



REPORT ON THE 2014 AIQUA SUMMER SCHOOL “LA GEOLOGIA DEL QUATERNARIO APPLICATA ALLO STUDIO DELLE FAGLIE ATTIVE: DAI TERREMOTI ALLA MICROZONAZIONE SISMICA”

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ABSTRACT: We here summarise the activities carried out during the 2014 AIQUA Summer School, held from the 29th of September to the 3rd of October at Istituto Nazionale di Geofisica e Vulcanologia (INGV) of L'Aquila, and supported by INGV-Progetto Abruzzo. The school aimed at highlighting the major contribution of Quaternary geological investigation to the analysis of active and capable faults: this approach involves seismotectonic analysis and surface faulting hazard assessment on faults and deep seated gravitational slope deformations. The participants attended two days of classes, related to those topics, held by experts, and actively and largely joined the discussions raised during the lessons; furthermore, they took part to a three-day fieldtrip in the 2009 L'Aquila earthquake area and surroundings. Concepts and methods learned during the lessons were applied to selected case studies: these included the 2009 L'Aquila earthquake causative fault and other major active normal faults affecting the Gran Sasso Range and the middle Aterno river valley. Moreover, participants actively took part in still ongoing paleoseismological investigations that aimed at the reconstruction of the recent kinematic behaviour and slip history of the Assergi fault, a major active normal fault of the central Apennines.

Keywords: Quaternary geology, active and capable faulting, deep seated gravitational slope deformation, paleoseismology, surface faulting hazard, seismic microzonation.

Active and capable faults and large scale gravitational slope deformations represent geological criticalities that, as elements of surface fragility, can interfere with human development; they must therefore be taken into consideration for seismotectonic analysis and, consequently, for a proper land use planning. These topics were discussed during the 2014 AIQUA summer school concerning, in particular, investigation methodologies and hazard assessment.

The school took place in the Abruzzi region, at the Istituto Nazionale di Geofisica e Vulcanologia in L'Aquila, from the 29th of September to the 3rd of October. An appreciable number of “students” attended the event: undergraduates and Ph.D. students, postdoctoral fellows, researchers and freelance geologists, from central and southern Italy, and one coming from Great Britain.

During the first two days, lessons were held by experts in active tectonics, Quaternary geology, paleoseismology, neotectonics, earthquake geology, seismic microzonation. They lectured with laudable enthusiasm (and without remuneration!). They held high-value classes and stimulated discussion among the participants on the different topics mentioned above, some of which are presently a matter of debate in the scientific community, especially with regard to surface faulting hazard assessment. The speakers thoroughly emphasised the importance of “old-school” geological survey, which lays the foundation for a multi-methodological approach in

active and capable faulting analyses.

We warmly thank all the lecturers for their irreplaceable contribution to the success of the school!

MONDAY, SEPTEMBER 29

The first day of the school was opened by Dr. Andrea Sposato who, as a senior member of AIQUA, spoke on behalf of AIQUA itself, thanking all of the participants and lecturers for taking part to the summer school; he emphasised the importance of such events in increasing the awareness of the fundamental role of Quaternary geology in active tectonics analysis, especially as for young scientists and students. Then, the INGV-Progetto Abruzzo was presented by its scientific coordinator Dr. Gianluca Valensise who, together with INGV-L'Aquila branch manager, Dr. Fabrizio Galadini, supported the AIQUA event.

After these introductory talks, a series of scientific classes began with Dr. Paolo Messina, who illustrated general aspects of Quaternary geological investigations and their contribution to the reconstruction of tectonic and paleoenvironmental history of the central Apennines.

Dr. Fabrizio Galadini gave a lecture on the role of Quaternary geological investigations on active and capable faulting studies; his lesson was also dedicated to the definition of time intervals to assess the notion of “active and capable faults” for engineering practices in

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Fig. 1 - Lessons held during the first two days of the summer school; a) Ing. Maria Basi illustrates microzonation studies presently ongoing in the Abruzzi region, b) Dr. Marco Moro shows the re-activation of large scale gravitational slope deformation during the 1997 Colfiorito earthquake.

Italy.

Dr. Daniela Pantosti focused on general and methodological aspects of paleoseismological analysis, showing several case studies all over the world, and highlighting the effectiveness of such investigations for seismic hazard assessment.

Dr. Gianluca Valensise illustrated the Italian Database of Individual Seismogenic Sources (DISS); he also showed some examples of peculiar geological features that mimic active faulting, and other cases where the relation between active faults at surface and seismogenic structures at depth can be complicated by the inheritance of older tectonic structures.

Ing. Maria Basi explained the role and task of the

Abruzzi Region local government in the seismic microzonation studies of the whole region (Fig. 1a).

Dr. Paolo Boncio gave a lecture on the criteria to define zones of surface fault-rupture hazard; he illustrated the new guidelines – currently underway – for surface fault rupture zonation in Italy that are still a matter of interest and debate within the Italian scientific community and the Italian governmental institutions.

Dr. Paolo Galli illustrated the state of the art of paleoseismological investigations in Italy, showing some recent examples of such analyses along Italian major active normal faults.

Dr. Alberto Pizzi showed the most recent outcomes of ongoing seismic microzonation studies of the town of



Fig. 2 - Fieldtrip – Visit to the paleoseismological trenches dug across the Assergi fault.



Fig. 3 - Fieldtrip – Moments of the lunch at Campo Imperatore, waiting for “arrosticini” to be cooked.



Fig. 4 - Fieldtrip – The group discusses on the Campo Imperatore active fault strands. Mt. Brancastello in background, through the clouds.

Sulmona, in the Abruzzi region: he outlined the geological factors that influence local seismic response and the issue of active and capable faulting affecting the Sulmona territory.

TUESDAY, SEPTEMBER 30

The second day of lessons began with Dr. Marco Tallini, who illustrated the results of seismic microzonation studies carried out in L’Aquila after April, 2009, in the difficult post-earthquake framework; he examined all of the geological complexities needed to be understood and unraveled.

Dr. Nicola Tullo showed the role of freelance geolo-

gists in the ongoing seismic microzonation studies in the Abruzzi region.

Dr. Marco Moro gave two lectures: the former about general aspects of deep seated gravitational slope movements and their relation with active tectonics; the latter focused on the use of satellite radar interferometry and paleoseismological techniques to investigate the kinematic behaviour and mechanics of large scale gravitational mass movements. He showed different case studies of large scale mass wasting that had been re-activated during large magnitude seismic events occurred in Italy during the past decades (among which the 2009 L’Aquila earthquake) (Fig. 1b).



Fig. 5 - Fieldtrip – Dr. Biagio Giaccio describes Middle Pleistocene tephra layers contained in alluvial sediments displaced by the Paganica fault.

Dr. Stefano Gori illustrated, through case studies selected over the central Apennines, the role of Quaternary geological field analysis in demonstrating the inactivity of tectonic structures despite the presence of misleading morphological hints suggesting activity.

The last talks introduced the fieldtrips:

Dr. Biagio Giaccio reported a comprehensive picture of the Quaternary geological evolution of the Paganica village area where, the activation of the normal fault causative of the 2009 earthquake caused surface fault rupture.

Dr. Emanuela Falcucci illustrated the Quaternary geological evolution of the middle Aterno river valley and of the Subequana valley, and their relation with the long term kinematic evolution of the active normal faults that affect the eastern borders of these intermontane depressions.

Dr. Stefano Gori and Dr. Marco Moro illustrated the present knowledge about the activity of the Assergi-Campo Imperatore fault system, where paleoseismological trenches, shown during the first day of the fieldtrips, have been dug. They also showed the structural and tectonic complexities that characterise the southwestern flank of the Gran Sasso Range, resulting from the interference between active extensional faults and inactive thrust faults inherited by the presently inactive compressive regime.

WEDNESDAY, OCTOBER 1

On the first day, the fieldtrip was spent along the Assergi active normal fault. Two paleoseismological trenches dug across the central part of the fault – made *ad-hoc* for the summer school – were visited. The walls

of the excavations were observed, analysing evidence of the recent fault movements and searching for elements that give information about its slip history (Fig. 2).

We moved, then, to the Fossa di Paganica tectonic depression, located along the southern portion of the Assergi fault. Here, geomorphological evidence of the recent activity of the tectonic structures was analysed in the light of the results coming from paleoseismological investigations, which were recently performed along this part of the fault (Moro et al., in prep.).

After a wonderful and pleasant lunch, where the participants experienced and made practice in the art of cooking “arrosticini” (accompanied by more than one glass of red wine!!) (Fig. 3), the fieldtrip continued in Campo Imperatore highland, specifically focusing on glacial and peri-glacial deposits exposed along the plain and on the active normal faults pattern that affects the area (Fig. 4).

During the last part of the afternoon, some of the closed tectonic depressions that characterise the southwestern flank of the Gran Sasso Range were visited, with a particular focus on the bounding fault scarps; the evidence of recent activity of these structures was discussed, together with their tectonic “significance” in the complex structural framework of the mountain front. Furthermore, geomorphic evidence of the occurrence of large scale gravitational slope deformation along the Gran Sasso southwestern flank was shown.

THURSDAY, OCTOBER 2

The first half of the fieldtrip on the second day was led along the Paganica fault, whose activation determined the April 6, 2009 seismic event. In particular, the



Fig. 6 - Fieldtrip – Dr. Emanuela Falucci describes the Middle Aterno Valley fault system.

site of the water main that had been damaged by the fault activation was visited, analysing the Quaternary (and Late Pleistocene-Holocene) deposits displaced by some secondary fault planes exposed along the main fault scarp, in the area of Paganica. Evidence of activation of the Paganica fault during seismic events preceding the 2009 one was examined. Alluvial fan and fluvial deposits containing Middle Pleistocene tephra layers and displaced along the fault were analysed in detail (Fig. 5).

During the afternoon, a fault plane exposed at the southern termination of the Paganica fault, in Poggio Picenze, was observed, described and analysed; the structure brings into contact lacustrine and alluvial deposits. Then, evidence for the late Quaternary activity of one of the northernmost segments of the Middle Aterno Valley fault was illustrated near Corbellino: fluvial-lacustrine deposits are affected by a complex shear zone, synthetic to the main fault scarp; as a consequence of the fault movement, they were placed in contact with slope deposits. The day ended with beers, teas, juices, snacks and laughs in San Demetrio ne' Vestini.

FRIDAY, OCTOBER 3

The last fieldtrip focused on the Middle Aterno Valley-Subequana Valley fault system. The participants enjoyed a wonderful panoramic view of the scarp of the Roccapreturo fault segment from the village of Goriano Valli (Fig. 6).

The Roccapreturo fault scarp is one of the most impressive fault scarplets of the central Apennines. Evidence for the Quaternary and Late Pleistocene-Holocene activity of the Roccapreturo segment was illustrated and described in more detail in the village

of Roccapreturo: there, the tectonic structure brought in to contact the carbonate bedrock, cropping out on the footwall, with Late Pleistocene-Holocene deposits, exposed at the base of the fault scarp.

The stop was followed by the description of the Quaternary morpho-stratigraphic and tectonic evolution of the Subequana valley. In particular, some fault planes related to the Subequana valley fault were shown in the



Fig. 7 - Fieldtrip – Dr. Giandomenico Fubelli describes one of the active fault plane that crosses Castelvecchio Subequo.

area of Castelvechio Subequo (Fig. 7). Evidence of the displacement of Middle Pleistocene fluvial deposits and of Late Pleistocene slope sediments along these faults were analysed in detail.

The organisers Emanuela Falcucci and Stefano Gori warmly thank all the participants for the days spent together and for the more than pleasant company! Everyone was extremely friendly, active and interested, and the mood was always overjoyed and superb!! The organisers consider the summer school experience as

extremely positive, a cultural and human growth, and they hope this will not be the last "stop" but the first of many other similar initiatives !!

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