

## PETROLEUM EXPERTS' SOFTWARE FOR THE UNIVERSITY OF UDINE

L'Università di Udine (Dipartimento di Scienze AgroAlimentari, Ambientali e Animali) ha stipulato con la Petroleum Experts Limited un Accordo Istituzionale per l'uso di 10 licenze del programma MOVE 2022.1 da utilizzarsi esclusivamente per scopi accademici (tutoriali, didattici, corsi di Dottorato e di Master) o di ricerca non commerciale.

Il pacchetto che la Petroleum Experts Limited ha donato a titolo completamente gratuito all'Università di Udine comprende: HARDLOCK, MOVE, 2D Kinematic Modelling, 3D Kinematic Modelling, Geomechanical Modelling, Fracture Modelling, Fault Response Modelling, Fault Analysis, Stress Analysis, MOVE Link for Petrel, MOVE Link for OpenWorks, MOVE Link for GST, per un contro-valore commerciale in sterline di £ 1,872,218.26.

Il pacchetto MOVE 2022.1 consentirà di sviluppare studi di alto livello all'interno di progetti di cartografia geologica, modellazione di dati strutturali e sismologici, ricostruzione 3D dell'architettura di catene orogenetiche.

The University of Udine (Department of Agrifood, Environmental and Animal Sciences) stipulated an Educational Institution Licence Agreement with Petroleum Experts Limited, for 10 academic licenses of MOVE 2022.1 exclusively for teaching tutorial, not-commercial research, Master and Phd courses.

The donated software package consists of HARDLOCK, MOVE, 2D Kinematic Modelling, 3D Kinematic Modelling, Geomechanical Modelling, Fracture Modelling, Fault Response Modelling, Fault Analysis, Stress Analysis, MOVE Link for Petrel, MOVE Link for OpenWorks, MOVE Link for GST for a commercial price of £ 1,872,218.26 (UK Sterling).

Move 2022.1 will enable to develop qualified studies in the frame of geological mapping, geo-modeling of structural and seismological data, 3D architecture of orogenic chains.

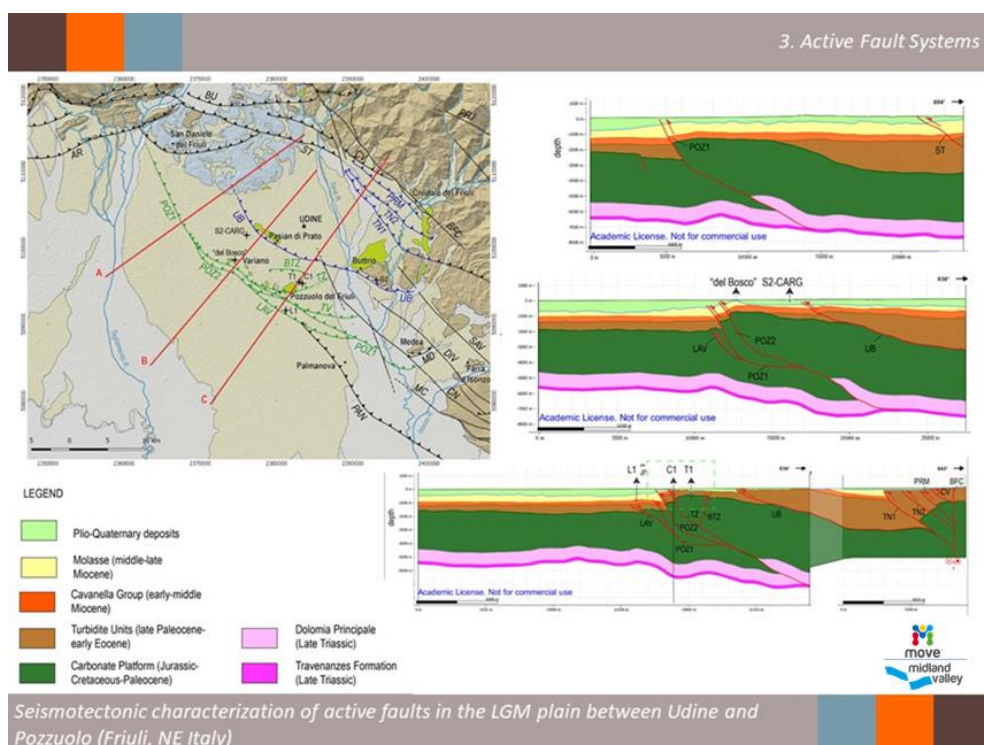
Sito MOVE/Petex

<http://www.petex.com/products/move-suite/>

## RESEARCH ACTIVITIES (2019-2022)

The research activity of our geology research group here at the University of Udine is currently focused on the active tectonics of the Venetian-Friuli prealpine area (NE Italy). Particularly, our research topics include interpretation of seismic lines, seismicity distribution analysis, morphotectonic analysis, geologic and morphostructural field surveys and paleoseismological investigations. In this context, the 3D Move Software reveals very helpful to manage and elaborate the data we collect and allows us to reconstruct the 3D seismotectonic model which integrates geological, geophysical and paleoseismological data of the investigated tectonic structures.

**2019: Reconstruction of the 3D structural model of the eastern Friuli Plain.** Thanks to ENI cooperation, enabled by the Friuli Venezia Giulia Region, we were able to interpret more than 200 km of seismic lines (supplied in jpg format) covering an area of about 6000 km<sup>2</sup> of the eastern Friuli Plain. By converting the interpreted seismic sections from time to depth we reconstructed the 2D geometry of the main stratigraphic horizons and tectonic structures. In a second step we elaborated the 3D geometry of the main fault systems by interpolating the fault lines drawn on each section.



*Patricelli and Poli (2020)*

Fig.1. A, B and C geological cross sections elaborated from the interpretation of ENI seismic lines, showing the 2D geometry of the active fault systems characterizing the Friuli Plain.

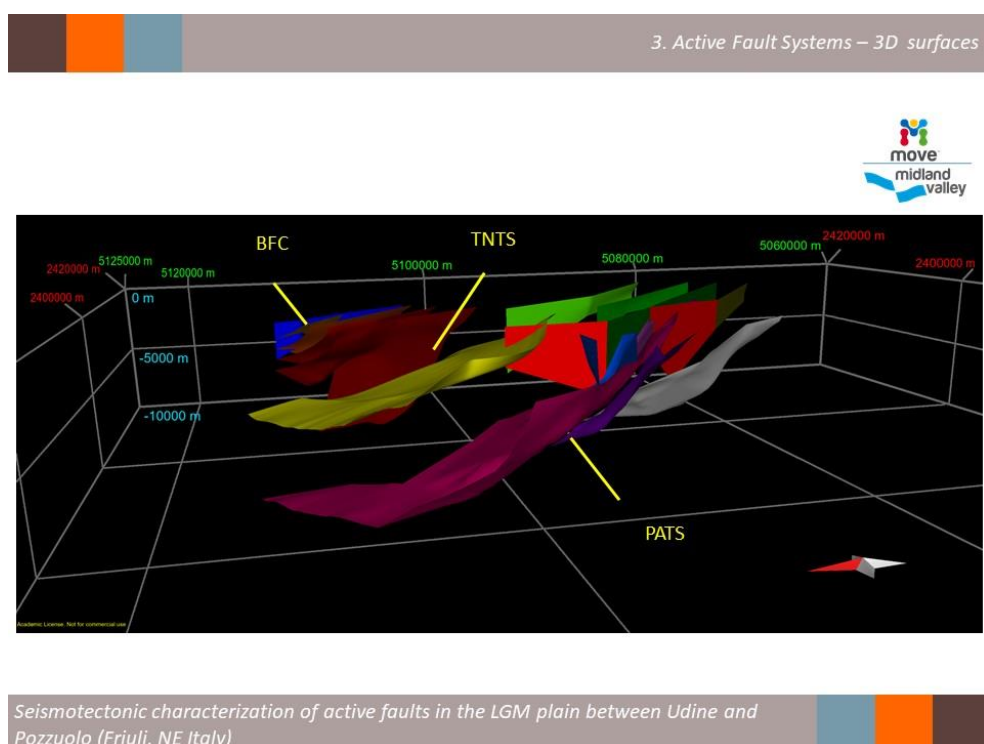
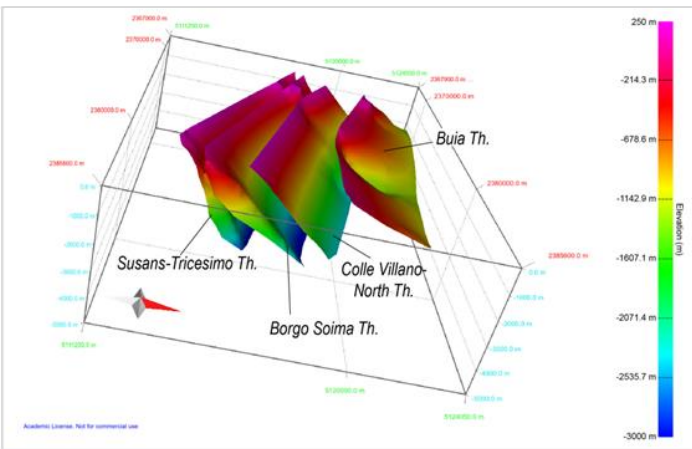
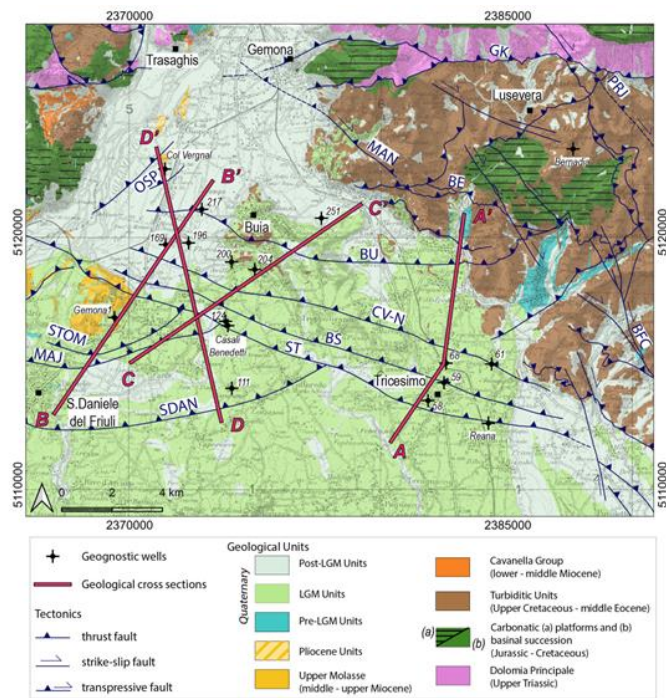


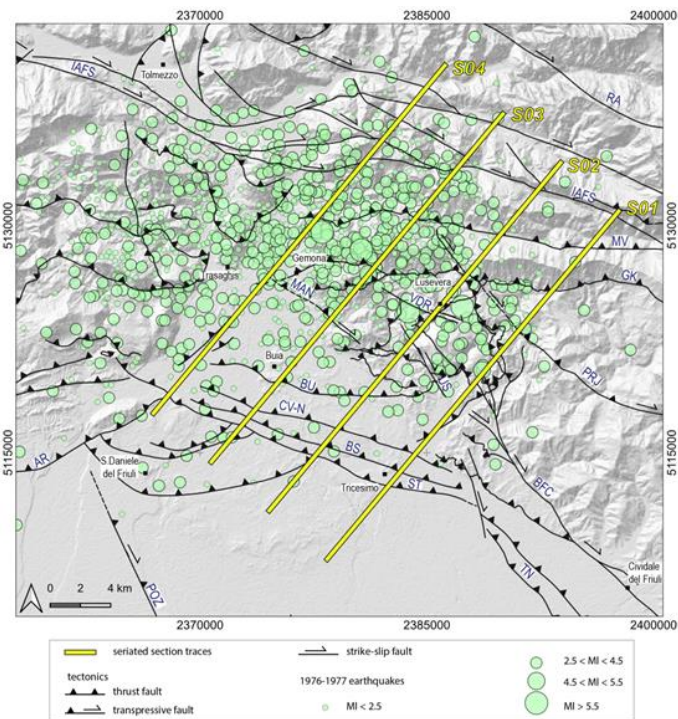
Fig.2. 3D surfaces of the active fault systems of eastern Friuli Plain, reconstructed through the interpolation of the 2D geological sections. Pozzuolo Thrust System (PATS), Trnovo Thrust System (TNTS) and Borgo Faris-Cividale Fault System (BFC).

2020: Reconstruction of the 3D structural model of the Susans-Tricesimo Thrust System (NE Friuli Plain). Thanks to ENI cooperation, enabled by the Friuli Venezia Giulia Region, we were able to interpret more than 200 km of ENI seismic lines. Through the 3D Move software, we reconstructed the 3D surface geometry of the Susans-Tricesimo Thrust System, which is considered the source of the 1976 earthquake. Moreover, the hypocentral distribution of earthquakes occurred in the latest 50 years was analyzed through the construction of seriated sections, with the aim to analyze the seismogenic potential of the investigated structure.



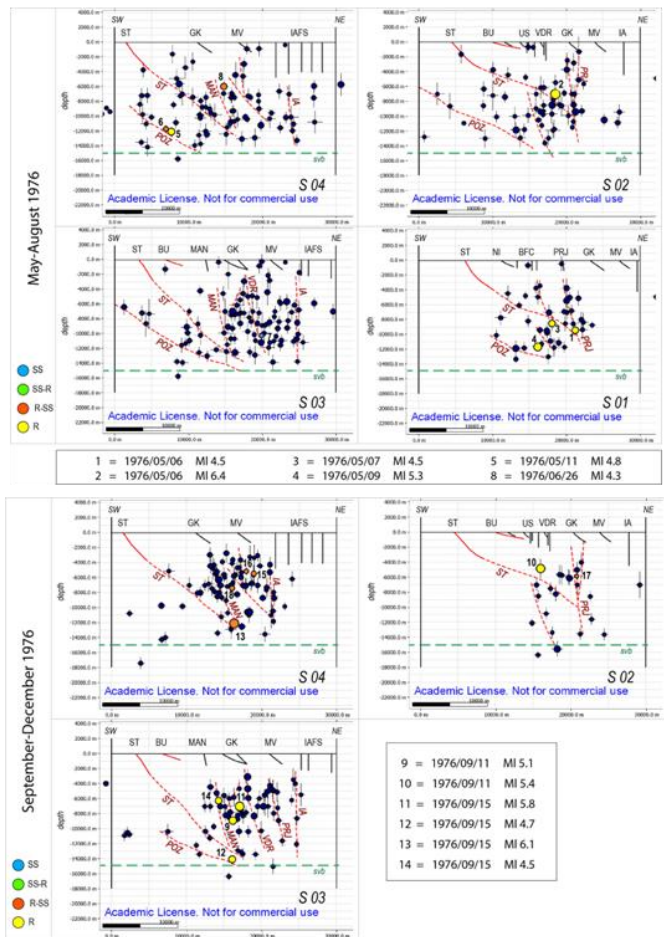
Patricelli et al. (2022)

Fig.3. 3D structural model of the Susans-Tricesimo Thrust System (STTS), reconstructed through the interpretation of ENI seismic lines and interpolation of the elaborated 2D geological sections.

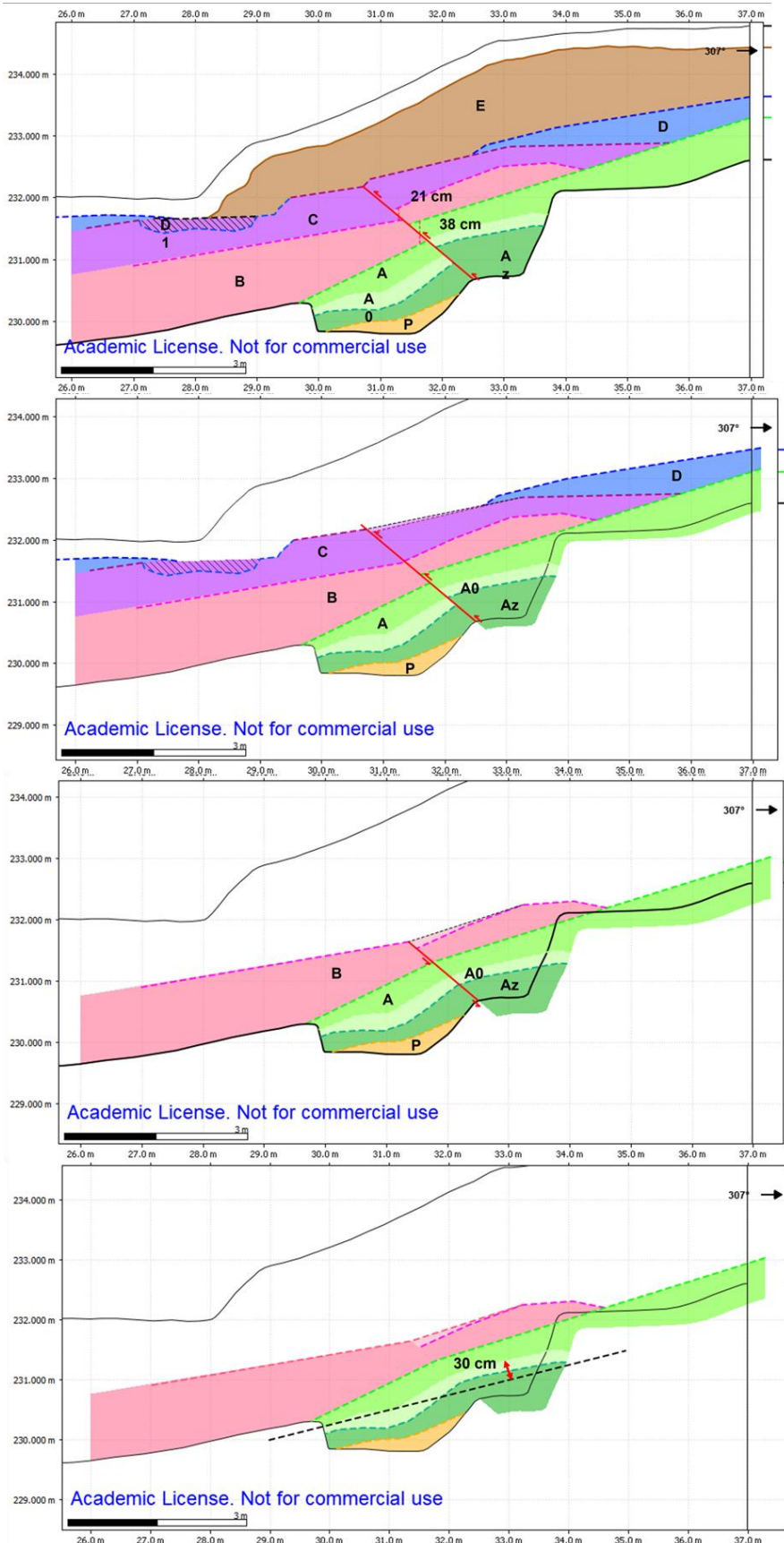


Patricelli et al. (2022)

Fig.4. Seriated sections crossing the Susans-Tricesimo Thrust System (STTS), realized for the analysis of the hypocentral seismicity distribution with respect to the reconstructed faults geometry.



**2021 ACTIVITIES: Seismotectonics of the Valdobbiadene-Vittorio Veneto Thrust, eastern Southern Alps.** During the last two years, in the framework of the Progetto di Microzonazione Sismica III livello, we realized 12 paleoseismological trenches in the Venetian Prealpine region. We digitalized in 3D Move the logs of the studied wall trenches on vertical sections. In a second stage, the restoration of the log sections allowed us to characterize the recent activity of the fault in terms of number of deformational events and slip per event. Furthermore, the comparison of the distinct trenches intersecting the same tectonic structure at different points was useful to characterize the recent activity of the tectonic structure also along its length.



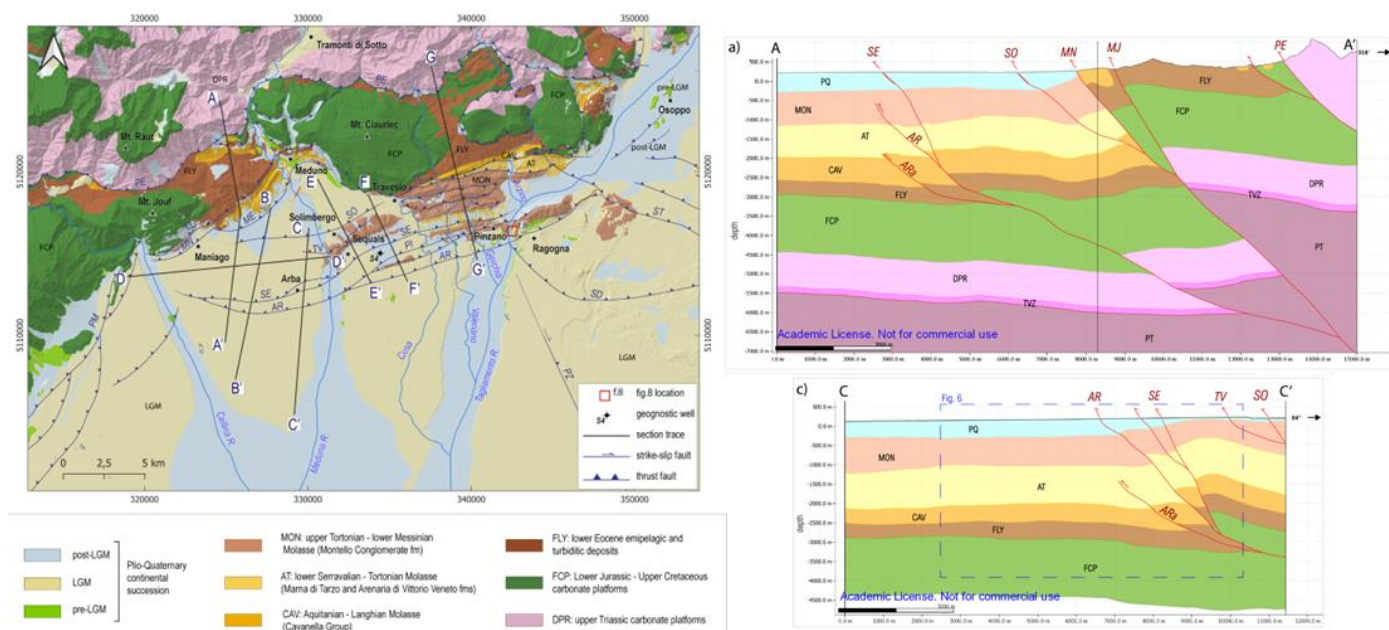
*Poli et al. (in prep.)*

Fig.5. Miane 3 trench restoration.  
Method: Fault Parallel Flow.

**2022 ACTIVITIES: reconstruction of the 3d structural model of the Arba-Ragogna Thrust System (NE Italy) and definition of the seismogenic volumes for the estimation of the seismogenic potential of the area.**

Starting from the interpretation of seismic lines, gently supplied by ENI, we realized 6 geological cross sections of the carnic prealpine bordering area and we reconstructed the 3D geometry of the investigated active thrust system: the Arba-Ragogna TS.

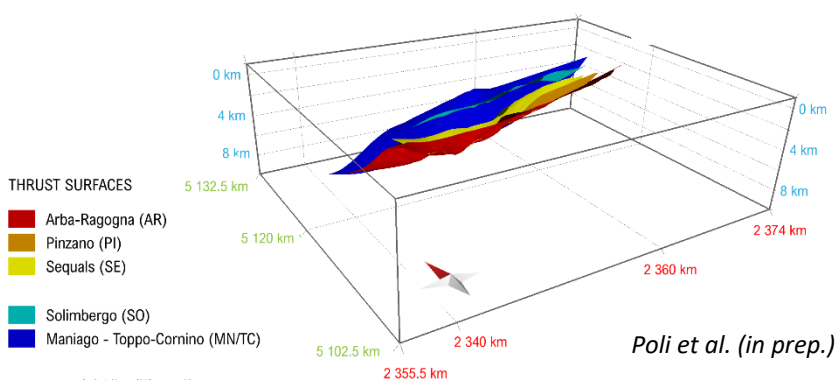
Aiming at the characterization of the seismogenic potential of the area, in terms of maximum potential magnitude (Mmax), we created and computed the geological volumes possibly corresponding to potential seismogenic volumes. We validated our results comparing the estimated Mmax values with the Italian Macroseismic Database (DBMI15 v4.0). The resulting good match highlights that the definition of the seismogenic volumes deserves to be further investigated since it can represent a new and alternative approach for the seismic hazard assessment of an area.



*Poli et al. (in prep.)*

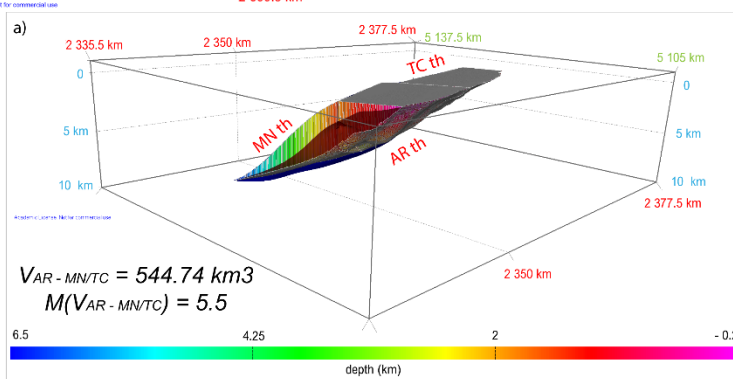
Fig. 6. AA' and CC' geological cross sections elaborated from the interpretation of ENI seismic lines, showing the 2D geometry of the Arba-Ragogna Thrust System.

Fig. 7. 3D structural model of the Arba-Ragogna Thrust System (ARTS) and the Maniago - Toppo-Cornino (MN/TC) Thrust System, reconstructed through the interpretation of ENI seismic lines and interpolation of the elaborated 2D geological sections, integrated with geological field data.



*Poli et al. (in prep.)*

Fig. 8. Geological volume comprised between the Arba-Ragogna Thrust (AR th) and the Maniago (MN) – Toppo-Cornino (TC) Thrusts and associated seismogenic potential estimates  $M(V_{AR - MN/TC})$ .



## THESIS PROJECTS:

- Master's degree thesis in Scienze e Tecnologie per l'Ambiente e il Territorio entitled "3D reconstruction of the active faults characterizing the epicentral area of 1976 earthquake", March 2020. Supervisor: Prof.ssa Maria Eliana Poli, Student: Leonardo Ronchiadin.
- PhD Thesis in Life Sciences (XXXIII cycle) entitled "Seismotectonic characterization of the Southern Alps-Dinarides junction area (NE Italy)", October 2021. Supervisor: Prof.ssa Maria Eliana Poli, PhD Student: Giulia Patricelli.

## PUBLICATIONS

- Patricelli G., Poli M.E., 2020. *Quaternary tectonic activity in the north-eastern Friuli Plain (NE Italy)*. Bollettino di Geofisica Teoria ed Applicata, **61 (3)**, pp. 309-332. DOI 10.4430/bgta0319.
- Poli M.E., Falcucci E., Gori S., Monegato G., Zanferrari A., Affatato A., Baradello L., Böhm G., Dal Bo I., Del Pin E., Forte E., Grimaz S., Marchesini A., 2021. *Paleoseismological evidence for historical ruptures along the Meduno Thrust (eastern Southern Alps, NE Italy)*. Tectonophysics, **818**, 229071, <https://doi.org/10.1016/j.tecto.2021.229071>.
- Patricelli, G., Poli, M. E., & Cheloni, D., 2022. *Structural Complexity and Seismogenesis: The Role of the Transpressive Structures in the 1976 Friuli Earthquakes (Eastern Southern Alps, NE Italy)*. Geosciences, **12(6)**, 227, <https://doi.org/10.3390/geosciences12060227>.

Two other papers collecting our latest results are in preparation:

- Poli M.E., Monegato G., Patricelli G., and Zanferrari A., 3D STRUCTURAL SETTING AND NEOGENE-QUATERNARY TECTONIC ACTIVITY OF THE ARBA-RAGOGNA THRUST-SYSTEM (EASTERN SOUTHERN ALPS, NE ITALY): IMPLICATIONS FOR THE SEISMIC HAZARD ASSESSMENT OF THE FRIULI REGION.
- Poli M.E., Patricelli G., Paiero G., Marchesini A. PALEOSEISMOLOGICAL TRENCHES ON THE VALDOBBIADENE-VITTORIO VENETO THRUST (EASTERN SOUTHERN ALPS, NE ITALY): NEW HINTS FOR THE SEISMOTECTONICS OF THE VENETIAN PREALPS.

## PRESENTATIONS

- **Poster presentation at EGU General Assembly 2019.**

Patricelli G., Poli M.E., "3D geometry of Ne-Friuli Quaternary faults (NE Italy)".  
<https://meetingorganizer.copernicus.org/EGU2019/EGU2019-15489.pdf>.

- **Poster presentation at CRUST Interdisciplinary Workshop in memory of Giampaolo Pialli "Tools, data and models for 3D seismotectonics: the Italian over time laboratory" 2019.**

Patricelli G., Poli M.E., "3D geometry of the buried Quaternary faults in the NE Friuli Plain".  
[https://www.crust.unich.it/sites/st17/files/crust\\_workshop\\_programme\\_finale.pdf](https://www.crust.unich.it/sites/st17/files/crust_workshop_programme_finale.pdf).

- **Oral presentation at the Congresso Nazionale SIMP-SGI-SOGEI Parma 2019. "Il tempo del pianeta Terra e il tempo dell'uomo: le geoscienze tra passato e futuro".**

Patricelli G., Poli M.E., "Seismotectonic characterization of active faults in the LGM Plain between Udine and Pozzuolo (Friuli, NE Italy)". <http://parma2019.socminpet.it/index.php/abstracts/elenco-abstracts>.

- **Oral presentation at the GNGTS 2021 June 2021.**

Poli M.E., Patricelli G., Paiero G., Marchesini A., "Indagini paleosismologiche al fronte delle Alpi Meridionali orientali: nuovi dati sull'attività tettonica di epoca storica del sovrascorrimento Bassano-Valdobbiadene (Italia NE)".  
<http://gngts.inogs.it/content/programma-0>.

- **Two oral presentations at the 90° Congresso della Società Geologica Italiana “Geology without borders”  
September 2021:**

Poli M.E., Paiero G., Patricelli G., and Marchesini A., “Historical tectonic activity of the Valdobbiadene-Vittorio Veneto thrust (NE Italy)”.

[https://www.socgeol.it/files/download/pubblicazioni/Abstract%20Book/Abstract%2090mo%20Congresso%20SGI\\_DE\\_F.pdf](https://www.socgeol.it/files/download/pubblicazioni/Abstract%20Book/Abstract%2090mo%20Congresso%20SGI_DE_F.pdf).

Patricelli G., Poli M.E., Paiero G., Zanferrari A., Marchesini A. and Monegato G., “New evidence of recent tectonic activity of the Susans-Tricesimo thrust-system (NE Italy)”.

[https://www.socgeol.it/files/download/pubblicazioni/Abstract%20Book/Abstract%2090mo%20Congresso%20SGI\\_DE\\_F.pdf](https://www.socgeol.it/files/download/pubblicazioni/Abstract%20Book/Abstract%2090mo%20Congresso%20SGI_DE_F.pdf).