LOOKING FOR ACTIVE AND CAPABLE FAULTS IN FRIULI: A MULTIDISCIPLINARY APPROACH TO STUDY THE MANIAGO THRUST (WESTERN CARNIC PREALPS, NE ITALY).

M.E. Poli[1], E. Falcucci[2], S. Gori[2], G. Monegato[3], A. Marchesini[1], A. Zanferrari[1], A. Affatato[4], L. Baradello[4], G. Bohm[4], I. Dal Bo[5,7], E. Forte[5], E. Del Pin[6], S. Grimaz[6]

[1] Dipartimento di Scienze AgroAlimentari, Ambientali e Animali, Università di Udine, Italy
[2] INGV- Istituto Nazionale di Geofisica e Vulcanologia- Roma-L'Aquila, Italy
[3] CNR - IGG - Istituto di Geoscienze e Georisorse, Torino, Italy
[4] OGS - Istituto Nazionale di Oceanografia e Geofisica Sperimentale, Trieste, Italy
[5] Dipartimento di Matematica e Geoscienze, Università di Trieste, Italy
[6] Dipartimento Politecnico di Ingegneria e Architettura, Università di Udine, Italy
[7] Agrosphere (IBG-3), Forschungzentrum Jülich GmbH, Germany

In the framework of the agreement between the Friuli Venezia Giulia Region (Geological Survey), I.S.P.R.A. and University of Udine, in order to improve knowledge about the active and capable faults in the Friuli Venezia Giulia Region and update the ITaly HAzard from CApable faults (ITHACA) database, new geological, morphotectonic, geophysical and paleoseismological studies were carried out on the Maniago thrust (western Carnic Prealps, Friuli) near Meduno locality (PN).

The Maniago thrust belongs to the Quaternary front of the eastern Southern Alps (ESA), a polyphase fold and thrust belt in evolution from the Middle Miocene to the Present. The development of this polyphase belt is linked to the N-ward indentation Adria microplate and, starting from the Miocene-Pliocene transition, to its NE-ward counter-clockwise rotation (Vrabec and Fodor, 2006). Up today Adria moves northward about 2-3 mm/yr (Caporali *et al*., 2013) and its motion is accommodated not only by the WSW-ENE trending, SSE-verging thrust-front of the ESA in Veneto and Friuli regions, but also by the NW-SE trending, right-lateral strike slip fault-systems in W-Slovenia.

In the western Carnic Prealps the ESA-external front is arranged in a set of WSW-ENE trending, SSE-verging, middle angle, mostly blind thrusts involving both the uppermost Pleistocene (i.e. LGM) and Holocene sediments cropping out in the pre-alpine area and in the Friuli piedmont Plain. Morphotectonic investigations identified surficial traces of the recent fault activity, generally represented by drainage anomalies and gentle scarps connecting uplifted and back-tilted Quaternary paleo-landscapes with the plain. Tectonic activity is also testified by the historical and instrumental seismicity (Rovida *et al*., 2016). Historical earthquakes hit the western Carnic Prealps causing widespread damage and losses: the 1776/7/6 Prealpi Friulane (Mw: 5.82; Imax: 8-9); the 1812/10/25 Pordenonese (Mw: 5.7; Imax: 7-8); the 1873/18/10 Alpago (Mw: 6.3; Imax: 9-10) and the 1936/10/18 Cansiglio (Mw: 6.1; Imax: 9). In the last decades maximum recorded magnitude is the Claut 1996/4/13 event (Mw 4.43; Imax: 5-6).

The study area is located at the lower reach of the Meduna valley, where the incision of the Meduna River crosses the Miocene succession and cuts the Pliocene-Holocene alluvial deposits of the piedmont plain. The study shows that the valley configuration has been shaped during the Pliocene-Quaternary with long lasting steady intervals, spaced out by periodic tectonic pulses linked to the activity of the thrust front of the ESA. The most recent pulse related to the Maniago thrust shows an Upper Pleistocene – Holocene slip-rate of about 0.5 mm/yr (Monegato and Poli, 2015). During the last pulse the activity of the Maniago thrust gave rise to a tectonic scarp (about 900 m long and 1-4 m high) shaped in the LGM Rivalunga terrace near Meduno. Integrated geophysical investigations (Electrical Resistivity Tomography, seismic refraction and reflection, Ground Penetrating Radar (GPR), passive seismic (HVSR, ReMi) and MASW) were performed across this morphological feature. All the geophysical data showed, at different scale, remarkable lateral anomalies across the morphological scarp, highlighting that it is compatible with a tectonic origin. Two paleoseismological trenches were dug across the scarp. Progressive thickening of the colluvial sediments toward the tectonic scarp, gentle

anticline-trend of LGM and Early Holocene (historical) deposits, middle to high angle reverse faults with clasts-rotation along the shear zones involving the historical sediments and extrados cleavage, indicated that the Maniago thrust is not only an active fault but also a capable one. Moreover the very recent age of the deformed stratigraphic units (1460 AD), compared with the DBMI-15 Catalogue allowed us to consider the 1776.07.10 earthquake (Imax=8-9), as the last seismic event linked to the Maniago thrust tectonic activity. These new data cast new light on the seismic hazard assessment in the western Friuli.

References

Locati M., Camassi R., Rovida A., Ercolani E., Bernardini F., Castelli V., Caracciolo C.H., Tertulliani A., Rossi A., Azzaro R., D'Amico S., Conte S., Rocchetti E.; 2016: *DBMI15, the 2015 version of the Italian Macroseismic Database*. Istituto Nazionale di Geofisica e Vulcanologia. doi:http://doi.org/10.6092/INGV.IT-DBMI15

Monegato G. and Poli M.E.; 2015: *Tectonic and climatic inferences from the terrace staircase in the Meduna valley, eastern Southern Alps, NE Italy*. Quat. Res., **83**, 229–242.

Vrabec M. and Fodor L.; 2006: *Late Cenozoic tectonics of Slovenia: structural styles at the Northeastern corner of the Adriatic microplate*. In: Pinter, N., Grenerczy, G., Weber, J., Stein, S., Medak, D. (Eds.), The Adria Microplate: GPS Geodesy, Tectonics and Hazards, 151-168. Nato Science Series: IV: Earth and Environmental Sciences, 61, Springer.

Caporali A., Neubauer F., Ostini L., Stangl G., Zuliani D.; 2013: *Modeling surface GPS velocities in the Southern and Eastern Alps by finite dislocations at crustal depths*. Tectonophysics **590** (2013) 136–150.

THE FASTMIT PROJECT (FAGLIE SISMOGENICHE E TSUNAMIGENICHE NEI MARI ITALIANI)

G. Rossi[1], R. Basili[2] and FASTMIT Working Group

[1] *Istituto Nazionale di Oceanografia e di Geofisica Sperimentale – OGS, Centro di Ricerche Sismologiche, Trieste, Italy*

[2] *Istituto Nazionale di Geofisica e Vulcanologia – INGV, Roma, Italy*

Italy and its surrounding Seas straddle the active margin between the European and Nubian plates, and together are one of the most seismically active areas of the Mediterranean region. Despite the quite good knowledge about the earthquake-induced hazards in the Italian landmass, large uncertainties and knowledge gaps exist in the marine areas. Recent researches in marine geophysics and geology conducted independently by CNR, INGV, OGS, and by several other scientists from Italian Universities, as well as International research organizations in the Adriatic Sea, Ionian Sea, Tyrrhenian Sea, and Sicily Channel testify the presence of active structures that are still poorly known and may host a significant seismogenic and tsunamigenic potential.

FASTMIT (FAglie Sismogeniche e Tsunamigeniche nei Mari ITaliani) is an OGS-INGV project funded by the Ministry of Education, University and Research (MIUR) within the National funding program "Premiale 2014" with a planned duration of two years.

FASTMIT aims to improve the knowledge and rationalize the available information on the tectonic structures in Italy's adjacent Seas, with a particular focus on four study areas (the Adriatic Sea, the Gulf of Taranto, the Sicilian Channel, and the southern Tyrrhenian Sea). The expected results will significantly improve the basic input for future seismic and tsunami hazard estimates at three distinct levels:

- for probabilistic seismic hazard and tsunami hazard assessment at national scale developed for building codes, land-use planning, and other regulatory purposes;
- for assessments of the hazard and risk characterizing the Italian coastal areas - particularly critical for the high population density and the concentration of facilities classified as "RIR" (Rischio di Incidente Rilevante; Italian for "at risk of significant accident") in the recent maps edited by ISPRA;

- for local estimates of hazard and risk associated with hydrocarbon extraction, either ongoing or planned, both in national waters (Adriatic Sea, Ionian Sea, Strait of Sicily) and in the waters of the central Mediterranean countries (Croatia, Greece, North Africa).

The FASTMIT project relies on the collaboration between the two most important Italian institutes in the sector of the geosciences (OGS and INGV) that over the years gained considerable expertise in the various aspects of the onshore and offshore geological hazards. The different skills developed by both institutes will mutually complement and complete toward a homogeneous data product, which will contain a characterization of the crustal faults affecting the studied marine areas, together with their classification in terms of seismogenic and tsunamigenic potential.

The project will benefit from the infrastructure managed by the two institutes, such as observational geodetic and seismometric networks, mobile equipment, the research vessel OGS Explora with its high-profile instrumentation.

In addition, the project will benefit from the results of several projects already completed or in progress under national or European research-funding programs (MAGIC, RITMARE, Smart Cities CLARA, EMODnet-Geology2, EPOS-IP, ASTARTE, STREST, SHARE, AlpArray, TSUMAPS-NEAM), several of which represent examples of active cooperation between OGS and INGV, or with the parties that have expressed their interest in it. In this respect, several institutions, not directly involved in the project, have formally expressed their interest in FASTMIT's potential results. A noteworthy example is the Ministry of Economic Development, which has recently started a program on the safety of offshore installations involving both OGS and INGV, with complementary targets to the FASTMIT's. Below is the list of the institutions that have formalized their interest in FASTMIT:

- Ministero dello Sviluppo Economico (MiSE);
- Dipartimento della Protezione Civile (Presidenza del Consiglio dei Ministri);
- Protezione Civile Regione Friuli-Venezia Giulia e del Veneto;
- CNR-IMAA;
- Istituto Superiore per la Protezione e la Ricerca Ambientale (ISPRA);
- University of Malta.

The already broad international collaborations of OGS and INGV will also be strengthened by the results of the project: the seismological cross-border network CE3RN will be further extended toward the sea; this is of particular interest especially for neighboring countries, such as Croatia and Slovenia. The installation of a seismic array in the Maltese Archipelago, for which we thank the availability of the University of Malta, will constitute an international research infrastructure which will remain operational even after the end of the project. This type of infrastructure, diffused in the countries bordering the North Sea, would be the first one in the Mediterranean dedicated to the study of the offshore seismicity.

The results expected from the FASTMIT project shall constitute a significant contribution to the knowledge of seismogenic structures in the Italian Seas and the potential hazards they may pose. Considering Italy's geographic position, this information will help improve future efforts in estimating seismic hazard and the hazard posed by tsunamis of earthquake origin, not only for Italy but also for conterminous countries and Mediterranean countries in general.