RU2 - INGV RM1: Activity report

POSTER S4-11

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Abstract: As part of Task 2 the activities of data collection and compilation of new monographs produced 136 forms on new digital accelerometric stations containing: station coordinates and elevation, photographic documentation and aerial photo of the site. Geological map at 1:25,000 scale, geological sections, respectively at 1:25,000 and 1:2,000 scale are also included. Following the April 6, 2009 L'Aquila earthquake, the activities of new monographs compilation have been redirected on the 57 stations of the Accelerometric National Network (RAN) which recorded the mainshock. Site classification of ITACA stations according to the EC8-NTC2008 subsoil classes has been revised and the new version (2.0) is going to be released with the next ITACA website upgrade. The ITACA stations are all georeferenced and have been incorporated into a GIS for the assignment of the subsoil category on the basis of the lito-technical map derived from the Geological Map of Italy at 1:100,000 scale.
The UR2 planned and realized in Task 4 a seismic network in Fucino Basin. The activity was aimed at detecting amplification effects in the basin and to relate them to the geometrical and geotechnical properties of soft sediments. The network was based on 18 seismic stations deployed between October and January 2009 and was operative until October 2009. In the recording period the seismicity was dominated by L'Aquila earthquake sequence that produced many hundreds record nowadays only partially processed. Many events generated by other seismic region in a 30-40 km distance range were recorded. A preliminary spectral ratios analysis performed and on seismic noise data is presented. The contribution of UR2 to Task 5 consists in an attempt to formulate a new site classification for the Italian territory which could be independent of the knowledge of the site geological conditions and not based on the conventional Vs30 intervals. The innovative approach we introduce for ITACA is based on the estimate of a site predominant period T. For sites where strong ground motions are recorded, the predominant period is estimated from the average horizontal-to-vertical spectral ratios of the 5%-damped response spectra of records. The method formulated in Task 5 is applied to the determination of sites with relevant amplification/deamplification performed in Task 4

Task 2: Preliminary site classification

This activity was requested by the project coordinators since it was necessary to provide an early version of the recording stations classification in order to interface the ITACA database with the REXEL software for the selection of natural accelerograms compatible with NTC2008 response spectra.
Since site classification for all the 616 ITACA stations was immediately needed while the compilation of the monographs was still in progress, we performed a preliminary classification based only on the geological data available with a homogeneous level of detail. This goal has been achieved using the lithological map of Italy at the scale 1:100,000 produced by INGV to be used in shakemap production. This map derives from the Geological Map of Italy at 1:100,000 scale, by merging different geological formations, based on lithological and geological age criteria, in several lithological units. Each unit was attributed an EC8 subsoil class (see Figure). The main difficulty in the redaction of the map was to homogenize the legend of the original maps that where compiled by many different authors in different time (over more than 50 years).
The limits of this type of "geological" classification are well known, as it allows only a approximate level of knowledge, but, as already mentioned, it was dictated by the urgency to set up a first classification.
This classification based on lithological map was subsequently checked and adjusted using, if available:

a)   detailed geological data;
b)   a geological "expert" evaluation;
c)   H/V microtremors measurements;
d)   photos of the sites;
e)   Vs$_{30}$ values from down-hole and cross-hole tests.

The major problems were found for the sites located near a geological limit between two different soil categories (eg. A and C), for sites with a sediment layer with thickness lower than 20 m and for sites located on landslides of some importance.
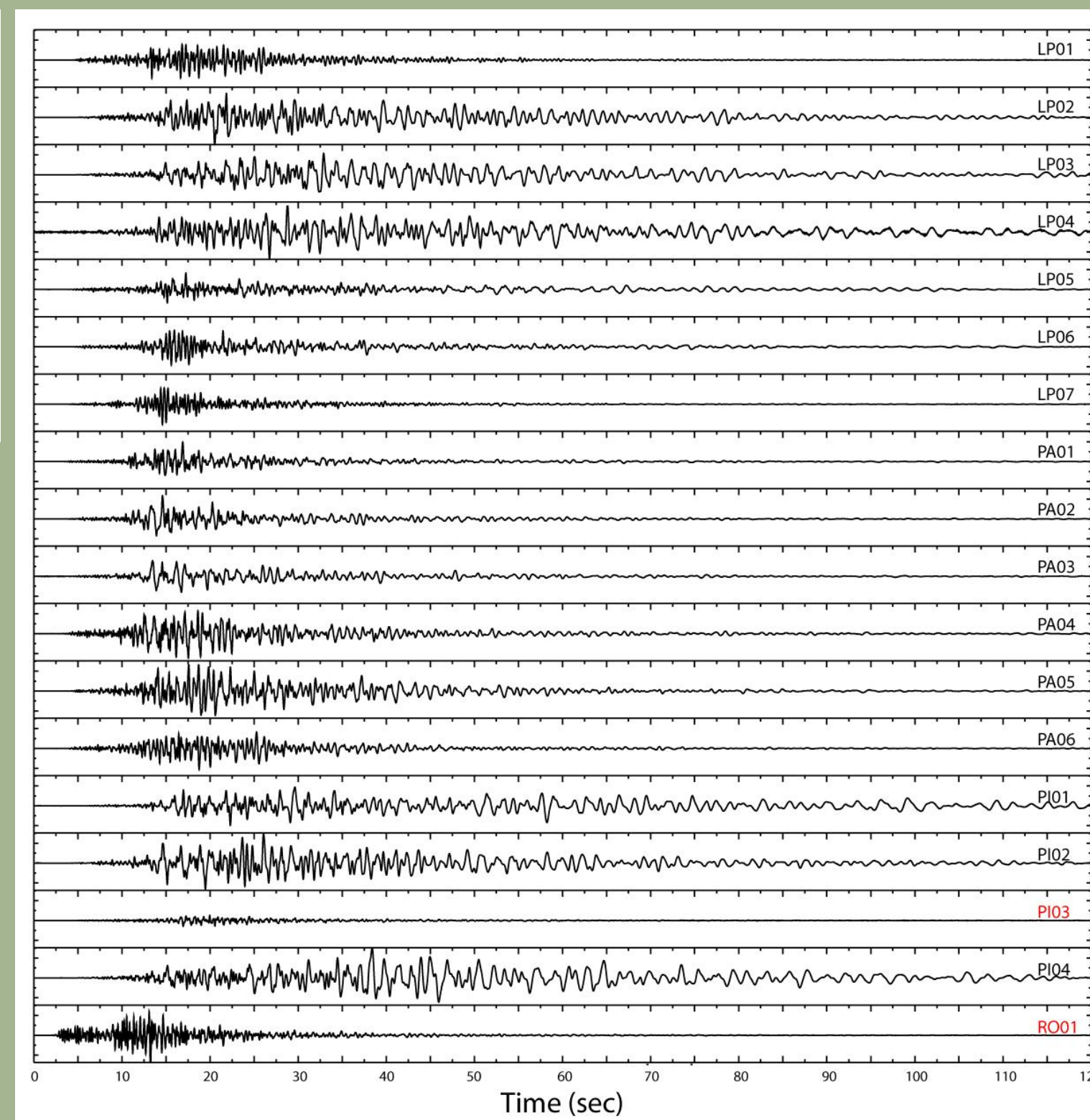At the end of the first year activity, a preliminary classification (version 1.1) according to the EC8-NTC2008 subsoil categories, has been produced for all ITACA stations. This classification will be used in the ITACA-REXEL interfacing. A new version of the site classification (2.0) has been released in these days. V$_{S30}$ values are available for very few stations.
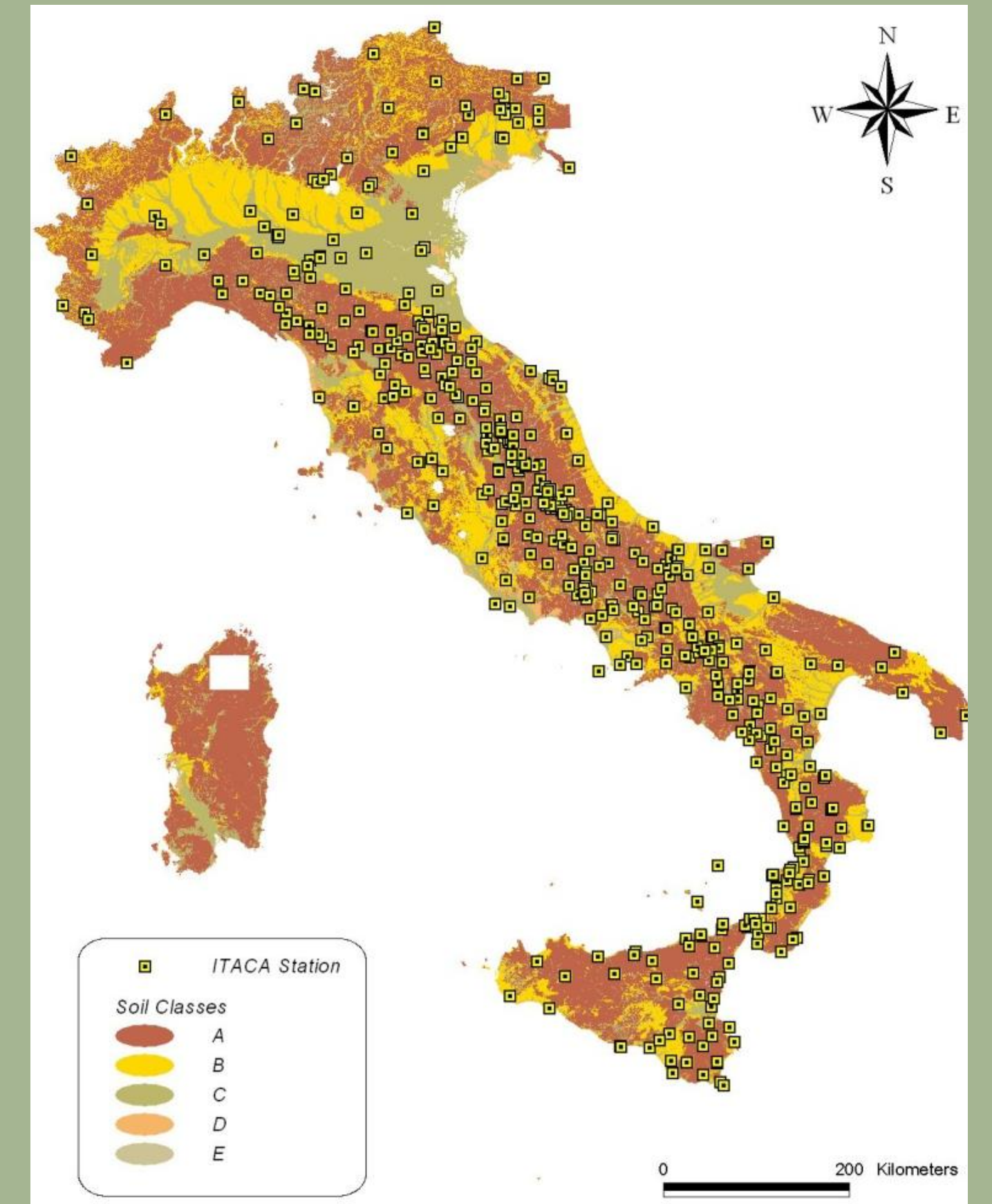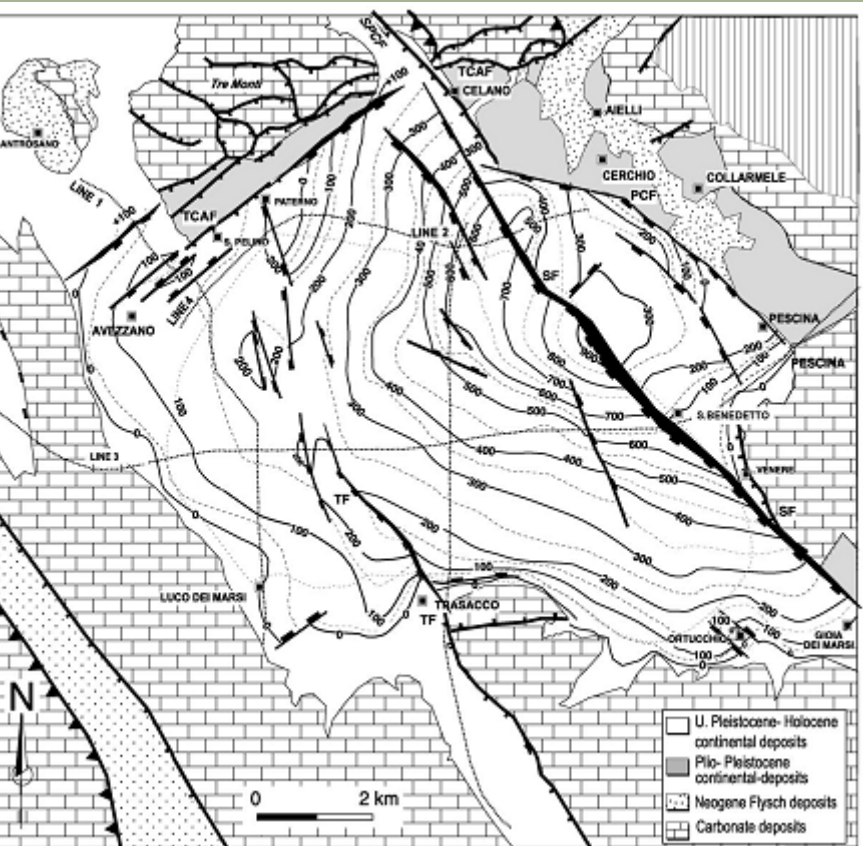

Task 4: Fucino Basin Seismic monitoring (The network was installed between October 2008 and January 2009 and operated until October 2009. The stations are marked with yellow labels on the map)
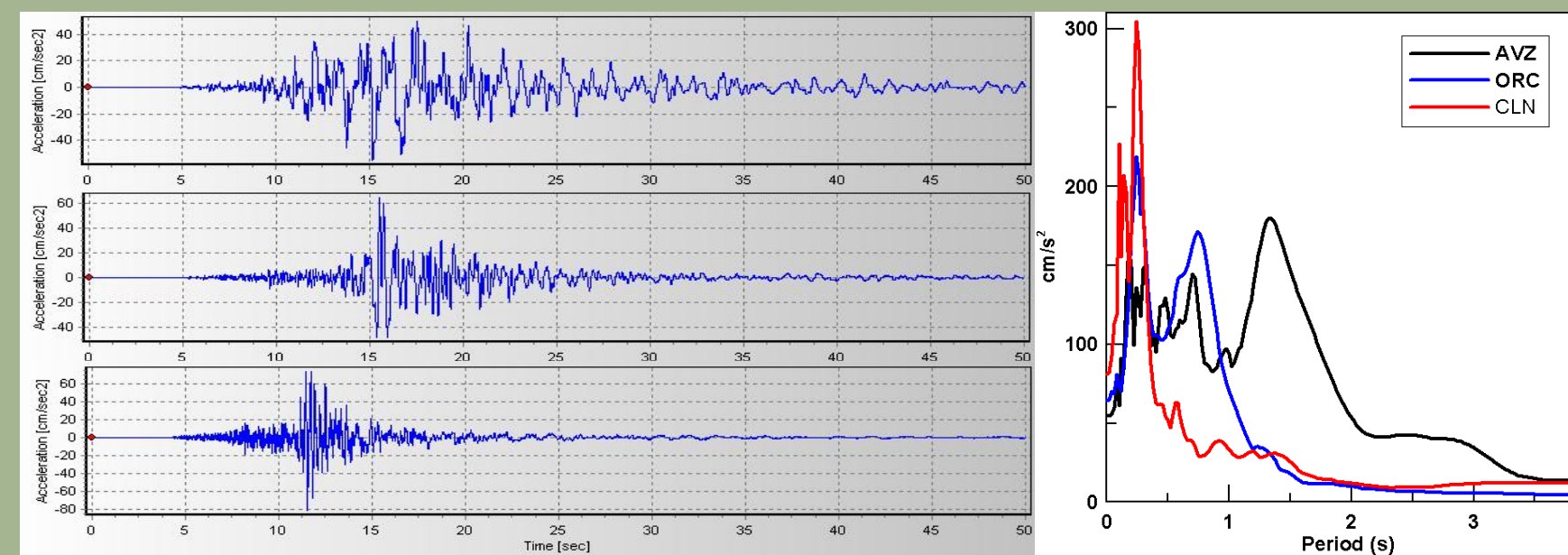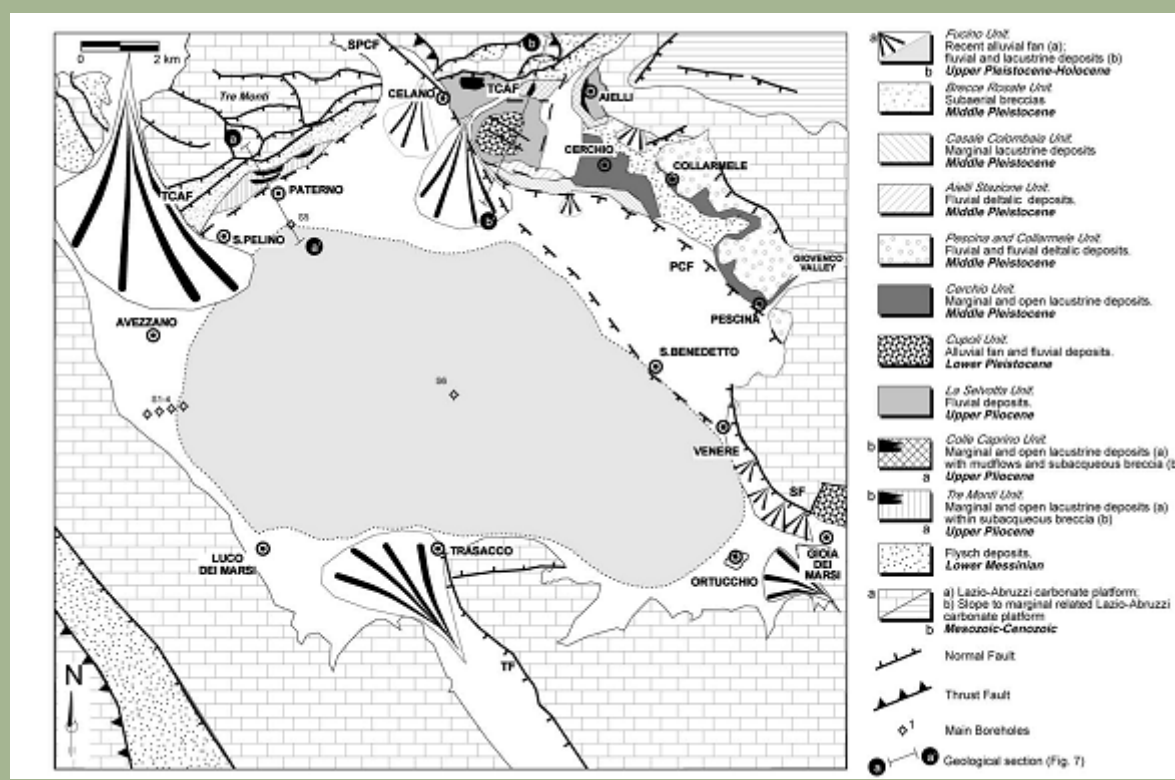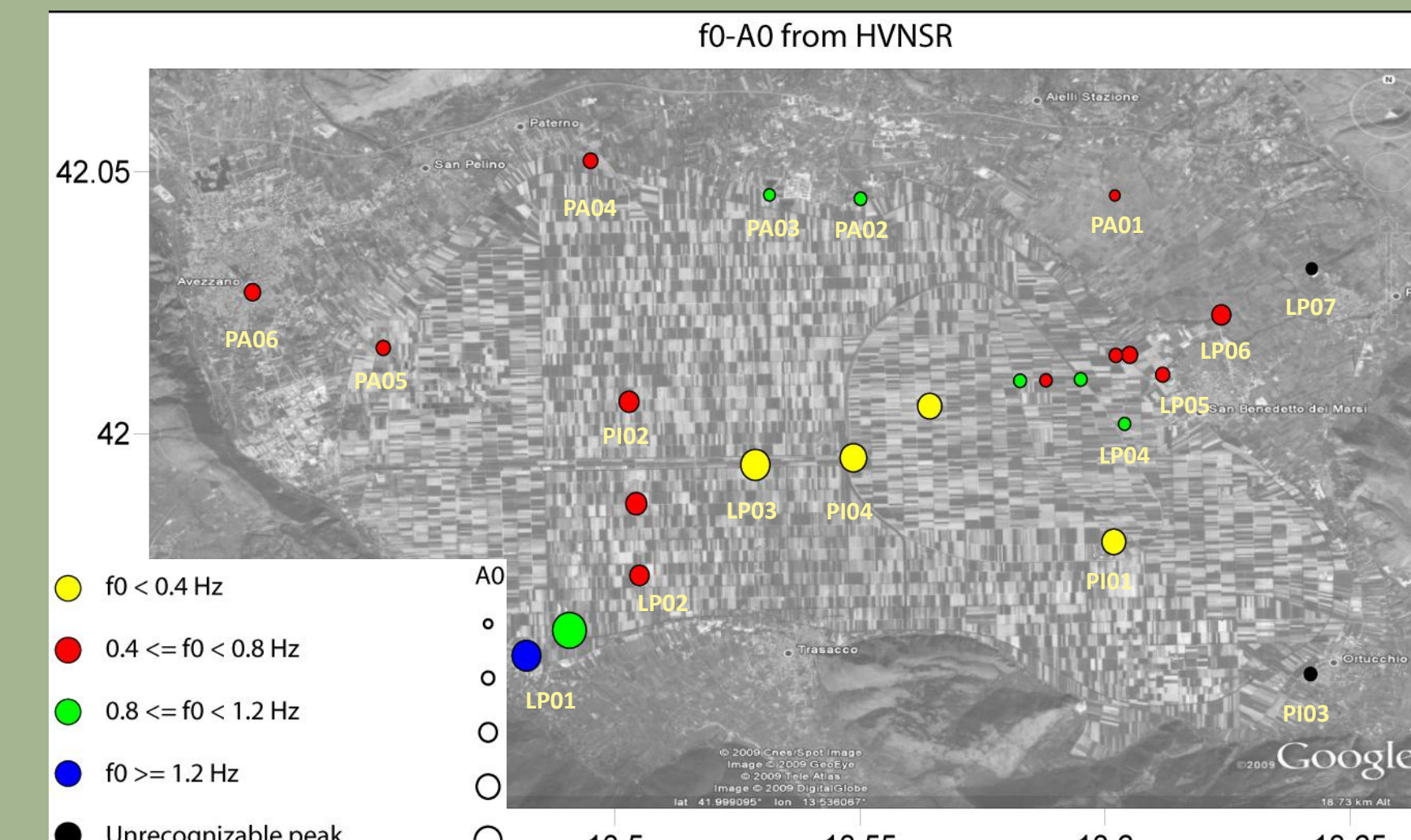

L'Aquila mainshock and 5% damping response spectra recorded at R.A.N. stations of: Avezzano soil site (AVZ), Ortucchio and Celano rock (ORC – CLN).

Geological setting of Fucino Basin and isochron contour map of alluvial and lacustrine deposits (travel times expressed in ms double time). In the northern part the presence of alluvial fan and gravel is very massive. The basin can reach a thickness of about 800-1000 meters in the San Benedetto dei Marsi area where important regional direct faults can dislocate the basement of the basin. The network was based on 16 stations installed into the basin on soft soil sites and 2 rock reference stations located at Alba Fucens and Ortucchio.

*Image from Cavinato et al.(2002). Sedimentary and tectonic evolution of Plio-Pleistocene alluvial and lacustrine deposits of Fucino Basin (centra Italy), Sedimentary Geology 148, pp.29-59

HVNSR results for Fucino Basin. The colored dots indicate the position of stations. Dots colors are related to f0 value, dots size to HVNSR amplitude.

Waveforms of the June 22 Ml 4.5 event recorded at Fucino network. Distances ranges from 40 Km (RO01) to 60 Km (PI03). Rock sites of Alba Fucens and Ortucchio are marked in red. Data are plotted on the same vertical scale.

Task 4-5: Classification of sites based on predominant period

For the purposes of Task 4 and Task5, we adopt an approach never applied so far to the ITACA data set. It uses both formalism and site classification different from the conventional ones (e.g., Sabetta and Pugliese, 1987 and 1996). According to Fukushima et al. (2007), in our formalism the dependence on distance is expressed by two terms, physically related to geometrical spreading and anelastic attenuation. In this way, we reach a better performance in fitting observations at large (≈100 km or so) distance compared to other GMPEs that do not include the contribution of anelastic attenuation. The site classification is based on the station predominant period and is derived from Fukushima et al. (2007) as well (see Table 1).
This criterion is used in Japan for the seismic design of highway bridges (Japan Road Association, 1980 and 1990). Details are shown in this meeting in the poster by Di Alessandro et al. (2009). Since the predominant period at a site is related to the ratio between the sediment thickness and velocity, it represents a combination of the traditional Vs30 criterion with the bedrock depth, implicitly introducing one more important parameter for the site classification. Zhao et al. (2006) describe an exhaustive application of this approach to a huge amount of data in Japan. The predictive equations formulated by Di Alessandro et al. (2009) are also used in Task 5, where the performance of alternative site classification techniques are checked, with particular attention to low cost methods such as spectral techniques using available strong/weak motion records.

Site Class – Zhao et al. (2006)		Site Class – Fukushima et al. (2007)		Site Class - our proposal	
SC-I	Tg < 0.2 sec.	SC-1	Tg < 0.2 sec.	CL-I	Tg < 0.2 sec.
SC-II	0.2 sec. = Tg < 0.4 sec.	SC-2	0.2 sec. = Tg < 0.6 sec.	CL-II	0.2 sec. = Tg < 0.4 sec.
SC-III	0.4 sec. < Tg < 0.6 sec.			CL-III	0.4 sec. = Tg < 0.6 sec.
SC-IV	Tg >= 0.6 sec.	SC-3	0.4 sec. = Tg < 0.6 sec.	CL-IV	Tg >= 0.6 sec.
		SC-4	Tg not identifiable and original Rock site	CL-V	Tg not identifiable (flat H/V)
		SC-5	Tg not identifiable and original Soil site	CL-VI	broad amplification multiple peaks @ Tg > 0.2 sec.
				CL-VII	Tg not identifiable (multiple peaks over entire period range)

Table 1)
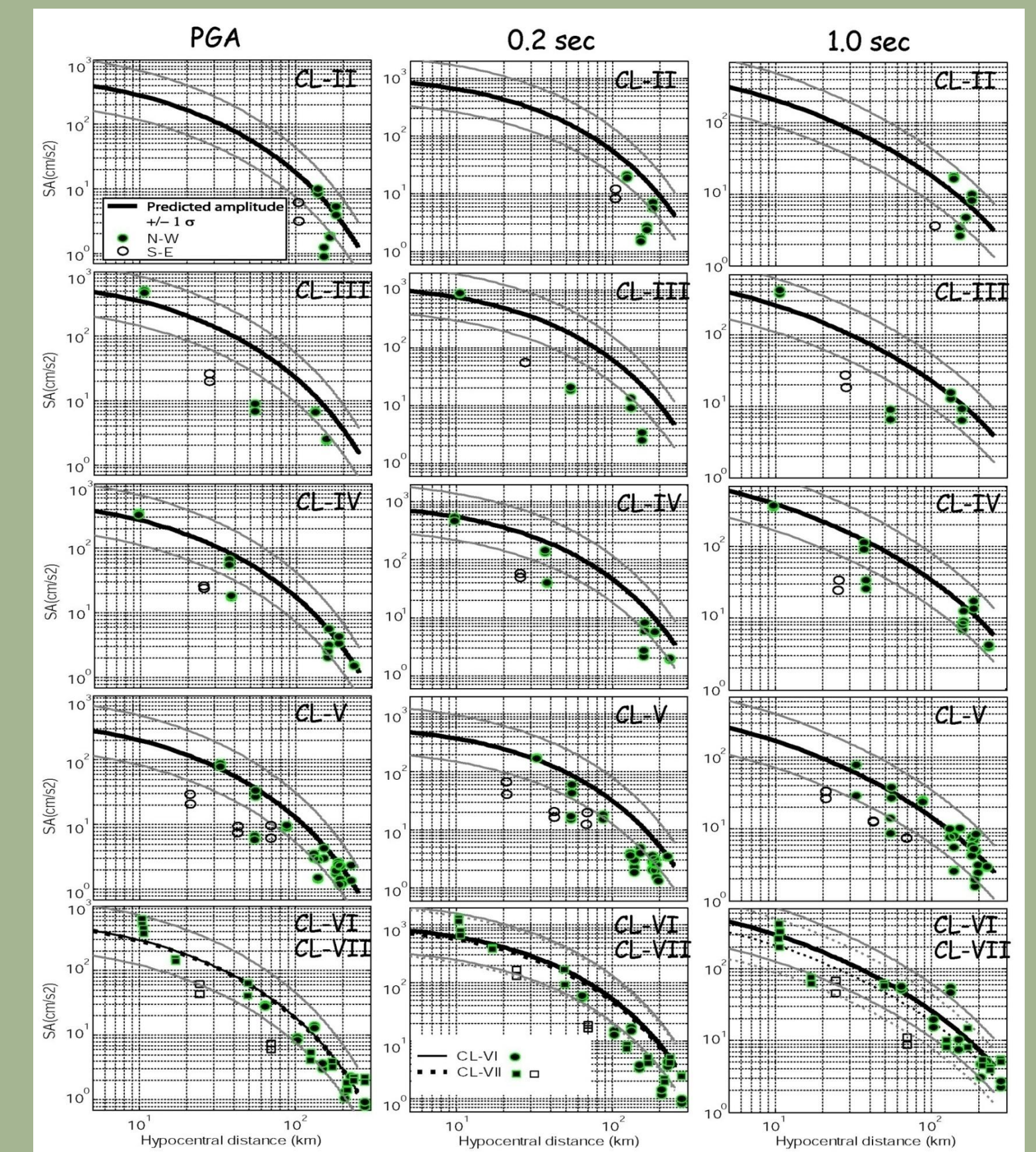
The Mw 6.3 L'Aquila earthquake offered the opportunity of new data of a moderate-magnitude, damaging event in Italy, not used in the regression analysis. Magnitude and distance of this earthquake are well sampled by Di Alessandro et al. (2009), and therefore it represents a useful opportunity for a validation test.

References:
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