

EDISON STOCCAGGIO S.P.A.

Micro-seismic monitoring

Our best practice

WOC 2 meeting in Pau, France, March 19 - 21, 2014

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Introduction



11 “conventional” gas storages are in operation in Italy

They are located in the Po plain or Alpine/Appenninic foreland and some of them near to seismically active structures.

Storage vs seismic activity

1. The application of “**Seveso Directive**” in 2010.



2. The **Emilia Romagna earthquake** of may 2012

CORRIERE DELLA SERA

Emilia, nelle zone devastate dal terremoto
via libera agli accertamenti per deposito gas

*Maxi deposito sotterraneo per 3,2 miliardi di metri cubi.
Il ministro Clini: progetto da riconsiderare. I Verdi: follia.*

3. The supposed **Groningen** gas field
case in 2013





4. The supposed **Castor** storage case
in 2013



Collalto Seismic Network (CSN)

Following this climate and according a ministerial prescription Edison Stoccaggio decided to entrust OGS with the task to design, build, manage and process data of CSN in order to obtain:

- **Versus ES:**  a high-quality service with an added value in terms of scientific support;
- **Versus:**
General Public  the maximum of the quality in the monitoring, and objectivity in terms of evaluation of data and the public access of data.

OGS = National Institute of Oceanography and Experimental Geophysics of Trieste

Collalto Seismic Network (CSN)

The Collalto Seismic Network consists of ten seismometric stations

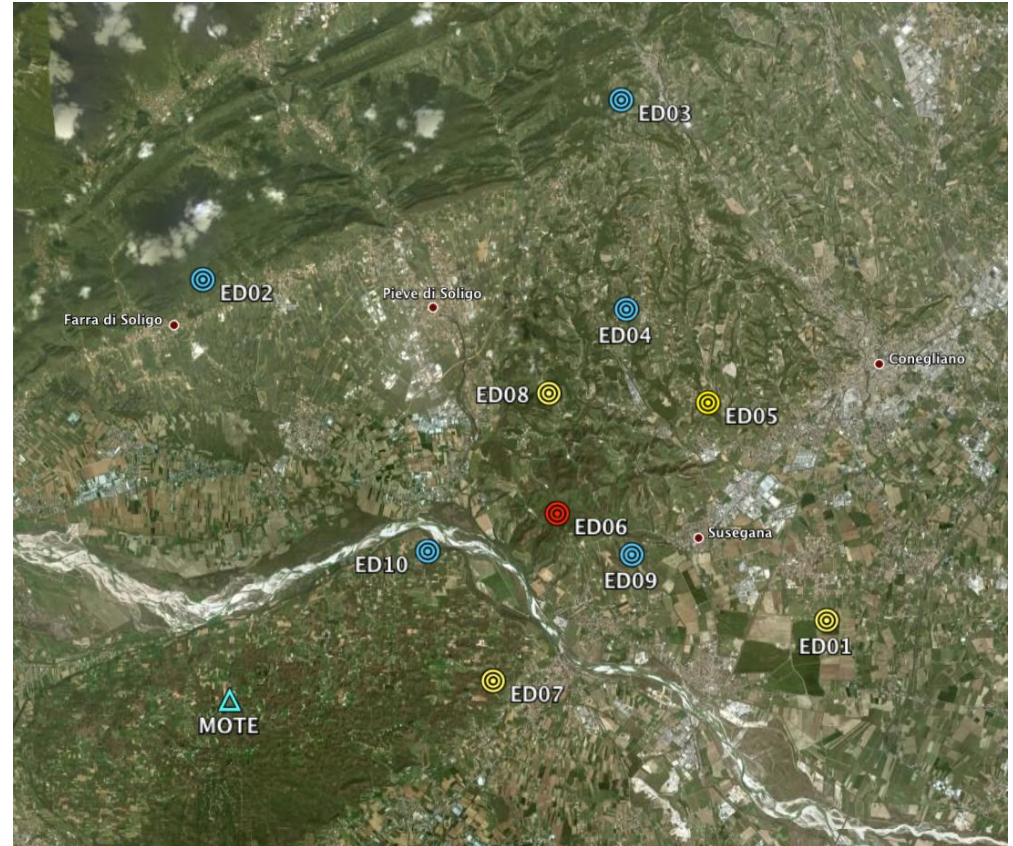
AIMS

Monitoring of:

- Micro-seismicity induced by storage activity.
- Natural seismicity

The network can detect:

- weak events ($M_L \cong 1.0$, or even less)
- medium-strong events ($M_L \geq 4.5$)

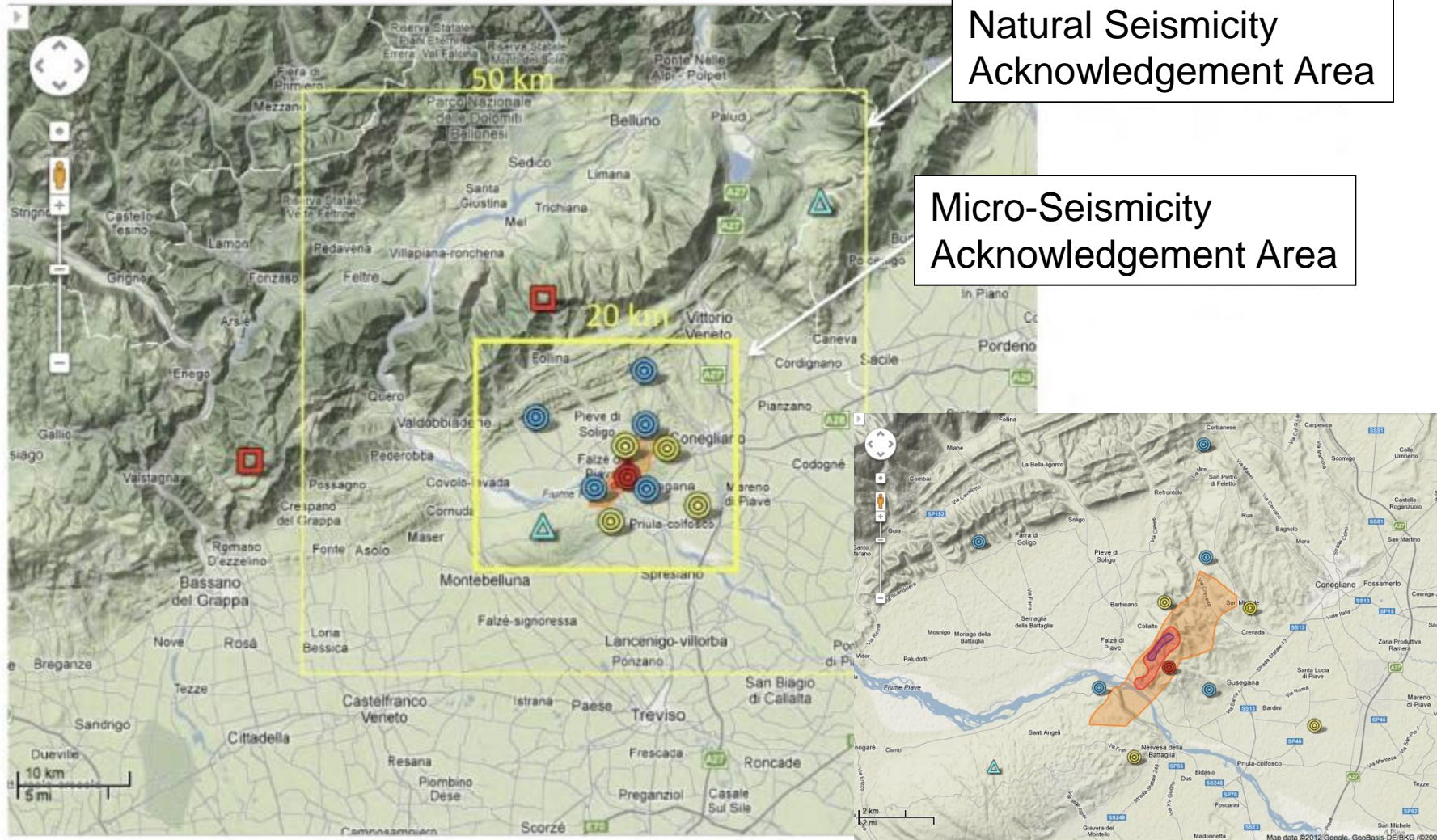


FEATURES

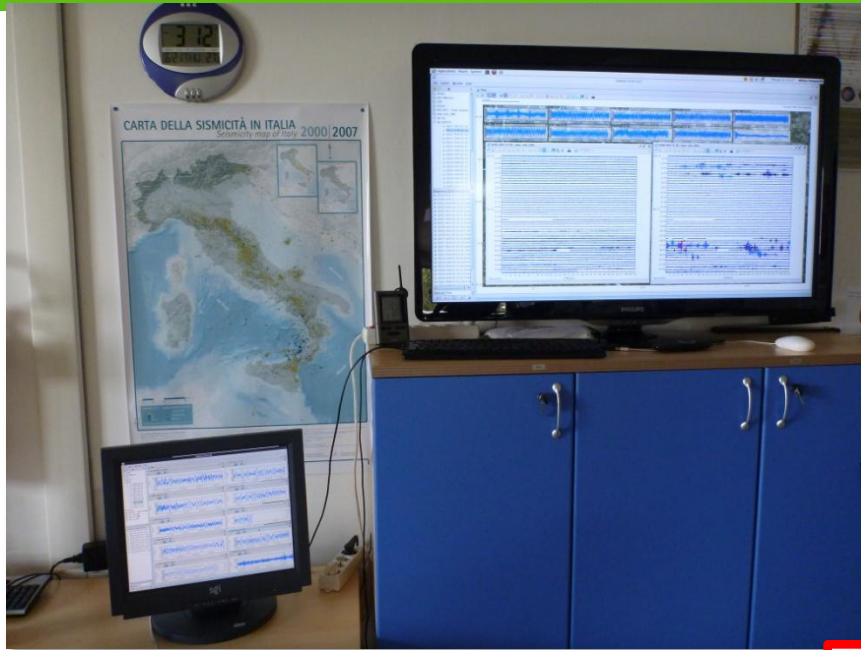
- 1 very broad-band and high-dynamics station (ED06);
- 3 broad-band and high-dynamics stations (ED05, ED07 and ED08);
- 5 broad-band stations (ED02, ED03, ED04, ED09 and ED10);
- 1 broad-band station located in a deep well (ED01).



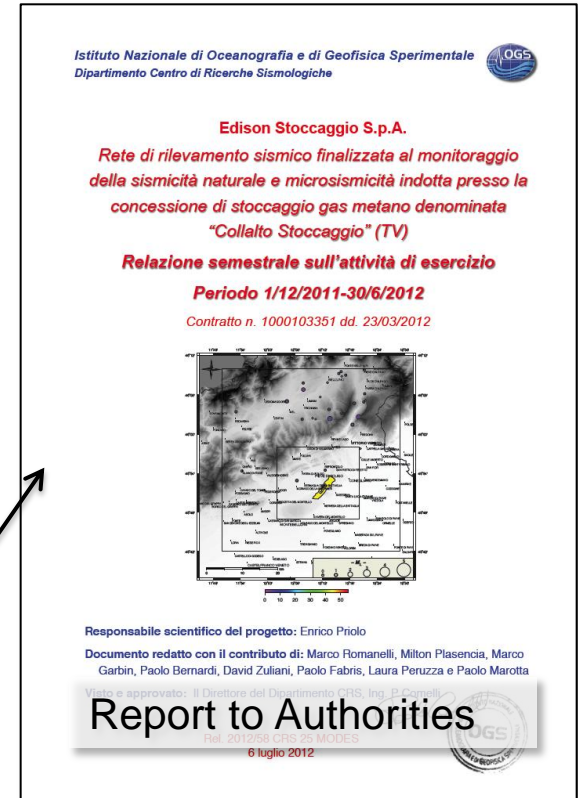
CSN: Acknowledgement Area



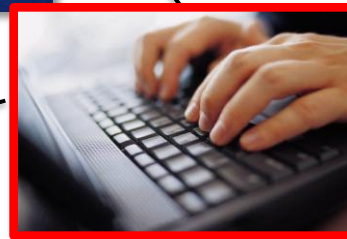
CSN: Equipment to analyze data



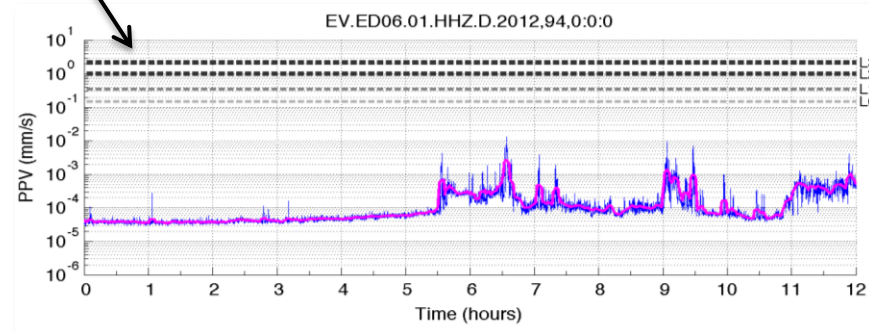
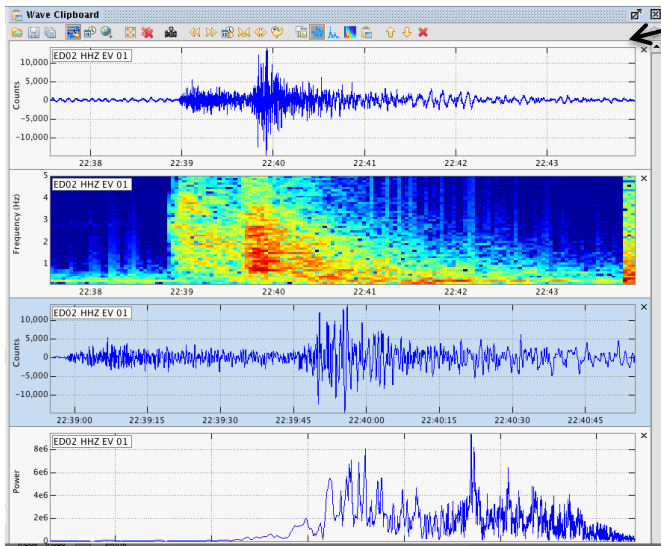
Real-time detection and quasi real-time analysis (manual review of "interesting" data)



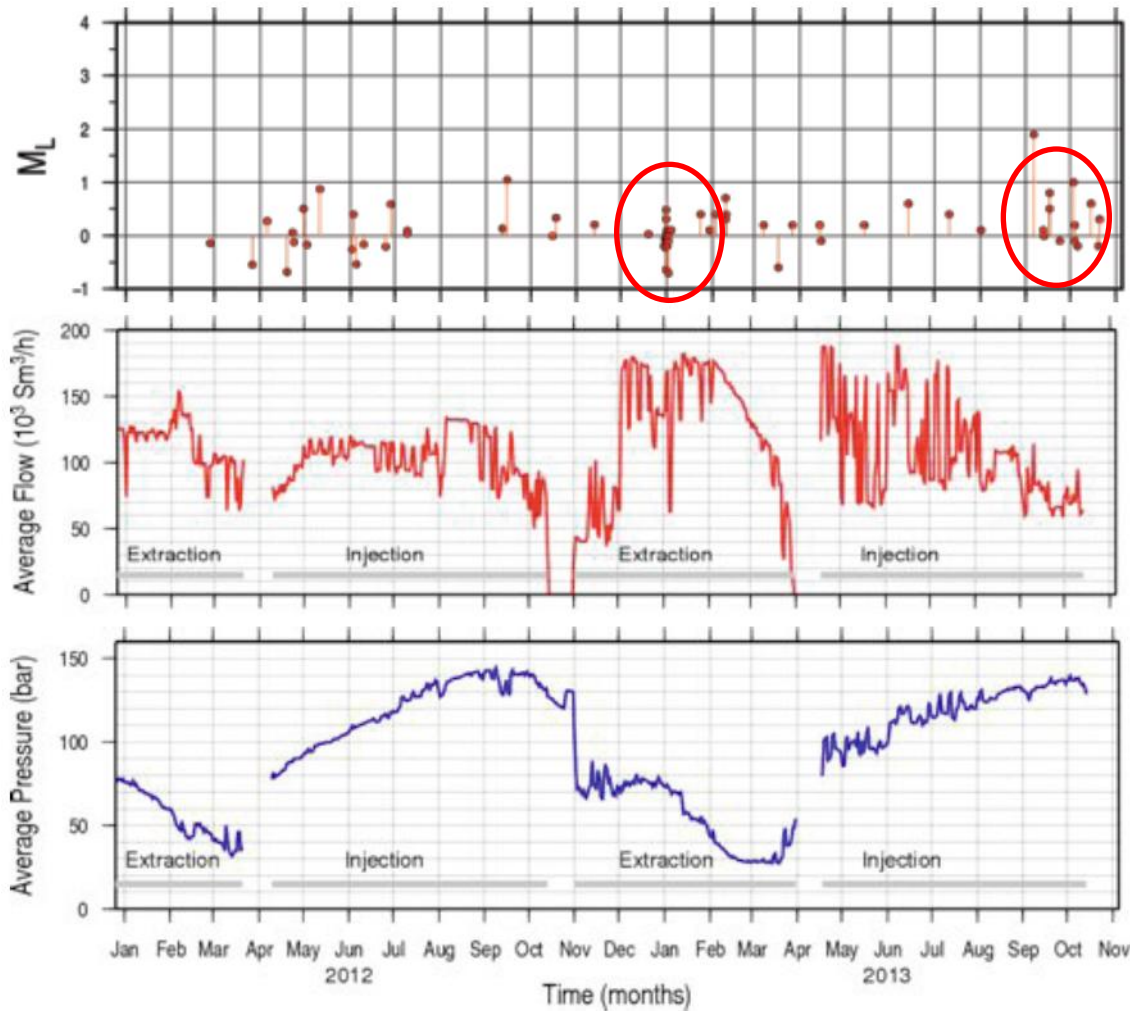
Waveform Analysis



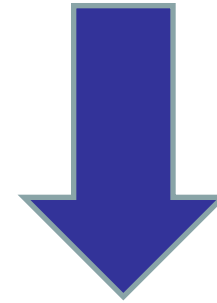
Automatic location of micro-seismic events



CSN: two years of monitoring - results

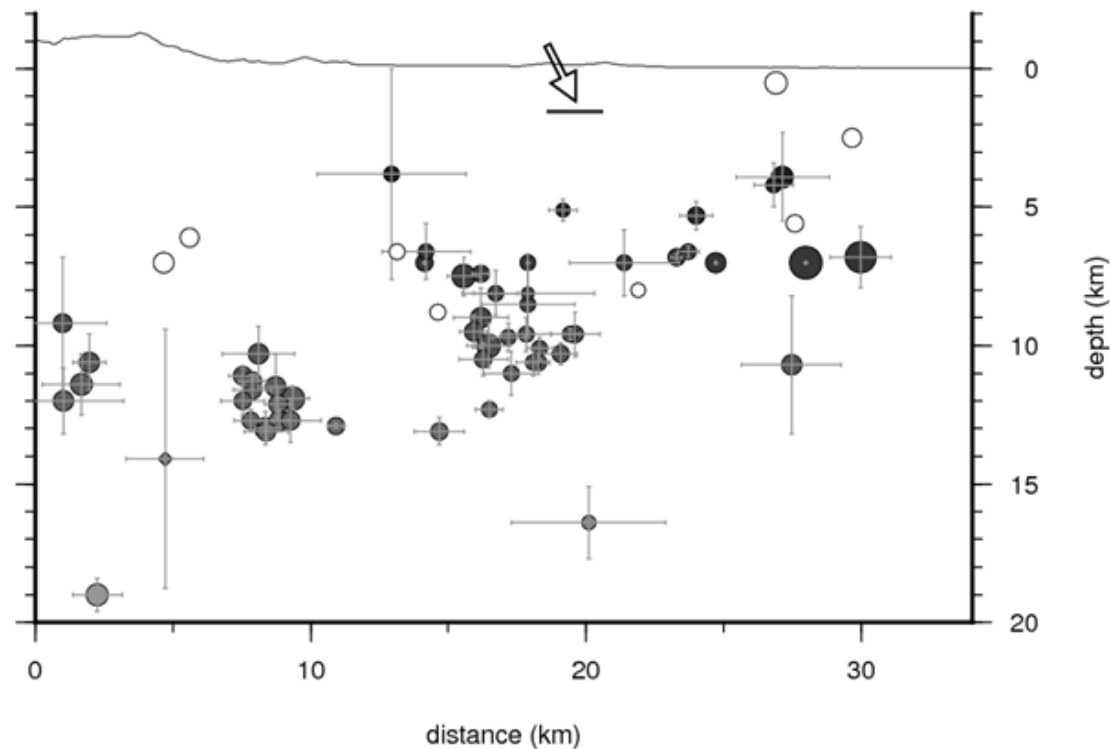
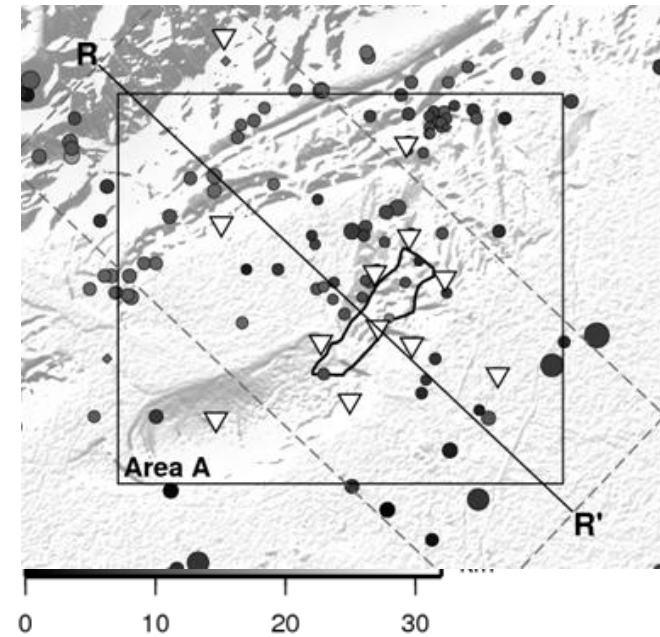
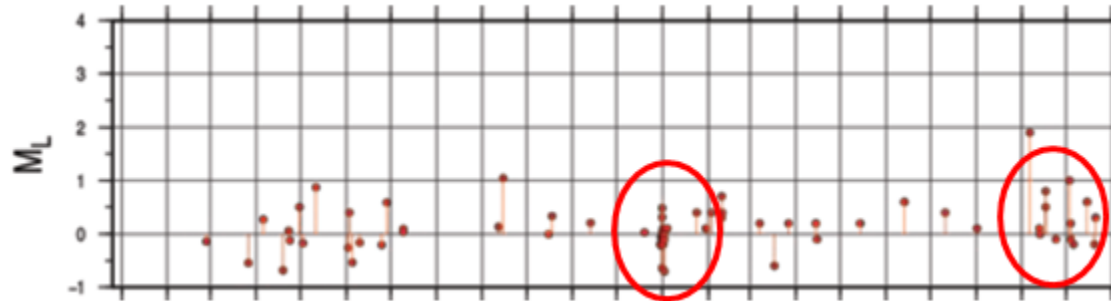


After two years of monitoring it is possible to state objectively that



The **seismicity** detected by the monitoring in the area is very weak and it isn't correlated with the storage activities.

CSN: two years of monitoring - results



CSN: open access to data – high level of information and transparency

Edison opted for a full transparency of data and information in order to:

- ✓ face false information or manipulations
- ✓ support the public acceptance of this kind of installations
- ✓ Enhance the climate of collective safety and security around the storage

WEB SITE: rete-collalto.crs.inogs.it

- Info and general references
- Meta-data and graphs freely available with no restriction
- Periodic reports

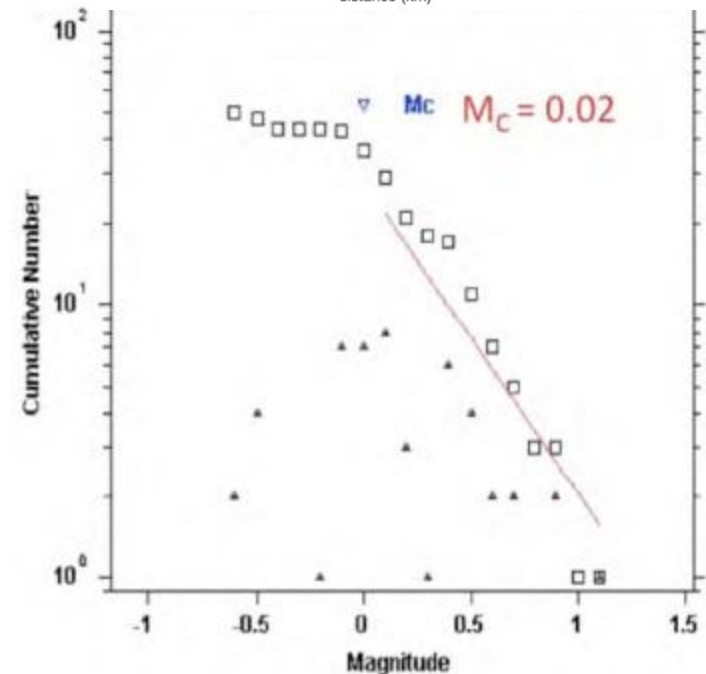
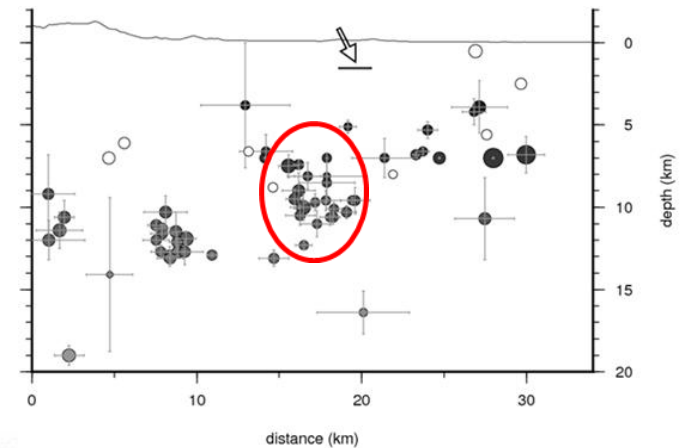
Meetings with local population, national and local Authorities to show how the network works and its results.



Modus Operandi (How to operate in case of....)

As most seismologists state, the induced seismicity has a precise footprint:

- ❑ Clusterization
- ❑ Increasing number of phenomena in a given time interval
- ❑ Increasing intensity of phenomena according with the Gutenberg-Richter law
- ❑ Correlation with the pressure/flow rate of the fluid injected/withdrawn.



A “Traffic light” system should be activated

The setting of thresholds depends on

- reservoir features
- seismicity of the area
- level of anthropization

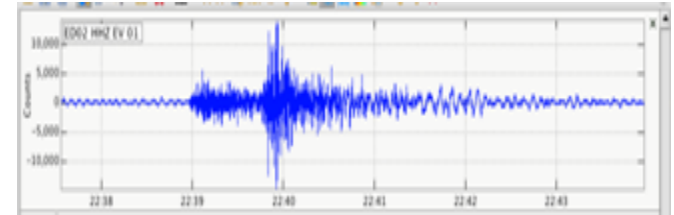
In Italy the induced activity mustn't exceed $M = 3$.



- **$M = 1,5$ attention level**
- **$M = 2$ action level**

Conclusion

- Micro-seismic monitoring is an effective solution to understand and control any possible seismicity phenomena induced by storage activities;
- A “traffic light” system should be activated; if induced seismicity exceeds set thresholds, a reduction in injection/withdrawal should be made.
- An agreement about “who does what” should be signed with the competent authorities;
- An open-access repository of data and publications should be available in order to fulfill the rising demand of transparency and knowledge by stakeholders chiefly by the population living around these plants



A look beyond....

The micro-seismic network made by ES and OGS is very effective, capable to detect and locate very weak events ($M \sim 0$).

A new project is starting with Potsdam University (Inst. of Earth and Environmental Sciences) and OGS regarding the Passive Seismic Interferometry.



The surface of the Earth is crossed by seismic ambient noise mainly generated by atmospheric phenomena and ocean waves.

The PSI is based on the crosscorrelation of the seismic ambient noise with a pair of seismic stations, in order to create a “virtual source-receiver pair” (like a 3D seismic acquisition).

For each time window, cross correlation is evaluated at the selected pair of stations.

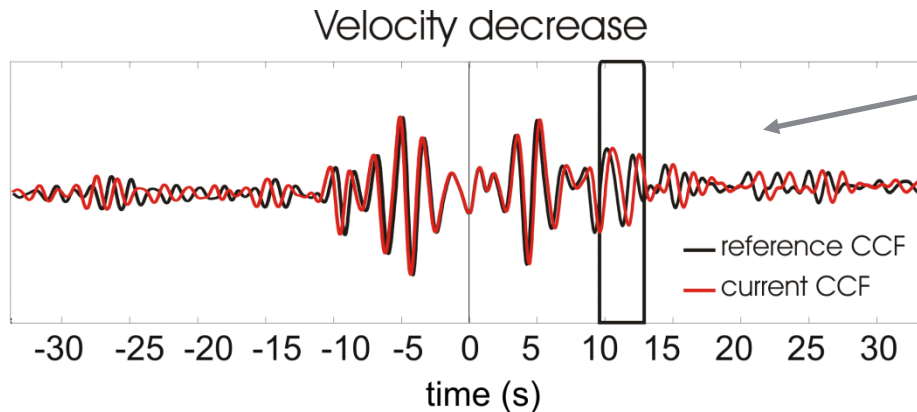


A Reference CCF is obtained by stacking of all CCFs traces

CCF = cross correlation function

A look beyond....

By evaluating the stretching/shortening of the reference CCF with current CCFs (see figure) we can estimate the temporal (relative) velocity change in the investigated medium.



The current CCF has a delay respect to the reference CCF.

A velocity change in the medium has been detected!!!

Such velocity variation can reflect changes of several physical properties (stress changes, pore pressure etc..)

A continuous time monitoring of features of reservoir during injection or withdrawal phase could be made.

Thanks
for your attention