Project S5 -High-resolution multi-disciplinary monitoring of active fault test-site areas in Italy

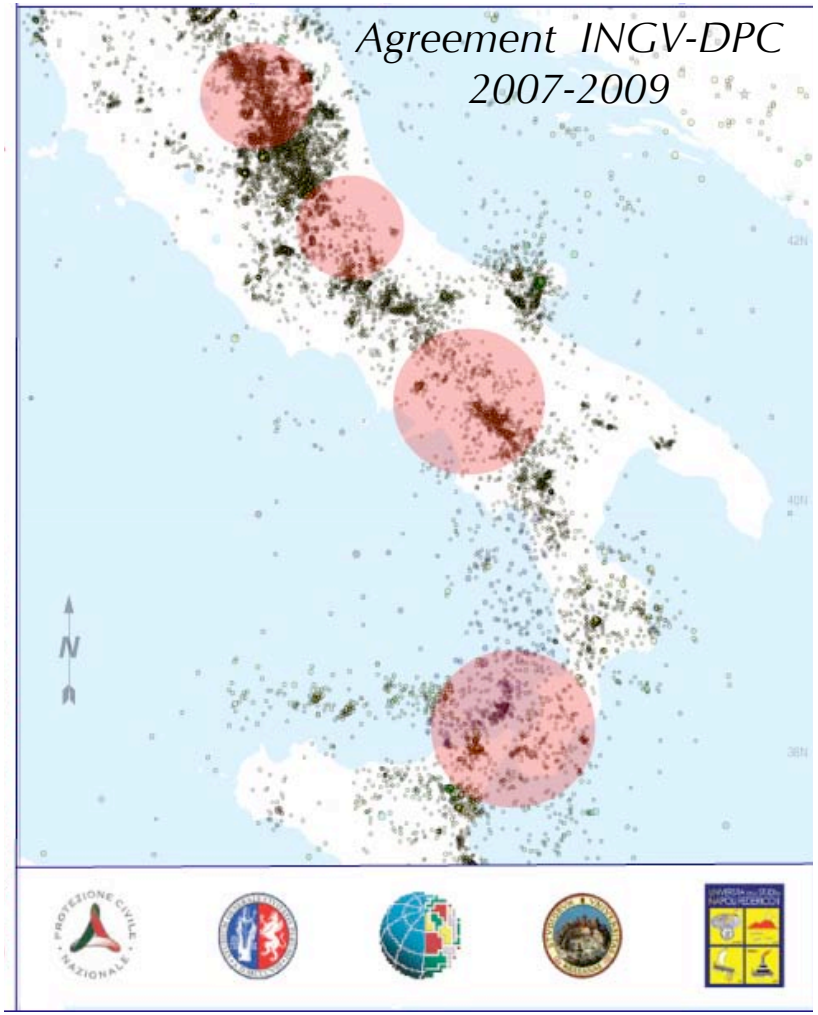
coordinators:

Lucia Margheriti (INGV- CNT)

Aldo Zollo (UniNA)

project web site:

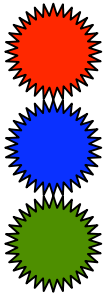
http://dpc-s5.rm.ingv.it



Project S5 30-06-2010

S5 project was aimed at supporting and integrating the ongoing research on selected Italian test sites where advanced GPS and seismic monitoring infrastructures are available.

To improve the understanding of earthquake generation we promote a multi-disciplinary approach based on data and methods from:



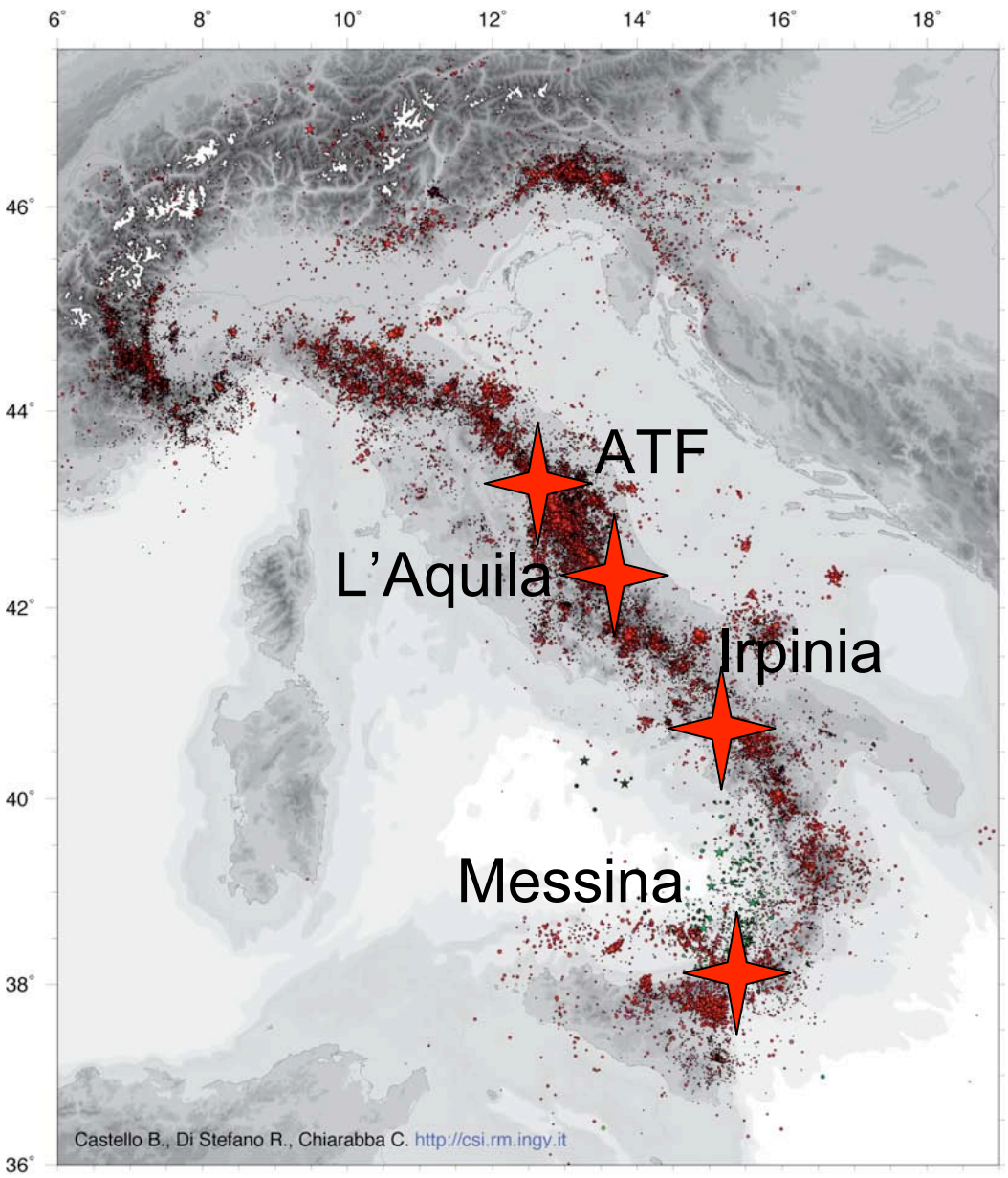
- Seismology
- Geodesy
- Geology

The project has been focused on the development and testing of advanced and innovative technologies and methodologies for the high resolution imaging of active fault zones in Italy.

Selected Test Sites

* Reference Co-financing Projects

- ATF : Project Airplane Multidisciplinary reserach platform on earhquakes and volcanoes INGV
- Messina Strait: Project INGV Messina 1908-2008
- Irpinia fault system : Project Early Warning – Regional Center of Competences, on Environmental Risks, AMRA
  + (September 2009)
- L'Aquila: INGV DPC earthquake emergency deployments



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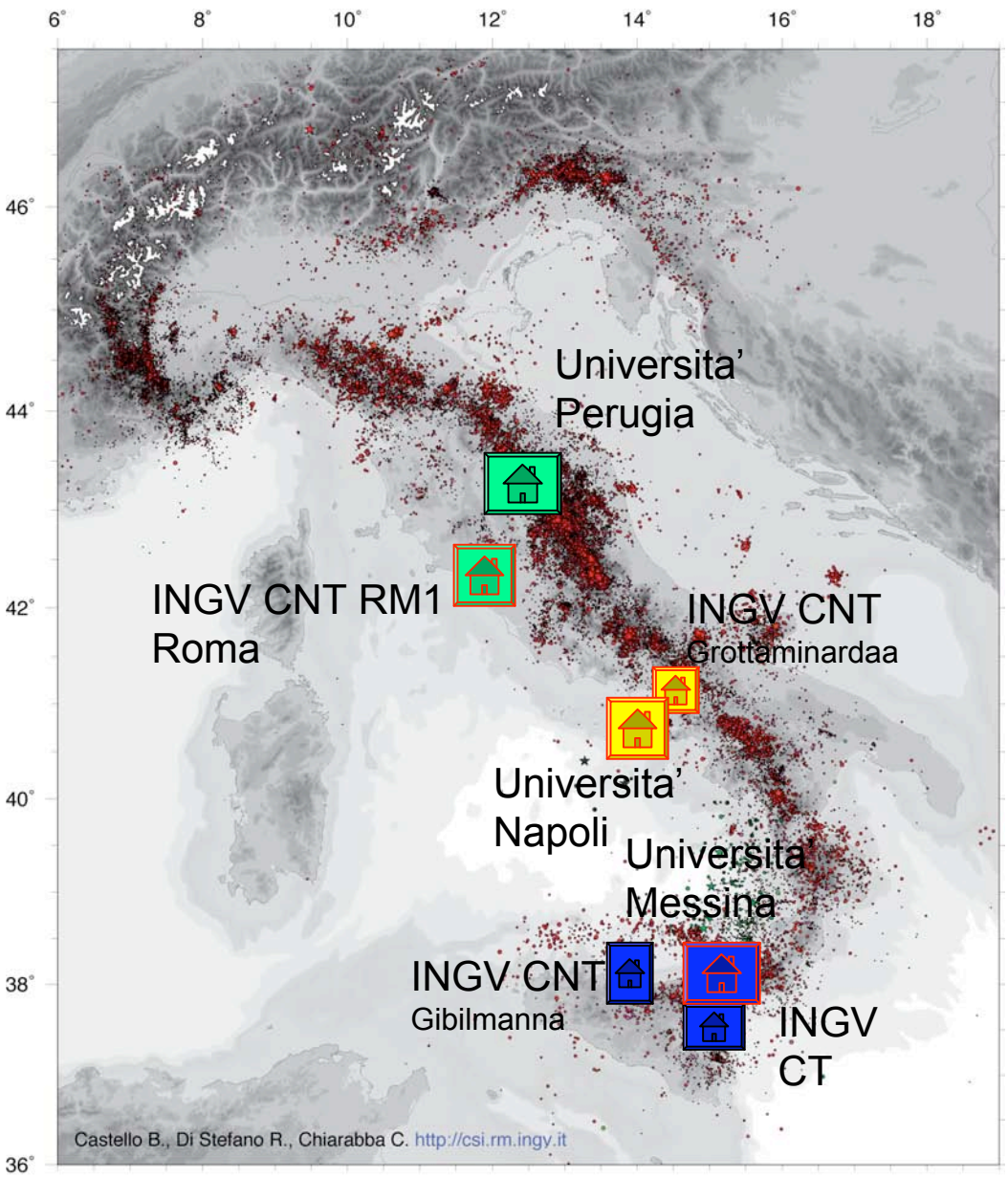
Participants Research Units

- **RU1** Lauro Chiaraluce (**INGV-CNT**)
- **RU2** Massimiliano Rinaldo Barchi (Department of Earth Science, **Univ. Perugia**)
- **RU3** - Lucia Margheriti (**INGV-CNT**); Giuseppe D'Anna (**INGV-Gibilmanna**)
- **RU4** Giancarlo Neri (Department of Department of Earth Science, **Univ. Messina**)
- **RU5** Antonio Avallone (**INGV – CNT**)
- **RU6** Aldo Zollo (Department of Physical Sciences, **Univ. Naples** Federico II)

+ starting in September 2009

- **RU7** Alessandro Amato (**INGV– CNT**)
- **RU8** Luigi Improta (**INGV – RM1**)



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The structure of the presentation is organized according to the following scheme for the three themes: Seismology , Geodesy and Geology

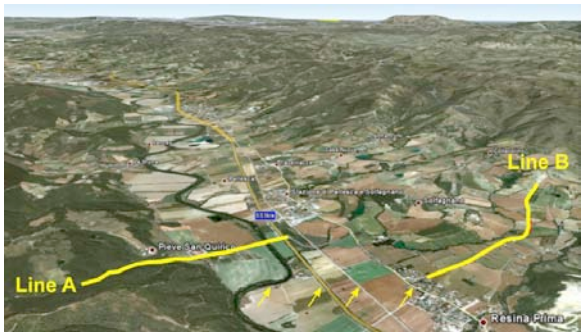
- Objectives
- New data acquired
- Development of new analysis techniques
- Scientific results

Seimology objectives:

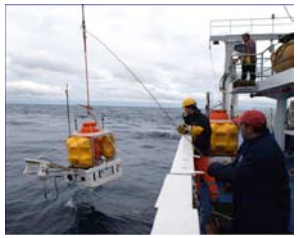
- to collect new seismological data with high density networks
- to develop and apply innovative methodologies aimed at the massive processing and analysis of seismological data available in real-time and off-line.
- to characterize the earthquake source and medium properties in the four sites

New seismological data acquired :

★ High resolution seismic exploration surveys aimed at obtaining reflectivity and V_P shallow images at ATF and L'Aquila



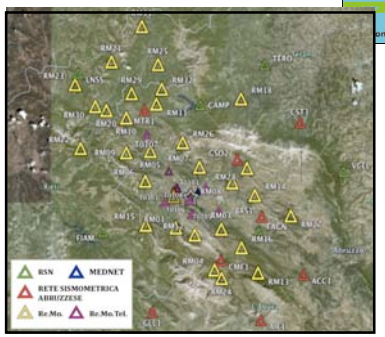
★ Two deployments of 5 OBS, Messina
D'Anna et al. 2009



★ Implementation of a new temporary network data management that allows the integration in EIDA (ME, AQ, ATF) of the temporary deployment together with all other seismological data produced by INGV. Moretti Govoni et al 2010.

http://dpc-s5.rm.ingv.it/

http://eida.rm.ingv.it/



★ Strong motion data base of L'Aquila aftershock sequence (RAN and INGV networks) in Itaca. Orefice

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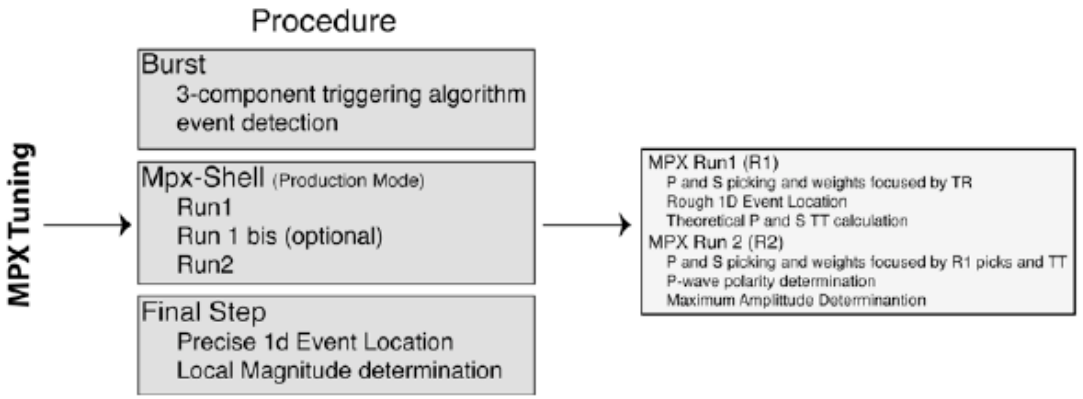
Development of new tools for Seismology :

- A modular and semi-automatic procedure that goes from continuous waveforms to high-resolution event location, magnitude and focal mechanism: new way to look at seismicity. Di Stefano

- We developed a semi-automatic procedure to evaluate the anisotropy for characterizing the deformation and fracture field of the crust. Piccinini and Pastori



- A new method for the multi-step inversion of path attenuation, site response and source parameters from microearhquake records have been developed and applied. Satriano

- Signal processing methods as in exploration seismology are developed and applied to local micro-earthquakes. Maercklin

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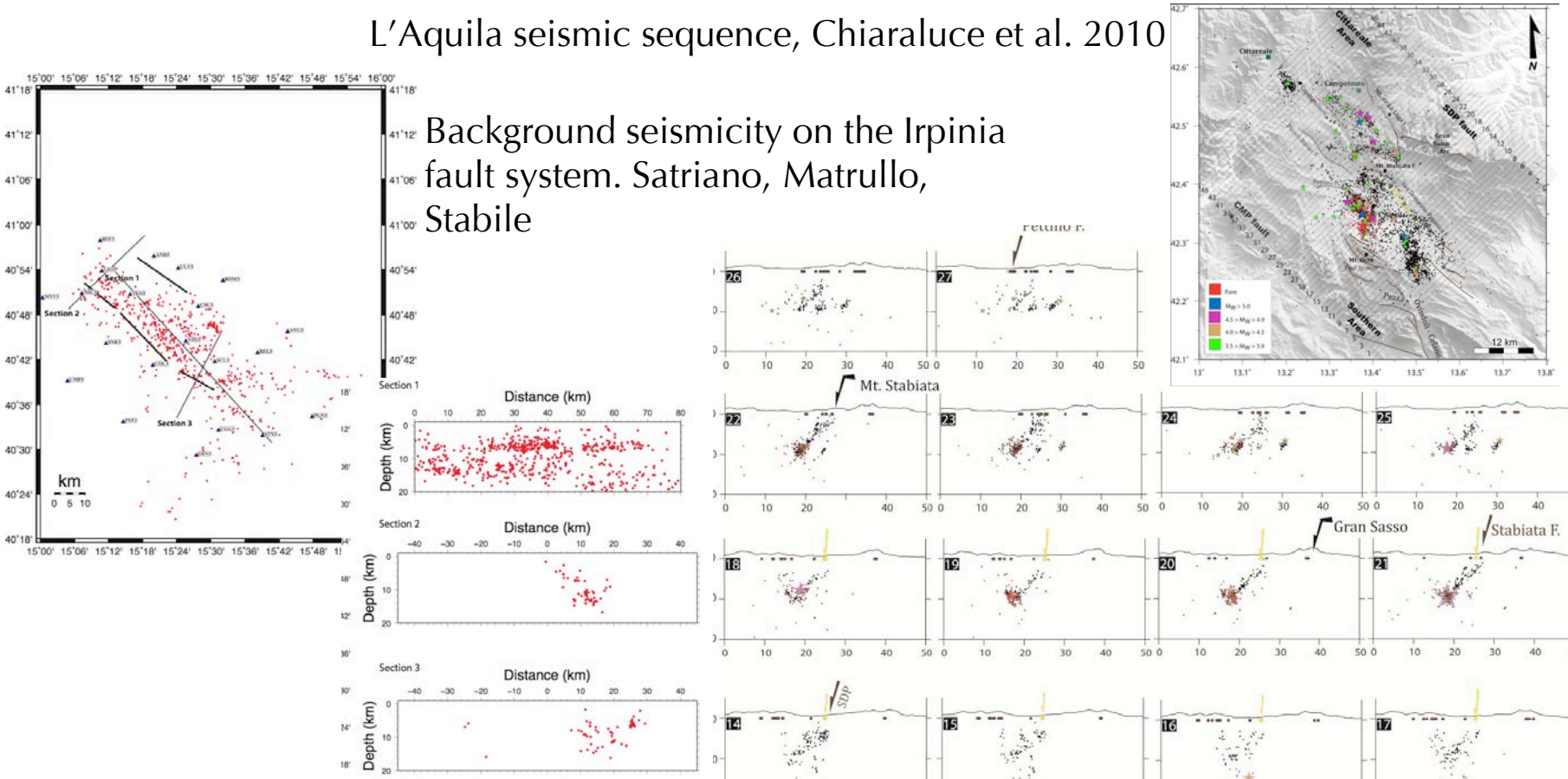
Seismological results :

Observing the micro-seismicity on active faults:

L'Aquila seismic sequence, Chiaraluce et al. 2010



Background seismicity on the Irpinia fault system. Satriano, Matrullo, Stabile

Observing active faults with seismic exploration.

Improta, Bruno

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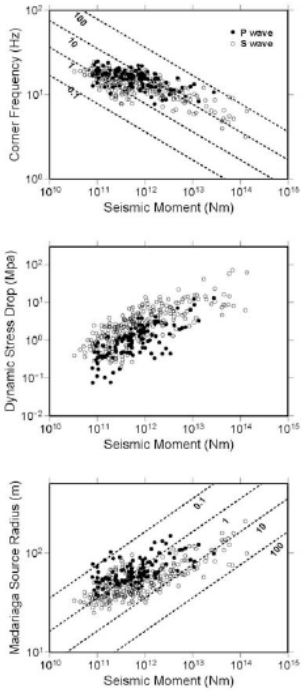
Seismological results :

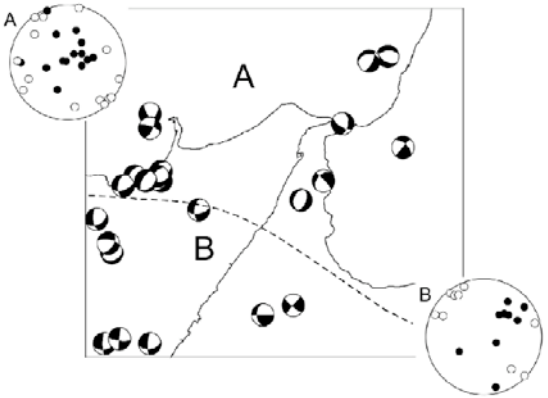
The regime of faulting significantly changes in the Strait region from north to south: normal faulting prevails clearly in the north while it appears mixed to strike-slip in the south.

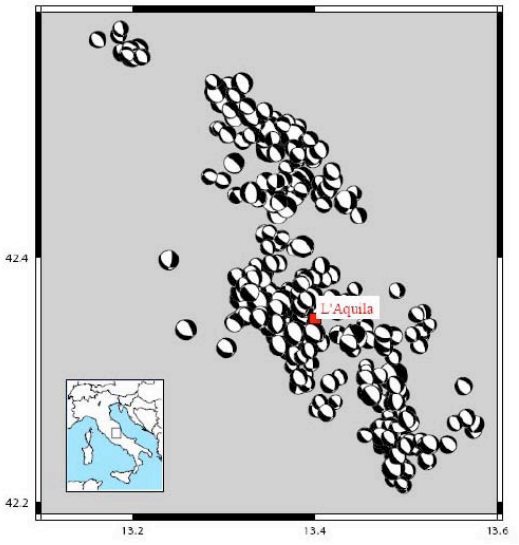
Normal faulting dominate in L'Aquila region.

D'Amico, Orecchio, Presti, Neri



Microearthquake source parameters and scaling laws (Irpinia): A self-similar, constant stress-drop scaling is observed down to Mw about 2 (Mo = 1e12 Nm). At smaller magnitudes the scaling-law breakdown is related to a saturation effect on corner frequencies: source or (unmodeled) path effect? Satriano, Orefice





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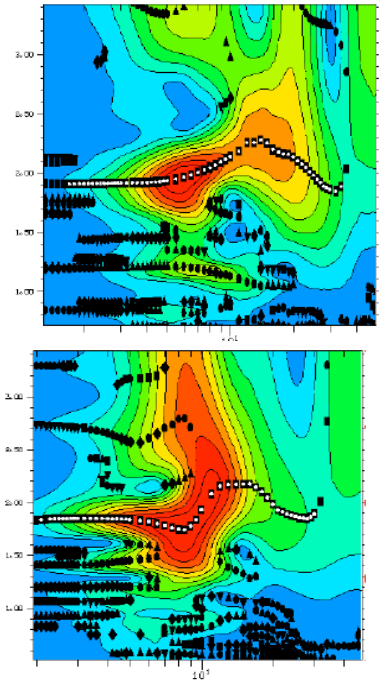
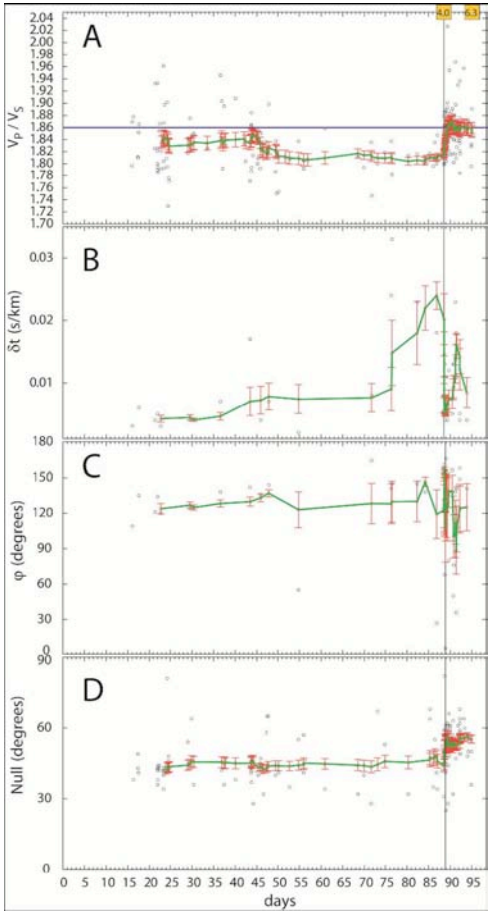
Seismological results :

- Extraction of Green's function from the noise recordings:The analysis of very long time series of seismic noise (> 6 month) revealed the feasibility of using the continuous noise recording to get information on the 1D earth structure at a regional scale in southern Apennines. Festa, Vassallo



- Variation of elastic and anisotropic parameters during the preparatory phase of L'Aquila earthquake has demonstrated that a complex sequence of dilatancy and fluid diffusion processes affected the rock volume surrounding the nucleation area. Lucente, De Gori et al. 2010



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Geodesy objectives:

- to collect new GPS data with high density networks and at high frequency sampling

- to learn and apply innovative methodologies aimed at the processing of high frequency GPS.

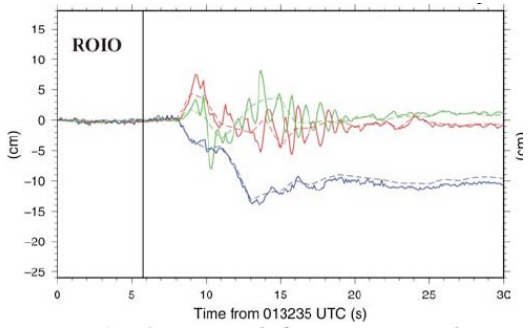
- to characterize the strain rate of the test site regions

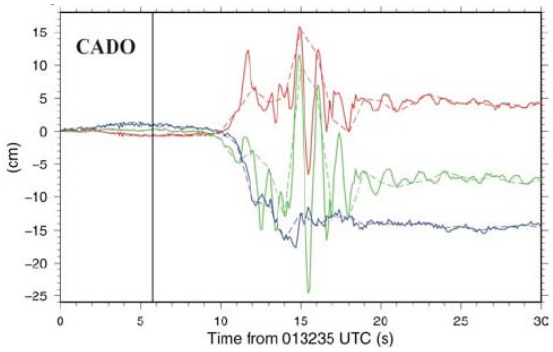
New geodetic data acquired :

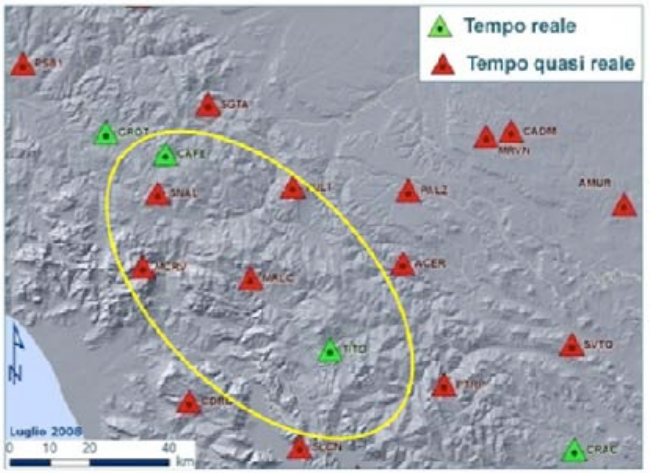
- At ATF Geodetic data integration of INGV and UniPG 1999-2010. D'Agostino et al. 2008

- At Messina new geodetic campaign and sharing of old data (?). Mattia, Anzidei

- At the Irpinia High frequency (1Hz) acquisition at RING Stations







- At L'Aquila High frequency (10Hz) GPS data near source. Anzidei et al.
- Temporary networks Cecere, D'Agostino et al.

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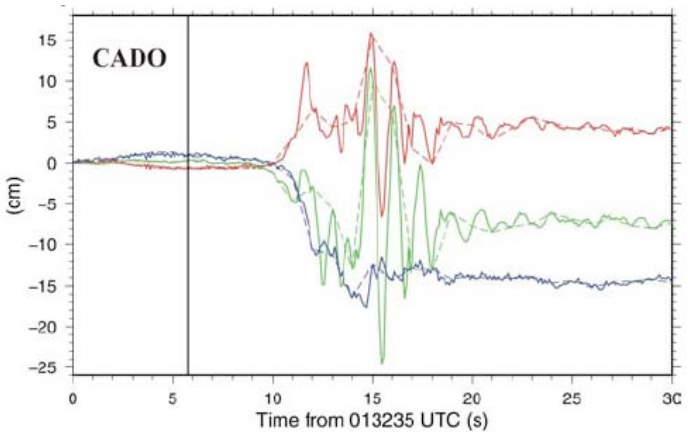
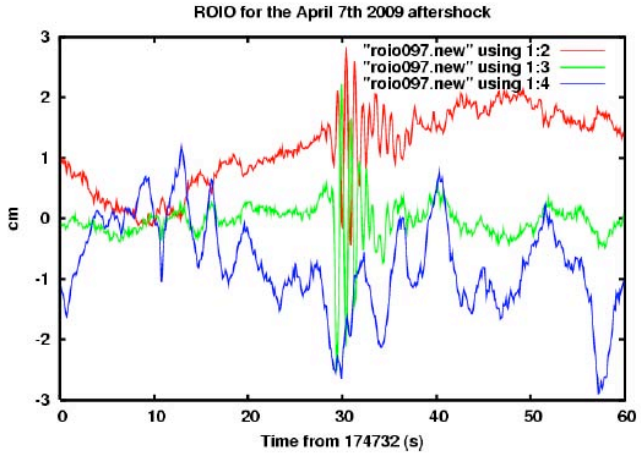
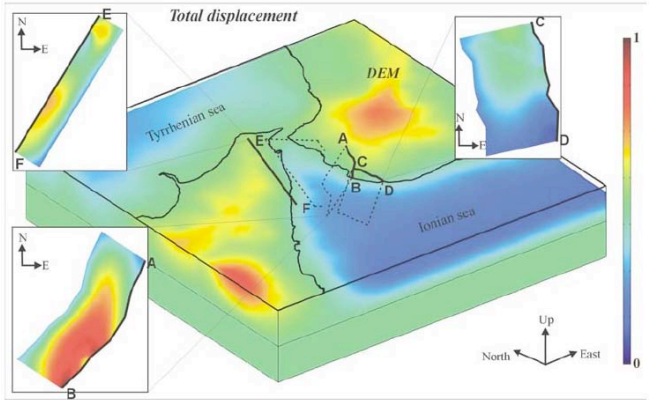
Development of new geodetic tools:

- Learning how to analyze high frequency GPS data: with high frequency GPS we can evaluate coseismic displacement. Only one of the aftershocks of L'Aquila (Mw=5.6)sequence was detect by GPS. Avallone Marzario





- Critical examination of the recorded leveling data of Loperfido using the Genetic Algorithms and the Pattern Search approaches and applying a Finite Element method to obtain the displacements on faults in the ME Strait. Aloisi



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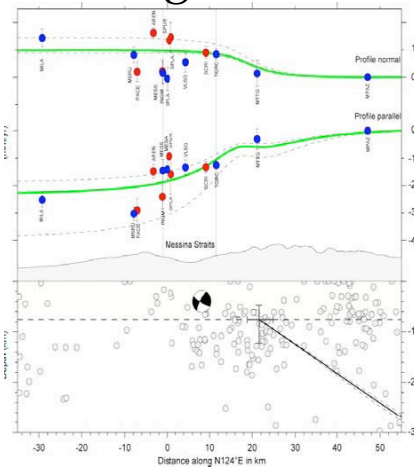
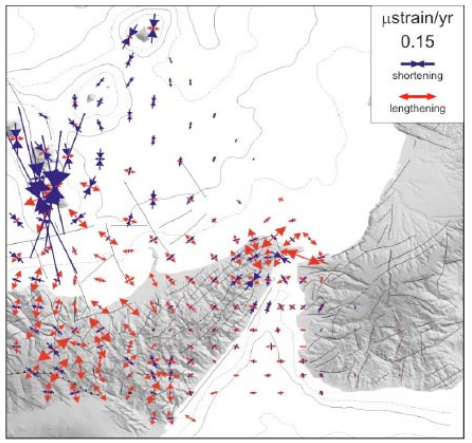
Results from Geodesy :

- The areas having maximum values of positive dilatation strain-rate (about 0.15 μstrain/yr) are localized along the two main active fault systems cutting the Messina test site region. Mattia et al 2009

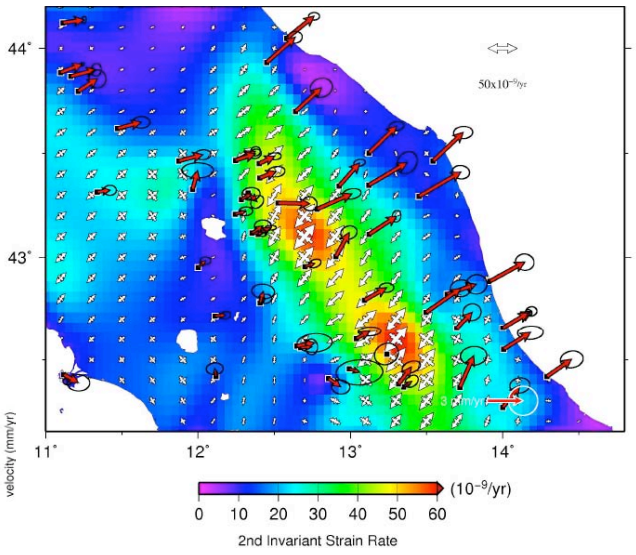


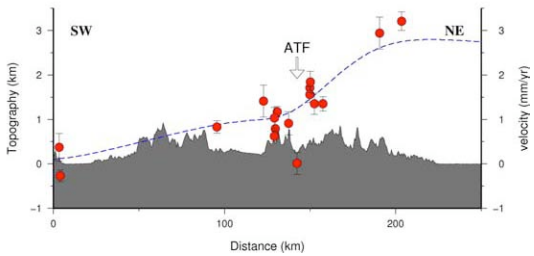
- The elastic block modeling has evidenced that the inter-seismic slip rate of the fault responsible of the 1908 earthquake is of about 3 mm/yr . Serpelloni et al. 2010



Maps of geodetic strain: 1 Axis of Strain

- Distribution of strain rate at ATF site shows a continuous band of deformation running along the crest of the Apennines. The geodetic strain rate is 3mm/yr. D'Agostino





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Geology objectives:

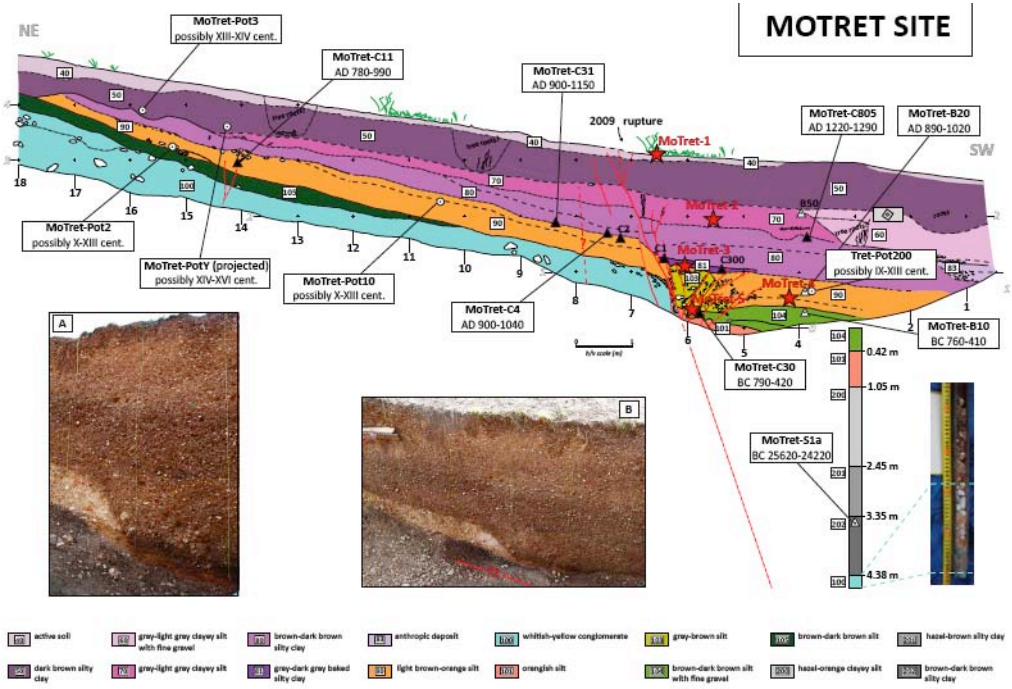
- to collect new geological and geomorphological data to map quaternary deposits and active faults

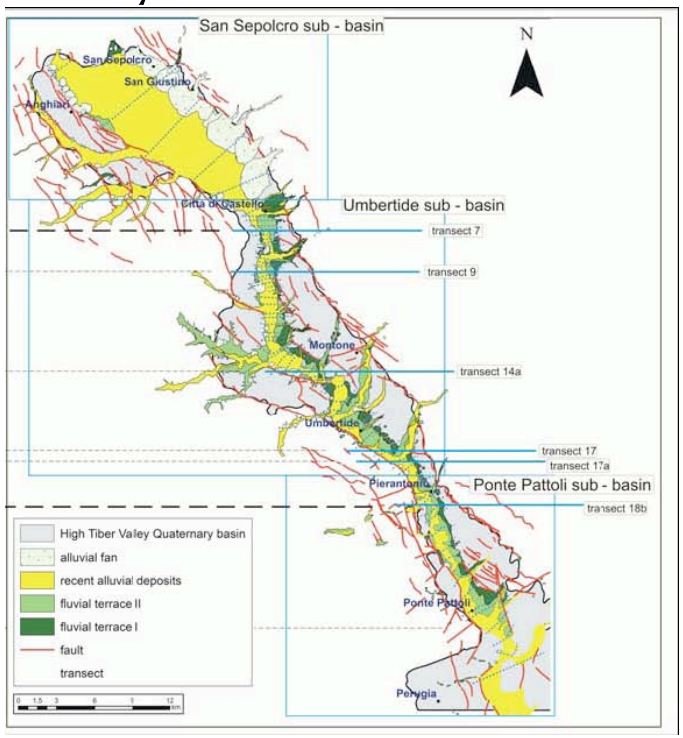
- to define a list of parameters describing active faults

- to improve the imaging of ATF at depth and evaluate the long term strain rate for the Alto tiberina fault.

New geological data acquired :

★Geological and geomorphological surveys of the Tiber valley. Barchi, Pucci, Saccucci et al.





★ Original data on active surface faults and datings of some of them were retrieved from extensive field work and paleo-seismological trenching. Cinti Pucci et al.

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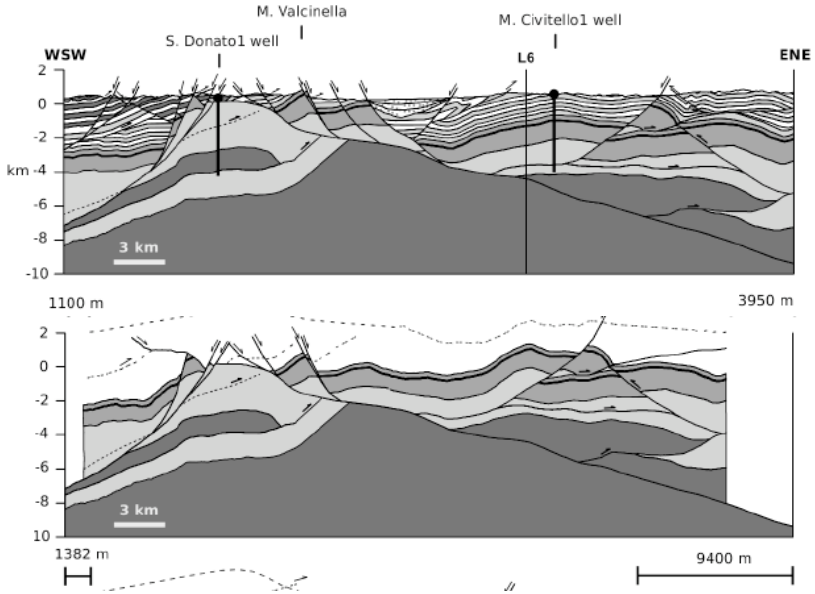
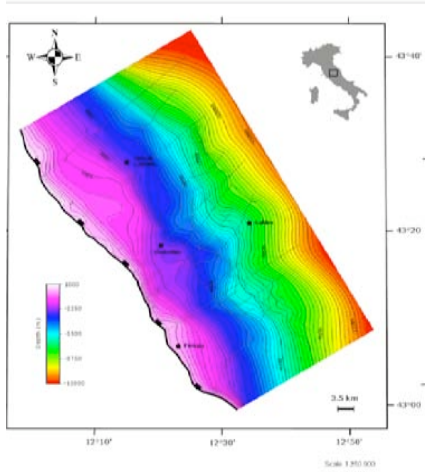
Development of new geological tools:

- Geological cross sections balanced in extension. Mirabella, Barchi

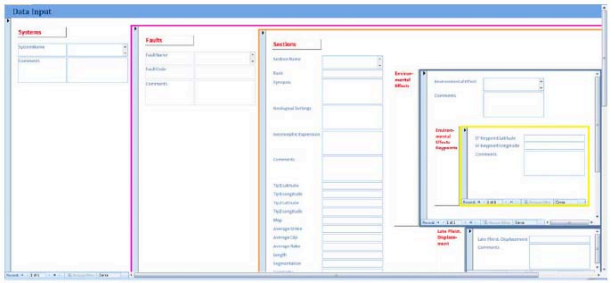


- 3D imaging of ATF. Mirabella, Lupattelli, Barchi



- Definition of the list of parameters describing active faults in Italy and construction of a geodatabese. Cinti, Pucci, Patera et al.

	PARAMETER	Type	Description	Uncertainties
FG	fault generalities			
a	SYSTEM NAME	text	(e.g. L'Aquila, Middle Aterno Valley, Conca subequana, Stabiata...)	
b	FAULT NAME	text	From main locality (e.g. Paganica Fault)	
c	FAULT CODE	text		
d	FAULT SECTION	text	If the fault has discrete branches that can be described separately	
e	RANK	text	To assign at the end (on the base of the assigned parameters. To be discussed the scale)	
f	COMMENTS	text	comments on points a-e	
g	SYNOPSIS	text	A concise summary of information that serves as a thumb-nail sketch of what is known about the structure.	
h	GEOLOGICAL SETTING	text	Amount of total or long-term (i.e. Pleistocene) geological offset, and general age of offset strata (from both geophysical and geological investigations).	
i	GEOMORPHIC EXPRESSION	text	Generalized description of geomorphic features at the surface that are related to the fault activity: fault scarps (size and shape), offset geomorphic markers (e.g. deformed paleosurfaces), anomalies of the drainage network (e.g. wind-gaps, deformed longitudinal profile, streams deflections), faceted	
l	COMMENTS and location of Key Point measurement sites	text		
FL	fault location			
a1	TIP1	numb		
a2	TIP2	numb		
b	FAULT TRACE	".dxf; ".shp; "		
c	MAP(S)	".dxf; ".shp ".tpo fi		
FD	fault data			
a	AVERAGE STRIKE	number		
b	AVERAGE DIP	number		



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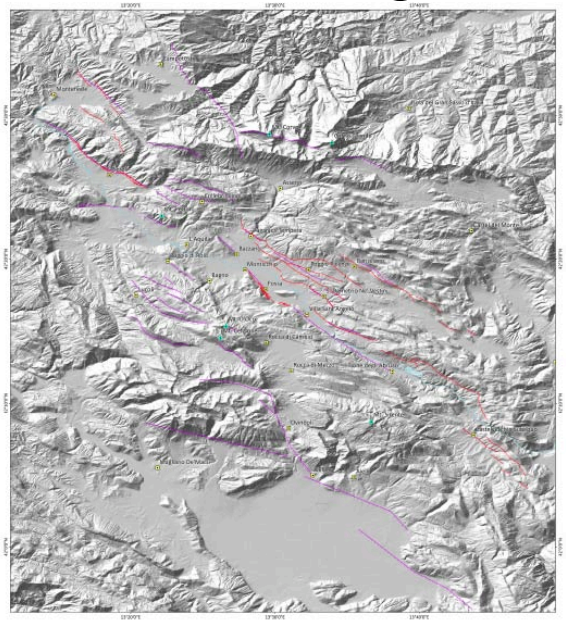
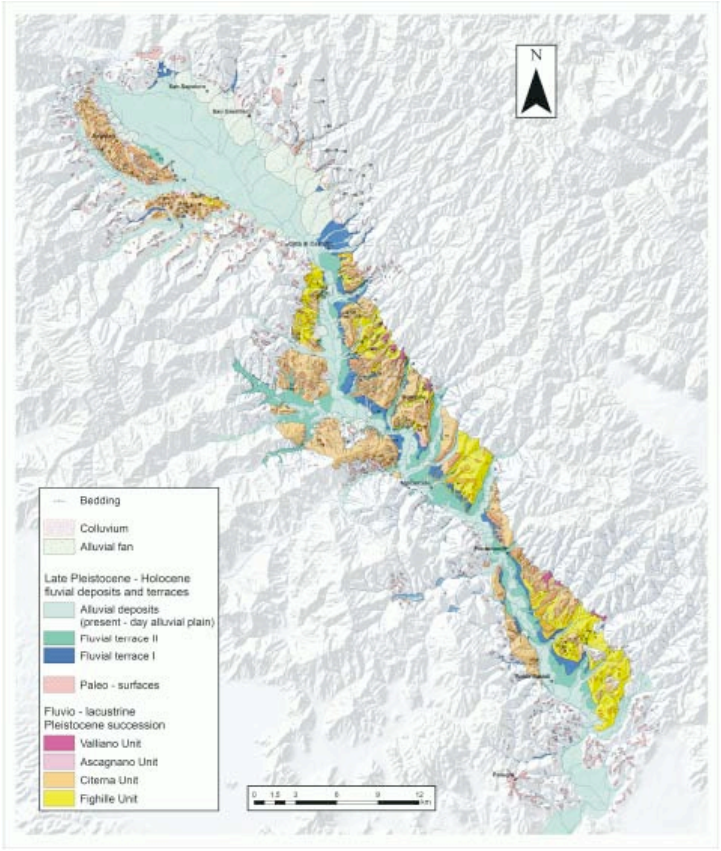
Geological results :

- Long term deformation rate on ATF 3mm/yr as for GPS. Mirabella, Barchi, D'Agostino
- Map of the quaternary deposits of the High Tiber Valley. Pucci, Saccucci, Barchi.



- Map of the active faults near L'Aquila. Cinti, Pucci et al. (INGV, CNR, ISPRA, DPC)



- The average recurrence of surface faulting on Paganica fault (AQ) is of ~700 yr the Holocene slip rate is of ~0.25 mm/yr, similar to the 0.2-0.3 mm/yr from the last 30 kyr.

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Cinti, Pucci et al. (INGV, CNR, ISPRA, DPC)

The relevance of S5 scientific achievements for Civil Protection can be classified in the broad categories of:

- technological developments,
- advanced data processing and mining,
- methodologies for data modelling and interpretation.

One of the relevant project key-words is the process automation, which implies the development of software and hardware systems and tools which are able to manage (in real- or near-real-time) massive data streams acquired by dense seismic and geodetic network deployed in active fault zones.

Conclusions

The development of dense seismic and geodetic networks to be integrated into the National Seismic Networks is an important target to improve the understanding of earthquake generation

Despite the difficulties encountered during these two years:

- the large part of involved researchers in S5 (both from INGV and Universities) are temporary employers
- the emergency of 2009 L'Aquila earthquake

we are very happy and proud for the quality of research and achievements in S5!

Perspectives

New skills have been acquired in S5 project thanks to the scientific and technological efforts done.

The final target is to improve our capability to image and monitor the spatial and temporal changes of the earthquake source and crustal parameters in relation to occurrence of background seismicity along active fault zones.

……and open issues

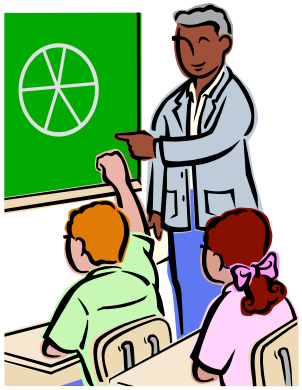
Does the back ground seismicity delineate the active fault systems that will rupture in the next large earthquake?

Can the temporal changes of crustal parameters be detected and monitored?

Are the subsurface seismic images and velocities inferred by active and passive seismic surveys comparable and consistent?

Should we extend the advanced technologies and methodologies of these test sites to other active seismic regions in Italy? (Only ATF and Irpinia are permanent monotoring structures)

S5 Presentations on July 1st



MORNING

9:00 **Zollo A.** Scaling relations for earthquake source parameters down to decametric fracture lengths in southern Apennines

9:30 **Chiaraluce L.** The Alto Tiberina Fault test site: towards a permanent multidisciplinary observatory

AFTERNOON

15:00 **Amato A.** 2009 L'Aquila emergency: history and perspectives

on July 2nd

MORNING

Invited talks by **Bird P., Ellsworth W., Cotton F. and Jordan T.**

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S5 Posters on July 1st

MORNING

Billi A., Presti D., Orecchio B., Faccenna C., and Neri G. Field structural surveys and seismological analyses of an incipient extension zone along the active convergent margin of Nubia in Sicily

Cinti F.R., S. Pucci, et al. Mapping of active faults and characterizing their seismic behavior

AFTERNOON

Avallone A., Marzario M. High Frequency GPS: a potential contribution

for monitoring a active faults

D'Amico S., Orecchio B., Presti D., Zhu L., Herrmann R., Neri G. Broadband Waveform Inversion for Mechanisms of Moderate Earthquakes In the Messina Straits, Southern Italy

Mattia M., Palano M., Bruno V., Cannavo F. Geodetic strain across the Messina Strait.

Moretti M., Govoni A., Margheriti L., Mandiello A. G., Pintore S., Di Stefano R., Chiaraluce L., Baccheschi P., Lauciani V., Marcocci C, and Mazza S. Integrated SEED data archive for temporary seismic experiments

Pastori M., De Gori P., Piccinini D.,Margheriti L., Valoroso L., e Chiarabba C. Investigating the relation between the occurrence of seismicity and the variations of the elastic parameters in the crust

Orefice A., Zollo A. Earthquakes scaling laws in Central Apennines

Serpelloni, E., Mastrolembo, B., Anzidei, M., Strain Accumulation Across the Messina Straits and Kinematics of Sicily and Calabria From GPS Data and Dislocation Modeling

Stabile T.A., Amoroso O., De Matteis R., Maercklin N., Matrullo E., Orefice A., Pasquale G., Satriano C., Zollo A. Velocity models and refined estimates of micro-earthquake source parameters for the Irpinia region, Southern Italy.

Vassallo, M., Festa, G., Bobbio, A. e Brondi, P. Seismic noise analysis across the Irpinia-Lucania region: a tool for investigating structure, site and stations

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