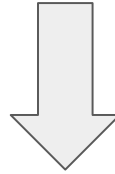


SECURE - WP 1



Enhancements of Existing Crustal Velocity Models and Seismic Datasets



WP 1.1 Crustal velocity models

WP 1.2 Strong motion and macroseismic dataset —→ **WP 3**

WP 1.3 Geological and seismotectonic input data

WP1- Enhancements of Existing Crustal Velocity Models and Seismic Datasets

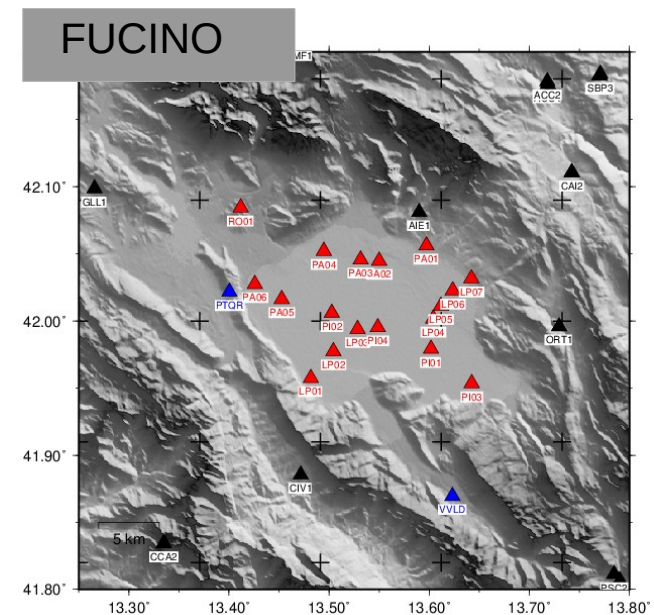
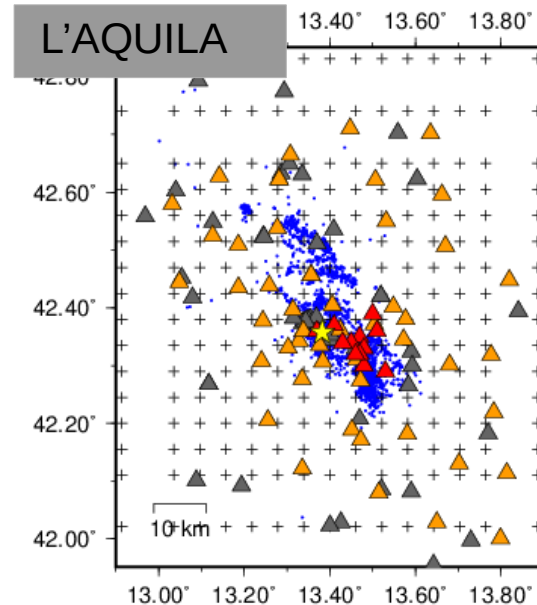
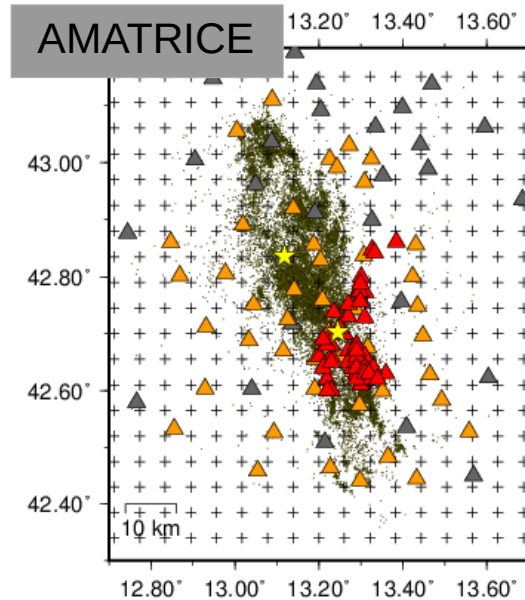
WP1.1 Improvements to Existing Crustal Velocity
Models and Seismic Data

P. De Gori &
WP 1.1 team
INGV

WP1.1 D1 – Detailed Vp and Vs models of the crust including basin structures embedded in tomographic models (INGV-ONT-RM1)

Dataset: seismic data deriving from the main seismic sequences (L'Aquila 2009, Amatrice-Norcia 2016) and background seismicity (Fucino)

Objectives: improve the spatial resolution of the existing tomographic models by using seismic stations mainly deployed on alluvial plains to study amplification effects



ENHANCED VELOCITY MODELS

- **Starting LET model (V_p , V_p/V_s) for the upper crust** (published model obtained with aftershocks data or background seismicity)
- **Starting Q_p , Q_s structure** (published models or values derived from velocity values $Q_s=0.05V_s$ (m/s); $Q_p=2Q_s$)
- **Resampling the LET model with a step size of a few hundred meters**
- **Integrating Topography**
Topography details (from geophysics and geology) are included at the top of the refined tomographic model
- ***Pfile*-determination**
To define the medium for waves propagation, rock density, V_p , V_s , Q_p , and Q_s models are reformatted into a *Pfile*.

AMATRICE-NORCIA - MODEL

Starting LET model Vp Vp/Vs (Chiarabba et al., 2018; De Gori et al, 2023) 5 x 5 x 3 km defined with aftershocks data;
Vp, Vs, $Q_p=2Q_s$, $Q_s=0.05V_s(m/s)$

Resampling LET model

300m on NS direction

250m on EW-direction

50 m along vertical direction at depths 0-1 km

200 m along vertical direction at depths 1-16 km

Integrating Topography

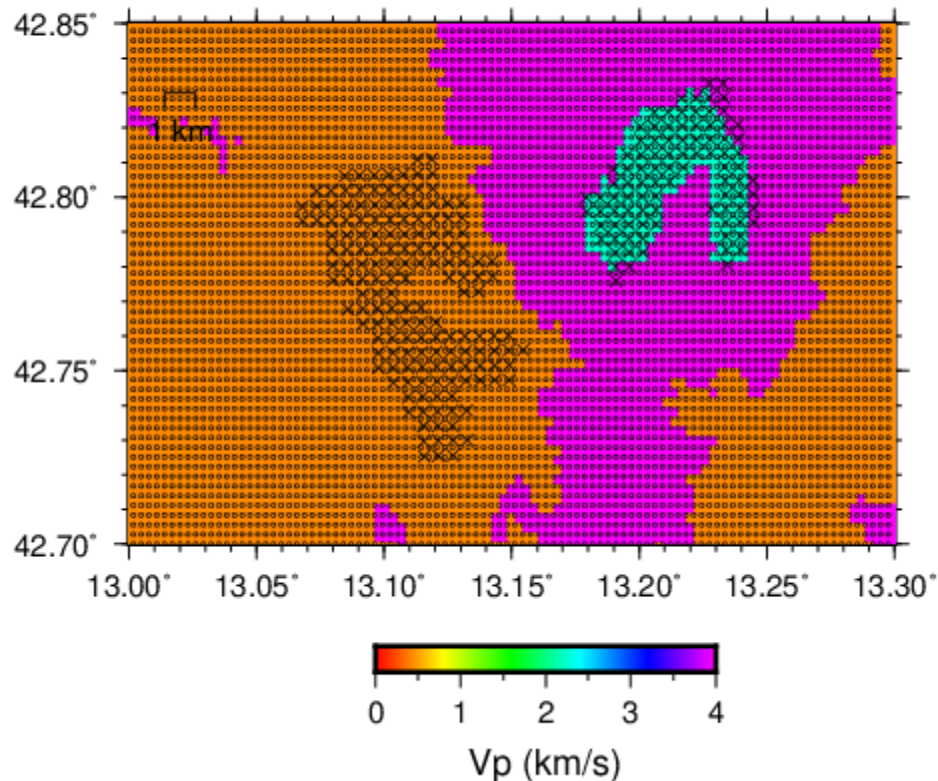
Velocity models of Norcia and Castelluccio basin (Di Giulio et al, 2020; Brozzetti et al, 2019) are included at the top of the tomographic model.

***Pfile*-determination**

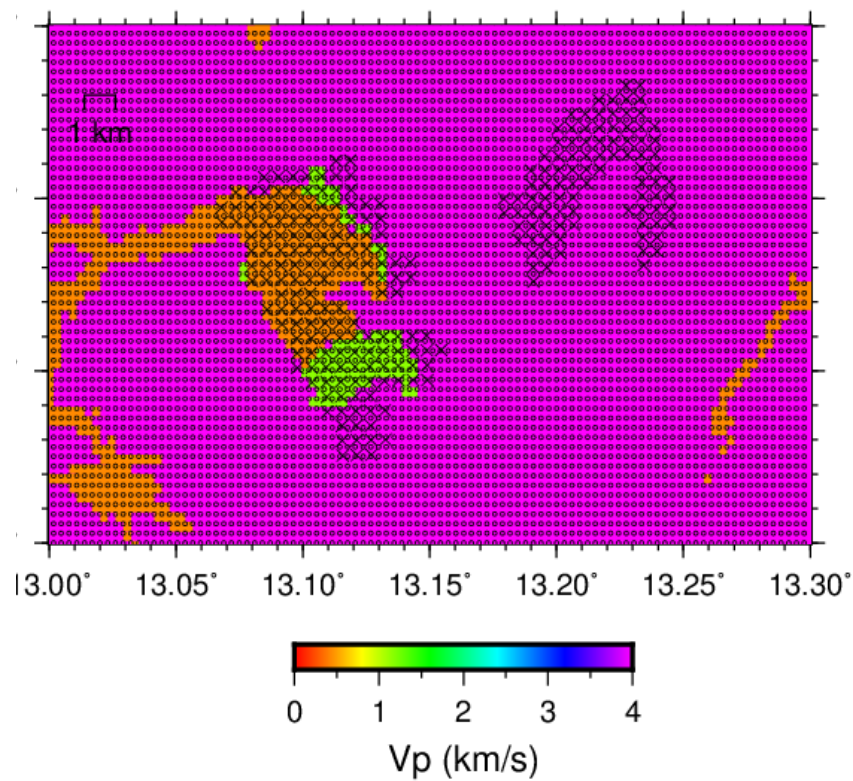
Accurate ground motion simulations for frequencies up to 3-5 Hz
(Pitarka et al., 2021; Akinci et al., 2024).

AMATRICE-NORCIA - MODEL

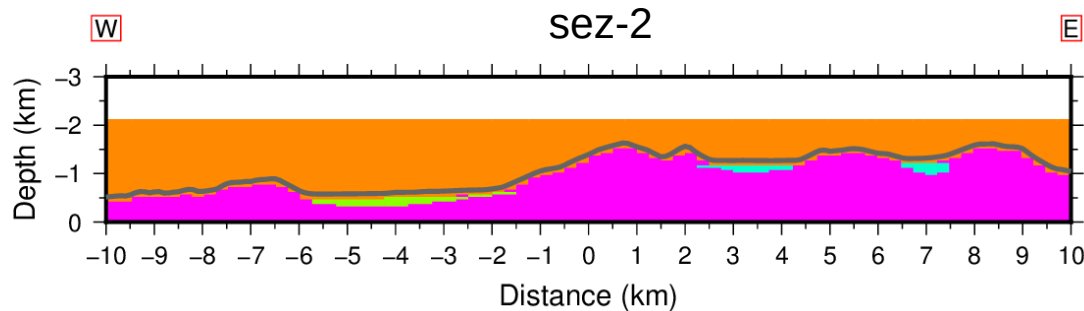
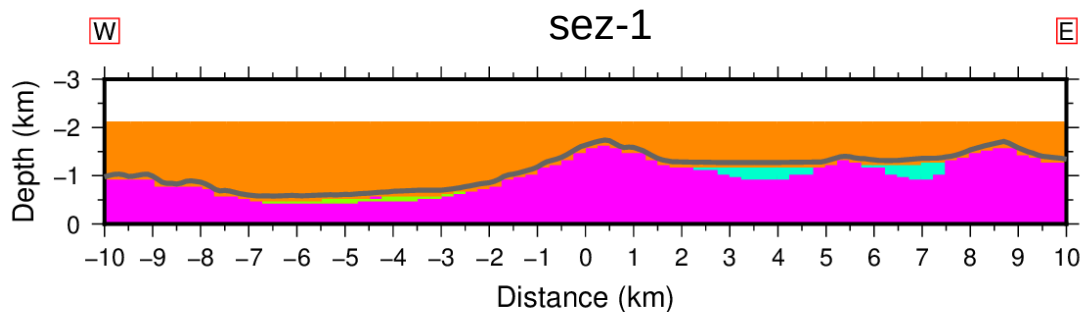
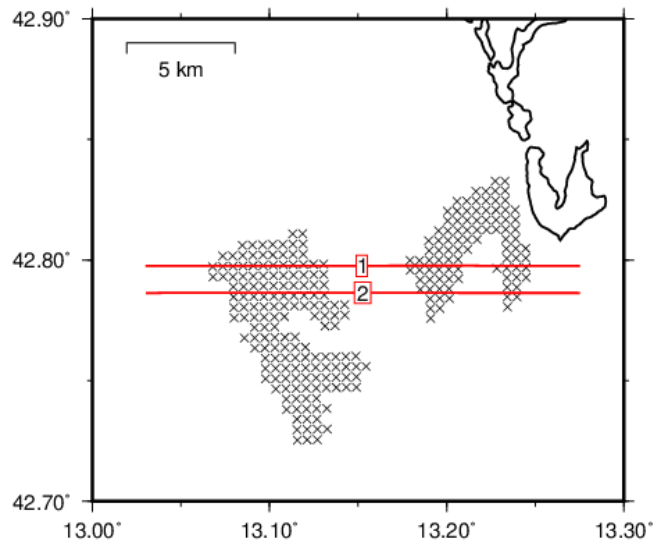
Depth = -1.25 km



Depth = -0.70 km



AMATRICE-NORCIA - MODEL



L'AQUILA- MODEL

Starting LET model Vp Vp/Vs (Chiarabba et al., 2020) 6 x 6 x 3 km defined with aftershocks data and background seismicity;
Vp, Vs, $Q_p=2Q_s$, $Q_s=0.05V_s$ (m/s)

Resampling LET model

300m on NS direction

250m on EW-direction

50 m along vertical direction at depths 0-1 km

200 m along vertical direction at depths 1-16 km

Integrating Topography

The Aterno basin velocity model is included in the tomographic model by means of the "squashing" approach

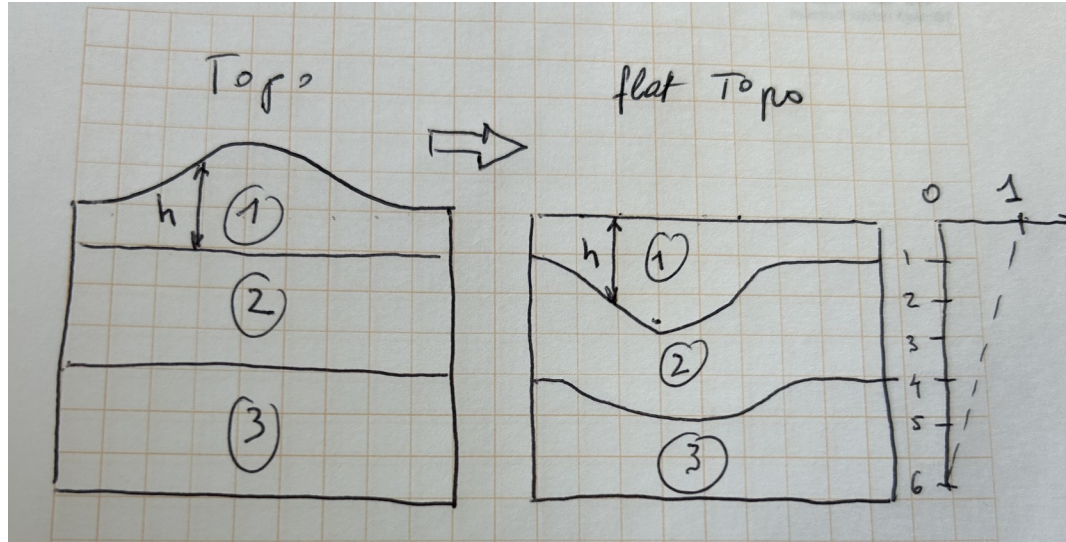
***Pfile*-determination**

wave modeling in progress

L'AQUILA- MODEL

Integrating Topography by “squashing” approach

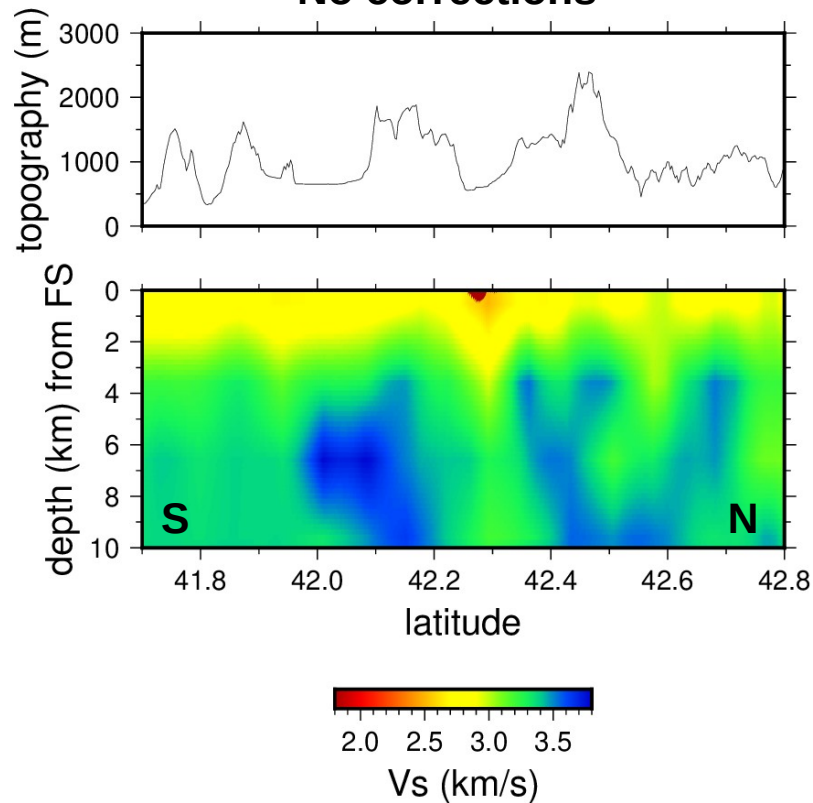
The squashing approach adjusts or "squashes" the topographic surface beneath the free surface preserving the physical properties of topography. A tapering effect with depth is used to gradually reduce the influence of topographic features as we move deeper in the model



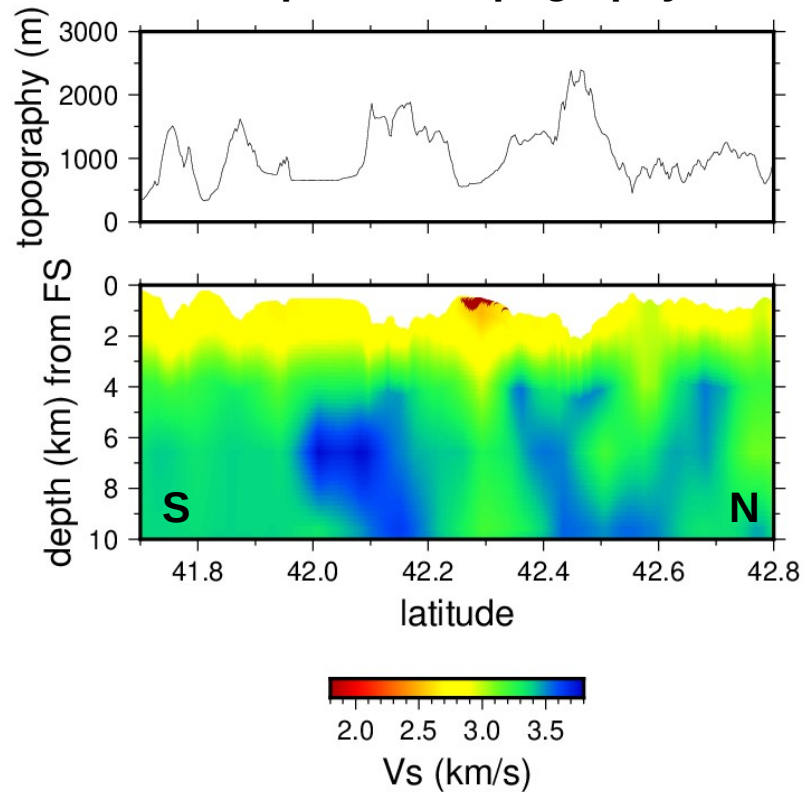
Arben sketch....

L'AQUILA- MODEL

No corrections



Squashed topography



FUCINO - MODEL

LET model Vp Vp/Vs (grid 5 x 5 x 3 km) in progress

AVAILABLE DATASETS

Instrumental seismicity detected by RSD is scarce and seismic station coverage is restricted to the surrounding mountain-ridge (PTQR, VVLD). We need of additional seismic stations and datasets to perform reliable seismic tomography:

- FIRB experiment (2003-2005) focused on the study of background seismicity of the Abruzzo region (Bagh et al., 2007)
- SLAM experiment (2009-2013) aimed to analyze seismicity in central Apennines (Frepoli et al., 2017)
- Bollettino Sismico (BSI, from 2014) for events located within 10/15 km from Fucino

FUCINO - MODEL

NEW DATASET: THE 2008-2009 SITE EFFECTS EXPERIMENT

- 18 temporary seismic stations, operating in continuous mode at 125 Hz, were installed in the Fucino area to investigate the basin seismic response and local site effects (Cara et al, 2011).
- The array operated during the occurrence of the 2009 L'Aquila sequence and we search on continuous seismograms the local seismicity probably triggered by the strongest events occurred about 30-40 km northward
- This dataset is integrated by the permanent stations of the Italian seismic network and Abruzzo regional network installed on the surrounding ridges, to construct a new earthquake catalog and perform a local-scale passive tomographic survey.

FUCINO - MODEL

NEW DATASET: THE 2008-2009 SITE EFFECT EXPERIMENT

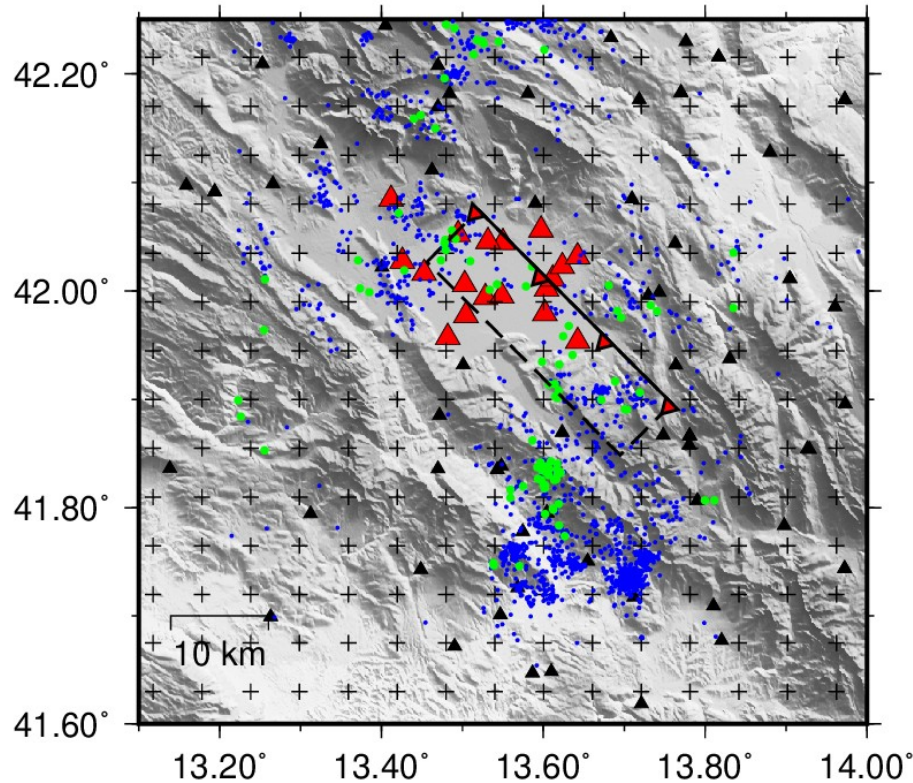
Data preceding the L'Aquila Mainshock (April 6th 2009 hh 01:32)

- We used a standard (STA/LTA) algorithm to detect very local weak events and manual picking to determine the P- and S-wave arrival times.
- We used a ML approach to detect P and S wave arrival times and event phase associations (R. Fonzetti presentation)
- Comparison between standard and ML procedures (R. Fonzetti presentation)

Data post L'Aquila Mainshock

Only ML application to detect P and S waves arrivals.
About 30-40 events/month are extracted and useful for tomography

FUCINO - MODEL



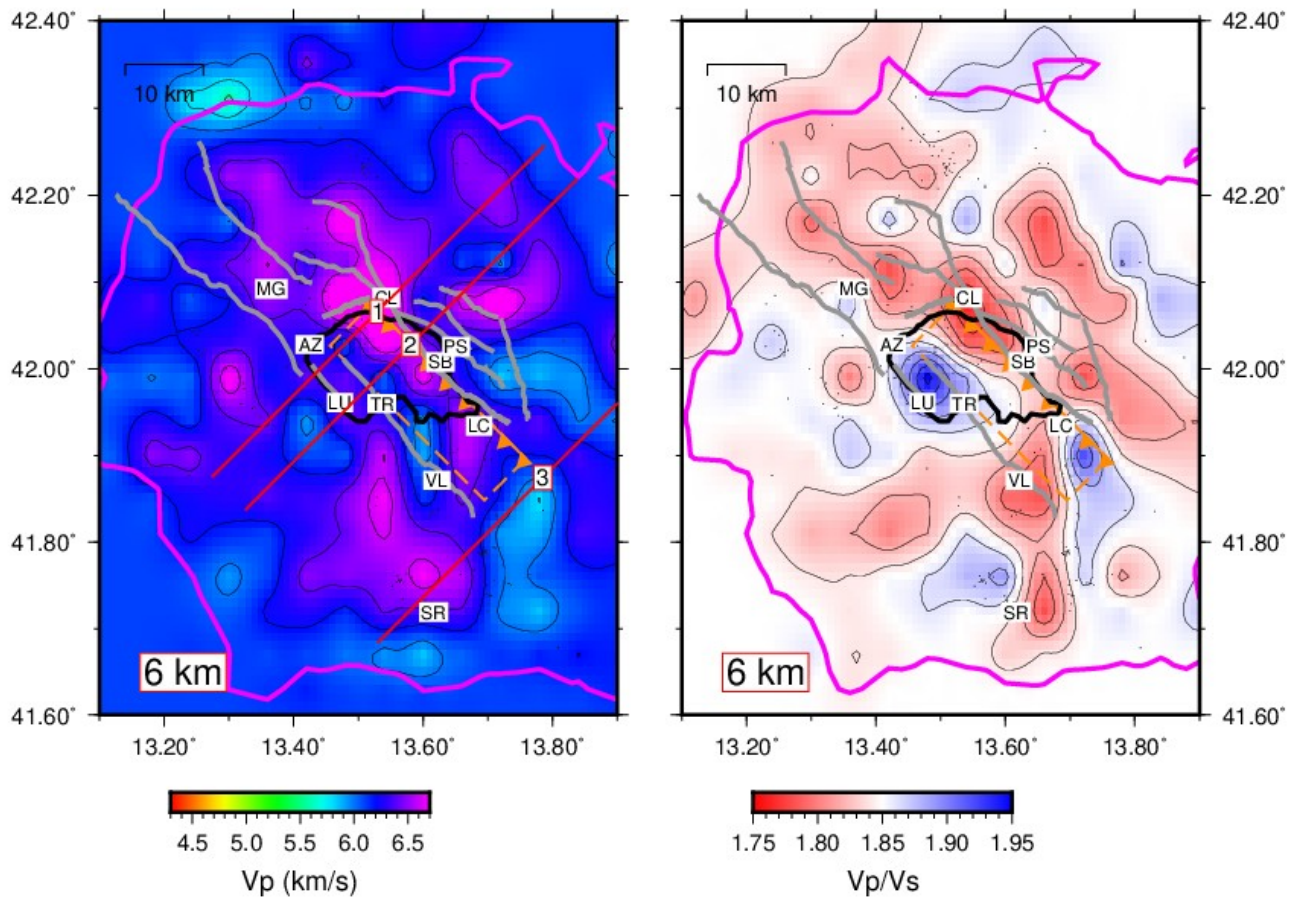
Preliminary LET MODEL

18 = N. of Fucino stations

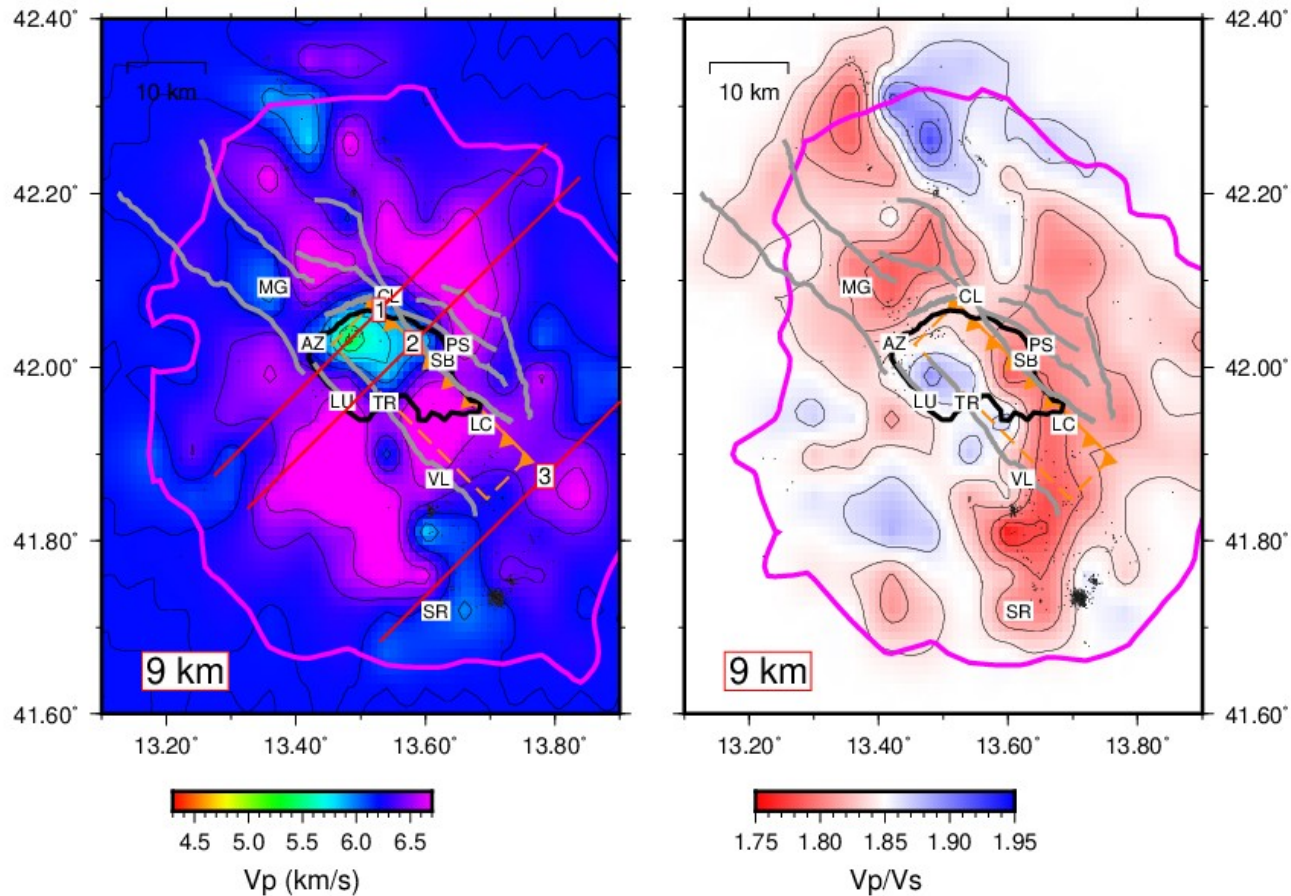
132 = N. of events recorded from
Fucino stations **from October 2008
to May 2009**

~2000 additional more recent
events from SLAM project and
background seismicity studies

FUCINO - MODEL

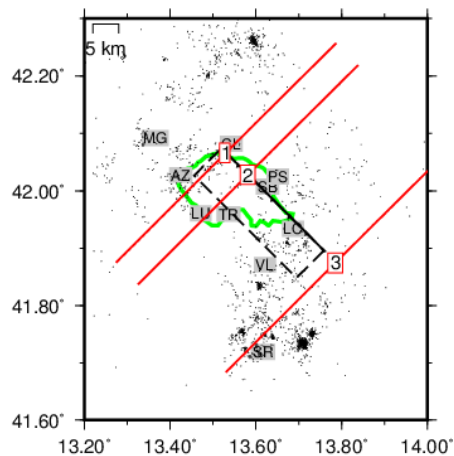
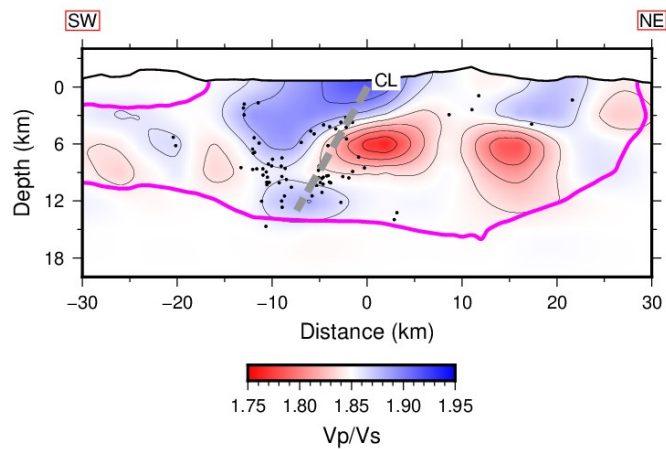
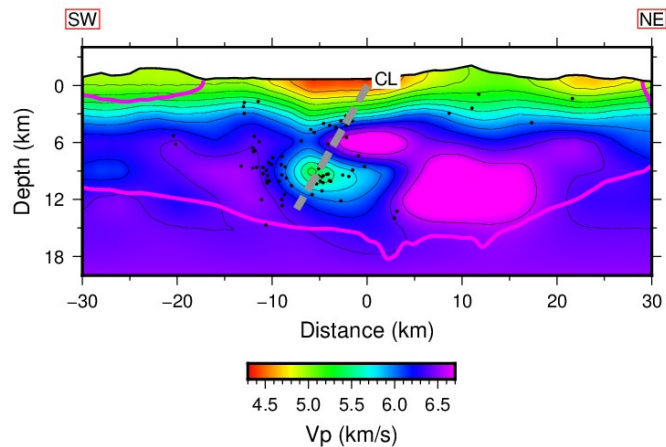


FUCINO - MODEL

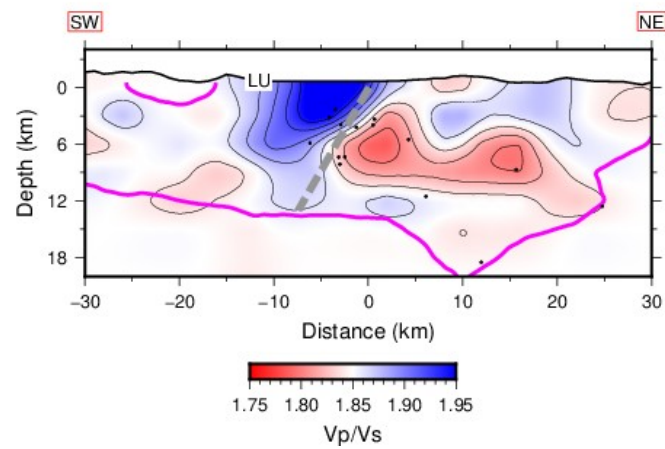
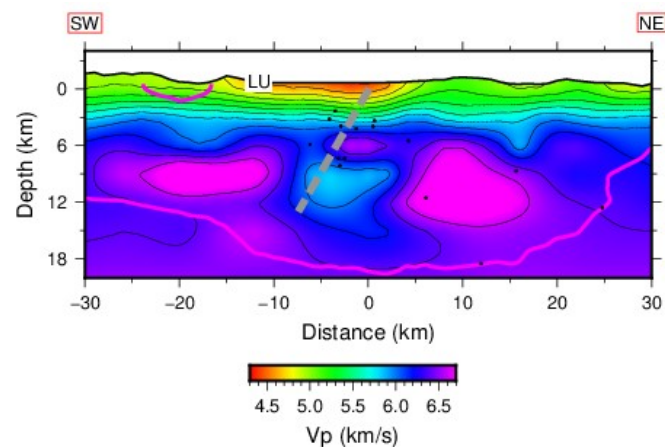


FUCINO - MODEL

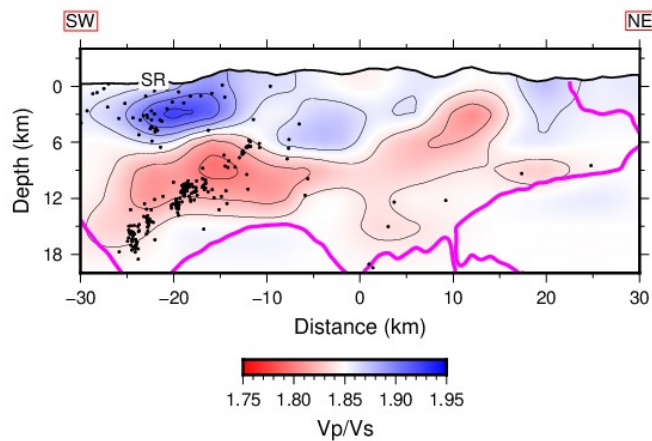
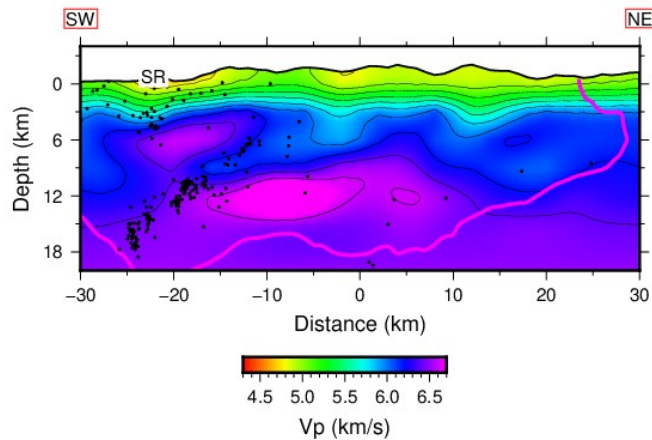
sez-1



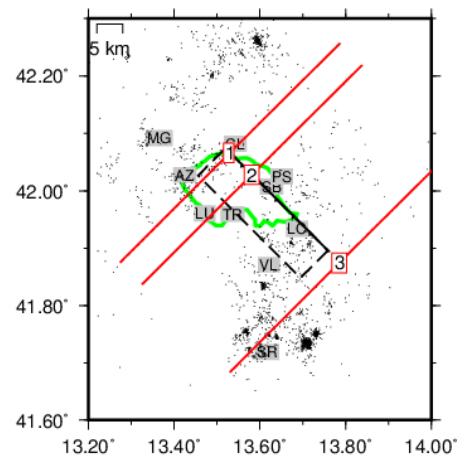
sez-2



FUCINO - MODEL



sez-3



NEXT STEPS FOR AREA 3

- The catalog of P and S arrival times at the Fucino array will be completed by the application of ML techniques (R. Fonzetti presentation).
- A final LET Vp, Vp/Vs model will be computed.
- The geological model of the basin (Burrato & Vannoli presentation) will be used to better define the shallow portion of LET model.
- *Pfile* determination for ground motion simulations.