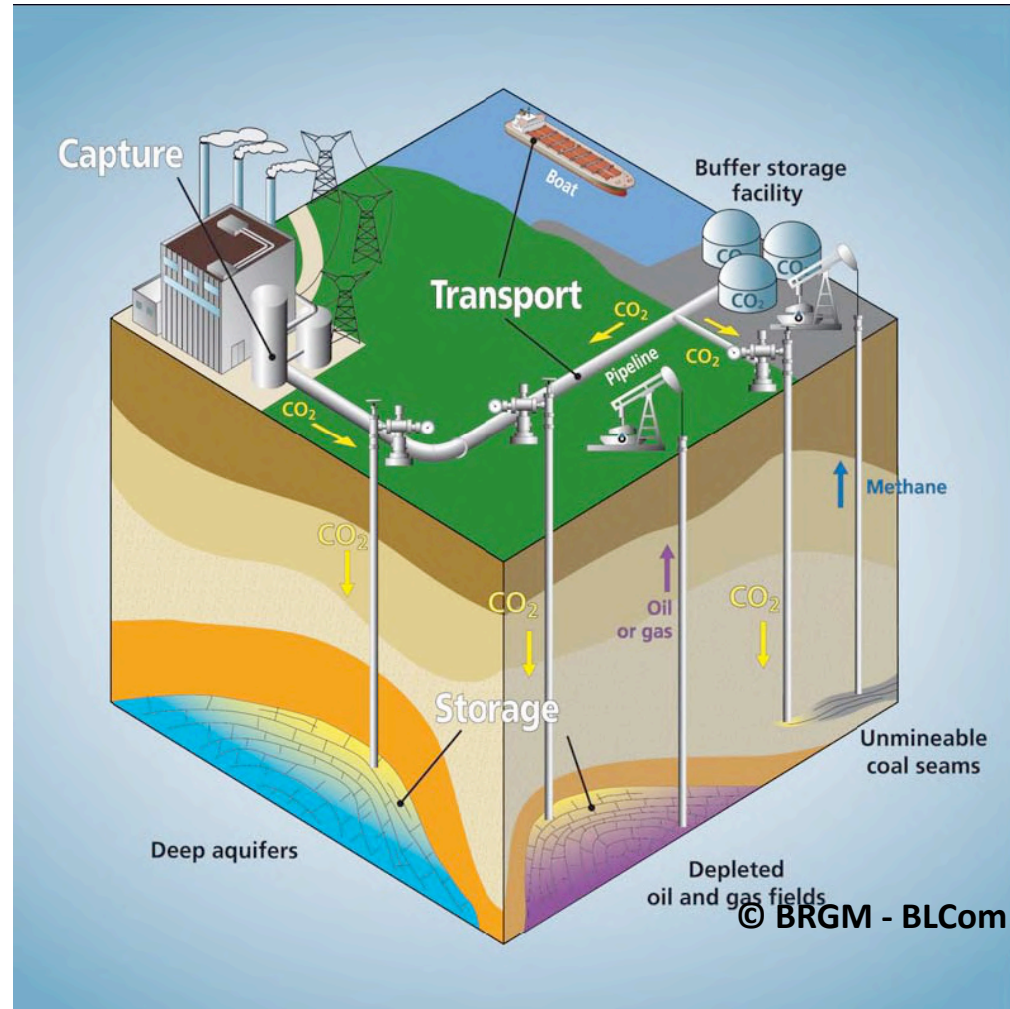
MAIN CO$_2$ EMITTORS

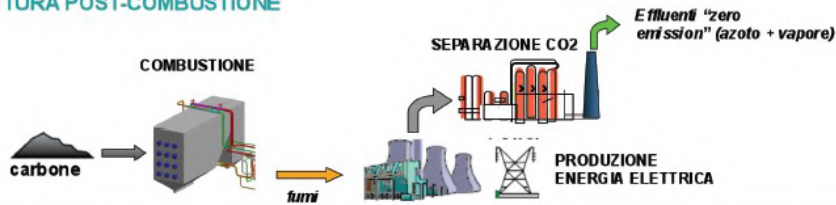The main sources of CO$_2$ emissions consist of the **BIG STATIONARY SOURCES**:

❑ FOSSIL FUEL POWER PLANTS

❑ INDUSTRIAL INSTALLATIONS FOR THE PRODUCTION OF IRON, STEEL, CEMENT
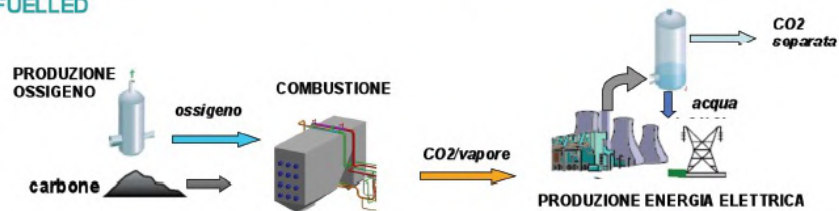
❑ CHEMICALS REFINERIES

CAPTURE PROCESSES
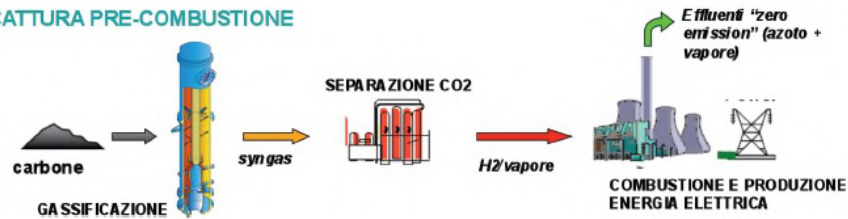
➤ **PRE- COMBUSTION:** the fuel (coal, gas) is first treated by transforming it into syngas (gas di sintesi) and subsequently separating it in two gas flows: one with a high concentration of hydrogen for the combustion (or other uses) and CO_2.

➤ **POST- COMBUSTION:** separation of CO_2 from flue gases at the end of the cycle; it does not need substantial modification to the power plant.

➤ **OXYGEN COMBUSTION:** The primary fuel is combusted in oxygen instead of air, which produces a flue gas containing mainly water vapor and a high concentration of CO_2 (80%). The flue gas is then cooled to condense the water vapor, which leaves an almost pure stream of CO_2.

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TRANSPORT OF CO_2

La CO_2 can be transported, both onland and offshore, in three phases:

GAS   **LIQUID**   **SOLID**

Tanks, pipelines and ships   **Not economically convenient**
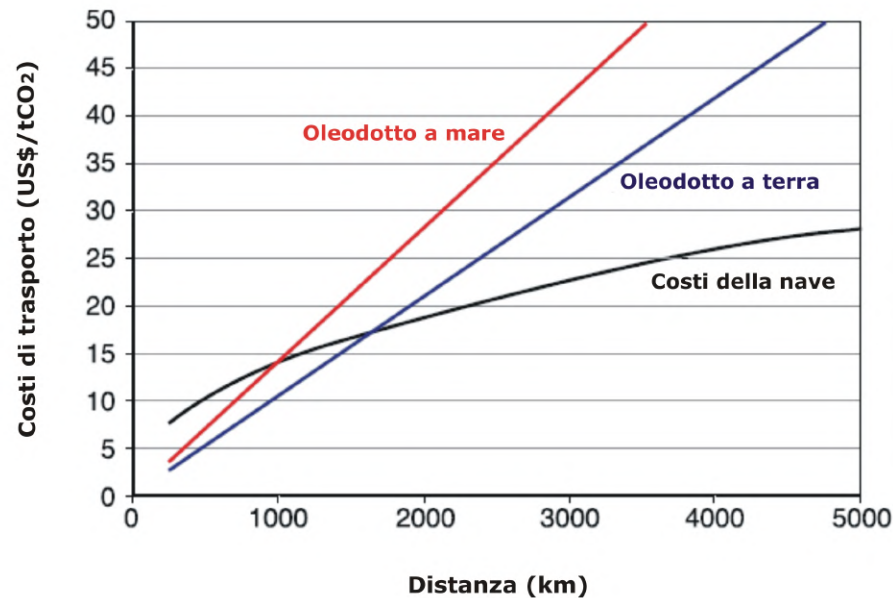
STORAGE OPTIONS
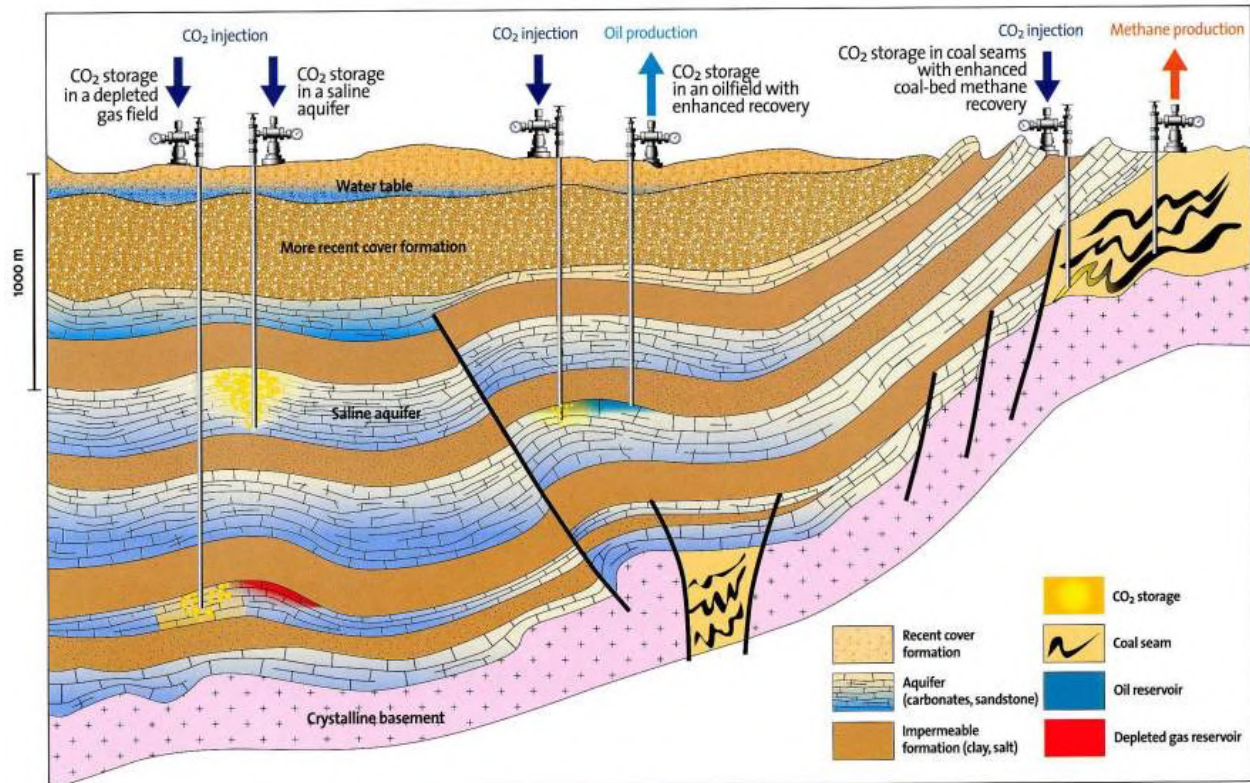
Existing Reservoir

- **Saline aquifers**
- **Oil and gas filed depleted**
- **Coal seams**

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CRITERIA FOR IDENTIFICATION
OF SUITABLE SITES FOR CO_2 STORAGE

Depth : between 800 (to allow the CO_2 supercritical stage) and 2000-3000 m

Characteristics of the reservoir: good porosity e permeability

Caprock: presence of a sealing geological formation

Distance: within a radius of 200 km from the source of emission of CO_2

Heat flow: the heat flow does not have to be high, in order not to alter the conditions of stability of CO_2

Tectonic setting/seismicity: the area must be stable to ensure the structural conditions for storage

CO$_2$ STORAGE

For the purposes of CO$_2$ storage, the rock that serves as a reservoir must meet the following requirements *:*

➤ **they must be at a DEPTH between 800 (so that the CO$_2$ remains in conditions of supercritical state) and 1500 m;**

➤ **they must have a certain <u>porosity</u>** and **<u>permeability</u>;**
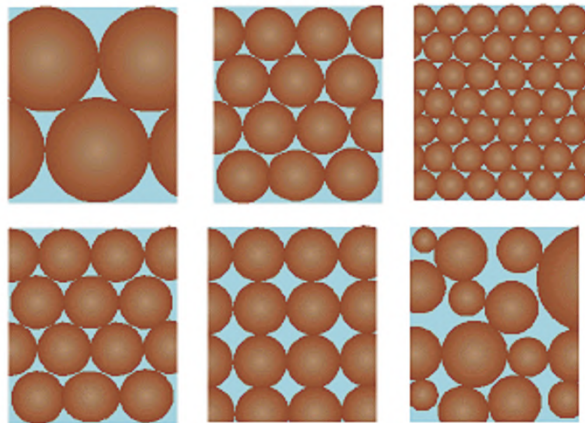
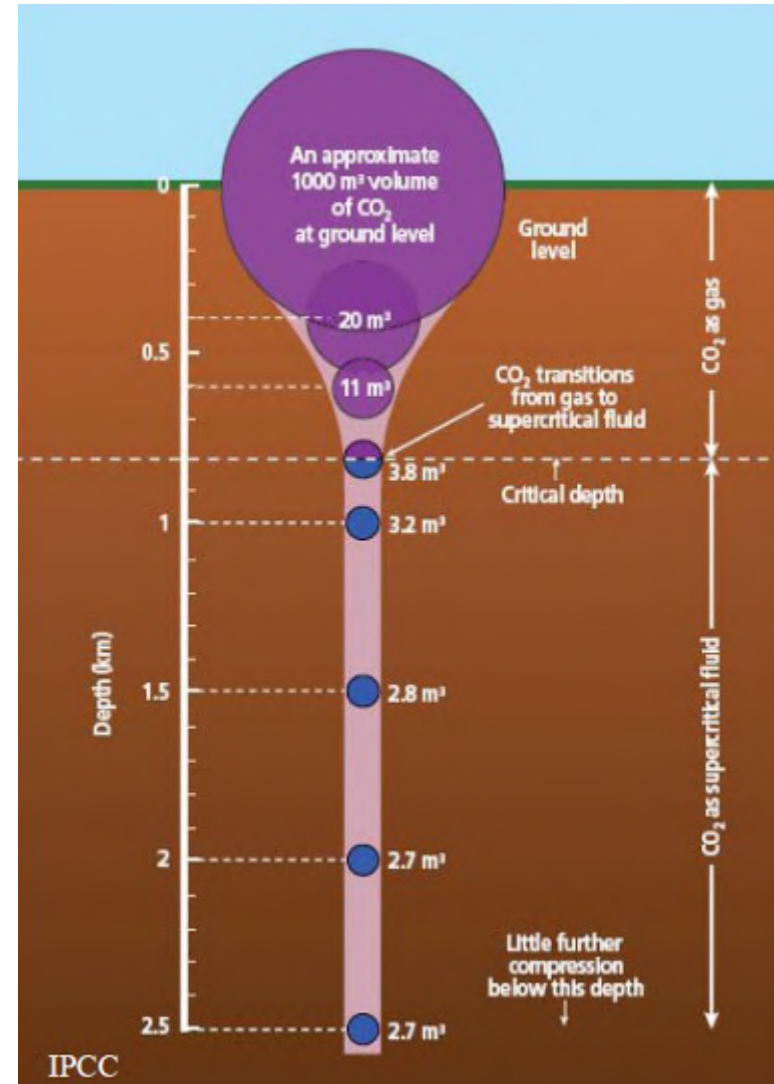Porosità   Grani
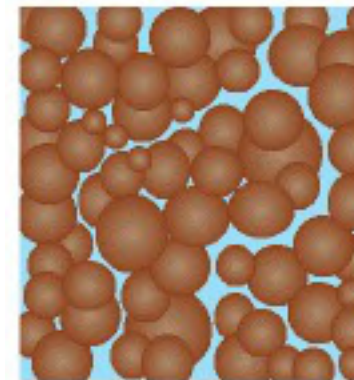
CO$_2$ PHASE: "supercritical state"
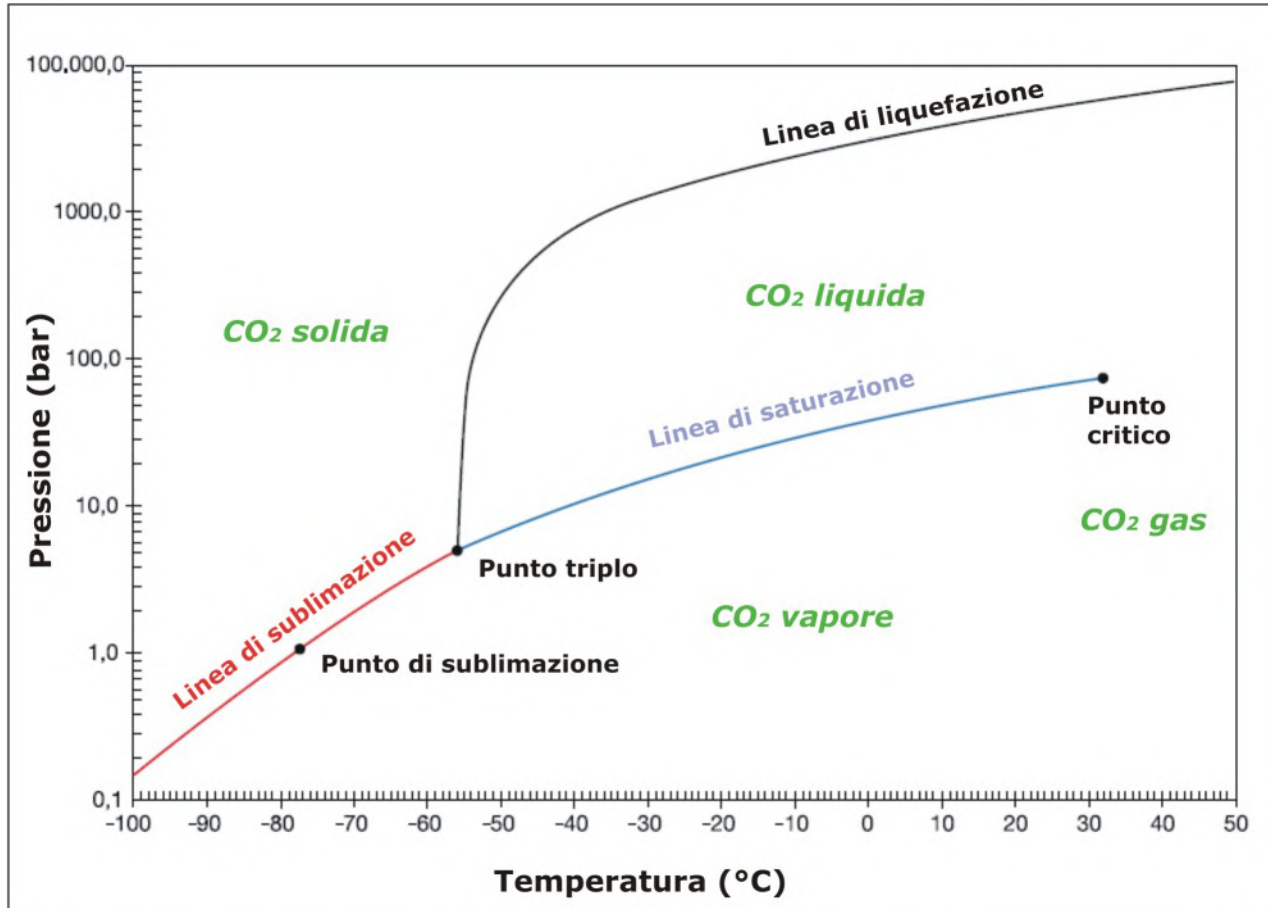
- **T>31.1° C**
- **P>73.9 bar**

...CO_2 in supercritical state is liquid or gas?

ANSWER:

• density similar to liquid

• viscosity similar to gas

T=100°C, P=280bar (2800m)	density (kg/m3)	Viscosity (cP)
CO_2 supercritic	615	0.05
water	804	0.16
gas (methan)	150	0.02

IPCC

The CO$_2$ at supercritical conditions tends to rise …

CAP ROCK

ESSENTIAL PRESENCE OF SEALING ROCK FORMATIONS (CAPROCK)

$\Delta \rho g h$
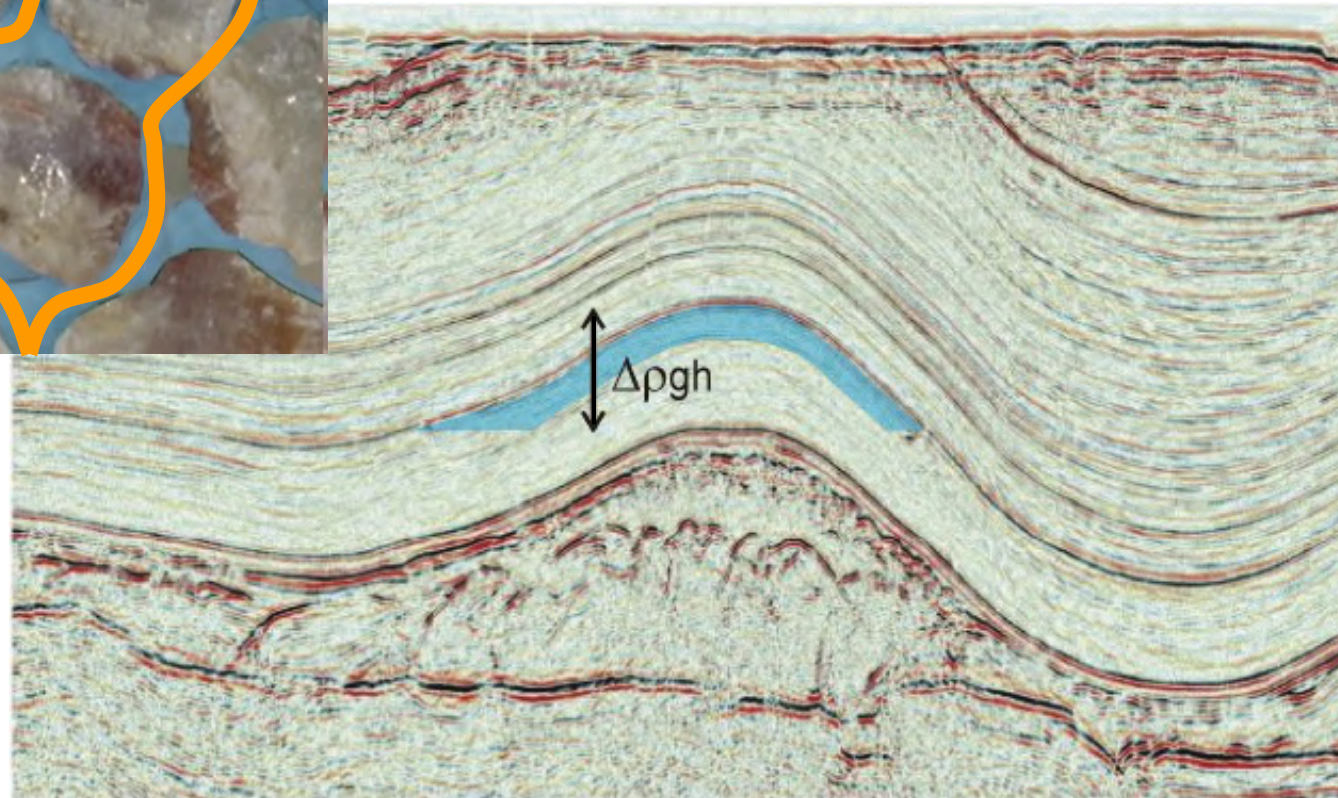
STRUCTURAL TRAPS

Faults and unconformities
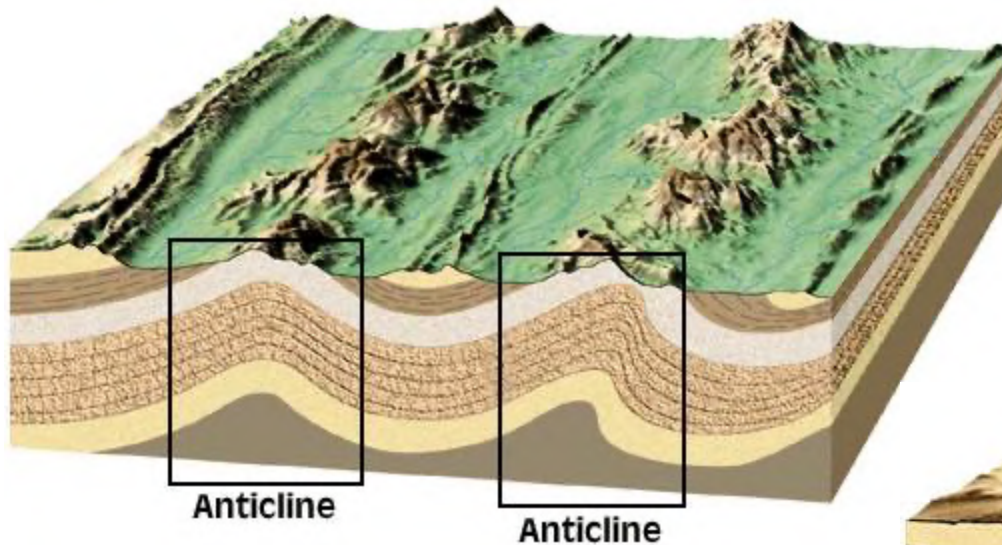
Folding and anticlines

Fault consists of different material
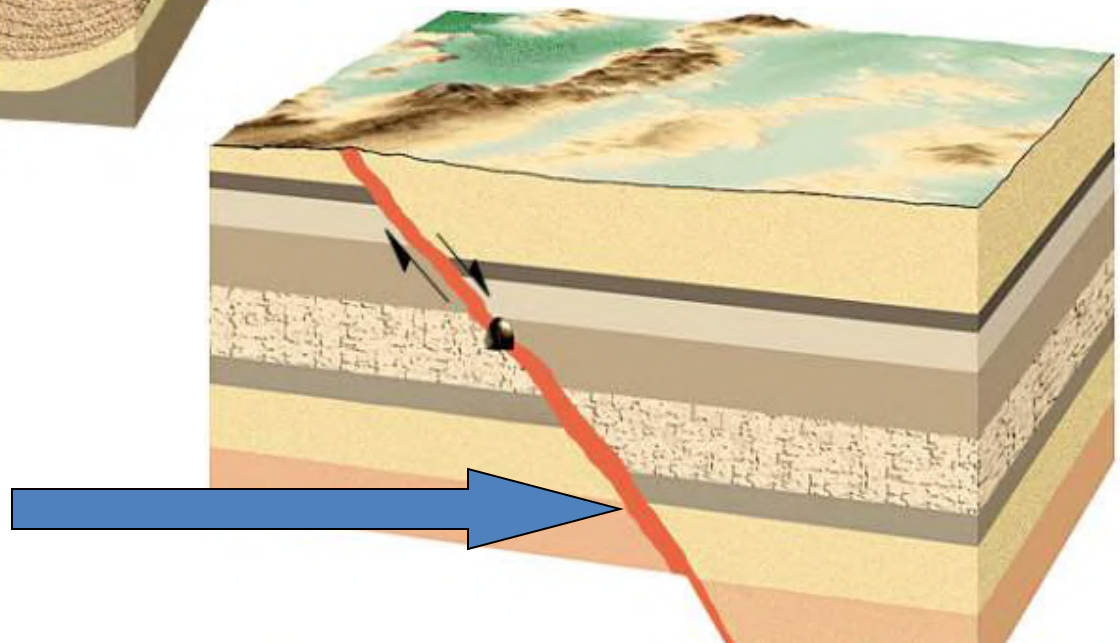
Trapping mechanisms

Structural & stratigraphic trapping

Residual CO_2 trapping

Increasing Storage Security

Solubility trapping

Mineral trapping

IPCC, 2005

% Trapping contribution

Time since injection stops (years)
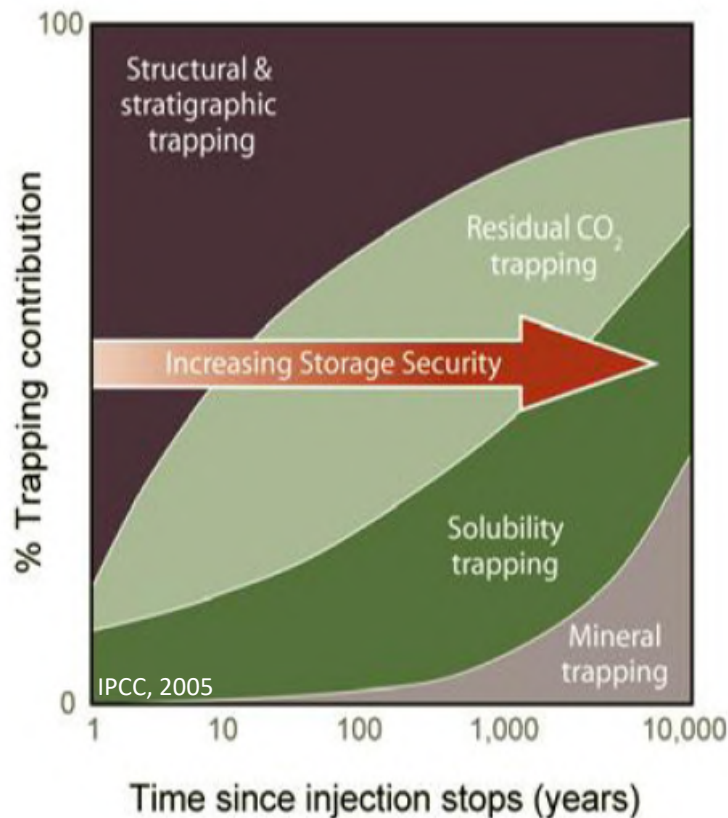
- **Structural trapping:** the CO_2 is lighter than the salt water present in the interstices of the rock and it tends to rise upward and trapped by the impermeable rocks (caprock)

- **Hydrodynamic trapping**, where CO_2 is injected into supercritical conditions at depths> 800 m and it moves the present salt water

- **Dissolution trapping:** once injected CO_2 starts to dissolve in salt water. The water now becomes heavier and tends to drop. This mechanisms put in contact water with dissolved CO_2 with fresh water, promoting additional dissolution. After 10 years: 15% of injected CO_2 is dissolved; after 10.000 years 95% of CO_2 is dissolved.

- **Mineral trapping** where CO_2 reacts with some minerals in the aquifer to form crystalline carbonates

KEY DATA FOR THE CHARACTERIZATION OF A RESERVOIR-CAPROCK SYSTEM

Wellbore data

- Logs (Sonic, Gamma Ray)

- Porosity e permeability of reservoir e caprock rock formations

- Temperature and pressure at reservoir depth

Multichannel seismic data
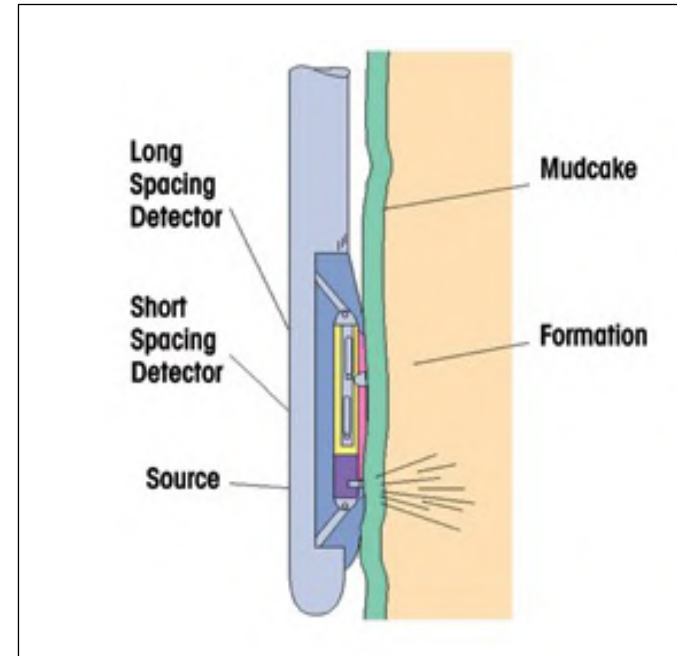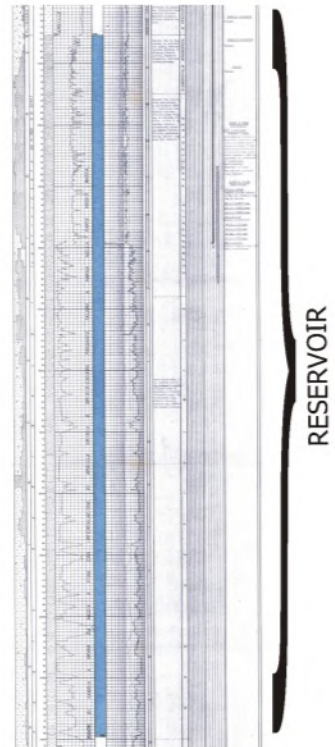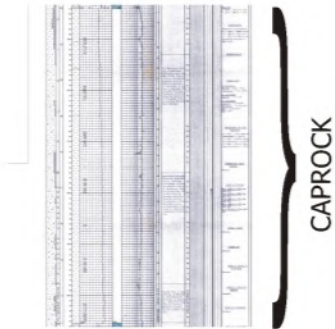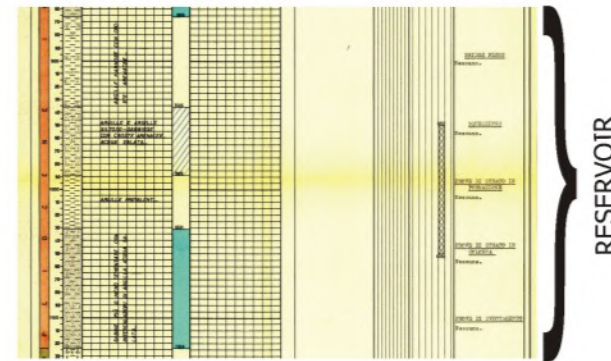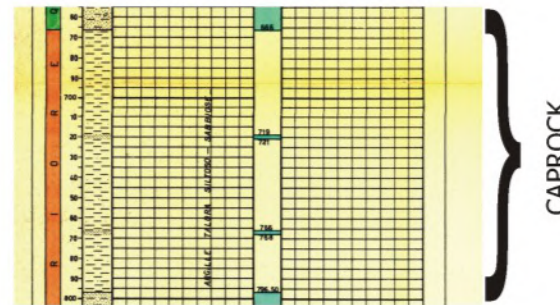
2D - regional scale

3D - site scale

Image of a logging tool in a hole

CHARACTERIZATION RESERVOIR-CAPROCK: WELL DATA analysis

CHARACTERIZATION RESERVOIR-CAPROCK: SEISMIC DATA ANALYSIS
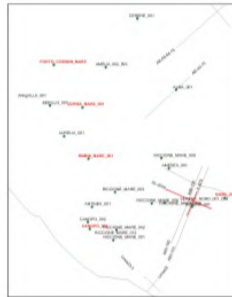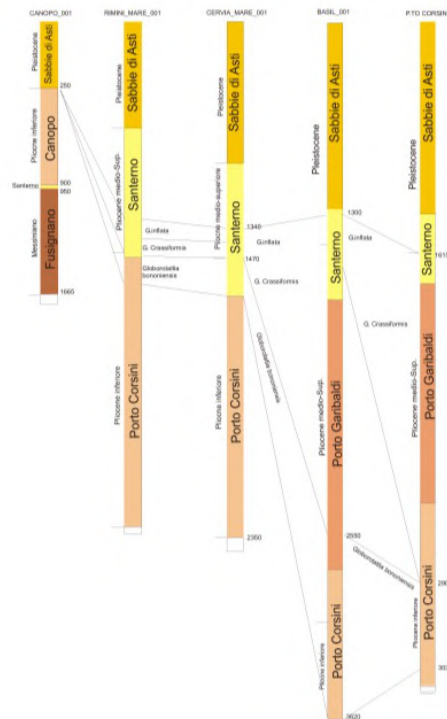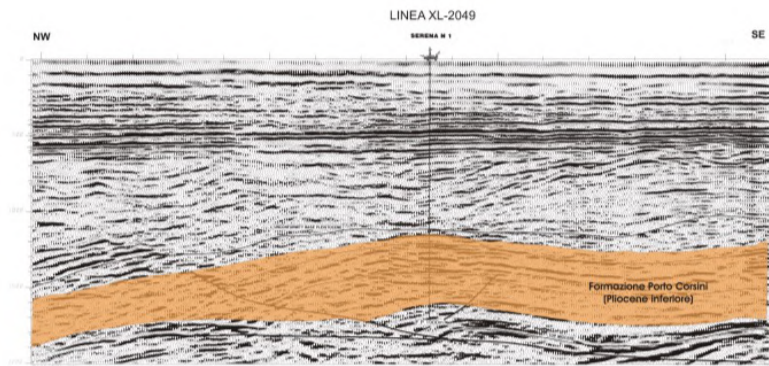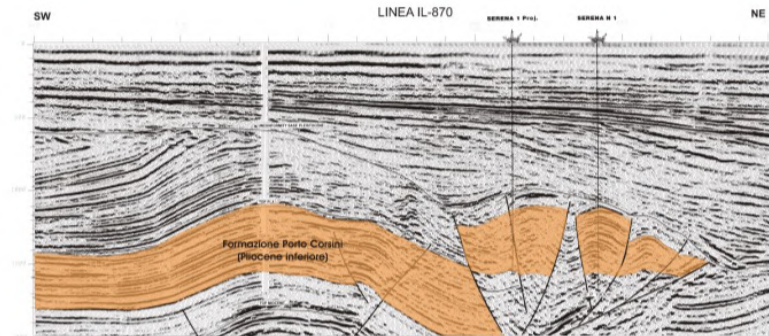
Main characteristics of a potential site for CO_2 storage

- *Capacity,* to contain the amount of CO_2 to be stored; key parameter: **porosity**

- *Injectivity,* to inject the CO_2 a certain rate of injection; key parameter: **permeability of reservoir**

- *Containment,* to avoid CO_2 leakage; key parameter: **permeability of caprock**

CCS Project

Main steps

1. Identification of the potential storage site

2. Modelling of CO_2 injection

3. Monitoring (pre-, during and post-injection)

4. Risk evaluation and remediation plan

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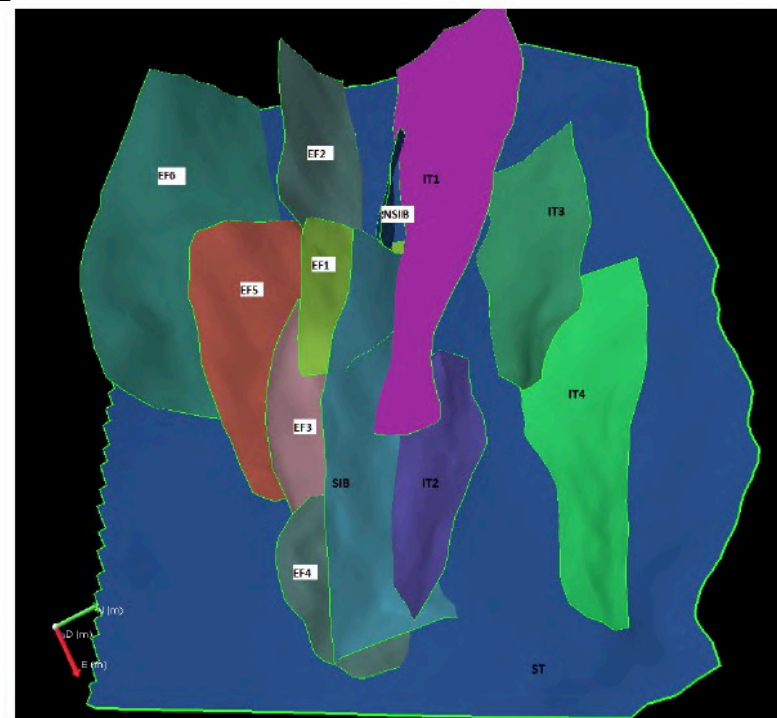di Oceanografia
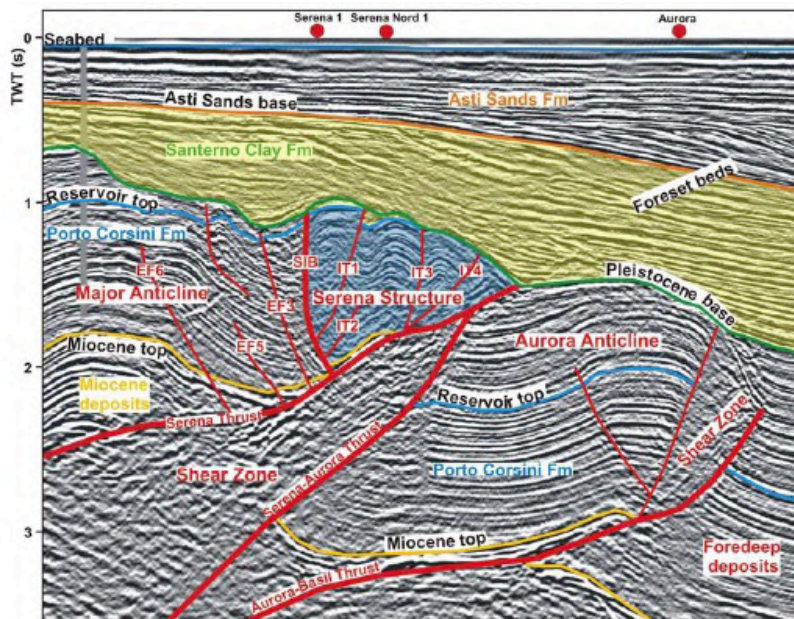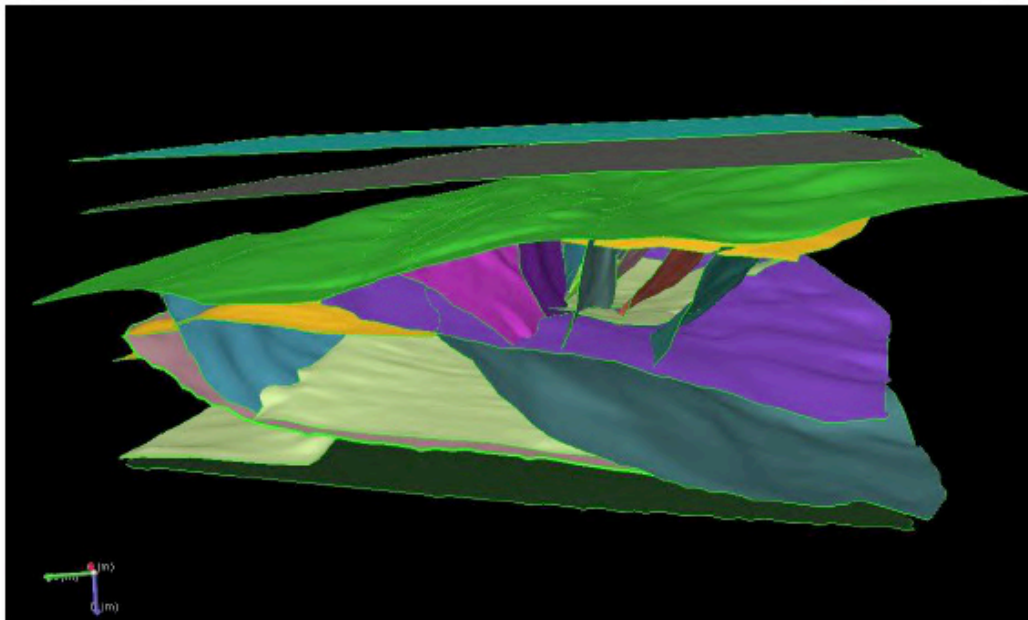e di Geofisica
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Data analysis
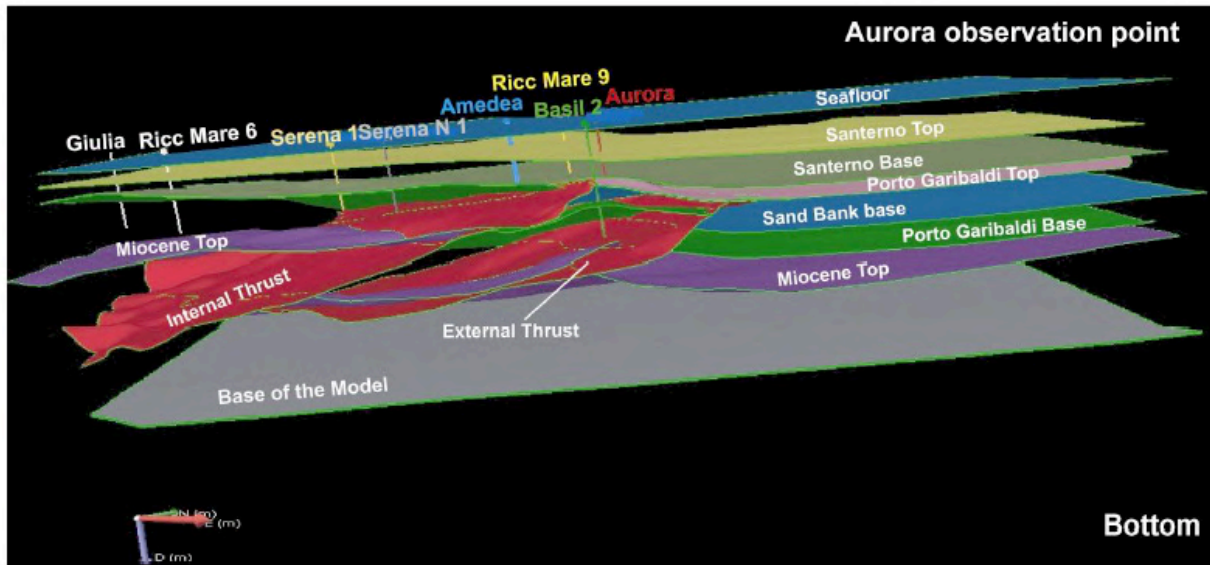
Geophysical log analysis

Seismostratigraphic and structural interpretation
of multichannel seismic profiles

+
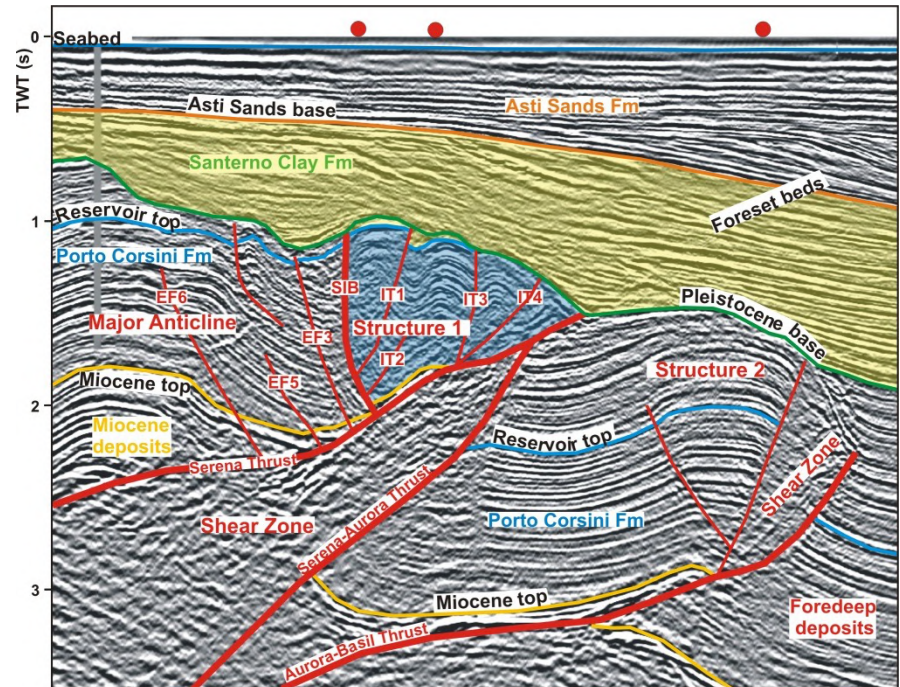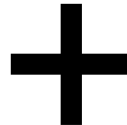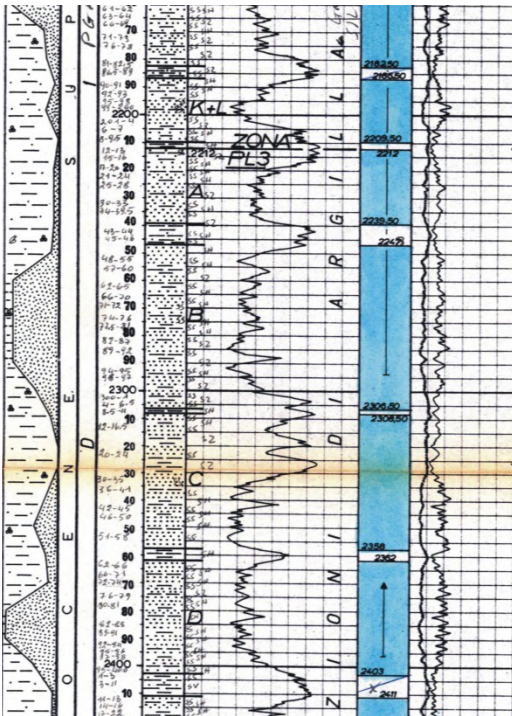
Geological modeling

Example of 3D geological model

Geological modeling

Example of
3D geological model
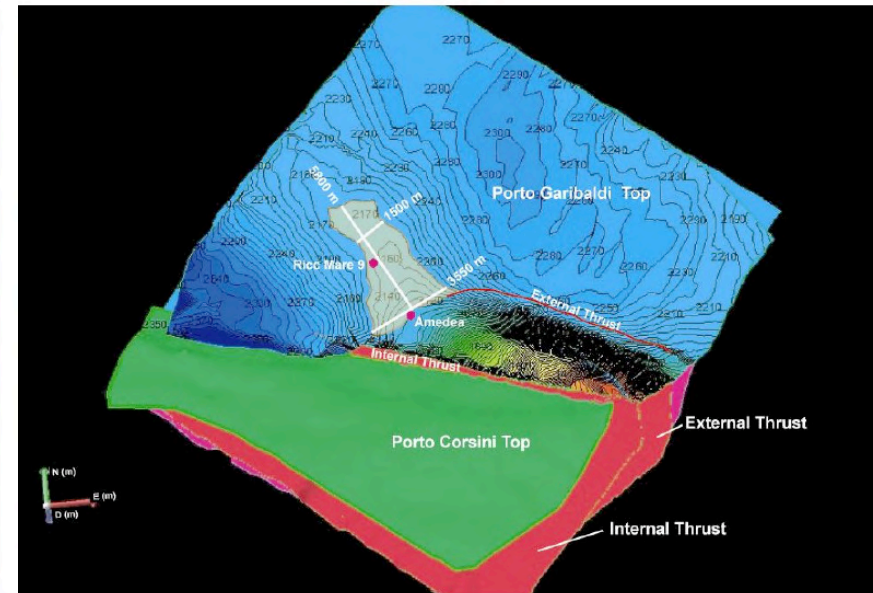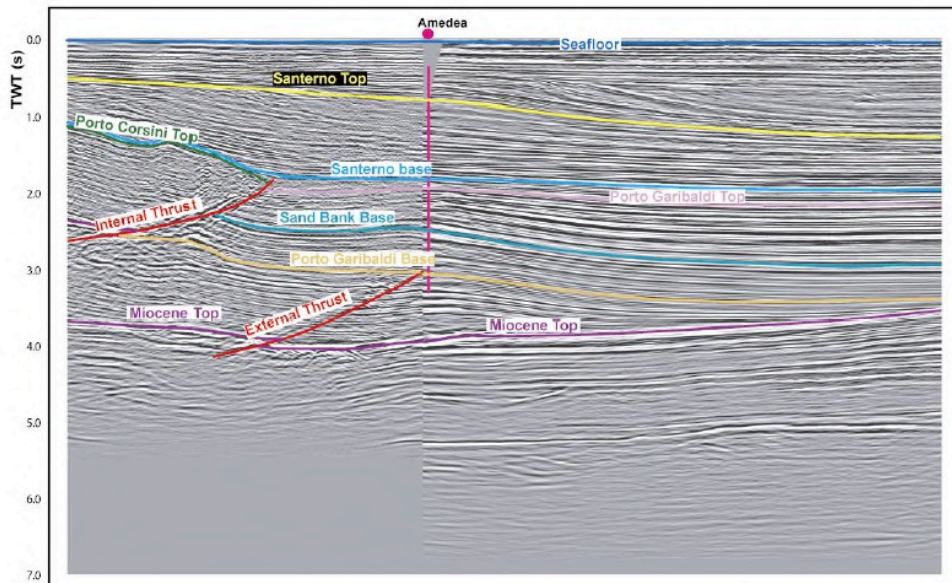
Modeling of CO_2 Injection
ONE WELL located on top of the anticline
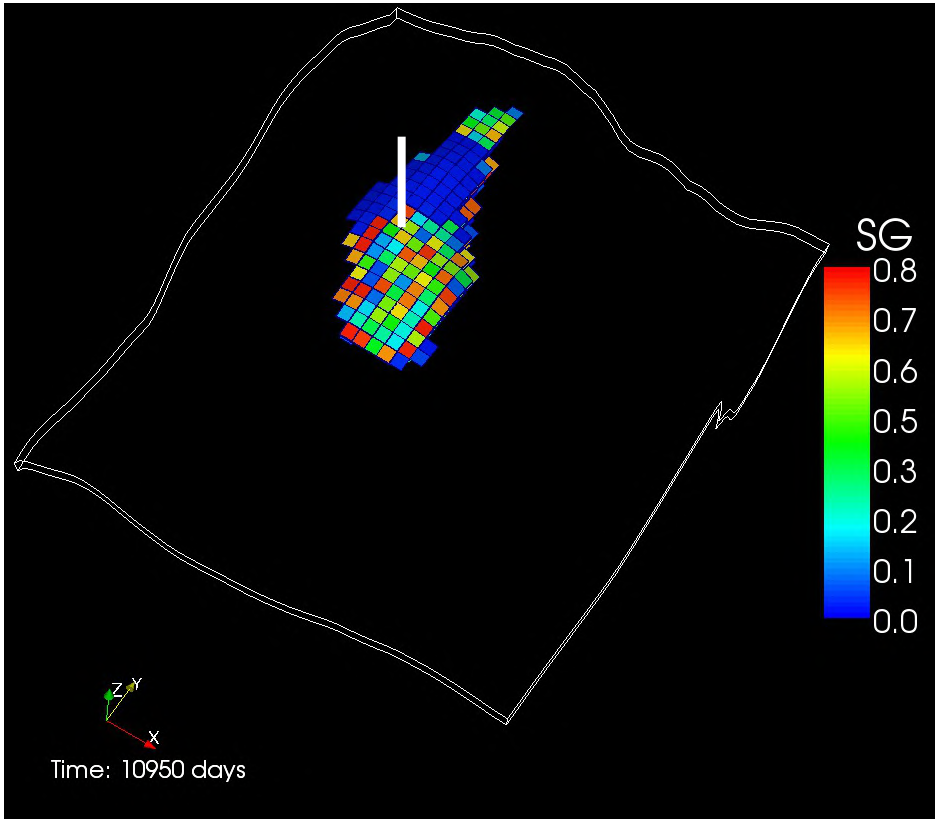
Free CO_2 saturation
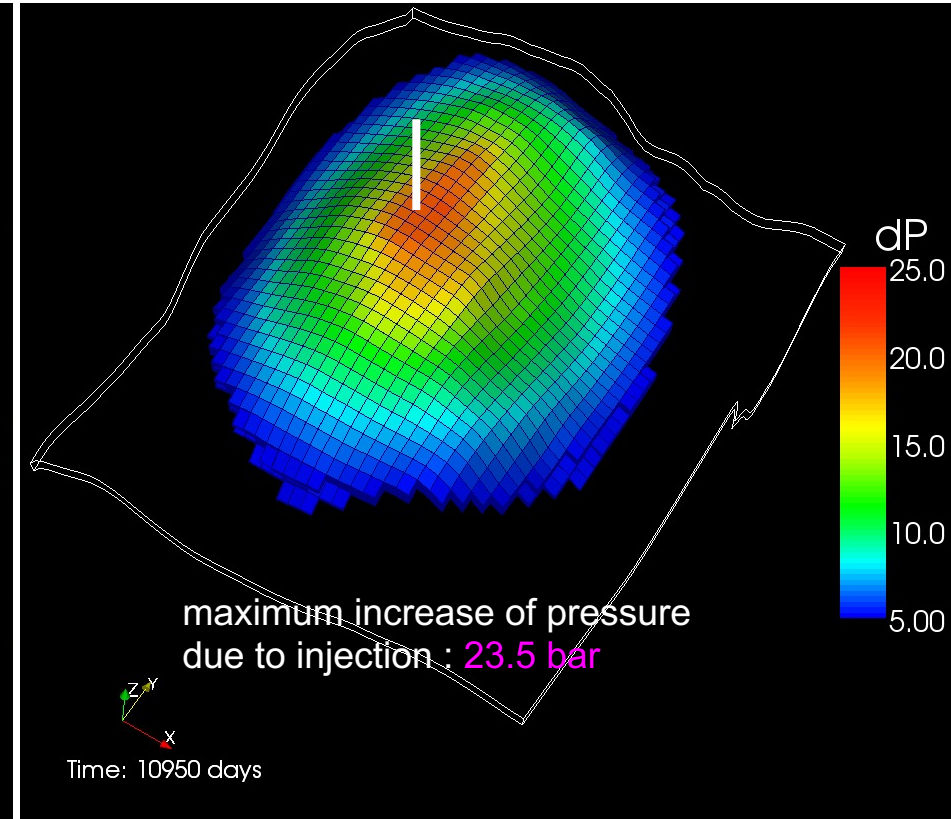
Pressure increase (>5bar) from static conditions

Potential areas suitable for CO_2 geological storage in siliciclastic formations

PRELIMINARY ESTIMATES OF THE STORAGE CAPACITY: ~ 12 Gt

Storage of Italy's annual CO_2 emissions for the next 50 years

Donda et al., 2011

Example of a potential area suitable for

CO_2 geological storage in a terrigenous formation

"EMILIA MARE"

Donda et al., 2011
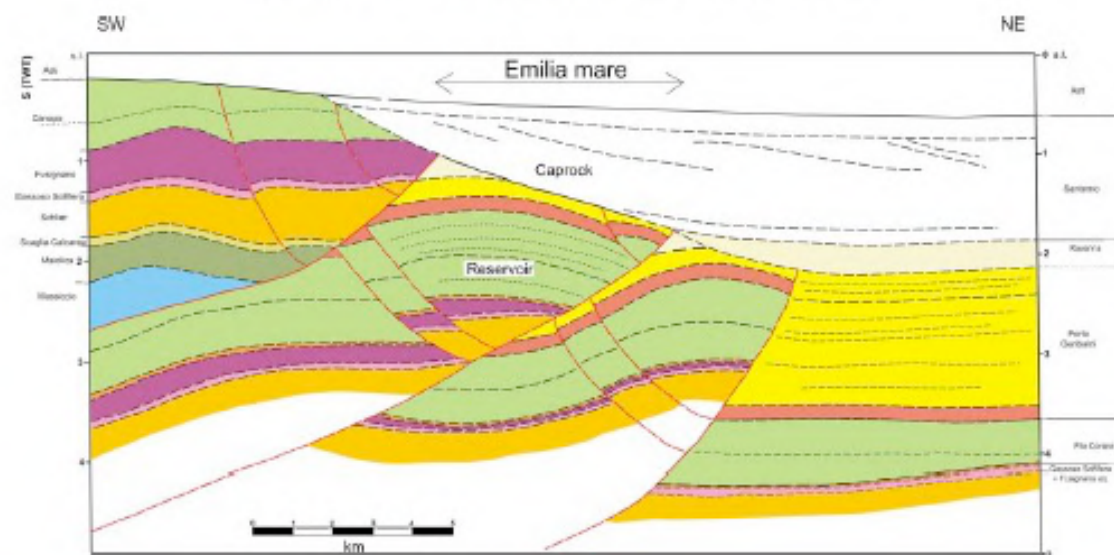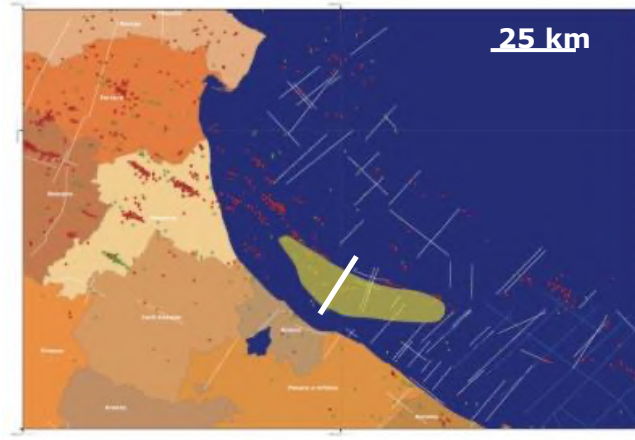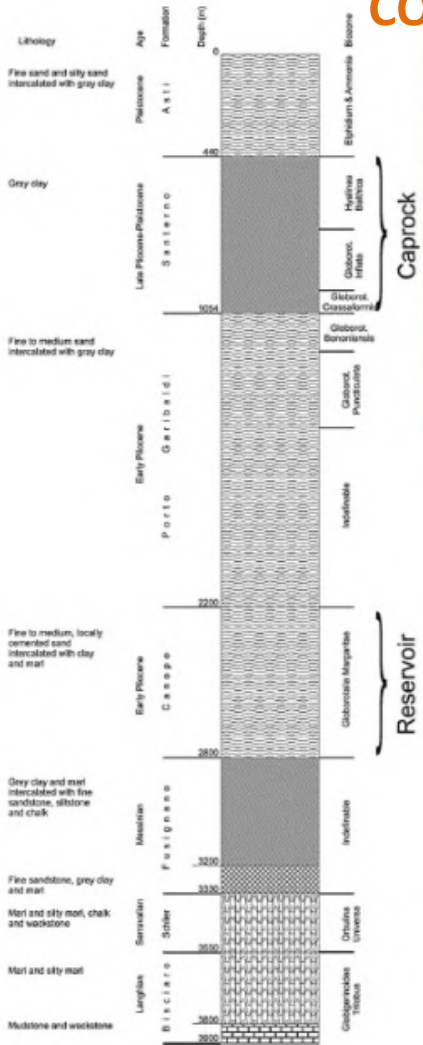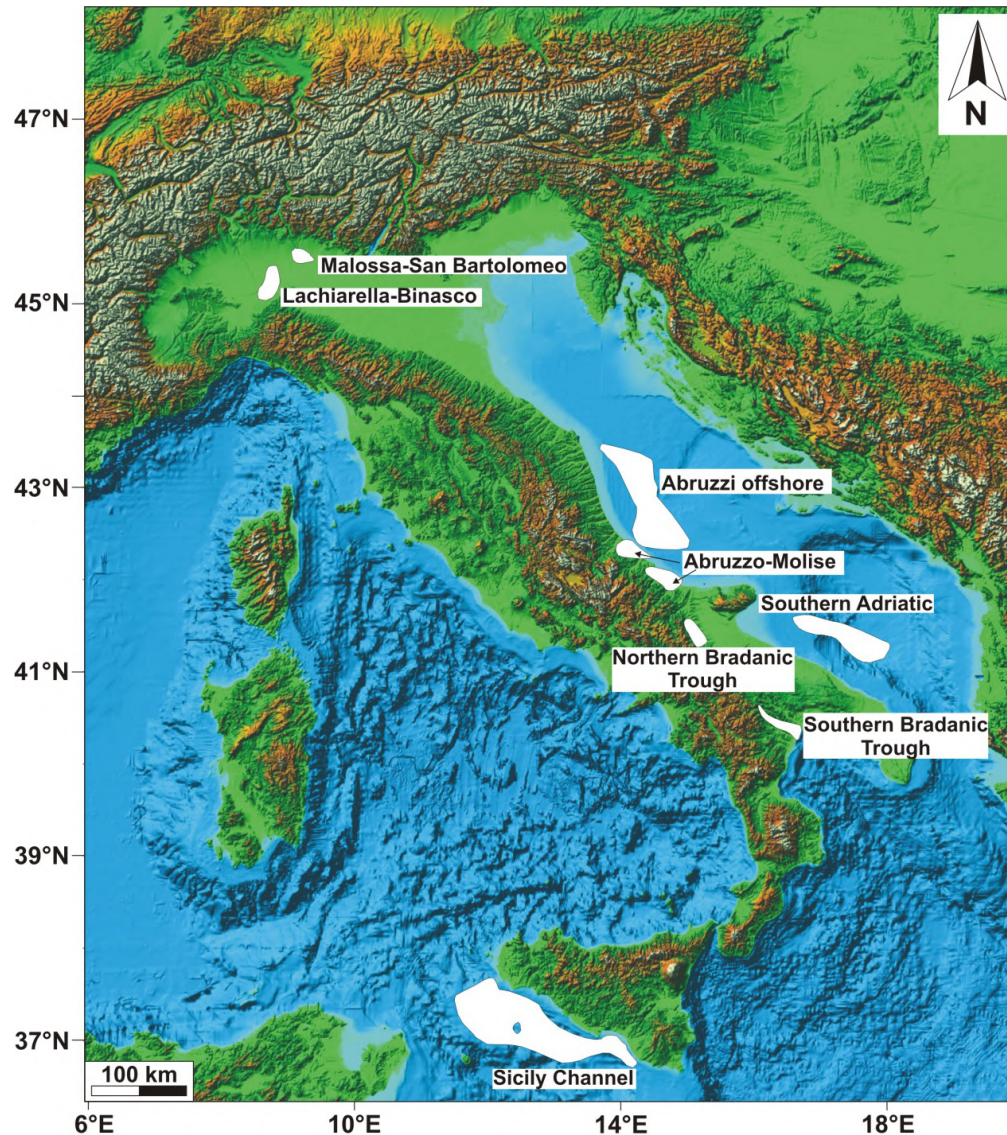
Potential areas suitable for CO$_2$ geological storage in carbonate formations

Civile et al., 2013

Example of a potential area suitable for CO₂ geological storage in a carbonate formation
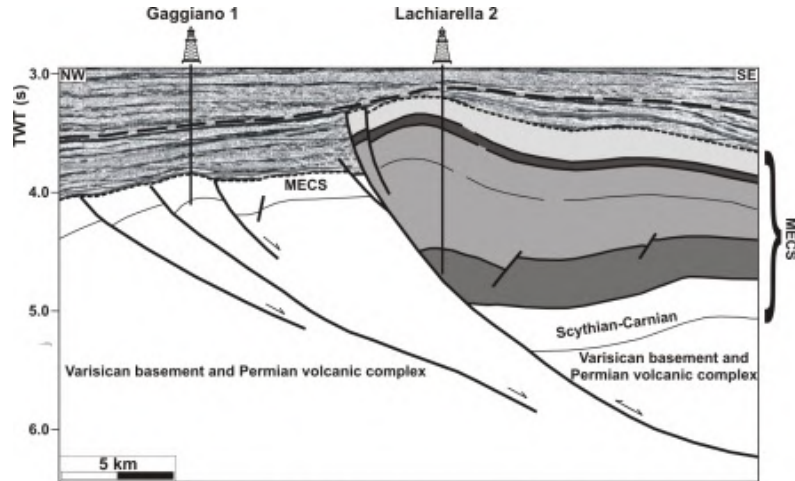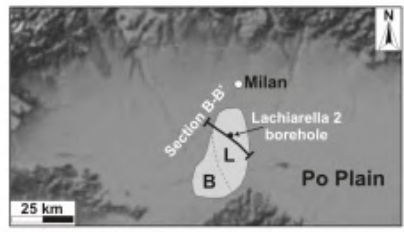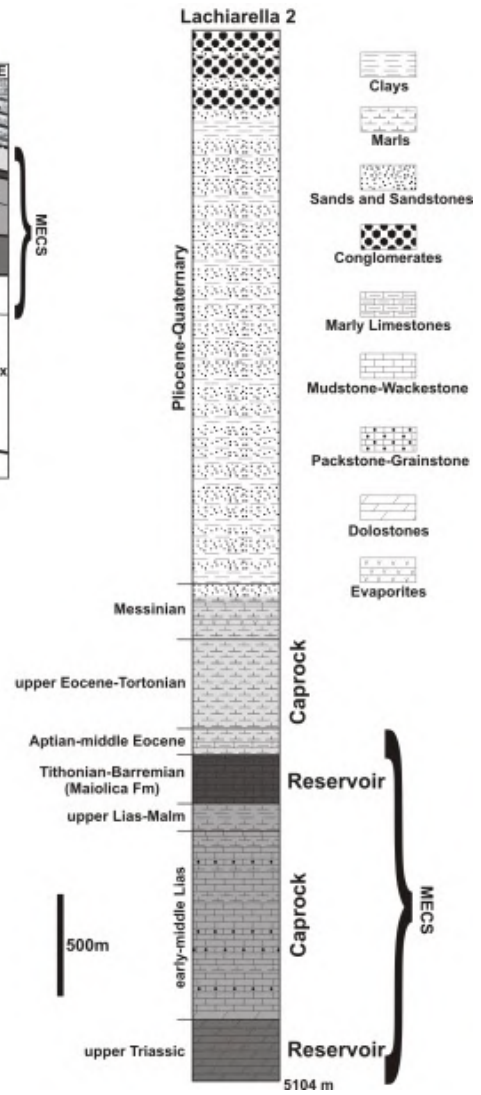
"Lachiarella–Binasco"

Civile et al., 2013

CHARACTERISTICS OF THE SOUTHERN ADRIATIC SITE OPTIONS
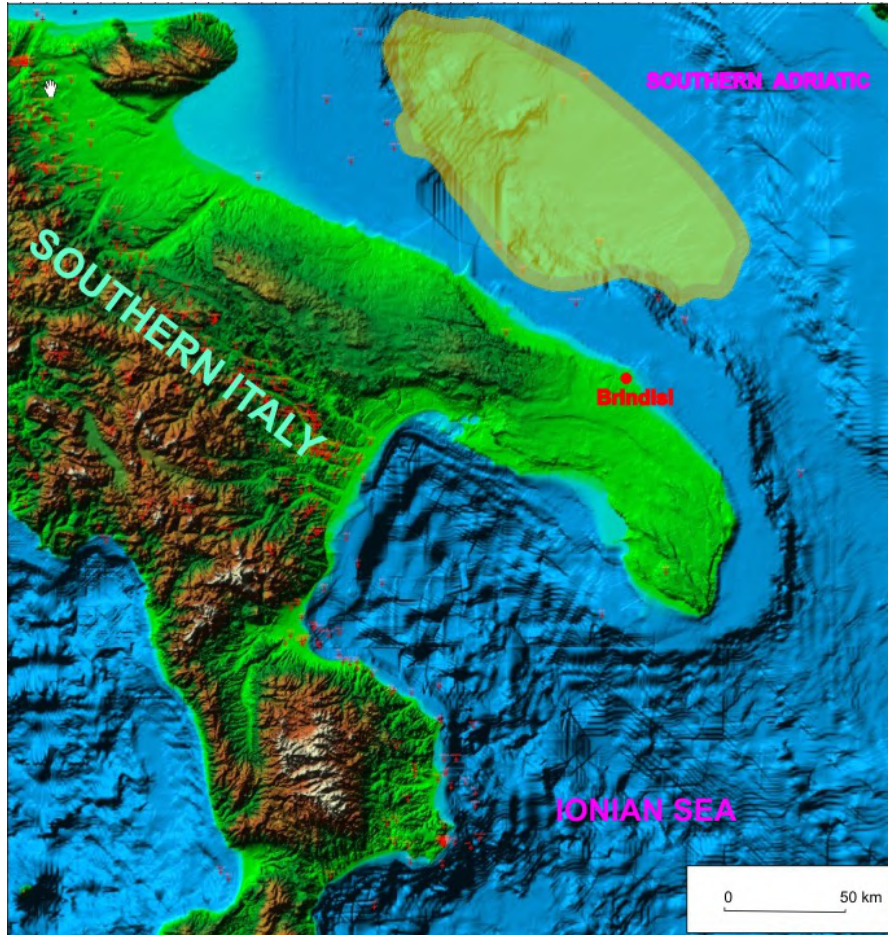
Storage options

> ➢ Saline aquifer/structural trap

Location

> ➢ Off shore

Lithology

> ➢ Carbonate reservoir

STORAGE SITE IN THE SOUTH ADRIATIC OFFSHORE
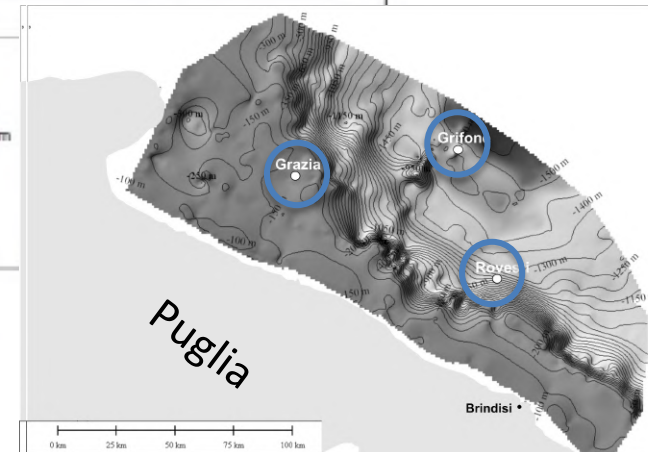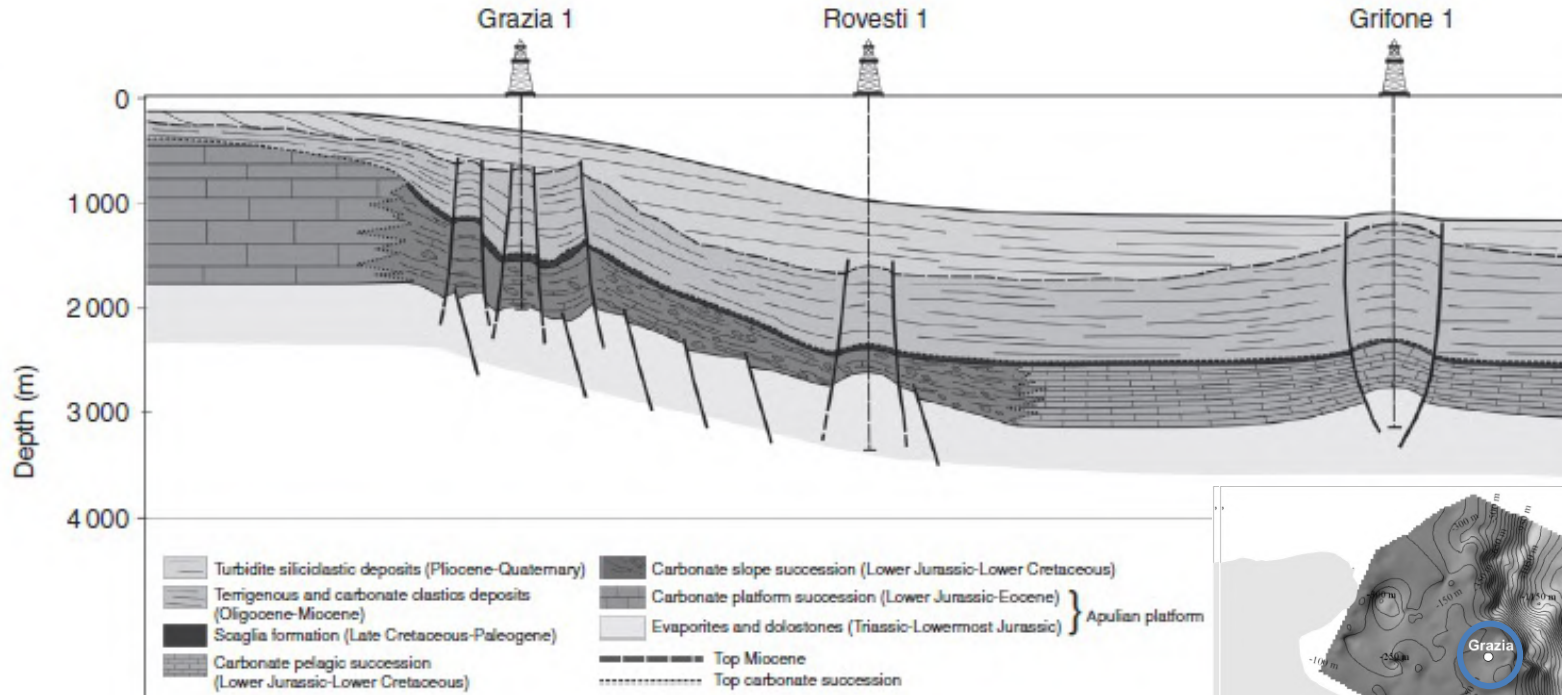
Name	Storage type	Area E+6 (M^6)	Bulk Volume E+6 (M^6)	Porosity (Scaglia)
Rovesti	Oil and Gas reservoir	1.7	195	13 -15 %
Grifone	Saline aquifer	1.0	191	10 – 20%
Grazia	Saline aquifer	1.3	241	2 - 13 %

Volpi et al., 2014.

GRAZIA STRUCTURE
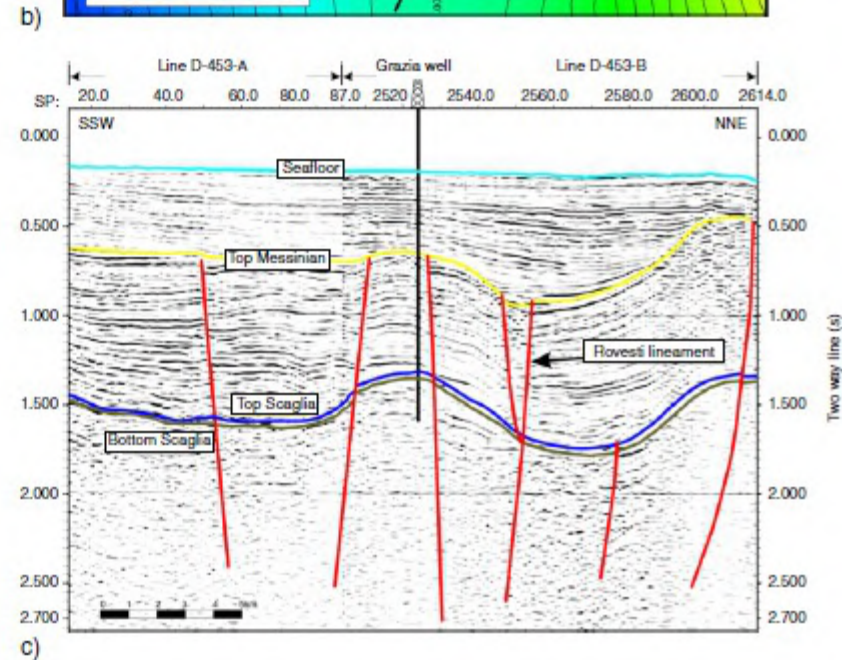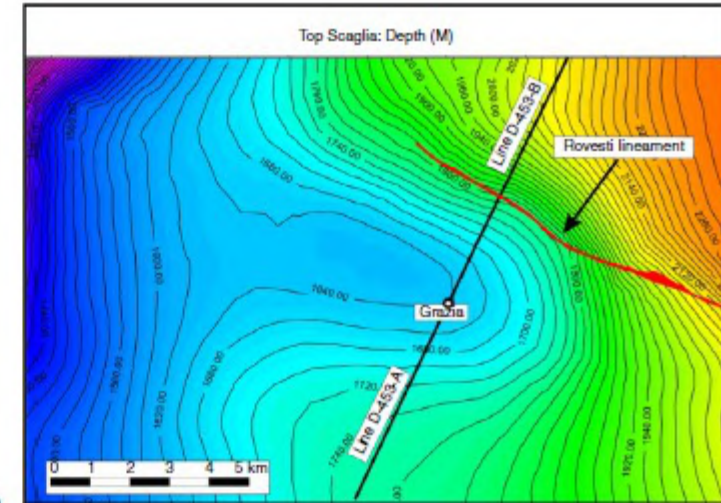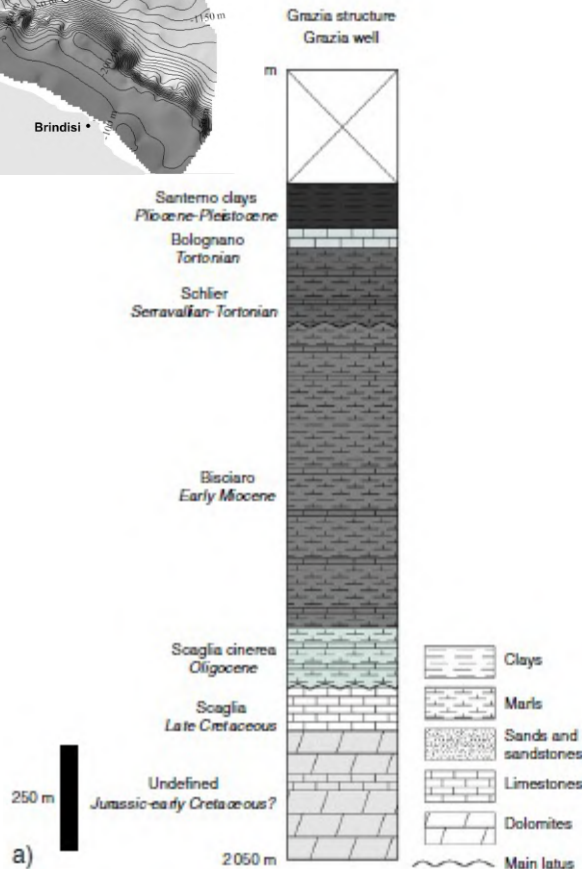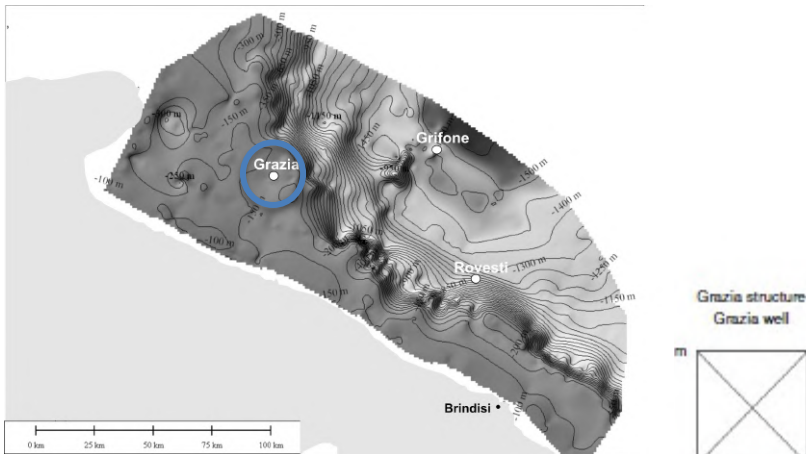
ROVESTI STRUCTURE
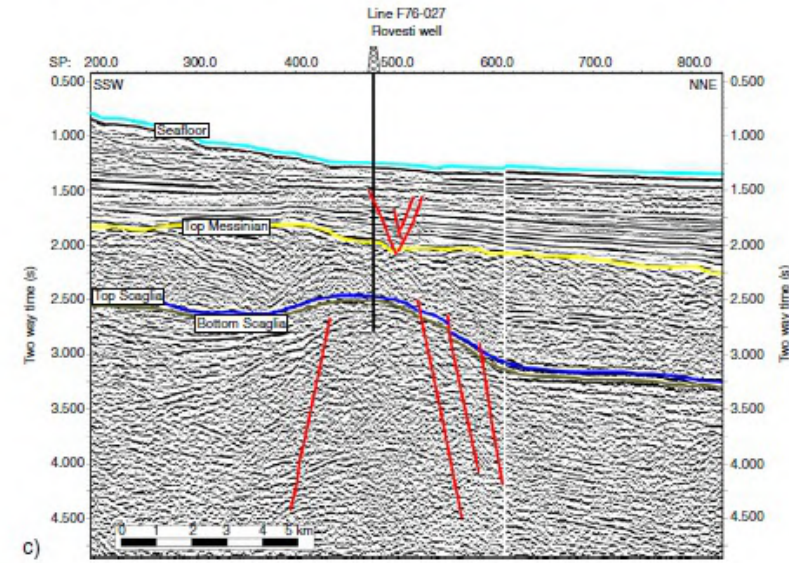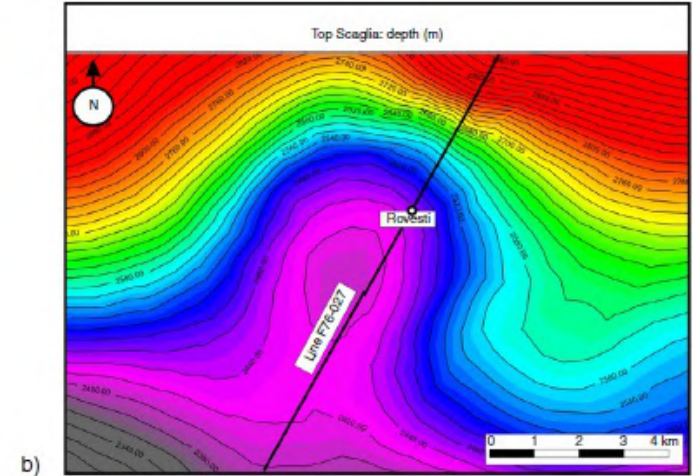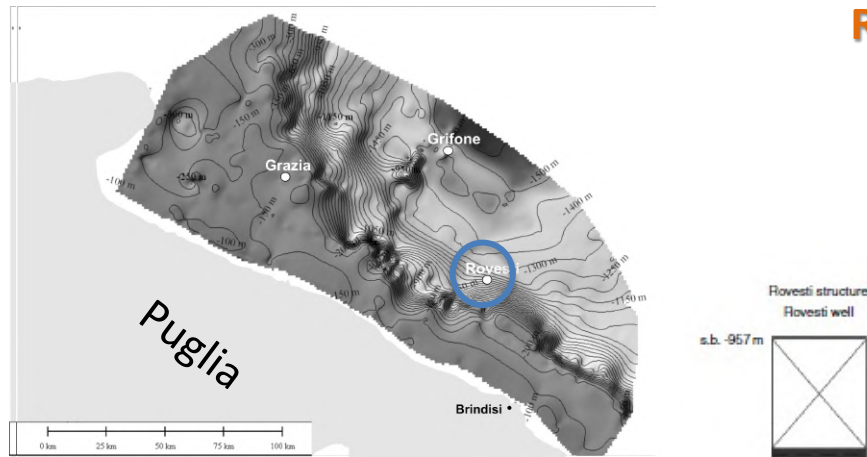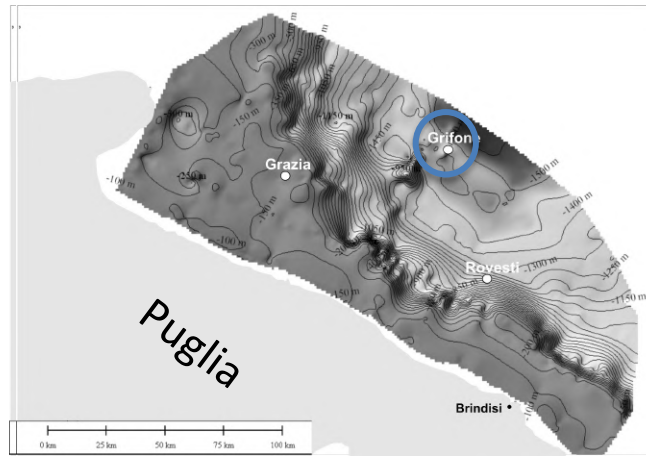
GRIFONE STRUCTURE
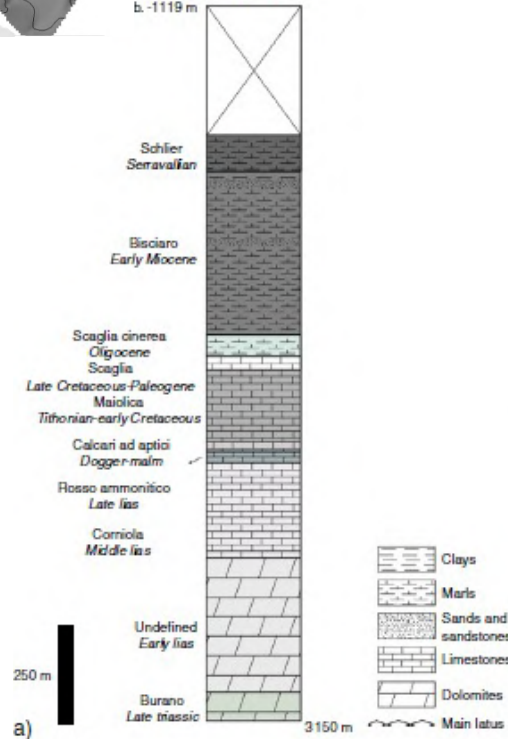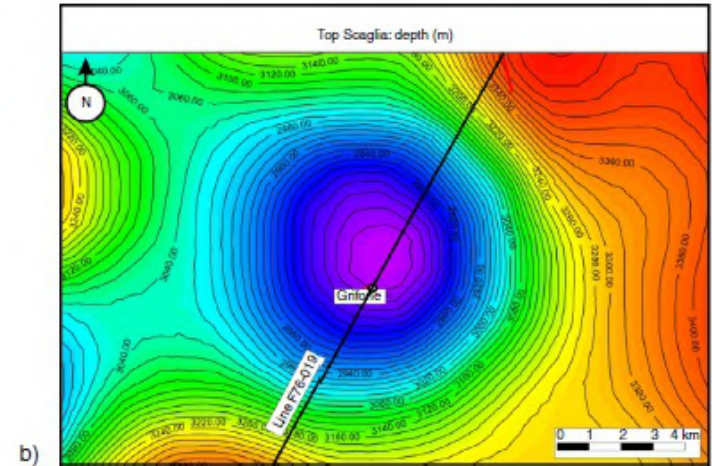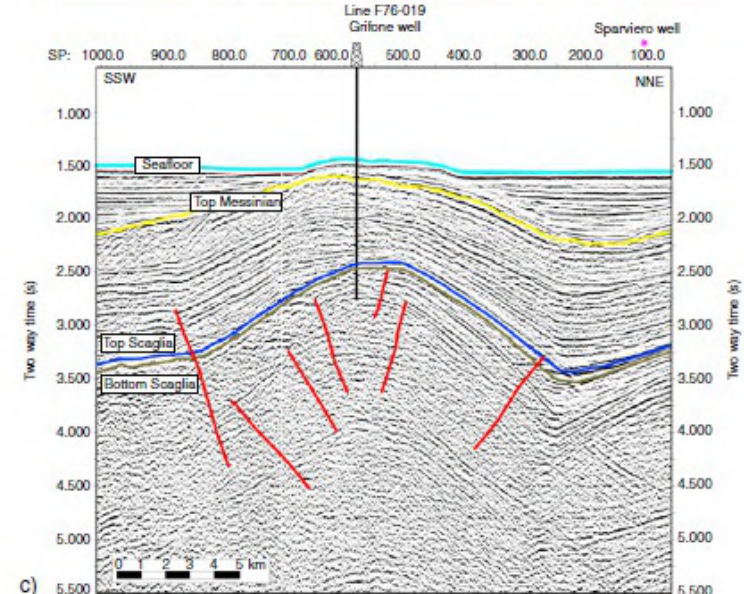
Monitoring of the selected sites

Monitoring is required in order to see whether:

- stored CO_2 behaves as expected

- migration or leakage occurs

- identified leakage damages environment or human health

Monitoring of storage site

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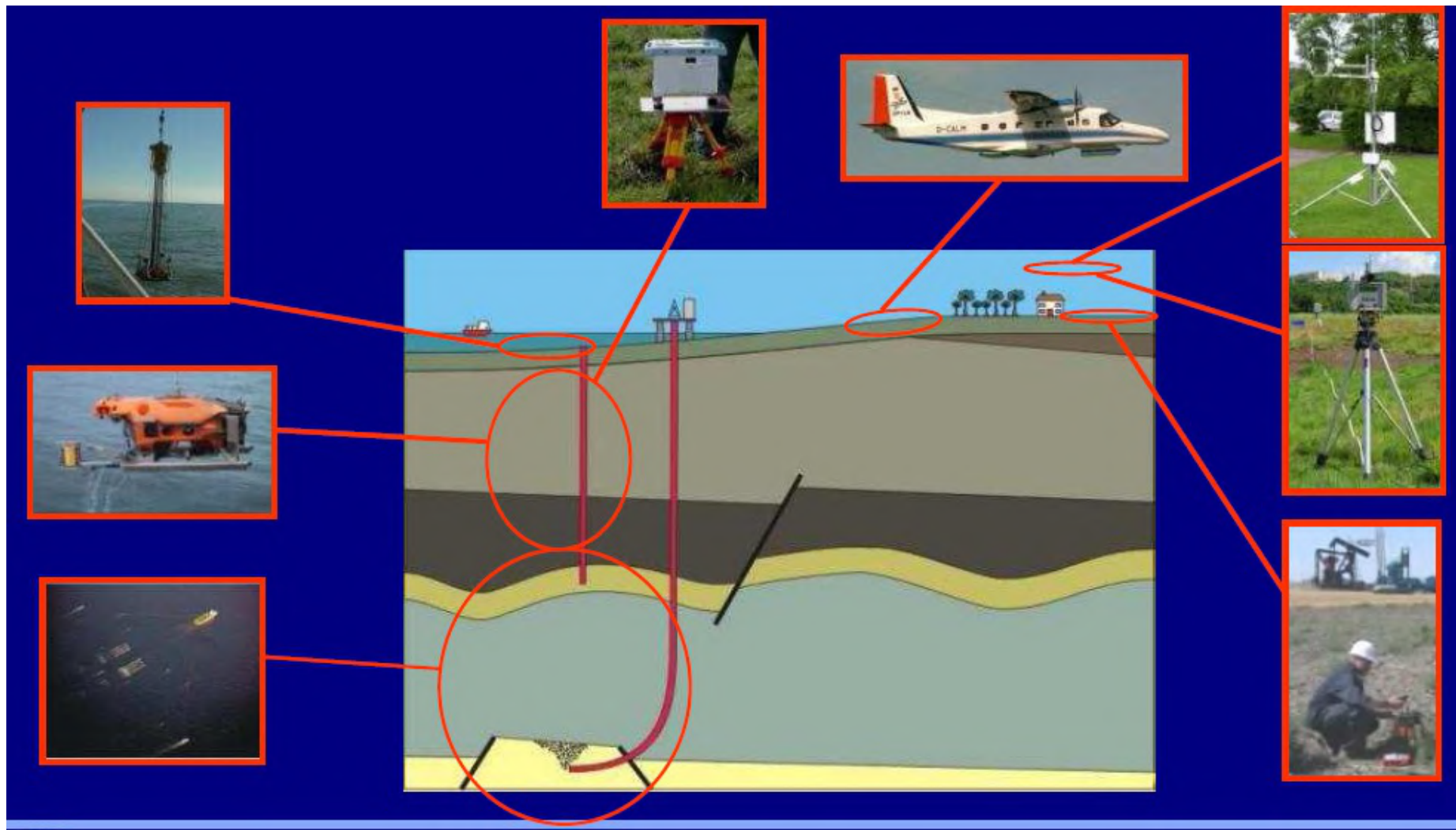
IDENTIFICATION AND MONITORING OF CO$_2$ BEHAVIOUR AFTER INJECTION
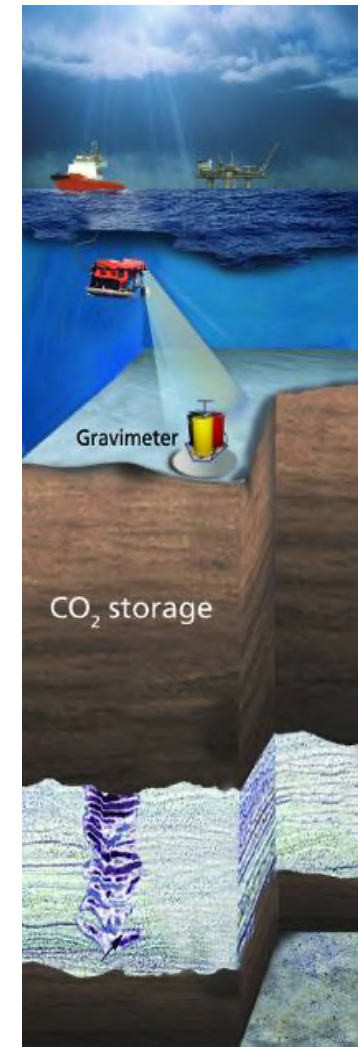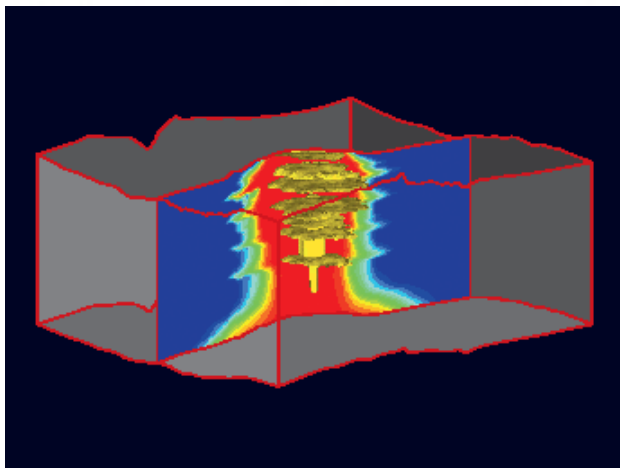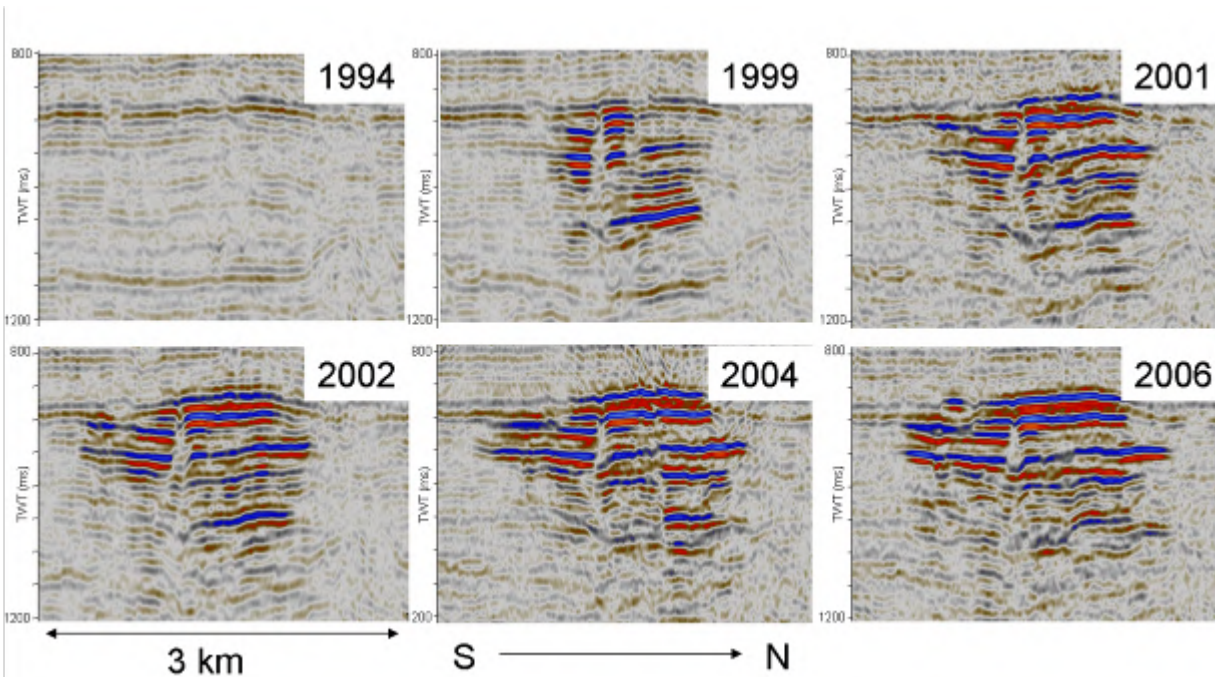
Courtesy Statoil/CO2STORE project

CO$_2$ GLOBAL EMISSIONS in 2019

CO2 emissions in million metric tons

● 2009 ● 2019

CCS facilities in the world

19 active plants

4 under construction

28 final or advances stage

around 40 Mton/year of CO$_2$ are stored today
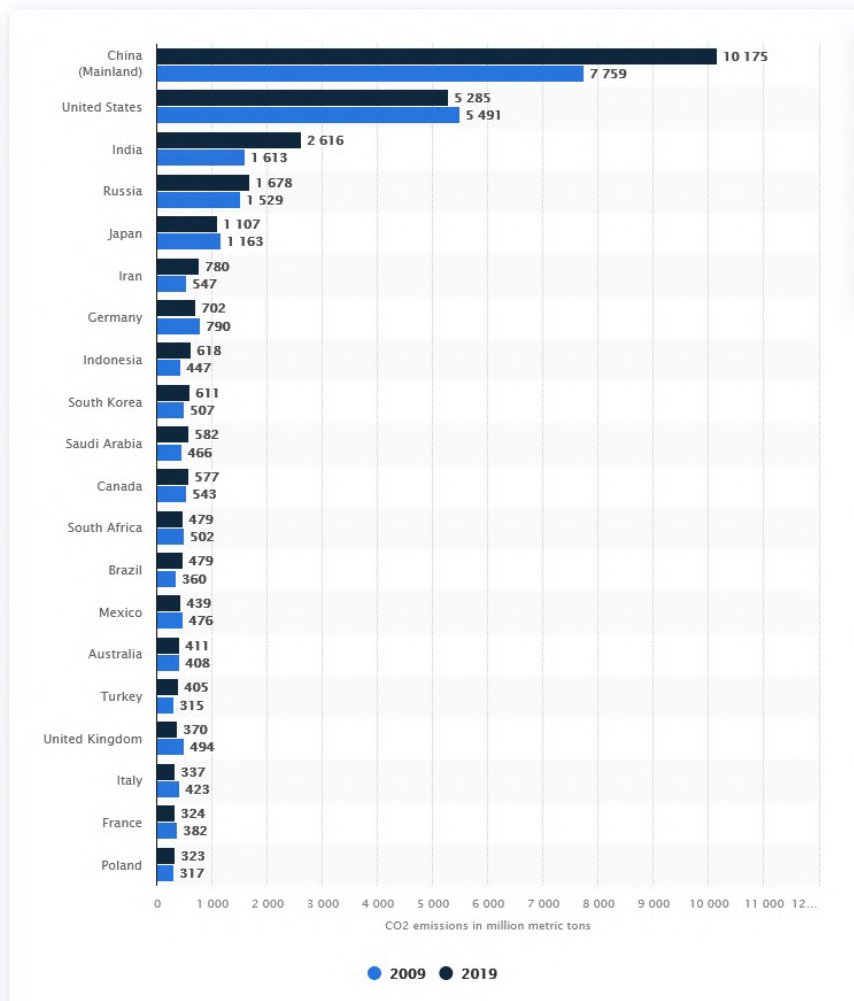
In 2019, global CO$_2$ emissions from final combustion were ~35 Gton, more than double the rate of early 70s.

Global CCS Status Report 2019:
https://www.globalccsinstitute.com/wp-content/uploads/2019/12/GCC_GLOBAL_STATUS_REPORT_2019.pdf

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GLOBAL CCS FACILITIES UPDATE 2019
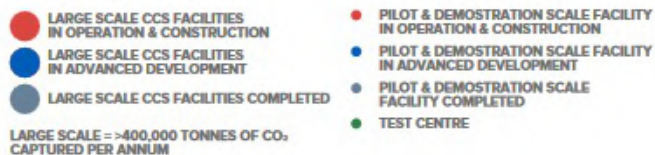
LARGE SCALE CCS FACILITIES
IN OPERATION & CONSTRUCTION

PILOT & DEMOSTRATION SCALE FACILITY
IN OPERATION & CONSTRUCTION

LARGE SCALE CCS FACILITIES
IN ADVANCED DEVELOPMENT

PILOT & DEMOSTRATION SCALE FACILITY
IN ADVANCED DEVELOPMENT

LARGE SCALE CCS FACILITIES COMPLETED

PILOT & DEMOSTRATION SCALE
FACILITY COMPLETED

TEST CENTRE

LARGE SCALE = >400,000 TONNES OF CO_2
CAPTURED PER ANNUM

Global CCS Status Report 2019:
https://www.globalccsinstitute.com/wp-content/uploads/2019/12/GCC_GLOBAL_STATUS_REPORT_2019.pdf

ACTIVE PLANTS IN EUROPE

SLEIPNER
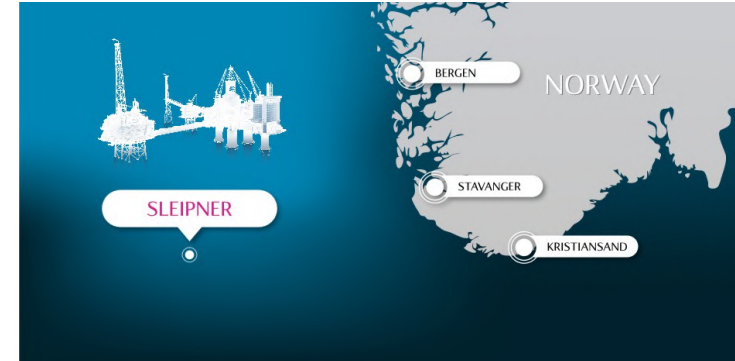
Approx. 1 Mton/year and over 17 Mtons of CO_2 injected from inception (1996)

SNØHVIT

Approx. 700 Mtons of CO_2 injected from inception (2008)

Source: International Energy Agency, "Energy Technology Perspectives 2017", Paris: OECD/IEA, 2017
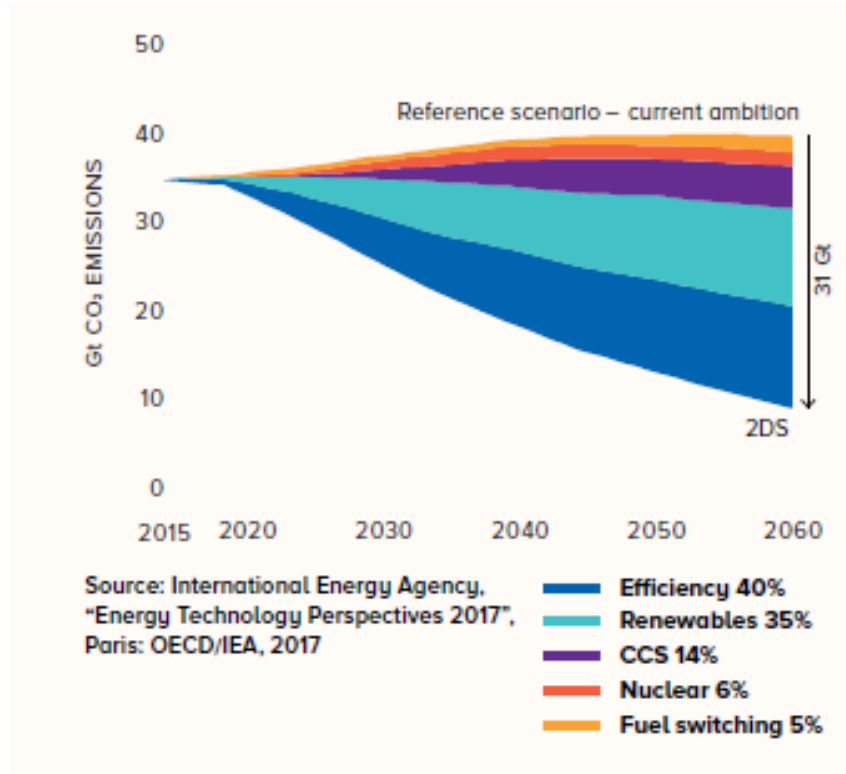
CCS IS CRITICAL to achieve the limit average global warming to well below 2°C above pre-industrial times, with the aspiration of limiting warming to 1.5°C (Paris Agreement, December 2015)

Modulo 1.5b (Energy storage) Docente: Federica Donda

OUTLINE

- Main concepts on energy storage

- Underground hydrogen storage
    - the EU Hystories project
    - the case study of the Veneto-Friuli Plain

- Underground gas storage

- The role of the geological-structural setting in the identification of storage sites
    - triggered and induced seismicity
    - OGS gas storage monitoring

ENERGY STORAGE

Energy storage is the capture of energy produced at one time for use at a later time to reduce imbalances between energy demand and energy production

UNDERGROUND ENERGY STORAGE

UNDERGROUND ENERGY STORAGE

- Pumped Hydro Energy Storage: a type of hydroelectric energy storage; it is a configuration of two water reservoirs at different elevations that can generate power as water moves down from one to the other (discharge), passing through a turbine

- Underground Thermal Energy Storage: heat pump schemes applied to single boreholes or arrays of boreholes suitably drilled in the subsurface, in which heated or chilled fluid is injected and extracted

- Compressed Air Energy Storage: is a way to store energy for later use using compressed air

- Underground Hydrogen Storage

- Underground Gas Storage

IDROGENO

Tra i tanti elementi che compongono la materia, l'idrogeno è **il più leggero e il più abbondante**. Costituisce quasi il 90% della massa visibile dell'universo, per la maggior parte nella sua forma gassosa, costituita da una semplice molecola a due atomi (H2).

L'idrogeno è il carburante delle stelle, cioè il propellente di cui si alimentano le reazioni di fusione nucleare con cui bruciano le stelle.

Tra i combustibili convenzionali è quello con il **massimo contenuto di energia per unità di peso**, tre volte superiore a quello della benzina.

Può giocare un ruolo decisivo per la **decarbonizzazione** delle industrie ad alta intensità energetica, come quella dei trasporti aerei e marittimi, della siderurgia o della chimica, e quindi viene considerato uno dei pilastri del futuro sistema energetico.

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I «COLORI» DELL'IDROGENO

Nero. L'idrogeno viene estratto dall'acqua usando la corrente prodotta da una centrale elettrica a carbone o a petrolio.

Grigio. È "grigio" più del 90% dell'idrogeno oggi prodotto. Questo elemento ha usi industriali, per esempio nella chimica. può essere lo scarto produttivo di una reazione chimica, oppure può essere estratto dal metano (che è formato da idrogeno e carbonio) o da altri idrocarburi.

Blu. Viene definito "blu" l'elemento estratto da idrocarburi fossili dove — a differenza del "grigio" — l'anidride carbonica che risulta dal processo non viene liberata nell'aria bensì viene catturata e immagazzinata.

CCS

Viola. L'idrogeno "viola" viene estratto dall'acqua usando la corrente prodotta da una centrale nucleare, cioè a zero emissione di CO_2.

Verde. L'idrogeno "verde" viene estratto dall'acqua usando la corrente prodotta da una centrale alimentata da energie rinnovabili, come idroelettrica, solare o fotovoltaica.

Soltanto il cosiddetto "idrogeno verde", ottenuto separandolo dall'acqua con un processo di elettrolisi alimentato da energia rinnovabile, è davvero a impatto zero

STOCCAGGIO DI IDROGENO

Lo **stoccaggio di energia** ha acquisito un'importanza fondamentale per la sicurezza energetica, nell'ottica di una **progressiva transizione energetica** dai combustibili fossili a fonti rinnovabili quali energia solare ed eolico.

Lo stoccaggio di idrogeno per approvvigionamento energetico può essere fatto anche attraverso **l'iniezione e l'immagazzinamento in formazioni geologiche profonde**, come avviene per il gas naturale e l'anidride carbonica (CCS), e da esse può successivamente **venire estratto** per essere utilizzato nei picchi di richiesta energetica.

UNDERGROUND HYDROGEN STORAGE

- Salt caverns (since the 70's in Europe)

- **Deep saline aquifers**

- **Depleted hydrocarbon (gas) reservoirs**

New frontiers and challenging!

da Heinemann et al., 2021
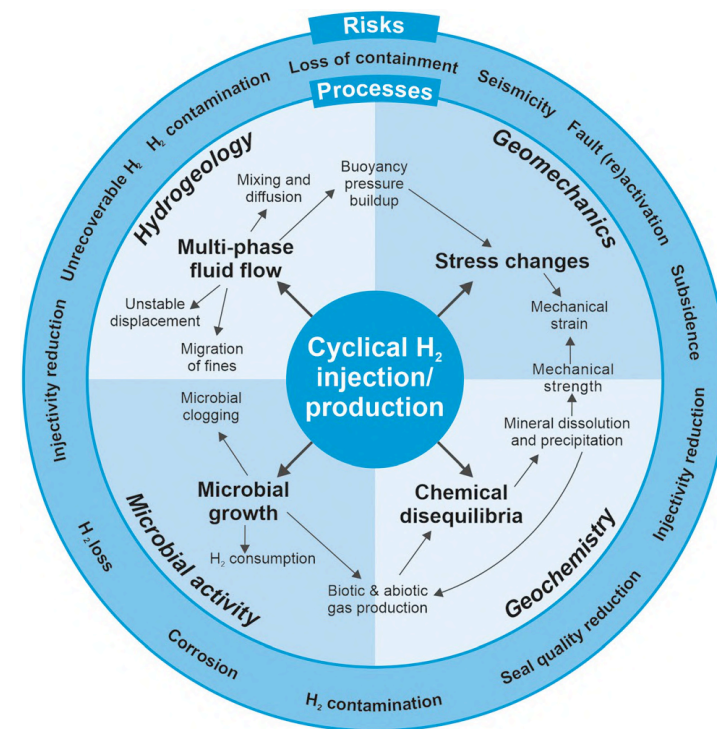
HyStorIES
HYDROGEN STORAGE IN EUROPEAN SUBSURFACE

- Call: H2020 FCH-02-5-2020 "Underground storage of renewable hydrogen in depleted gas fields and other geological stores"

- Duration: 24 months (2021-2022)
- Budget: 2,5 M€

Coordinator: GeoStock SAS (France)

OGS: CO2GeoNet third party

HyStorIES Hydrogen Storage In European Subsurface

CONCEPT

- **Renewable hydrogen**, when combined with large scale underground storage, balances out the impacts of **variable energy production** from renewable energy sources;

- While storing pure hydrogen in salt caverns has been practiced since the '70s in Europe, **hydrogen storage has not yet been carried out anywhere in depleted fields or aquifers**;

- Technical developments are still needed to validate this solution, i.e. **bio- and geo-chemical impacts** on the subsurface and **quality of hydrogen** extracted from the store.

HyStorIES** proposes to address the **main technical feasibility questions and to assess the techno-economical potential of underground large-scale storage of renewable hydrogen by 2050

OGS NEL PROGETTO HYSTORIES

- **Caratterizzazione avanzata** degli acquiferi salini italiani e dei giacimenti depleti potenzialmente idonei allo stoccaggio dell'idrogeno, sia a terra che a mare

- Implementazione del **database Hystories** dei potenziali siti di stoccaggio (acquiferi e campi depleti)

CRITERI

- Distanza da sorgenti sismogenetiche (Database of Individual Seismogenic Sources (DISS) M > 5.5 - INGV)

- Presenza di reservoir e caprock

- Profondità del reservoir > 500 m
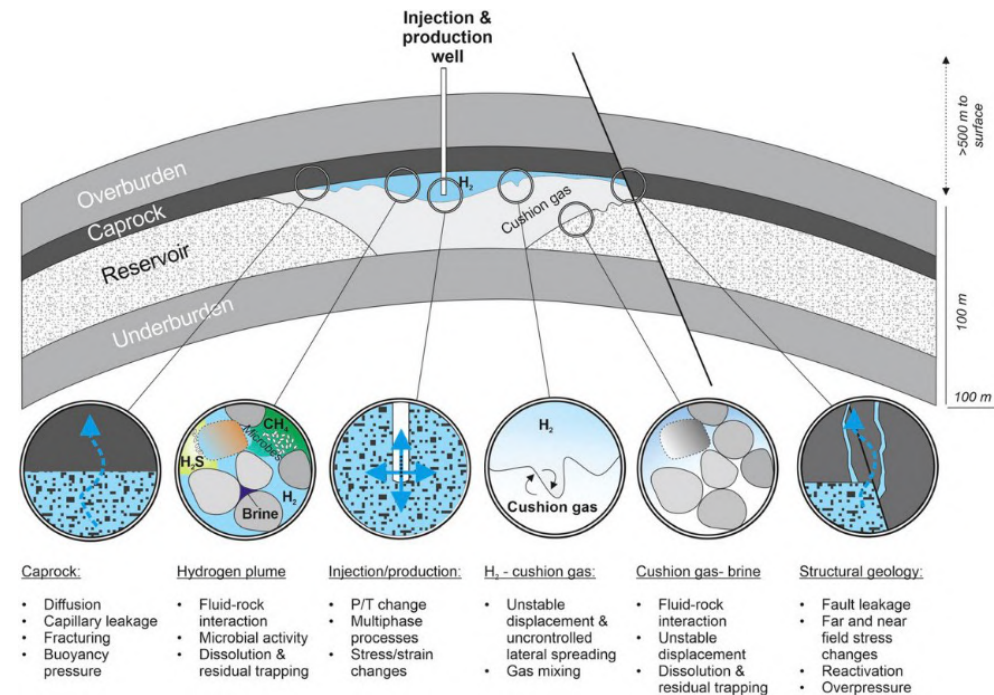
da Heinemann et al., 2021

OGS NEL PROGETTO HYSTORIES

Analisi dei logs di pozzo e revisione dei precedenti studi sugli acquiferi

- Acquiferi profondi terrigeni e carbonatici già identificati come possibili siti di stoccaggio della CO_2 (Donda et al., 2011; Civile et al., 2013)

- Acquiferi superficiali individuati dai logs di pozzo (database ViDEPI)

- Campi depleti ad idrocarburi, inclusi quelli attualmente usati come stoccaggio di gas naturale (*https://unmig.mise.gov.it/index.php/it/dati/stocc aggio-del-gas-naturale*)

SITES POTENTIALLY SUITABLE FOR HYDROGEN STORAGE IN THE VENETO-FRIULI PLAIN REGION
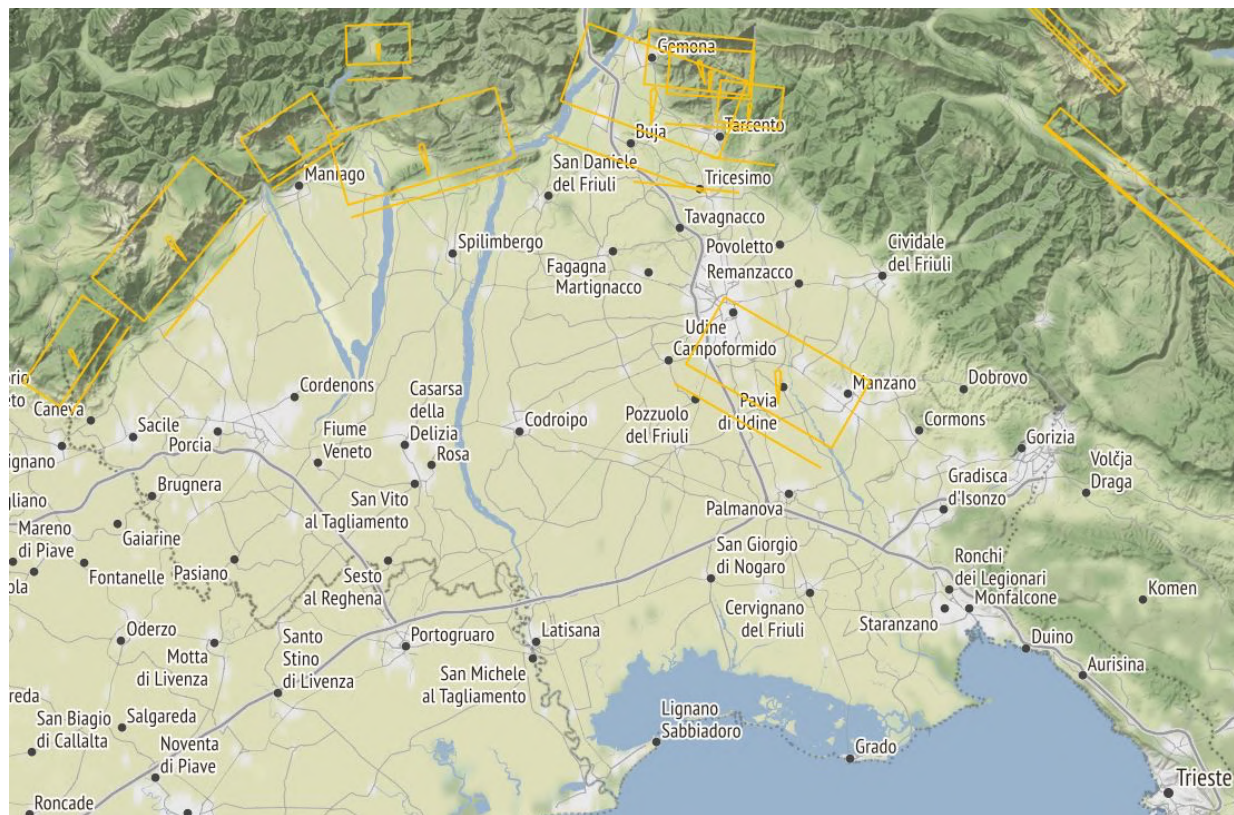
S. Mattera thesis work

SITES POTENTIALLY SUITABLE FOR HYDROGEN STORAGE IN THE VENETO-FRIULI PLAIN REGION

17 boreholes available from the «Visibility of petroleum exploration data in Italy (Videpi)» database

S. Mattera thesis work

NOT SUITABLE AREAS

- Per mancanza di potenziale complesso di stoccaggio (Cesarolo 1, Cavanella 1 e Cusignana 1)

- Per prossimità a faglie sismogeniche (Bernadia 1, Buttrio 1, Cargnacco 1, Gemona 1, Lavariano 1, Terenzano 1)

S. Mattera thesis work

INDIVIDUAL SUITABLE WELLS
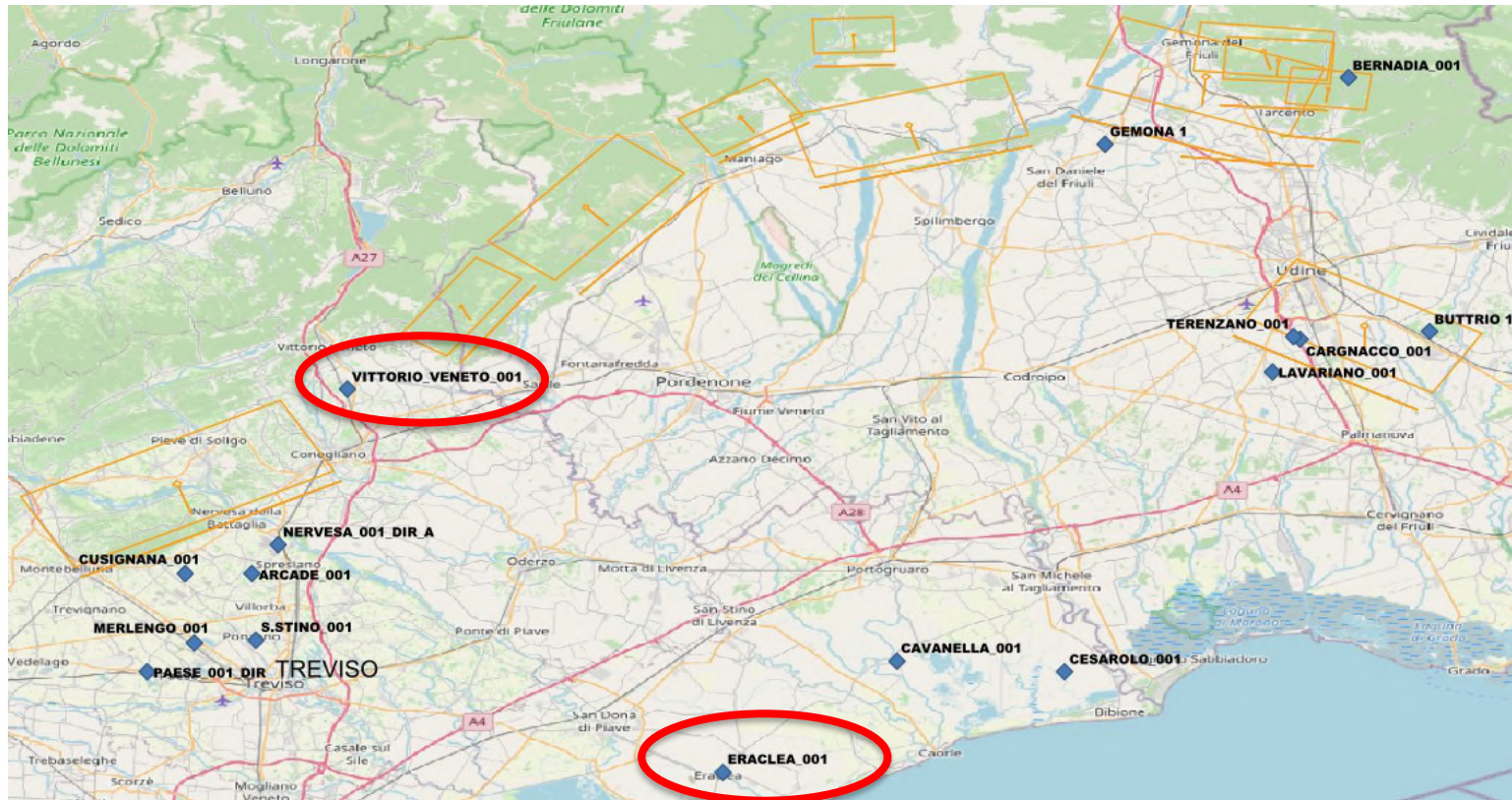
Reservoir: Late Cretaceous/Eocene limestones
    thickness: ca. 180 m
Caprock: Eocene marls
    thickness: ca. 860 m

S. Mattera thesis work

THE «TREVISO SITE»

- 7 boreholes
- 5 suitable boreholes

Reservoir: early Miocene sandstones (Glauconie di Cavanella)
 Thickness: min 115 m, max 290 m

Caprock: Tortonian Marls (Marne di San Donà)
 Thickness: min 160 m, max 950 m

Porosity evaluation from geophysical logs: 10-28%

S. Mattera thesis work
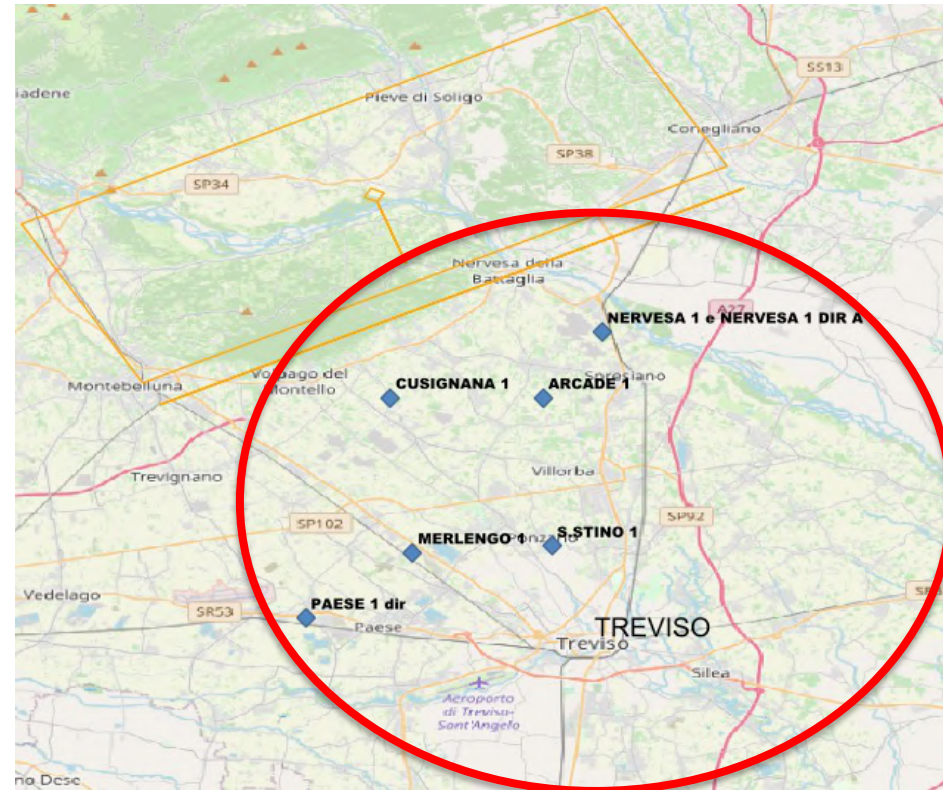
UNDERGROUND GAS STORAGE

Depleted gas reservoirs are one of the safest types of underground gas storage, as gas has been trapped inside at the confining pressure for millions of years.

The reservoir is a geological trap with porous and permeable rock layers, tens to hundreds of meters thick, sealed by impermeable formations.
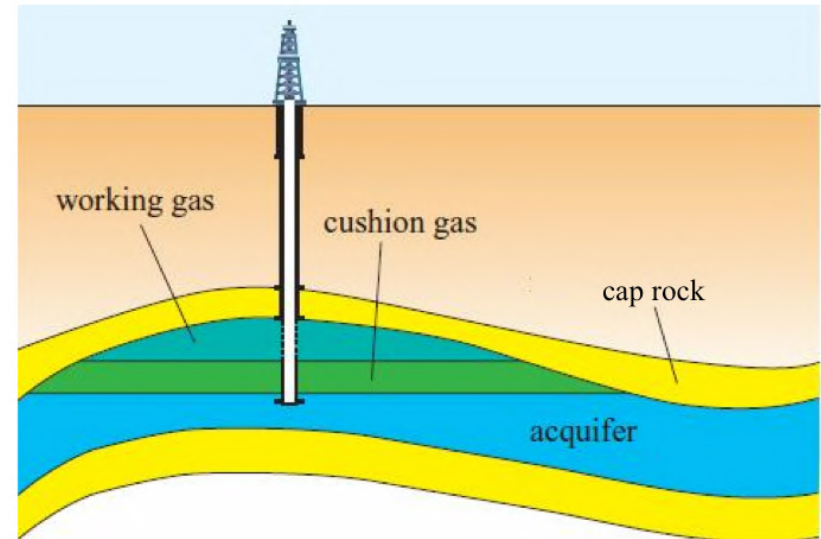
EXAMPLES
Italy has **15 active** underground gas storage, all in depleted gas reservoirs. No evidence of induced seismicity, ever.

Hutubi (China) is one of the biggest underground gas storage (WGV ≈ 10 billion Sm^3). First case of weak earthquake (M ≈ 2.8-3) hypothesized to have been induced by underground gas storage, by poro-elastic stress diffusion *(Qiao et al, 2018; Zhou et al, 2019).*

Underground gas storage in **depleted oil-reservoirs** is much **less safe**; e.g., the Castor Project (Spain)

Slide kindly provided by E. Priolo-OGS

UNDERGROUND GAS STORAGE

- 15 campi attivi
- 7 richieste pendenti

Capacità totale di stoccaggio:
16.5 Miliardi Sm^3, di cui
4.6 di riserva strategica

Pressione max di esercizio:
130-230 bar

(Sm^3 = metro cubo standard)

In Italia sono utilizzati
esclusivamente depositi
depleti; per nessun caso si
ha notizia di sismicità indotta
o innescata.

Brugherio (MI)	Collalto (TV)
Settala (MI-LO)	Romanengo (CR)
Sergnano (CR-BG)	Bagnolo Mella (BS)
Ripalta (CR)	Alfonsine (RV)
Cornegliano (LO)	S. Potito (RV)
Cortemaggiore (PC)	Sabbioncello (FE)
Bordolano (CR-BS)	Minerbio (BO)
	Palazzo Moroni (AP)
	S.Benedetto (AP)
	Cellino (TE)
	PoggioFiorito (CH)
	Fiume Treste (CH-CB)
	Sinarca (CB)
	Serra Pizzuta (MT)
	Cugno le Macine (MT)

Existing
Pending
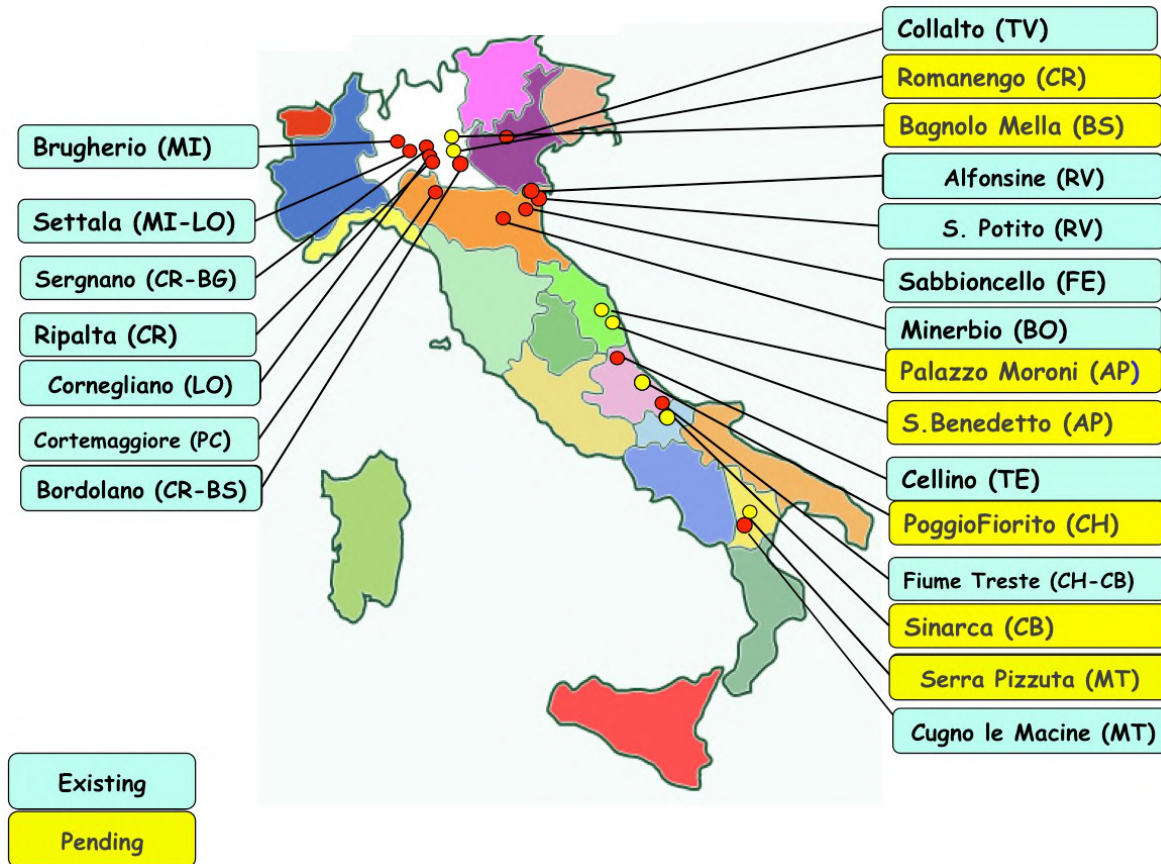
*Dati del Ministero dello Sviluppo Economico (MiSE)
Ultimo aggiornamento: febbraio 2021*

Slide kindly provided by E. Priolo-OGS

CRITERI

- Distanza da sorgenti sismogenetiche (Database of Individual Seismogenic Sources (DISS) M > 5.5 - INGV)

- Presenza di reservoir e caprock

- Profondità del reservoir
- > 500 m

da Heinemann et al., 2021

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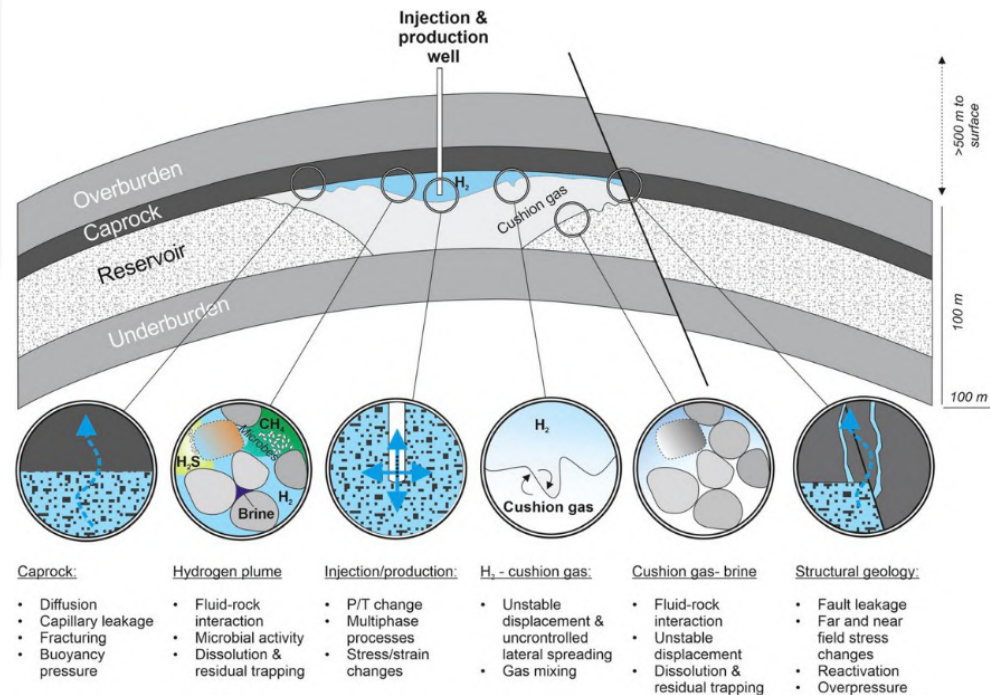
THE ROLE OF THE GEOLOGICAL-STRUCTURAL SETTING

"Gas fields and large shallow seismogenic reverse faults are anticorrelated"

Valensise G., Donda F., Tamaro A., Rosset G., Parolai S.
Sci. Rep., minor revisions requested
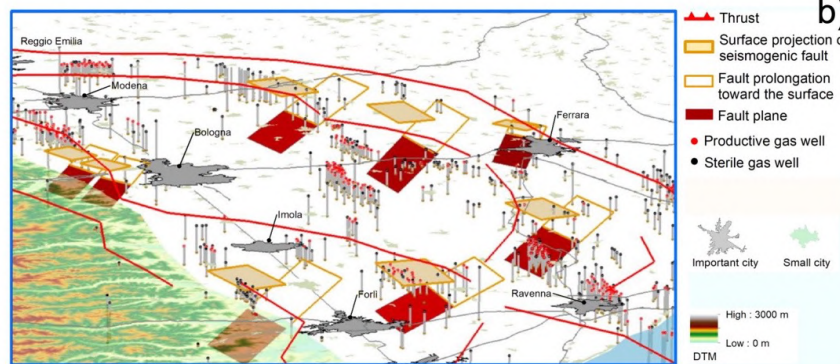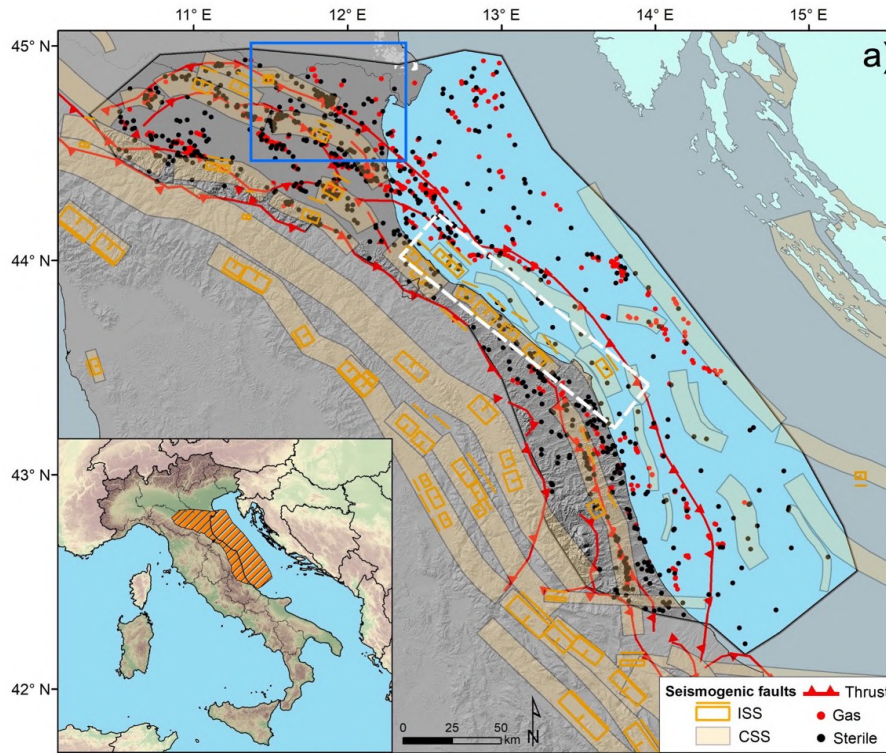
THE ROLE OF THE GEOLOGICAL-STRUCTURAL SETTING
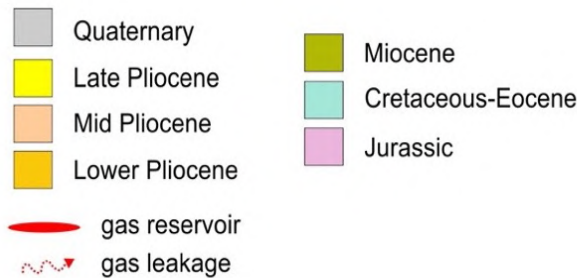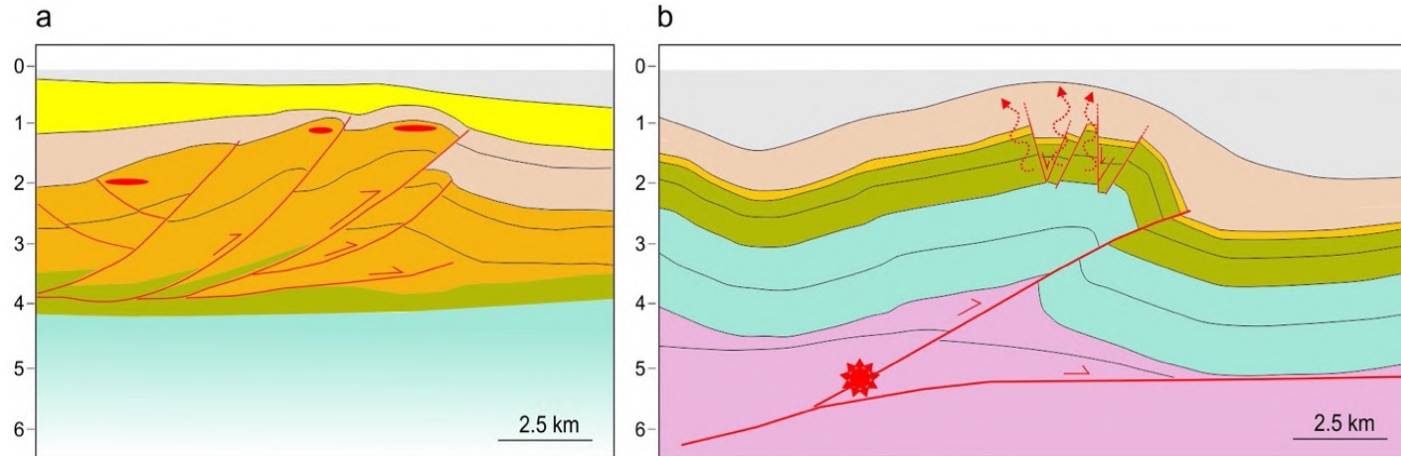
Valensise G., Donda F., Tamaro A., Rosset G., Parolai S., Sci. Rep., minor revisions requested

The most **productive reservoirs** are hosted in **small-scale anticlines** (Figure a-left), generated by faults that are shorter and narrower with respect to the **deep and large faults** driving long-wavelength folds that may generate significant **earthquakes** and where **gas is generally not found** (Figure b-right)

THE ROLE OF THE GEOLOGICAL-STRUCTURAL SETTING

- In a fold and thrust hydrocarbon province the lack of productive gas reservoirs is likely to be controlled by seismogenic faulting

- Conversely, the presence of significant reservoirs is in itself an indication of a predominantly aseismic behavior of the underlying faults

Our findings indicate that the best option for planning energy storage facilities is to **stay away from large seismogenic faults** and opt for a depleted reservoir

Valensise G., Donda F., Tamaro A., Rosset G., Parolai S., Sci. Rep., minor revisions requested

INDUCED AND TRIGGERED SEISMICITY

In the case of **induced earthquakes**, the nucleation, growth, and rupture process are determined by human-related stress perturbations.

In the case of **triggered seismicity**, the background stress field plays a more important role, and human activities are only responsible for the earthquake nucleation, while the rupture evolution is controlled by the background stresses (Dahm et al., 2013)

Strictly speaking, human activities CANNOT "induce" huge and devastating events, whereas they can trigger them.

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HUMAN-INDUCED EARTHQUAKES IN THE WORLD

To date, about 1200 entries of induced seismicity

http://inducedearthquakes.org/
(Wilson et al, 2017; Foulger et al, 2018)

Slide kindly provided by E. Priolo-OGS

INDUSTRIAL ACTIVITIES INDUCING EARTHQUAKES

Grigoli et al (2017)
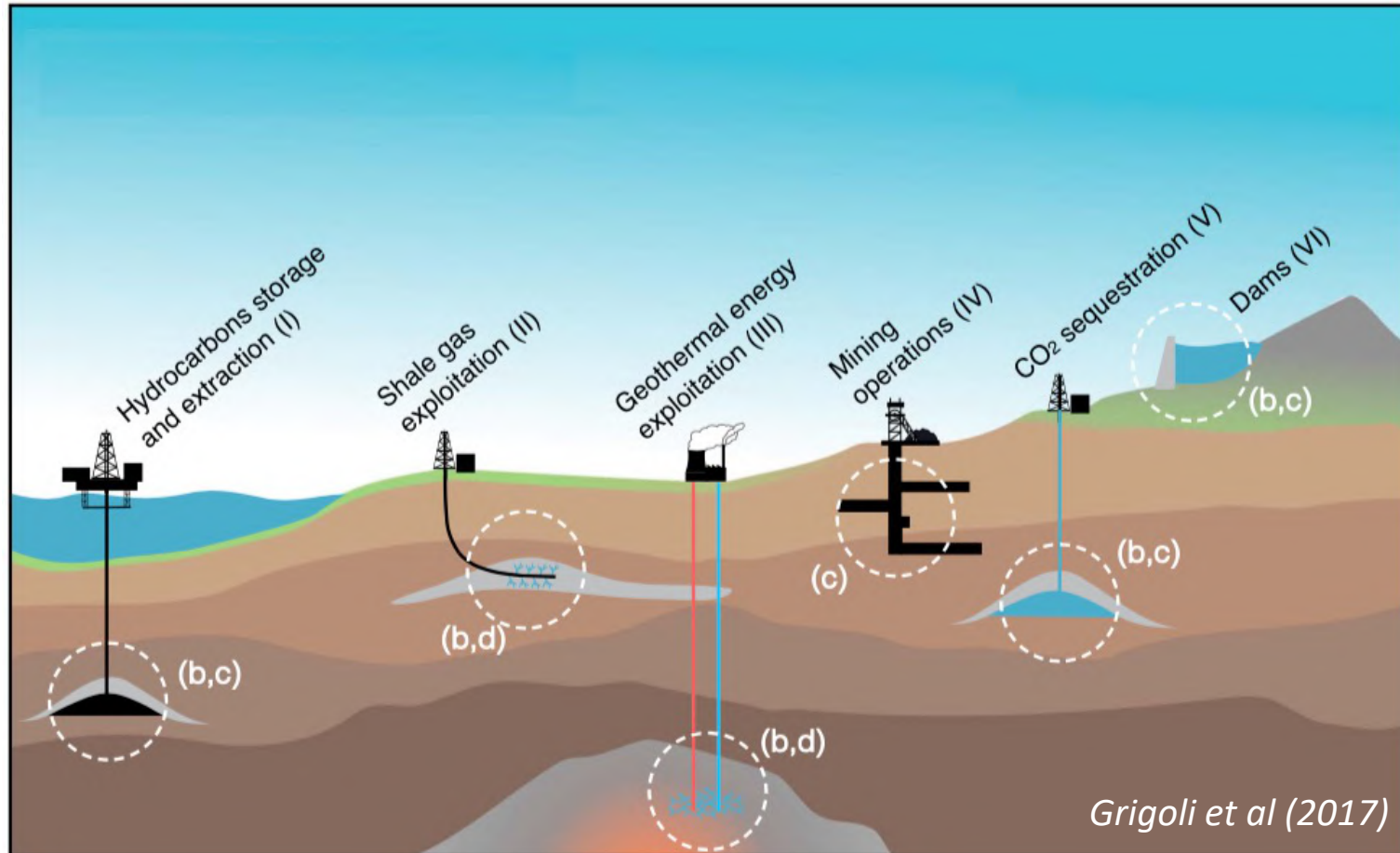
MAIN MECHANISMS FOR INDUCING EARTHQUAKES

- increasing the pore pressure acting on a fault

- changing the shear and normal stress acting on the fault

Ellsworth (Science, 2013)

Slide kindly provided by E. Priolo-OGS
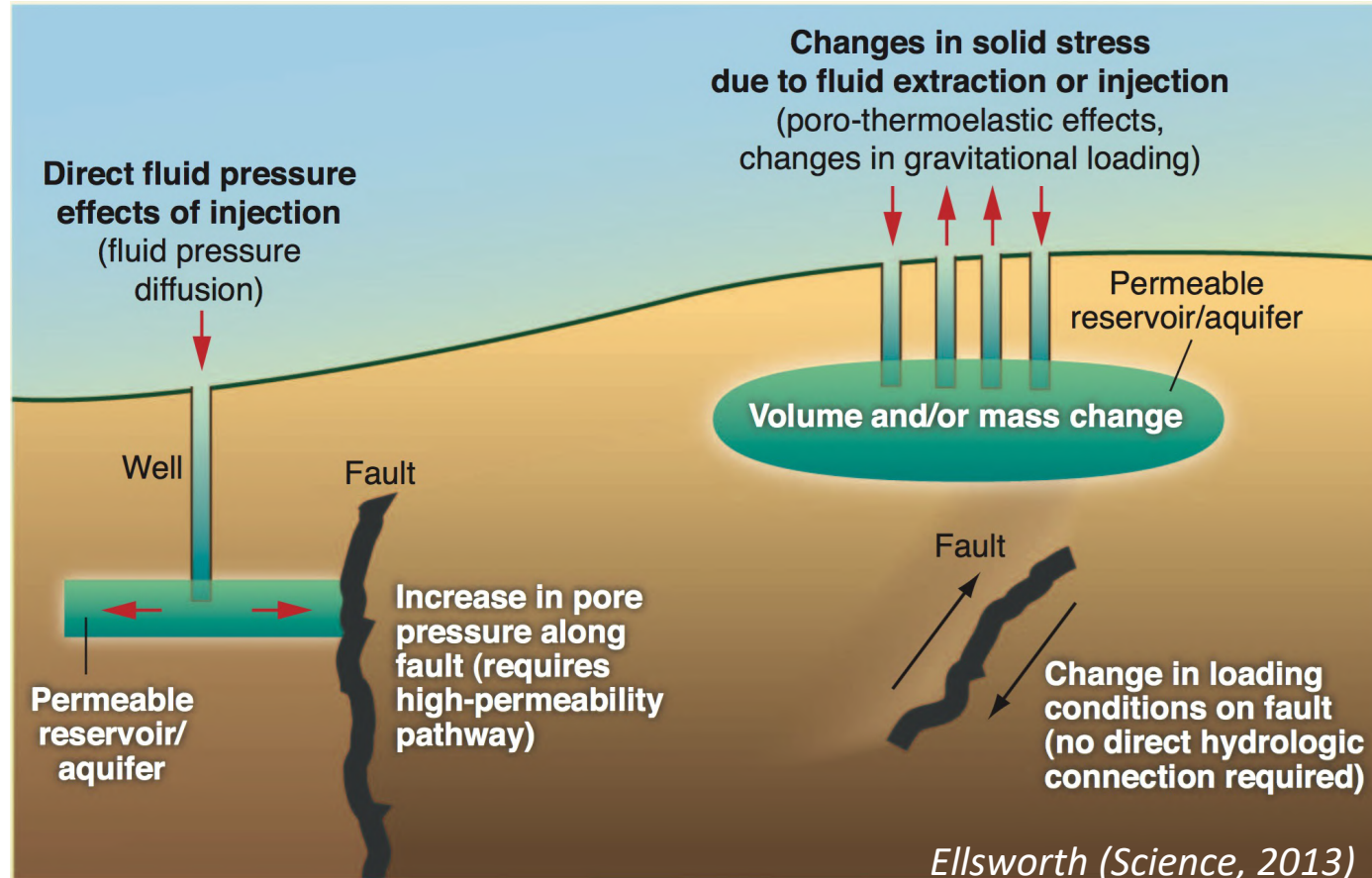
OGS GAS STORAGE MONITORING

OGS carries out the monitoring of two storage sites in depleted gas fields

Collalto
*(Edison Stoccaggio S.p.A.)
dal 2012*
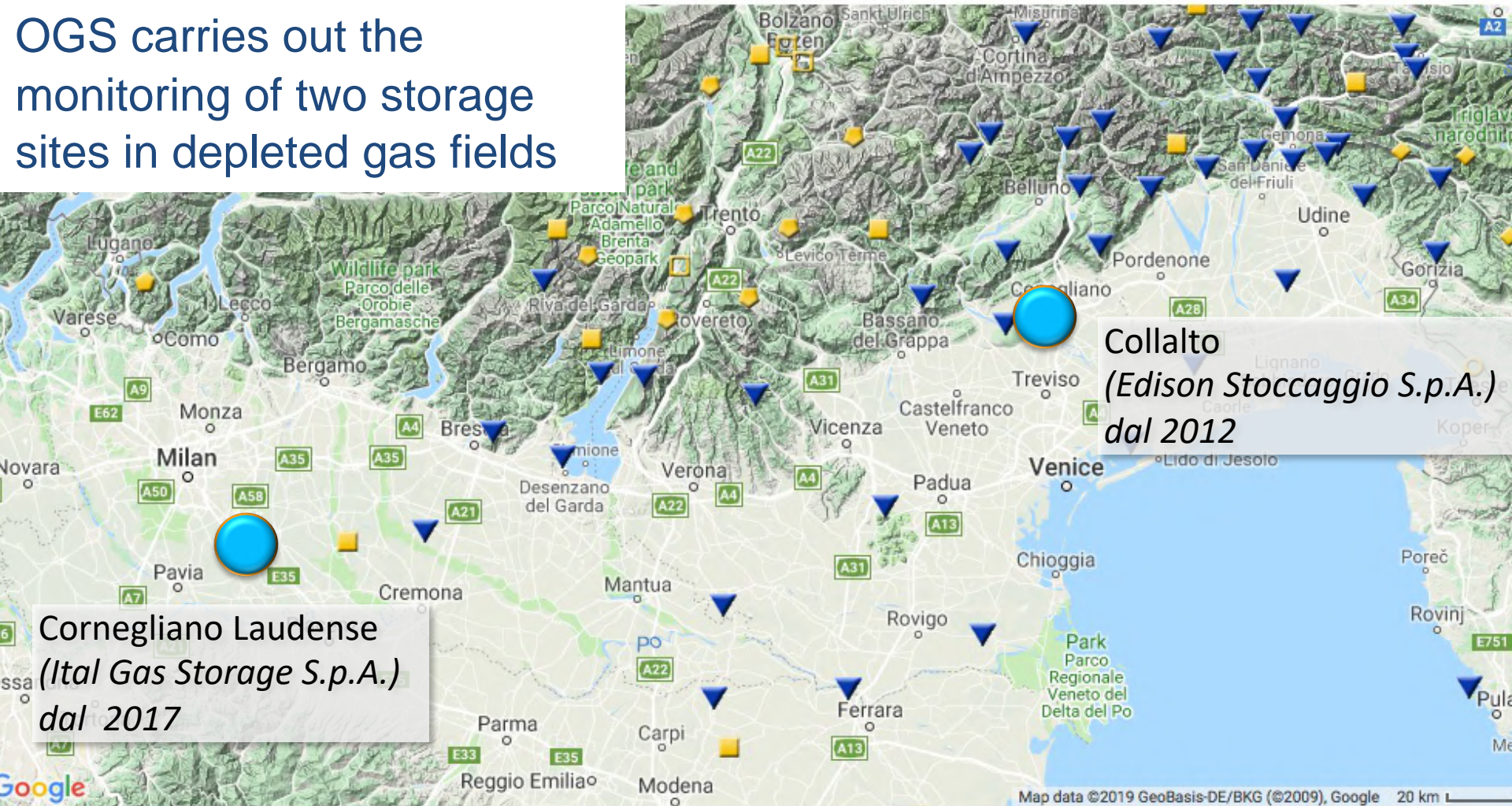
Cornegliano Laudense
*(Ital Gas Storage S.p.A.)
dal 2017*

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OGS GAS STORAGE MONITORING

Stazione sismica + GPS

75 m deep wells

Strumentazione Guralp:
- Minimus
- Radian
- Fortis

Bocca pozzo + accelerometro (Fortis)

Sismometro da pozzo (Radian)

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ITALIAN MONITORING GUIDELINES

Nel 2014 il MiSE-DGRME istituisce il Gruppo di Lavoro per la redazione di **Indirizzi e Linee Guida** (ILG) per i monitoraggi delle attività di coltivazione di idrocarburi, stoccaggio sotterraneo di gas naturale e reiniezione di fluidi nel sottosuolo svolte on-shore.

unmig.mise.gov.it > sicurezza > geomonitoraggi

Composizione del gruppo:

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Dott. Claudio Chiarabba (INGV, Roma)

Dott.ssa Daniela Di Bucci (DPC, Roma)

Prof. Carlo Doglioni (Univ. La Sapienza, Roma)

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Ing. Riccardo Lanari (CNR–IREA, Napoli)

Dott. Enrico Priolo (OGS, Trieste)

Prof. Aldo Zollo (Univ. "Federico II", Napoli)

MiSE = Ministero per lo Sviluppo Economico

DGRME= Direzione Generale per le Risorse Minerarie ed Energetiche

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