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MICRO-SEISMIC MONITORING OF UGSs. THE “COLLALTO” SEISMIC NETWORK

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O.G.S.



Micro-seismic Monitoring Network: Goals

Despite their essential role in the gas system **Underground Gas Storages** are **not well accepted** by public opinion because of the suspicion that they can generate induced/triggered seismicity.

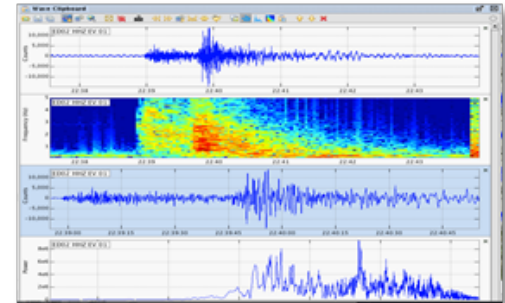
To cope with this climate of mistrust E.S., with the support of O.G.S. (an **Italian Public Research Institute**) developed a micro-seismic monitoring network named **R.S.C.** setting these aims:



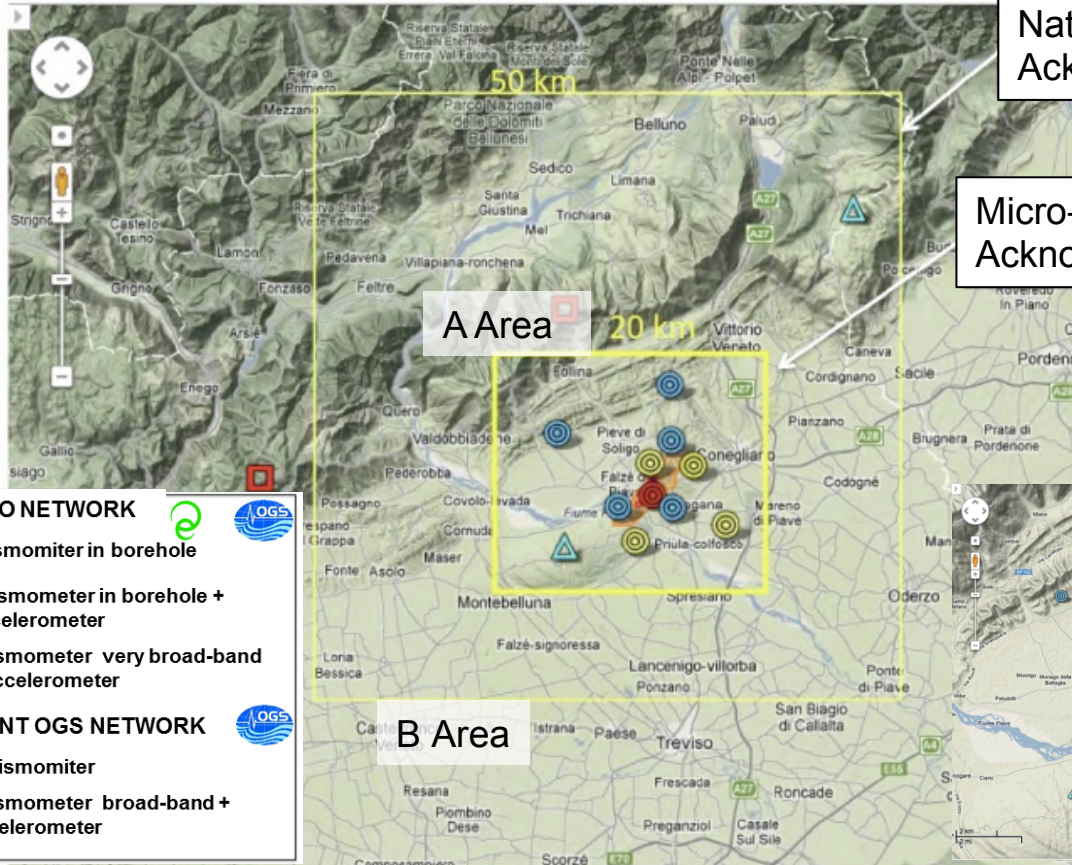
high quality of micro-seismic detection capability



full transparency of data information with no restriction



RSC: Acknowledgement Area



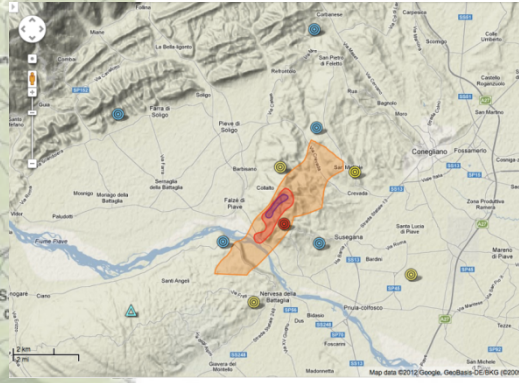
Natural Seismicity
Acknowledgement Area

Micro-Seismicity
Acknowledgement Area

A Area

B Area

**Completeness magnitude
 $M_c = 0,0$ in the A area**



- COLLALTO NETWORK**
- Seismometer in borehole
 - Seismometer in borehole + accelerometer
 - Seismometer very broad-band + accelerometer
- PERMANENT OGS NETWORK**
- Seismometer
 - Seismometer broad-band + accelerometer

RSC: Open Access Data and Transparency

Edison Stoccaggio is the first Company in Italy that has opted for full transparency of data and information in order to:

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

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

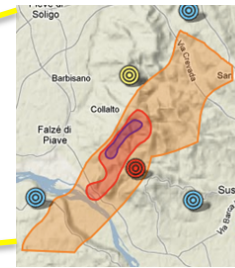
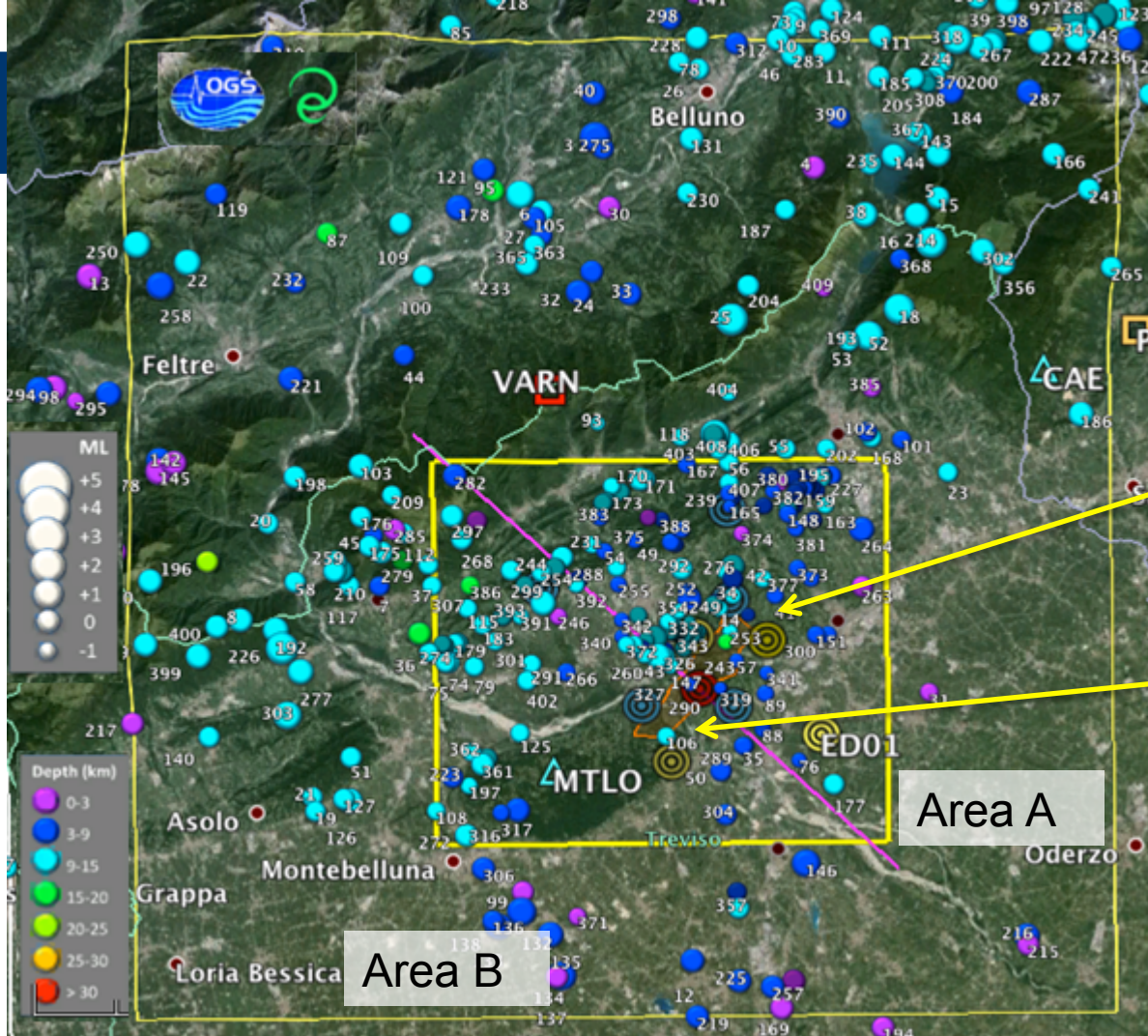
- Info and general references
- Meta-data and graphs freely available with no restriction
- Periodic reports

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



Detected Events

Seismicity
1/2012-10/2014
Google Earth (.kml)



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Area B: 429 eventi
 $-0.4 \leq M_L \leq 2.9$

Area A: 190 eventi
 $-0.8 \leq M_L \leq 1.3$

**Induced seismicity
=
Evolutionary Phenomenon**

Induced seismicity = Evolutionary Phenomenon



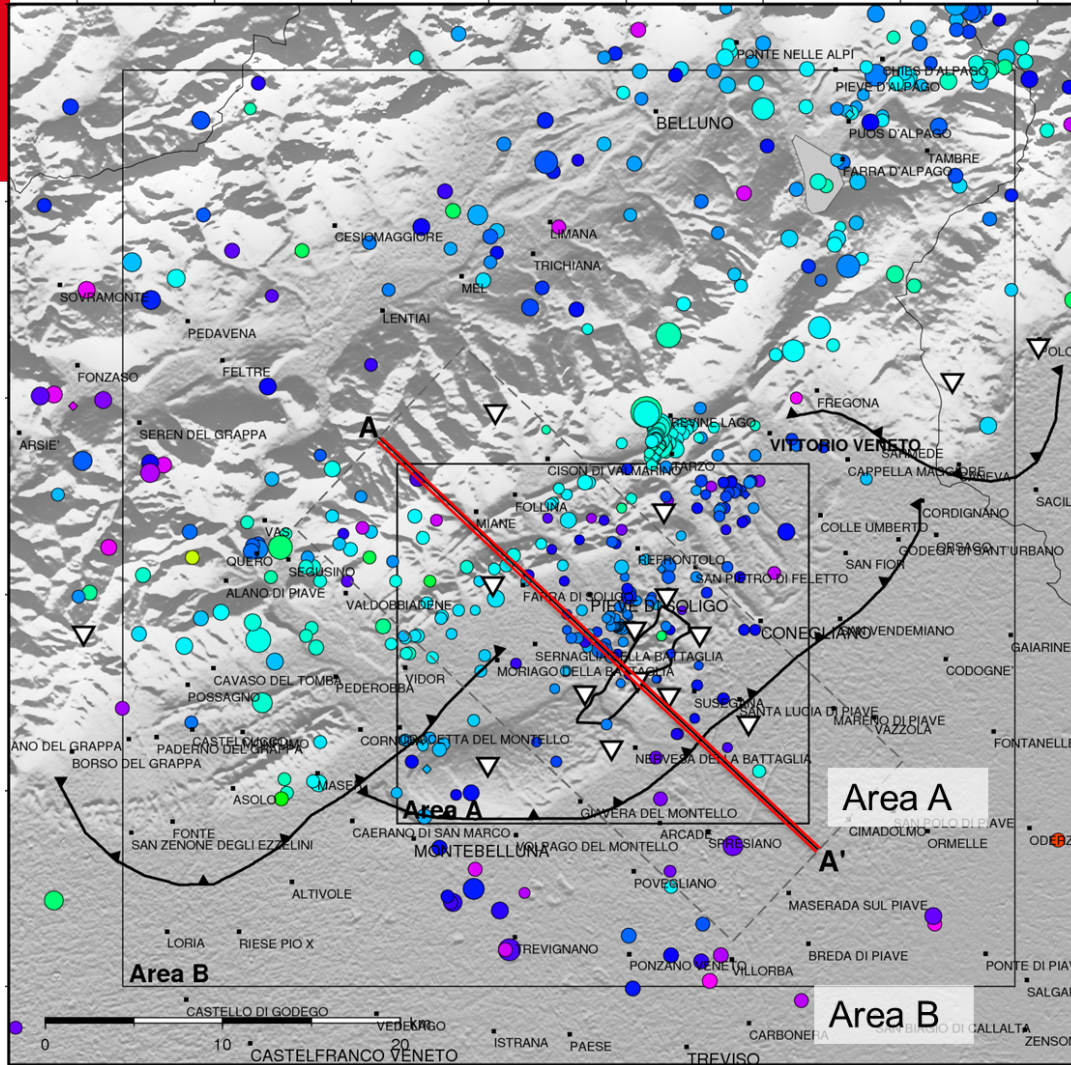
Clues/evidence:

- **Clusterization of the events near the stress source;**
- **Increase in number of phenomena in the time unit;**
- **Manifested correlation (with Pressure and Flow Rate);**
- **Variation of the “b parameter” of the Gutenberg-Richter law;**

Induced Seismicity?

Seismicity

01/2012 - 10/2014



0 10 20 30



▽ STATION

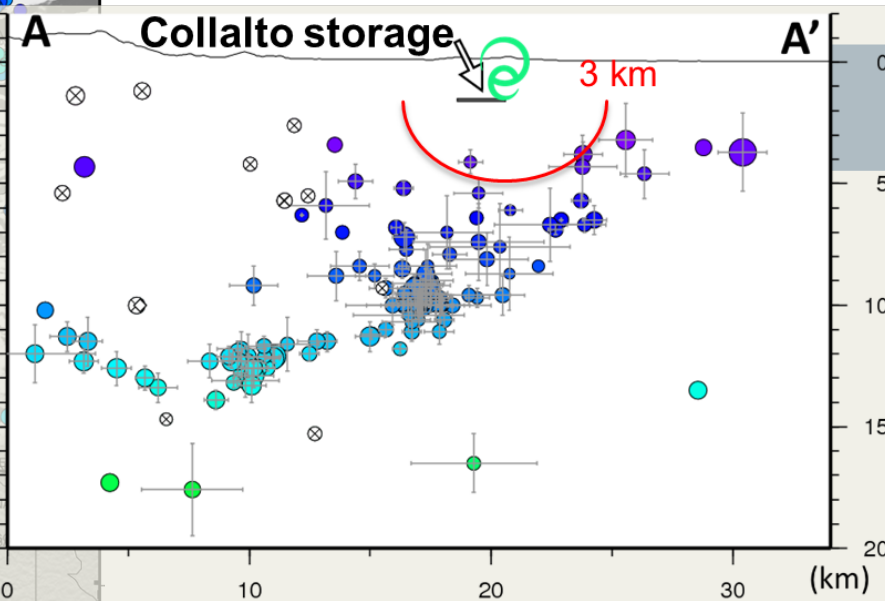
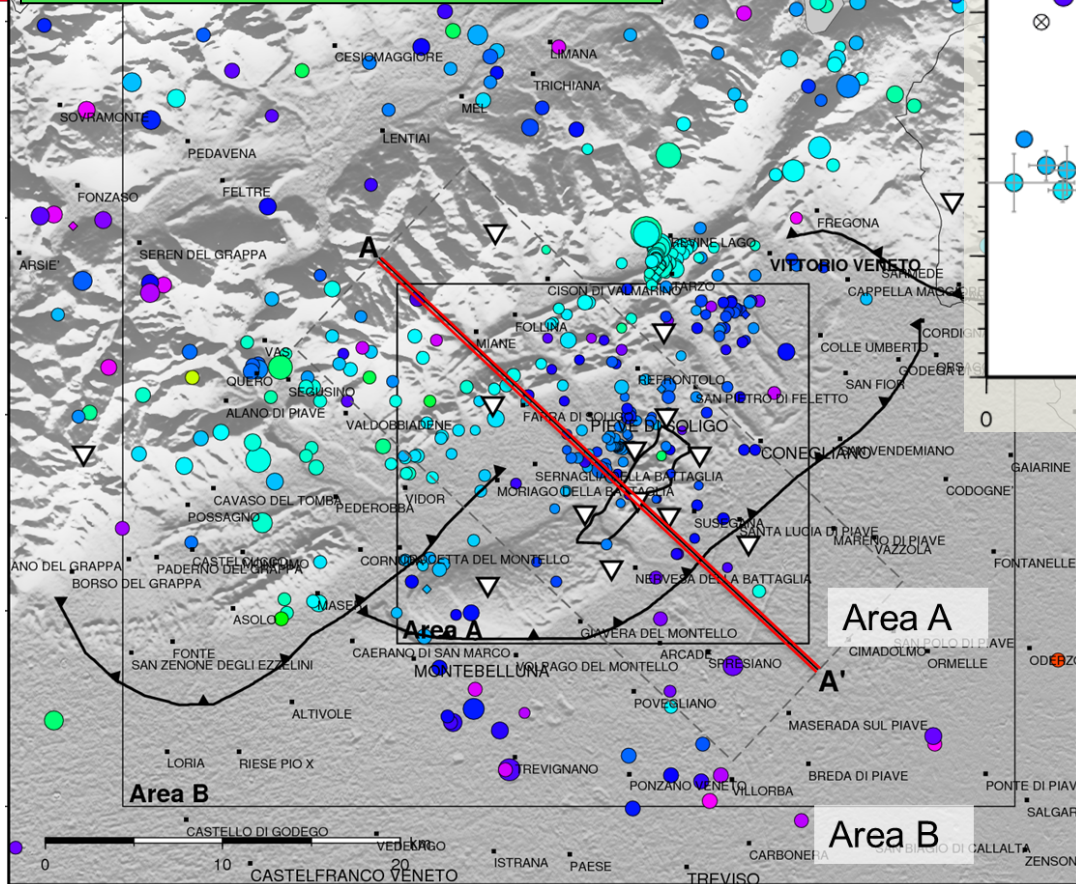
↘ STORAGE

ACTIVE FAULTS FROM POLI ET AL. 2008

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Section AA'

1/2012-10/2014

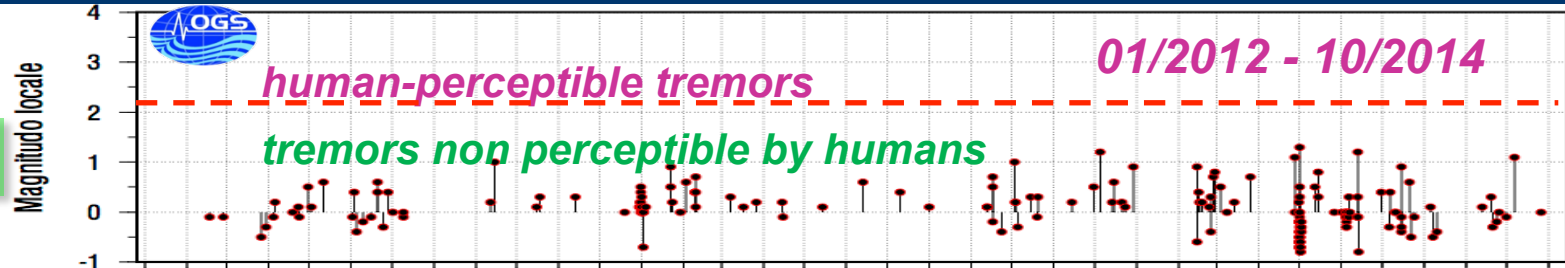


RSC has detected a natural micro-seismicity; in fact, as shown in the picture above, all the events recorded draw the tectonic faults already known in literature.

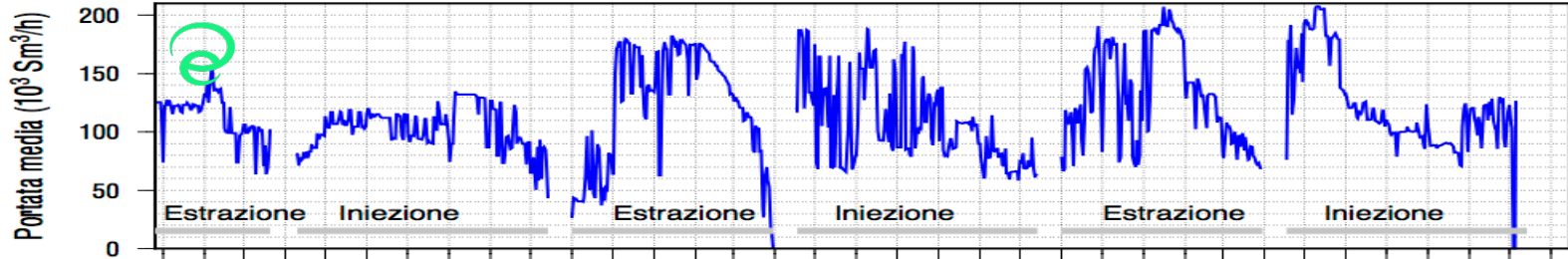


Seismicity Detected vs Storage Activity

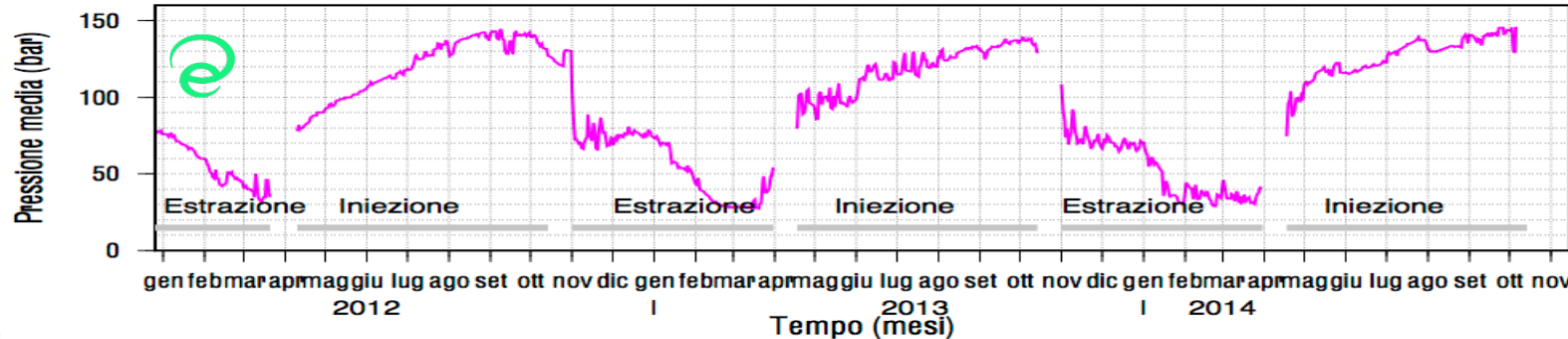
Magnitude



Flow rate

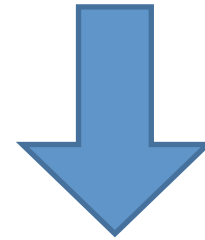
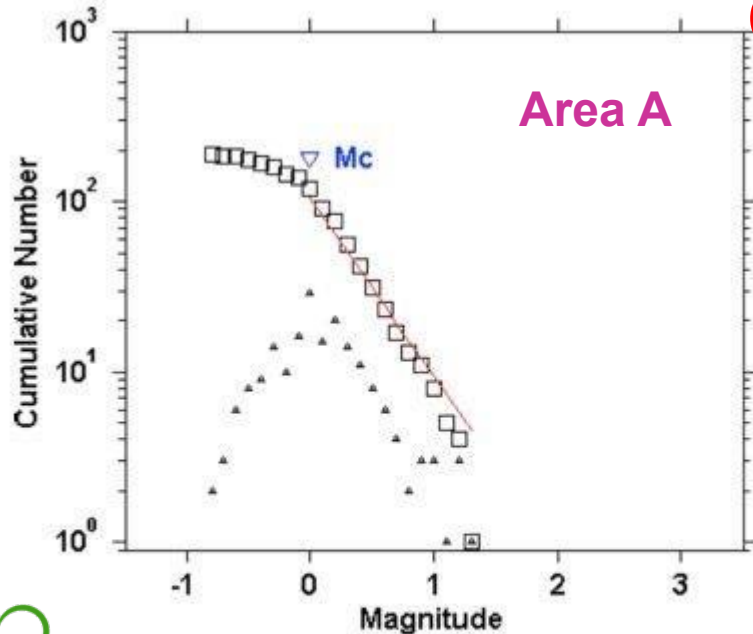


Pressure



Seismicity Detected vs Storage Activity

Gutenberg-Richter law



Picture on the left shows the

magnitude vs frequency

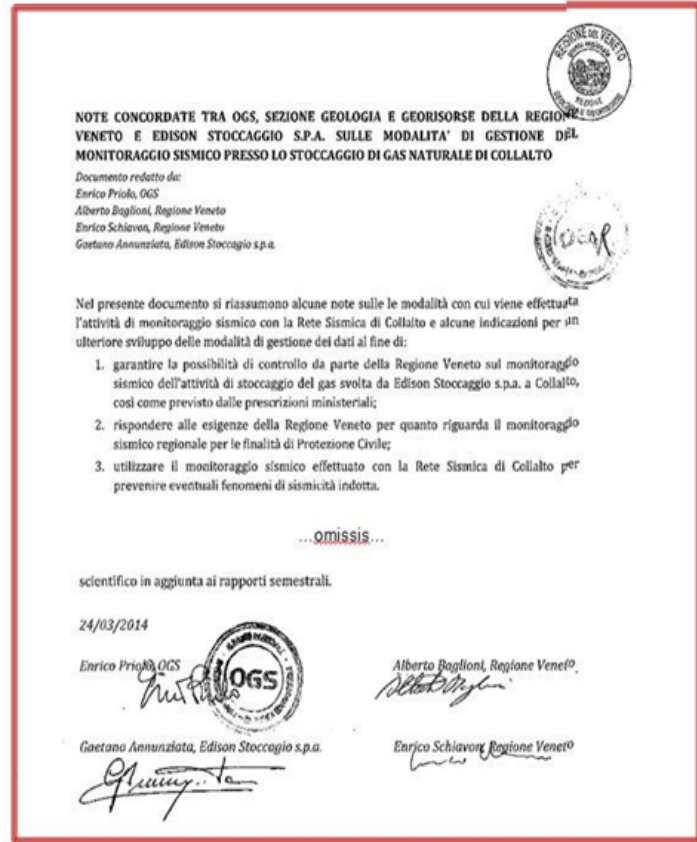
distribution for earthquakes located in A area. It is possible to see that the slope b of the segment that approximates and describes this **log-curve**, is about 1.



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Maximum Likelihood Solution
b-value = 1.05 ± 0.07 , a value = 2.02, a value (annual) = 1.59
Magnitude of Completeness = -0.01

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



In April 2014 ES, OGS and Veneto Region issued a common note in which the following subjects were considered:

- Agreement about the design criteria of the network
- Analysis of data detected during the first years in operations
- Definition of transmitting data procedures
- **Definition of control methods and of procedures to be activated in case of “anomalous signals”**

(first case in Italy even before specific “Guidelines” were issued by the Development Ministry in November 2014)

RSC: Procedure to Be Activated

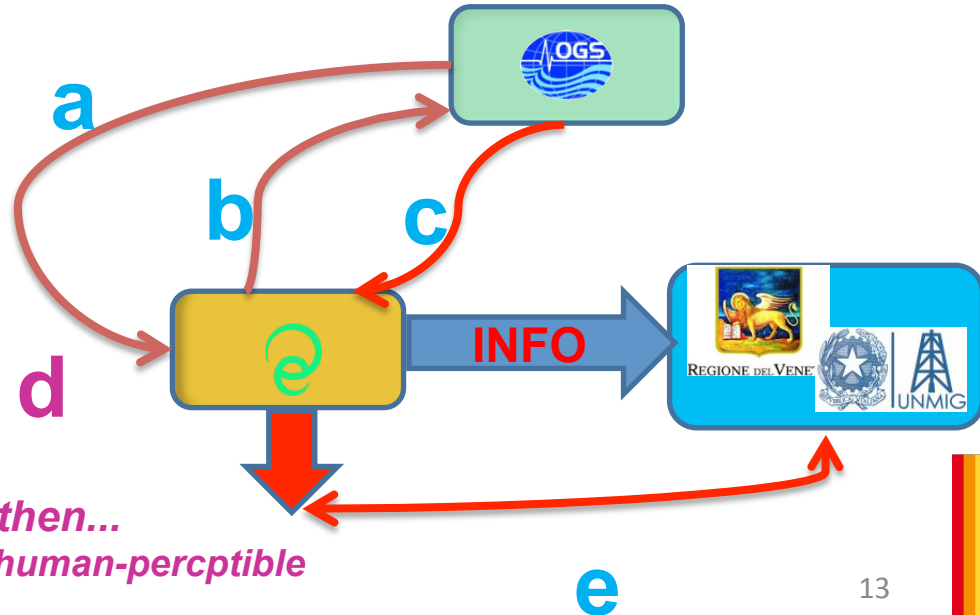
“Normal seismic signals” Analysis System:

1. Automatic real time analysis + semi-automatic off line adjustment;
2. Periodic Reports

“Anomalous seismic signals”:

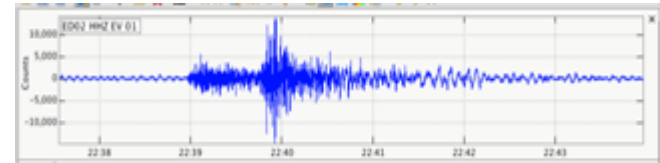
- a. Anomalous signals;
- b. Info for deeper analysis
- c. Evaluation of correlation**
- d. Actions to be actuated
- e. Info for the authorities

*if and only if C is true then...
and before the event get human-perceptible*



Conclusions

- ❑ The **Micro-seismic monitoring** is an effective solution for recognizing and coping with induced or triggered seismicity by storage activities.
- ❑ RSC is managed by a **public institute**. An **open-access repository of data and publications** is available to general public in order to meet the rising demand for transparency and information.
- ❑ **The first 3 monitoring years** of RSC show that no correlation has been detected between local seismicity and storage activity. Nevertheless ES and Veneto Region signed an agreement about “who does what” in any case
- ❑ The technical **criteria** adopted and the **managing procedures** introduced by Edison Stoccaggio and O.G.S. have become “a reference model” for “Guidelines” issued by the Italian Development Ministry.



Thank you
for your
attention

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***Seismic Monitoring of an Underground Natural
Gas Storage Facility: The Collalto
Seismic Network***



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