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# Improving the seismic monitoring of Northeastern Italy: the state of the art of the Northeastern Italy Seismic Network run by OGS

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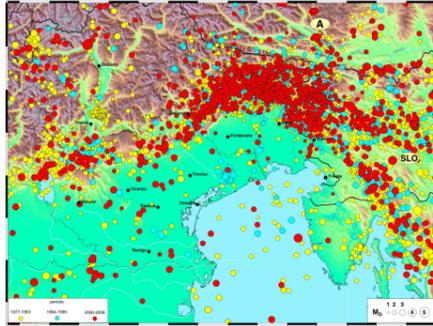
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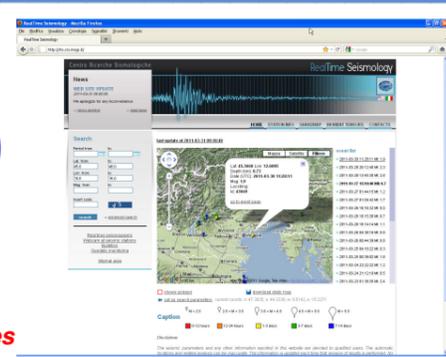
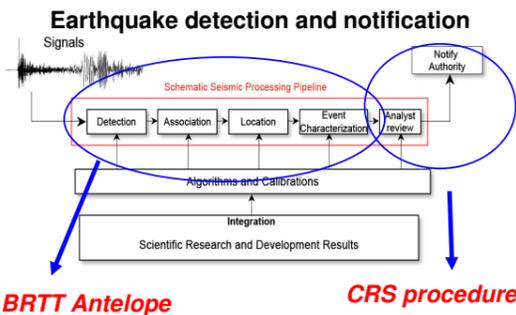
## SUMMARY



Seismicity of North-East Italy during 1977-2008 (courtesy of S. Urban). The 1976 Ms=6.4 was the last severe earthquake.

The Centro di Ricerche Sismologiche (CRS, Seismological Research Center) of the Istituto Nazionale di Oceanografia e di Geofisica Sperimentale (OGS, Italian National Institute for Oceanography and Experimental Geophysics) in Udine (Italy) after the strong earthquake of magnitude Mw=6.4 occurred in 1976 in the Italian Friuli-Venezia Giulia region, started to operate the North-eastern Italy (NI) Seismic Network: it currently consists of 12 very sensitive broad band and 21 simpler short period seismic stations, all telemetered to and acquired in real time at the OGS-CRS data center in Udine. Real time data exchange agreements in place with other Italian, Slovenian, Austrian and Swiss seismological institutes lead to a total number of 93 seismic stations acquired in real time, which makes the OGS the reference institute for seismic monitoring of Northeastern Italy. Since 2002 OGS-CRS is using the Antelope software suite on a SUN SPARC cluster as the main tool for collecting, analyzing, archiving and exchanging seismic data, initially in the framework of the EU Interreg IIIA project "Trans-national seismological networks in the South-Eastern Alps". SeisComP is also used as a real time data exchange server tool. In order to improve the seismological monitoring of the North-eastern Italy area, at OGS-CRS we tuned existing programs and created ad hoc ones like: a customized web server named PickServer to manually relocate earthquakes, a script for automatic moment tensor determination, scripts for web publishing of earthquake parametric data, waveforms, state of health parameters and shaking maps, noise characterization by means of automatic spectra analysis, and last but not least scripts for email/SMS/fax alerting. A new OGS-CRS real time seismological website (<http://rts.crs.inogs.it/>) has also been operative since more than one year in the framework of the Italian DPC-INGV S3 Project: the website shows classic earthquake locations parametric data plus shakemap and moment tensor information; recently also daily PSD quality check of seismic stations plots have been added.

## REAL TIME ANALYSIS

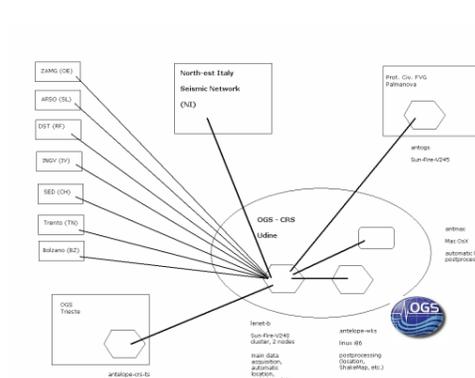


New "Real Time Seismology" OGS-CRS web page <http://rts.crs.inogs.it/>

## ACKNOWLEDGMENTS

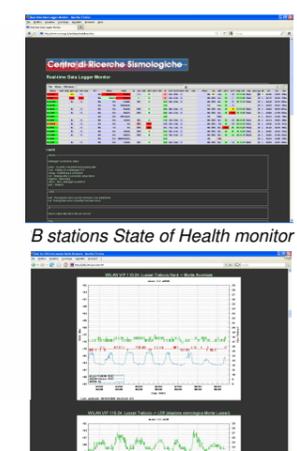
The technical staff of the OGS Centro di Ricerche Sismologiche (CRS) is acknowledged for its continuous effort in maintaining the seismic network. The Civil Protection Department of the Regione Autonoma Friuli-Venezia Giulia together with the Regione del Veneto and Provincia di Trento financially support the seismometric network maintained by the OGS Centro di Ricerche Sismologiche (CRS).

## DATA MANAGEMENT

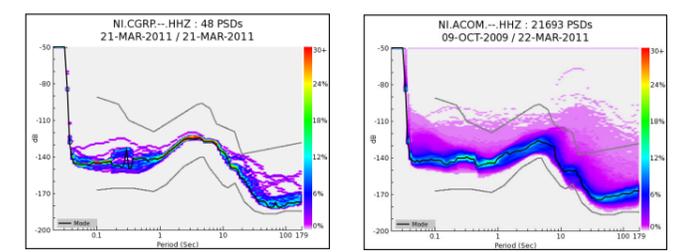


## Antelope @ OGS

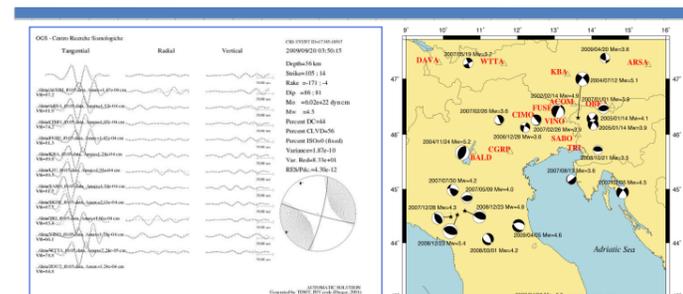
The Antelope software suite is used at OGS-CRS as the main data acquisition tool for the Northeastern Italy Seismic Network run by OGS. The main OGS-CRS Antelope server is running in Udine on a 2 nodes SUN Fire V240 cluster: the main module does data acquisition, automatic locations, data archiving and exchange, plus the alert system via Short Message Service (SMS), email, fax and web. Another 2 workstations, an old Linux and a new MAac PRO, running Antelope at the OGS-CRS headquarters in Udine are used for post-processing including ShakeMaps and manual relocations. Data is also forwarded for redundancy to a SUN Fire V245 Antelope machine at Protezione Civile della Regione Friuli-Venezia Giulia headquarters in Palmanova and for convenience to a Linux Antelope workstation at OGS headquarters in Trieste. Data is shared on the main Antelope cluster in Udine with a SeisComP server for data exchange.



Daily plot of the power supply voltage of the seismic stations and their radio link devices.



The data quality check of the broadband seismic stations is performed through the PQLX software (McNamara & Boaz, 2005) that computes power spectral density (PSD) for frequencies ranging from ~0.01 to 16 Hz. A comparison of day and night PDFs and an examination of artifacts related to station operation and episodic cultural noise allow us to estimate both the overall station quality and the level of Earth noise at each site.



We implemented the TDMT\_INV code (e.g. Dregler, 2003) for moment tensor computation. The automatic procedures is activate for earthquakes ML>3.6 located in NE Italy and surroundings.

## STATIONS

At OGS-CRS we also spent a considerable amount of efforts in improving the long-period performances of broadband seismic stations, either by carrying out full re-installations and/or applying thermal insulations to the seismometers. Efforts have been put also in strengthening the reliability of data links, exploring the use of redundant satellite/radio/GPRS links.



A new plastic container for installing seismic stations deep, to insulate from thermal variations affecting long period performances of seismometers (ZOU station)

Seismometers installed at the bottom on a pier, with extra thermal insulation (ZOU station)



Redundant data links: left UHF radio, right ASTRA connect satellite (BALD station)



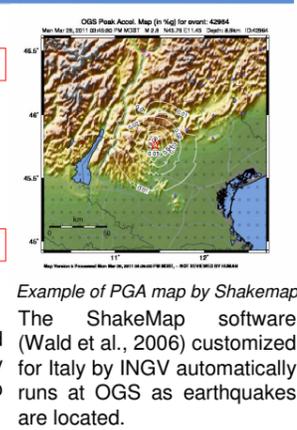
Where possible, stations are installed in natural caves or artificial tunnels, to improve long period performances (PRED station)



Since 2004 for bulletin production we use the SeisGram2K software (Lomax) for quick visualization and signal processing. Such program reads picks and waveforms from the Antelope system through an ad-hoc Java interface created at our department (PickServer).



Earthquake location and magnitude are automatically notified via multiple means to governmental institutions.



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