CESI RICERCA

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A preliminary study of the CO2 storage potential of Italian geological reservoirs based on the interpretation of deep well data

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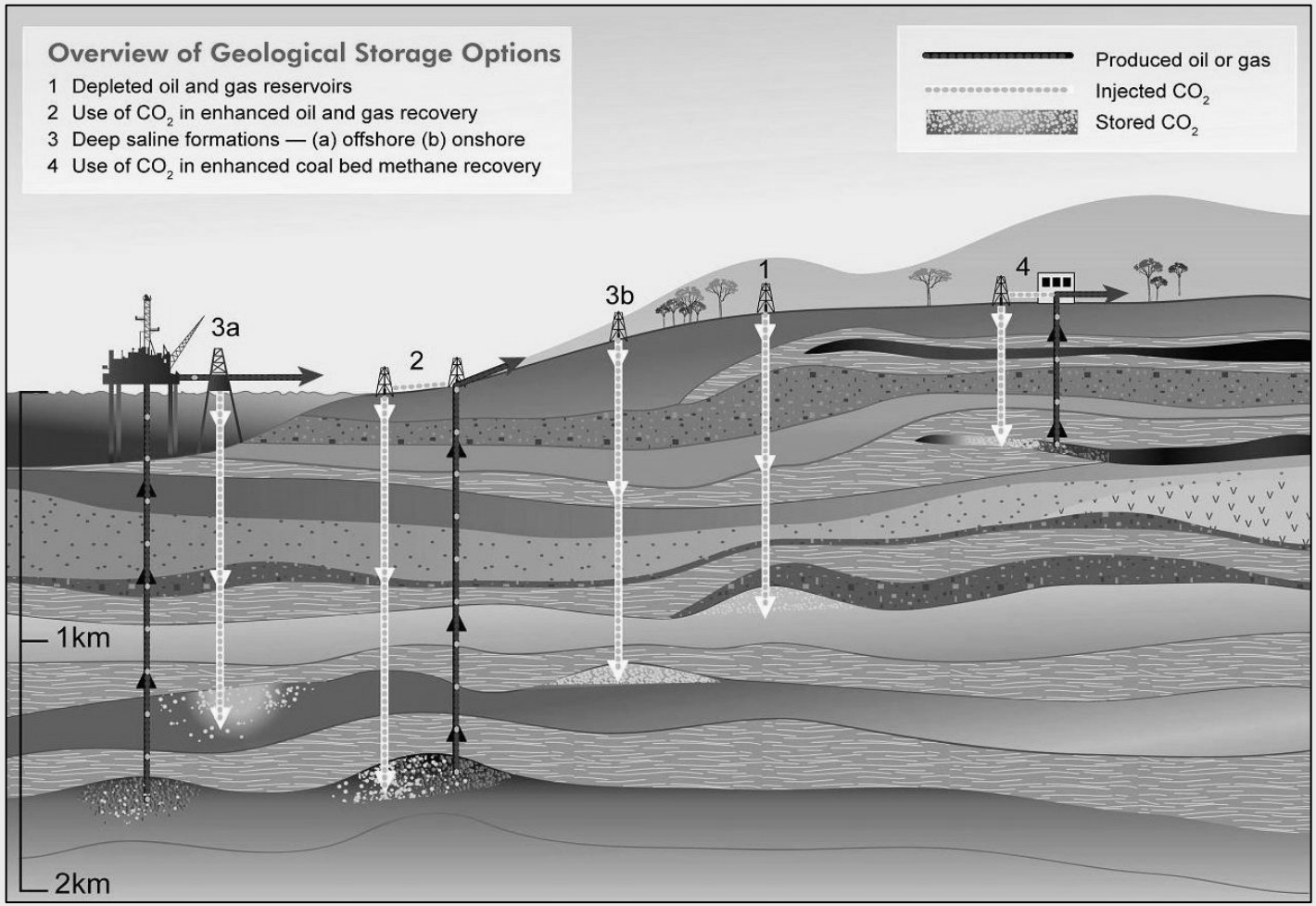
Geological Storage of CO_2

CO_2 storage in geological formations can be done in:

- ***✓Depleted oil/gas fields and with EOR/EGR***
- ***✓Deep saline formations (off and on-shore)***
- ***✓unminable coal formations and with ECBM***



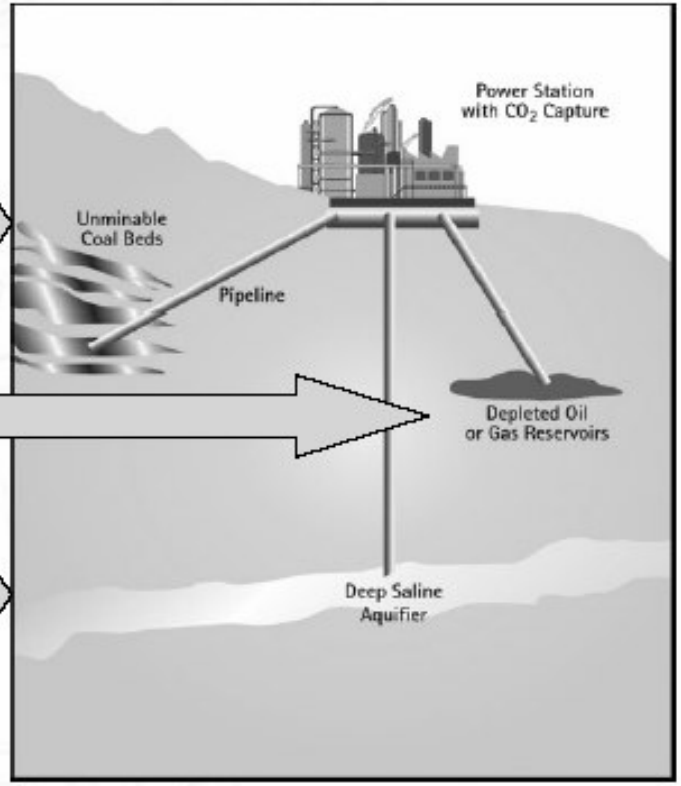
Potential sites for CO2 storage

The global level of storage capacity has been estimated by H.Audus (IEA, 2006) as:

Unminable Coal Seams
30 Gt CO_2
Able to store <2 Years of 2030 Emissions

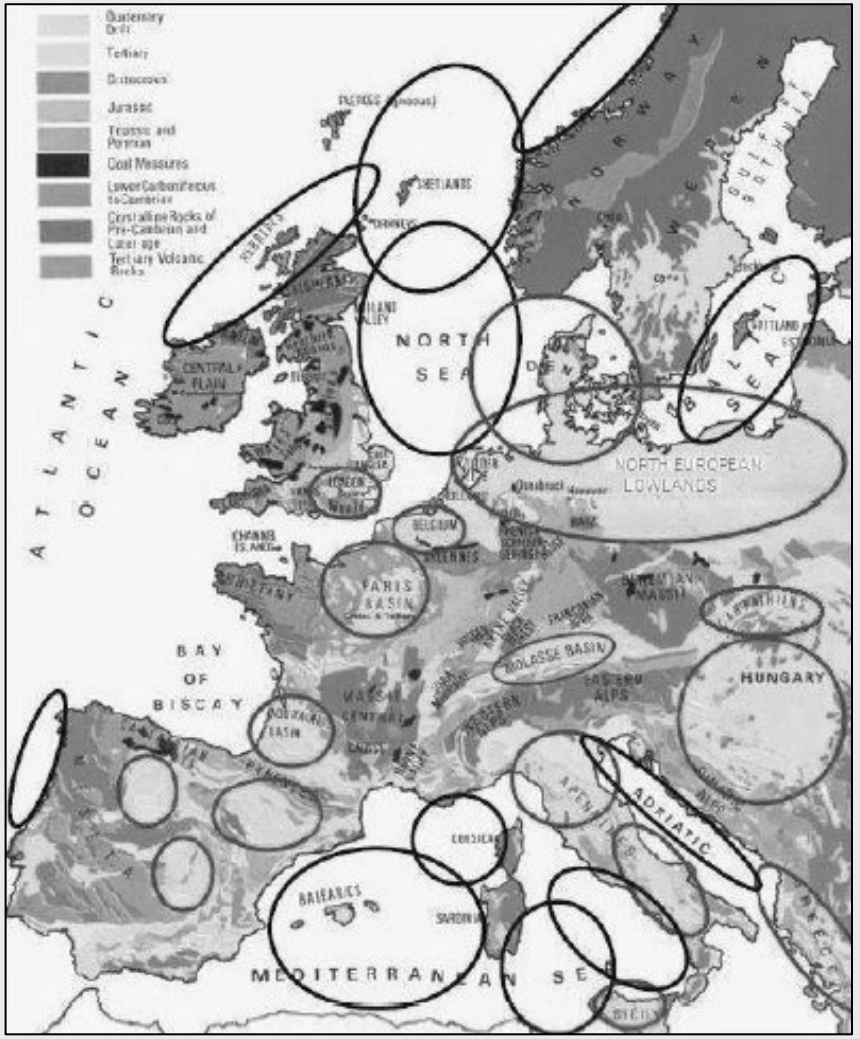
Depleted Oil & Gas Fields
930 Gt CO_2
Able to Store 50 Years of 2030 Emissions

Deep Saline Aquifers
400-10 000 Gt CO_2
Able to store 20 - 530 Years of 2030 Emissions



Potential areas for geological storage in Europe

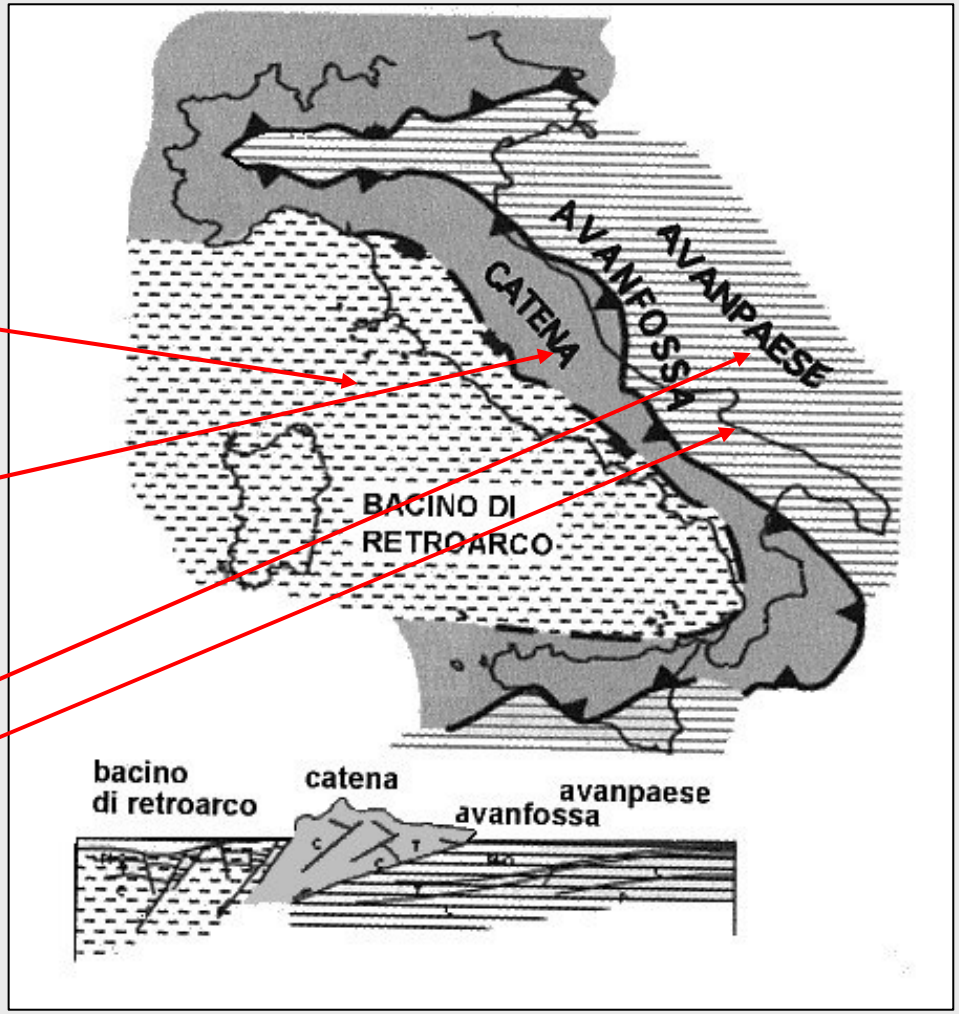
In the EU ZEP - Zero Emission Fossil Fuel Power Plans-, Strategic Deployment Document (2006), the European areas for geological storage of CO2 are indicated



Geology of Italy

The geology of Italy is quite complex and characterized by:

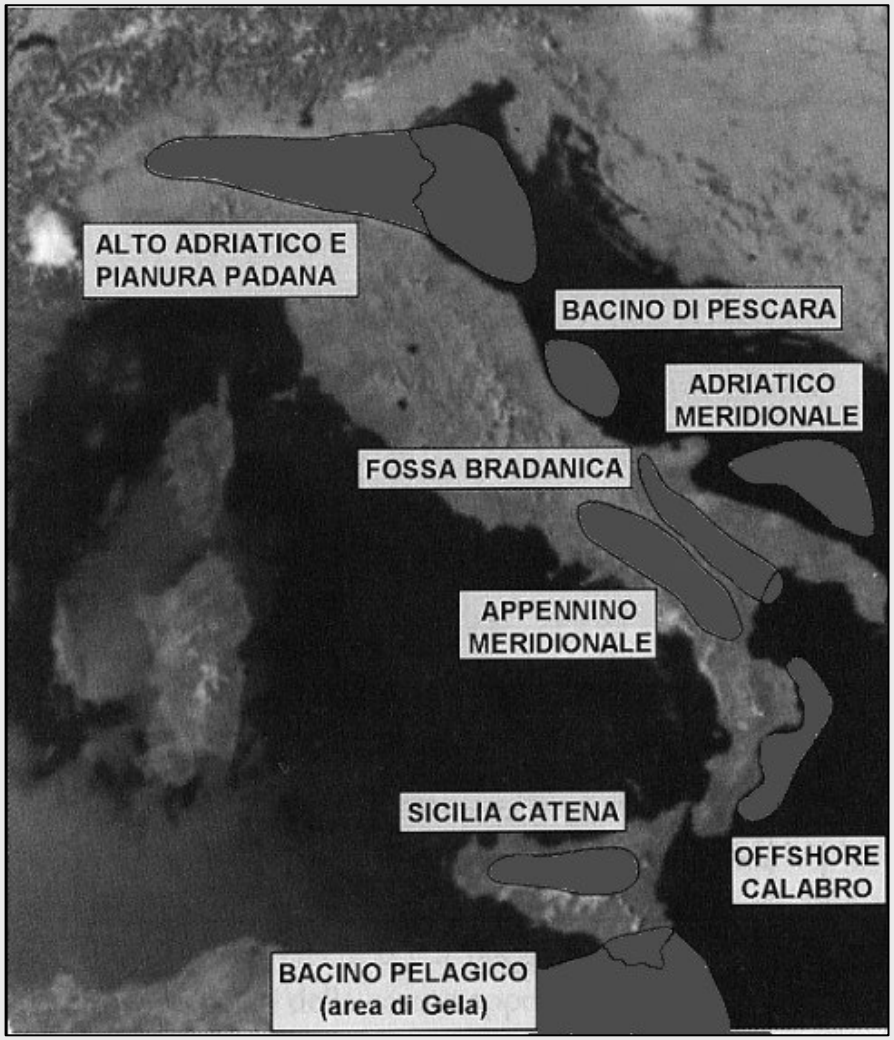
- ✓ ***a back-arc basin with extensional tectonic***
- ✓ ***a thrust belt area (Alpine orogenesis and Apenninic compressional tectonic regime)***
- ✓ ***a foreland areas (avampaese)***
- ✓ ***a foredeep deposit area (avanfossa)***



Italian gas and oil areas

The gas and oil exploration in Italy has been mainly carried out by ENI-AGIP in several sedimentary basins as:

- ✓ *Po plain and Northern Adriatic sea*
- ✓ *Pescara basin*
- ✓ *Southern area of Adriatic sea*
- ✓ *Bradanic trench*
- ✓ *Southern Apennines*
- ✓ *Sicily belt*
- ✓ *Calabrian offshore*
- ✓ *Pelagic basin of Gela*



Geological data from deep wells

6864 deep wells have been drilled in Italy for gas/oil exploration and:

- ✓ *1596 deep wells are available as paper copies or digital scanners (only 152 at date of the present paper) at General Department of Energy and Mineral Resources - National Mining Office for Hydrocarbons and Geothermal Resources of the Italian Ministry of Productive Activities*
- ✓*2770 deep wells exist but are not available*
- ✓ *2428 deep wells are lacking*

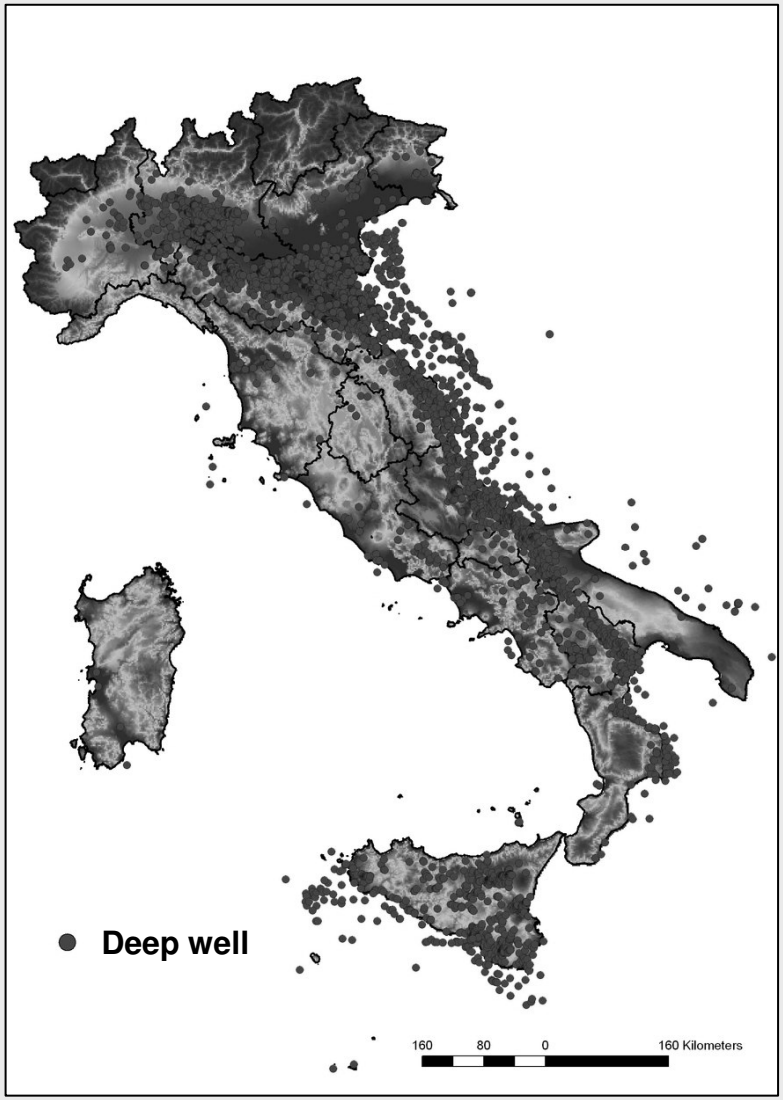
For a set of 70 deep wells, data are not complete and without coordinates

Deep wells drilled in Italy

Position of the 6797 wells drilled in Italy from 1895 to 2005 for hydrocarbon exploration (70 deep wells are without coordinates and not displayed in the map)

Only 640 wells were drilled before 1950

Other 948 deep wells for geothermal exploration exist but we don't consider them in this analysis (mainly drilled in Tuscan and Latium areas by ENEL – National Electric Power Board)

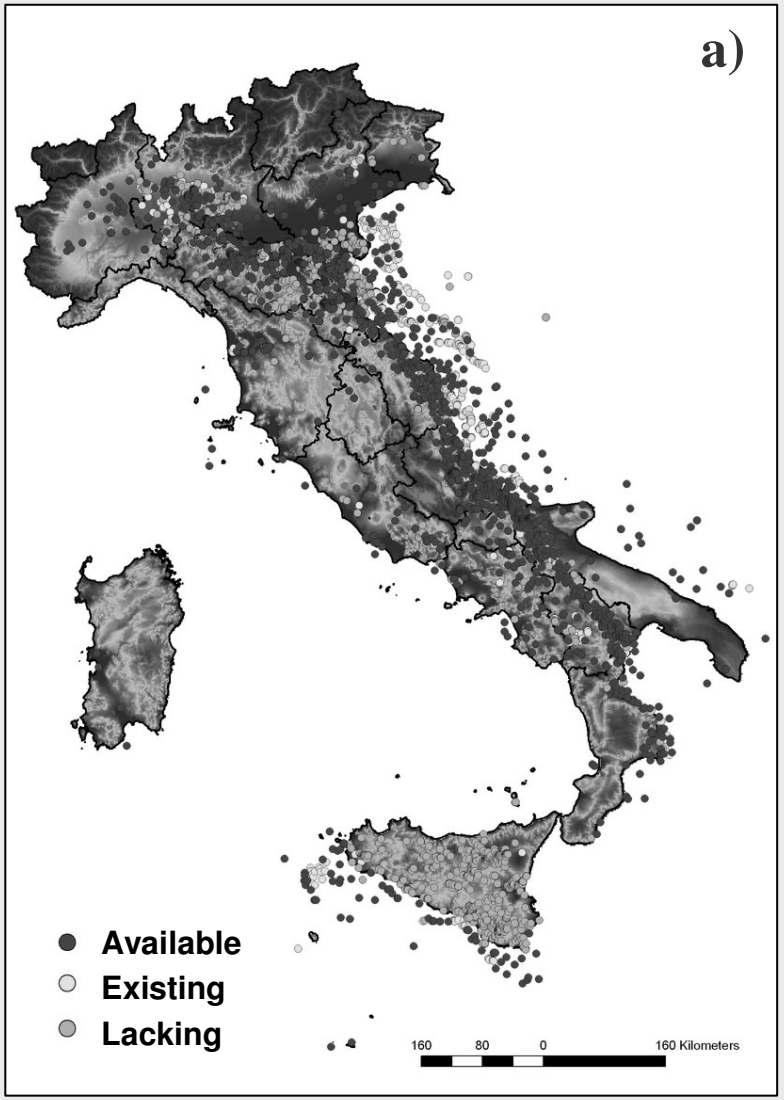


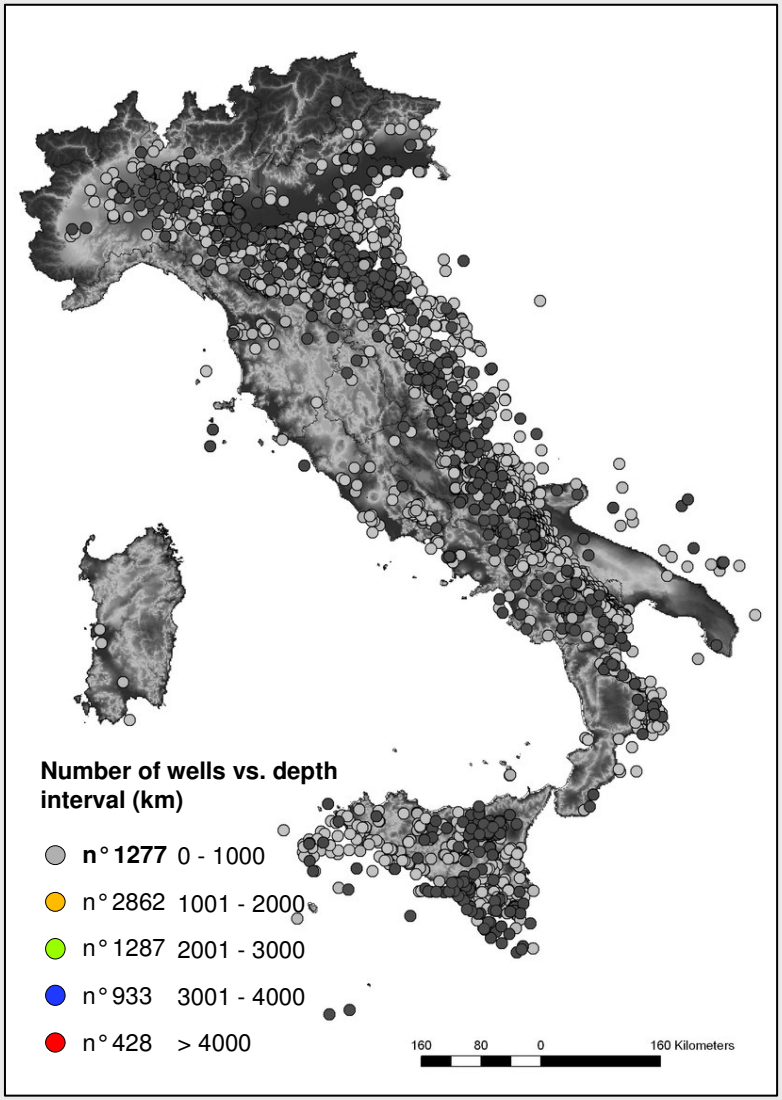
Deep wells drilled in Italy

- **Position of the 6797 deep wells drilled in Italy for hydrocarbon exploration**

a) **Availability**

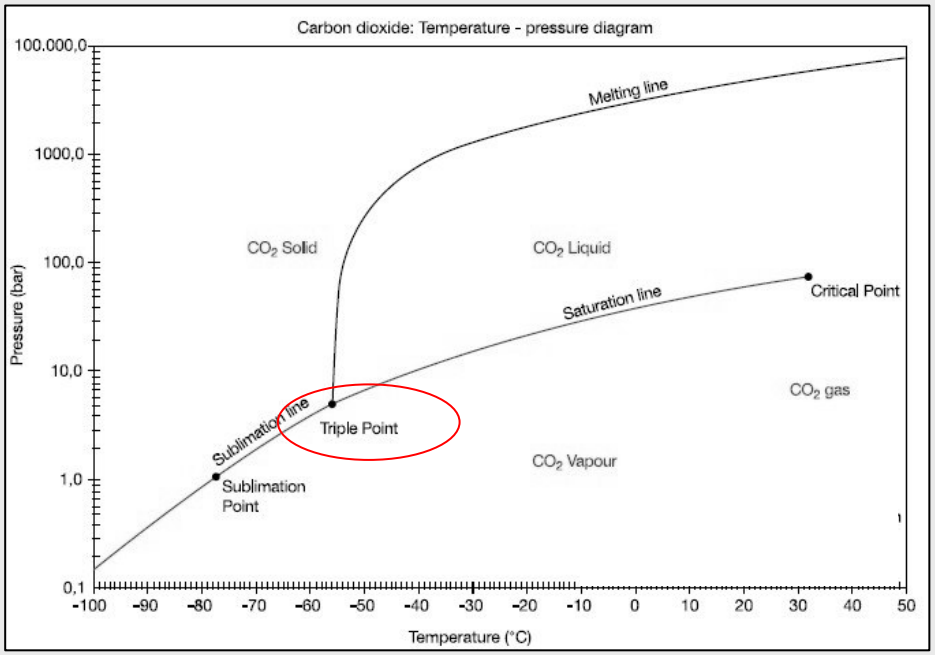
b) **Depth interval (km) from ground surface**

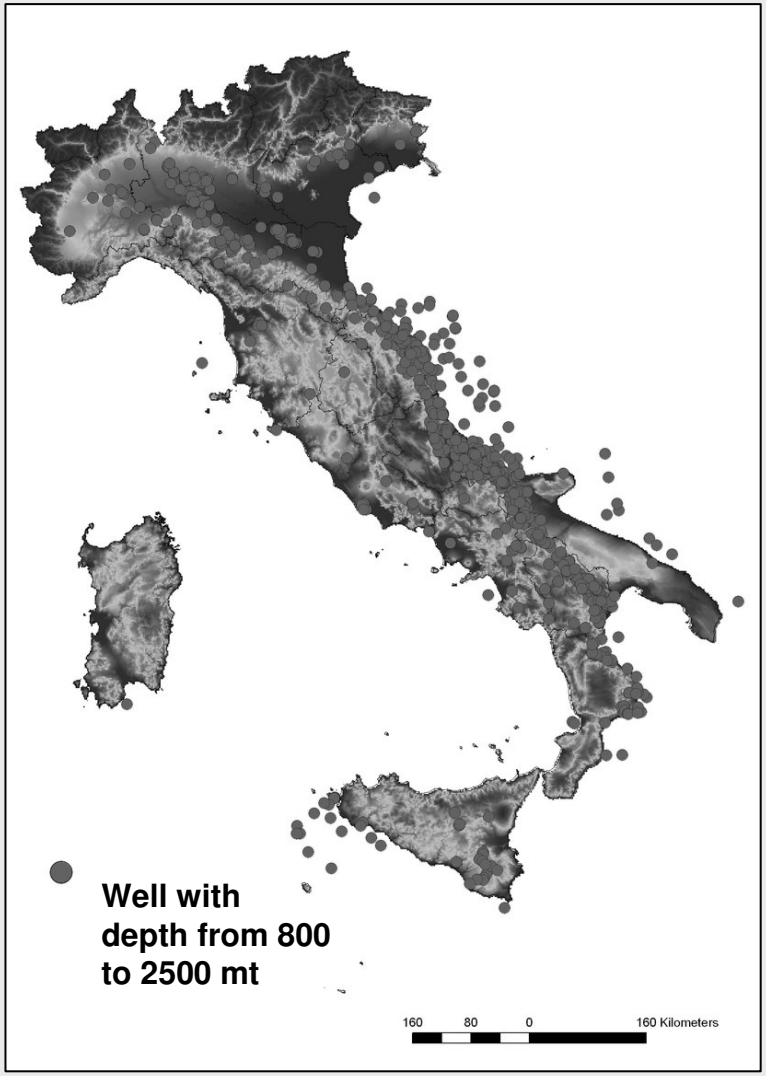




First set of deep wells analyzed

To characterize the Italian country for CO_2 geological storage a first set of <u>746</u> <u>"public" wells</u> has been analyzed and their depth is between 800 and 2500 meters so the CO_2 can be considered in supercritical condition (triple point of CO_2 diagram)

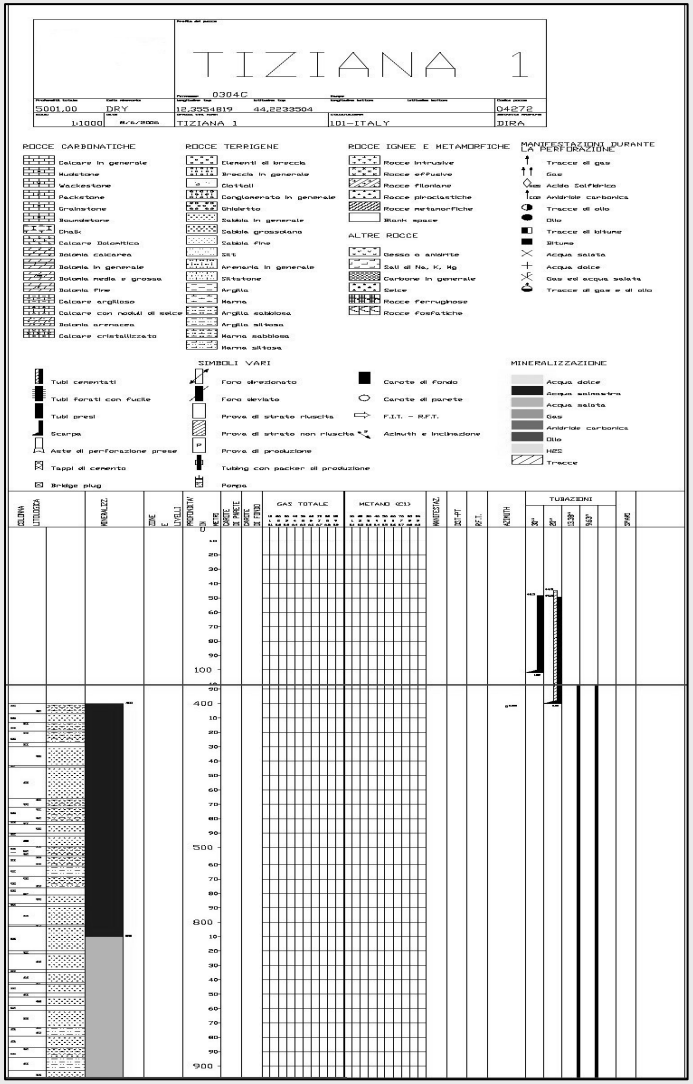




Deep well parameters

For each investigated well different parameters have been extracted for studying the suitability of geological caprock and introduced into a GIS data base:

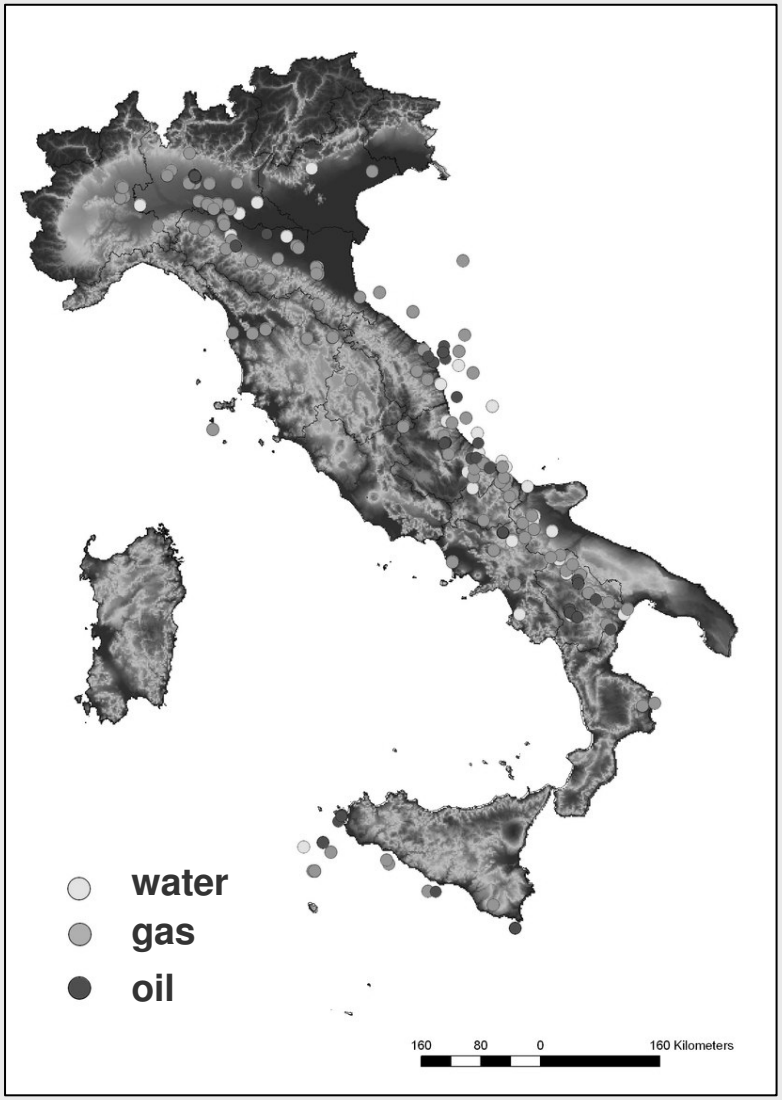
- ***stratigraphy of sediments/rocks (thickness and age of each litotype)***
- ***presence of saline aquifers and hydrocarbons (oil and/or gas)***
- ***physical-chemical analyses when available***



Wells with available physical and chemical analyses

The physical/chemical analyses in well recovered and introduced into the data-base are:

- ***water: n. 78 analyses from 58 wells***
- ***gas: n. 212 analyses from 148 wells***
- ***oil: n. 52 analyses from 35 wells***



Well Quality Factor

✓ *To evaluate the Caprock Quality Factor for each well the different geological litotypes are classified with a code from 1 to 5 as a function of their impermeability (Cl_i, e.g. Cl_i =1 for permeable rocks as gravel and breccias and Cl_i =5 for impermeable siltstones and claystones) and their thickness (Sp_i)*

✓ *Then a factor called Fb_i has been calculated as the ratio between the product of impermeability code and thickness of the litotype, Cl_i and Sp_i, and an optimal impermeable caprock thickness forced to 800 mt for maxima safety (Sp_c=800 mt)*

$$Fb_i = \frac{Cl_i \cdot Sp_i}{Sp_c}$$

✓*The Well Quality Factor (Fb_p) can be calculated by using the simple following expression*

$$Fb_p = \sum_{i=1}^{n} \frac{Fb_i}{n}$$

Where n represents the number of considered litotypes over the storage aquifer below an impermeable caprock

- ***La storia geologica dell'Italia è molto complessa e ha dato alla penisola un assetto strutturale e sedimentario complicato. Questo non ha favorito la formazione di grandi ed estesi bacini petroliferi ma ha creato localmente situazioni favorevoli alla formazione di numerose province petrolifere di una certa importanza, anche se di non grande estensione.***
- ***Il nostro Paese può, dal punto di vista tettonico, essere suddiviso in*** *4 "distretti"*, ***tutti legati alla presenza delle catene alpina e appenninica (vedi figura 7.12):***
- ***un "*****bacino di retroarco*****", area poco deformata costituita dal Mar Tirreno;***
- ***un'*****area di catena*****, che costituisce un grande "arco" che va dalle Alpi agli Appennini, fino a costruire l'ossatura della Calabria e della Sicilia;***
- ***un*** **area di "avanfossa"**, ***un bacino depresso e poco deformato che si trova al fronte delle catene montuose che avanzano sul cosiddetto "avampaese", rappresentata dal margine adriatico e ionico e dal Canale di Sicilia;***
- ***un "*****avampaese*****", zona non ancora deformata verso la quale avanzano le catene montuose in formazione, costituita dalla Pianura Padana, dal Mare Adriatico, dalla Sicilia Sud-orientale e dal Canale di Sicilia.***