GeoMol

Assessing subsurface potentials of the Alpine Foreland Basins for sustainable planning and use of natural resources

Alpine SPACE — EUROPEAN TERRITORIAL COOPERATION

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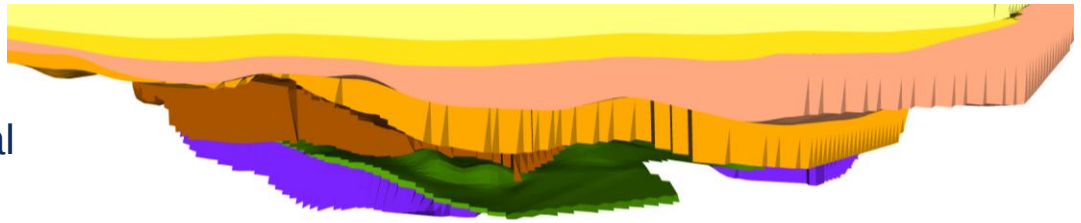
3D Geological model of the central Po Plain (Italy): subsurface geopotentials vs geological risks

Maesano F.E.[1], D'Ambrogi C. [1], Ferri F. [1]& the Italian GeoMol Team[2]

1) ISPRA – Servizio Geologico d'Italia
2) The Italian GeoMol Team
Burrato P., Istituto Nazionale di Geofisica e Vulcanologia – INGV (Roma);
Cagnoni A., Regione Lombardia. DG Territorio, Urbanistica e Difesa del suolo, (Milano);
Molinari F.C., Servizio Geologico, Sismico e dei Suoli – Regione Emilia-Romagna (Bologna);
Monesi E., Università degli Studi di Milano (Milano), CNR IGAG (Roma);
Piccin A., Regione Lombardia. DG Territorio, Urbanistica e Difesa del suolo, (Milano);
Scardia G., CNR IGAG (Roma), Instituto de Geociências e Ciências Exatas - Universidade Estadual Paulista (Sao Paulo, Brasil);
Torri G., Servizio Geologico, Sismico e dei Suoli – Regione Emilia-Romagna (Bologna);

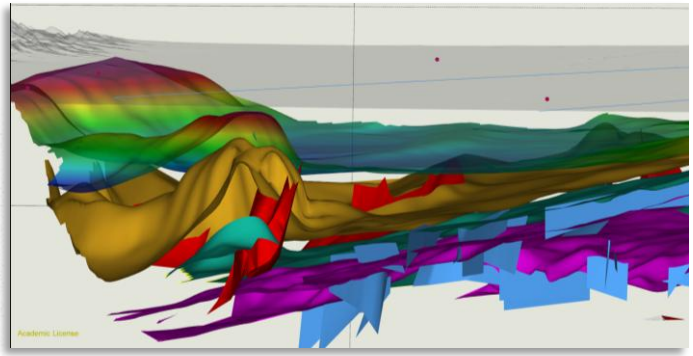
Goals of the GeoMol Project



Transnational/transregional 3D geological models

Common criteria of model building and analysis

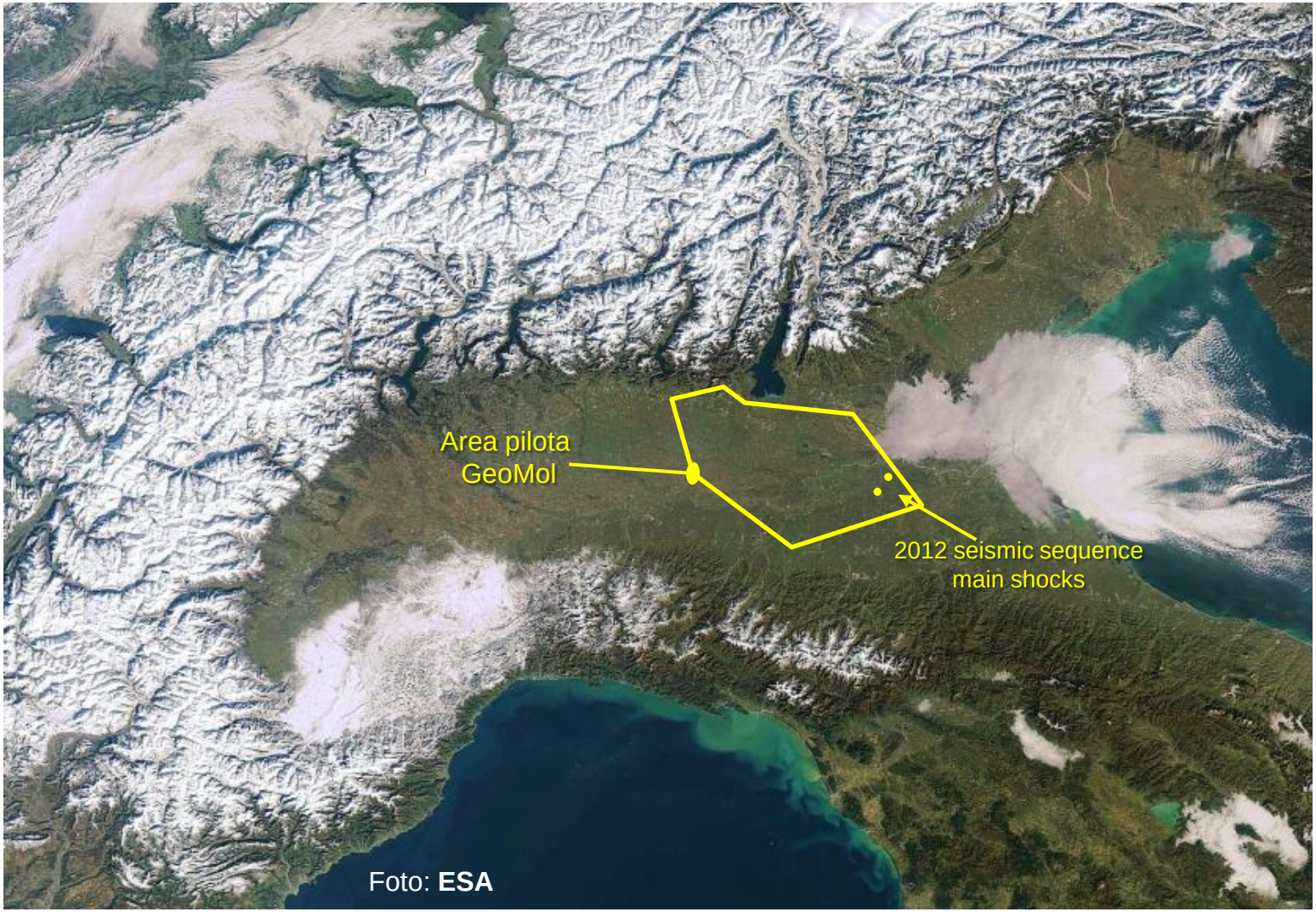
Italian pilot area – 3D geological model for the assessment of **geothermal** potential and focus on the **tectonic structures** (e.g. area of the 2012 earthquake)

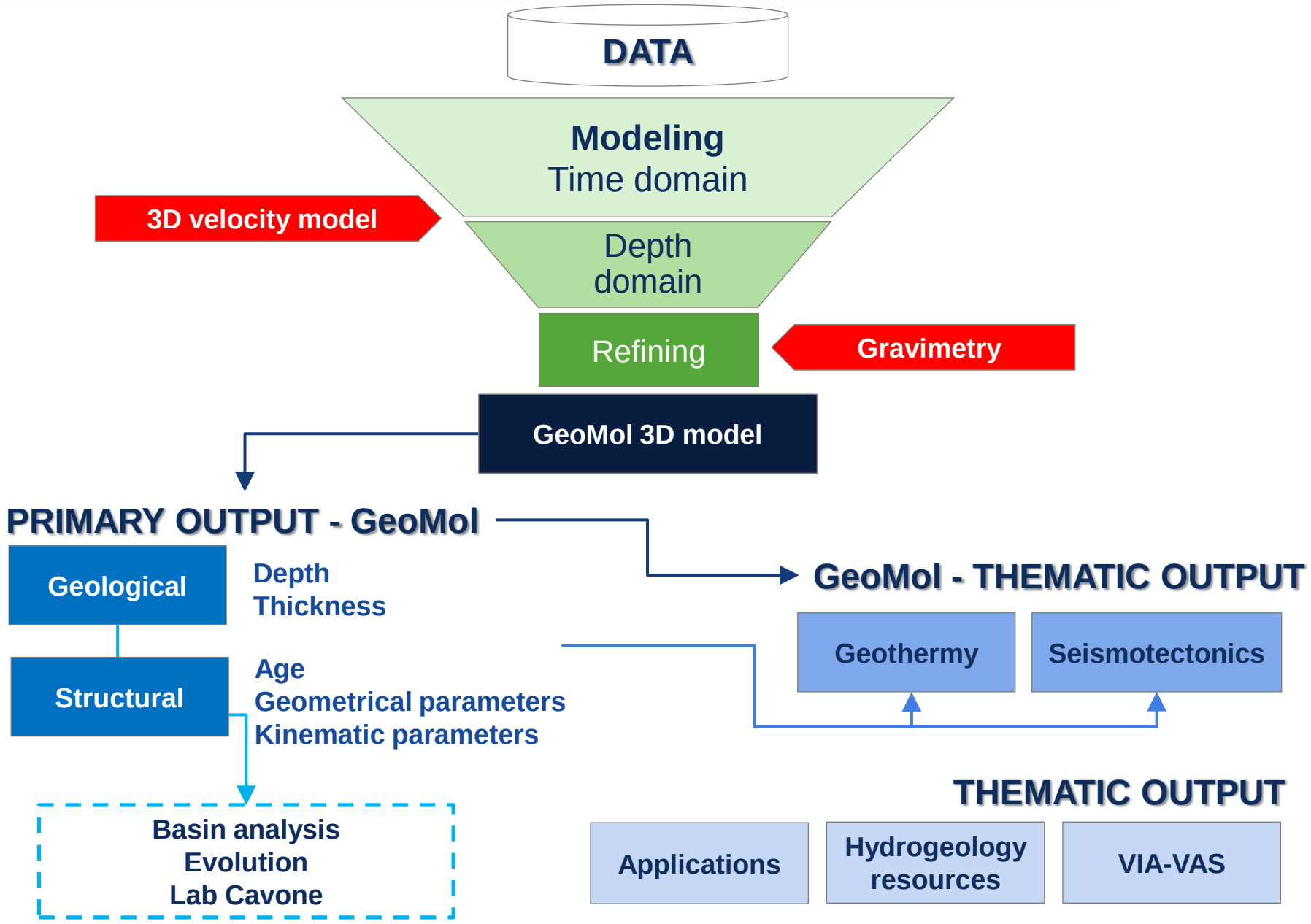


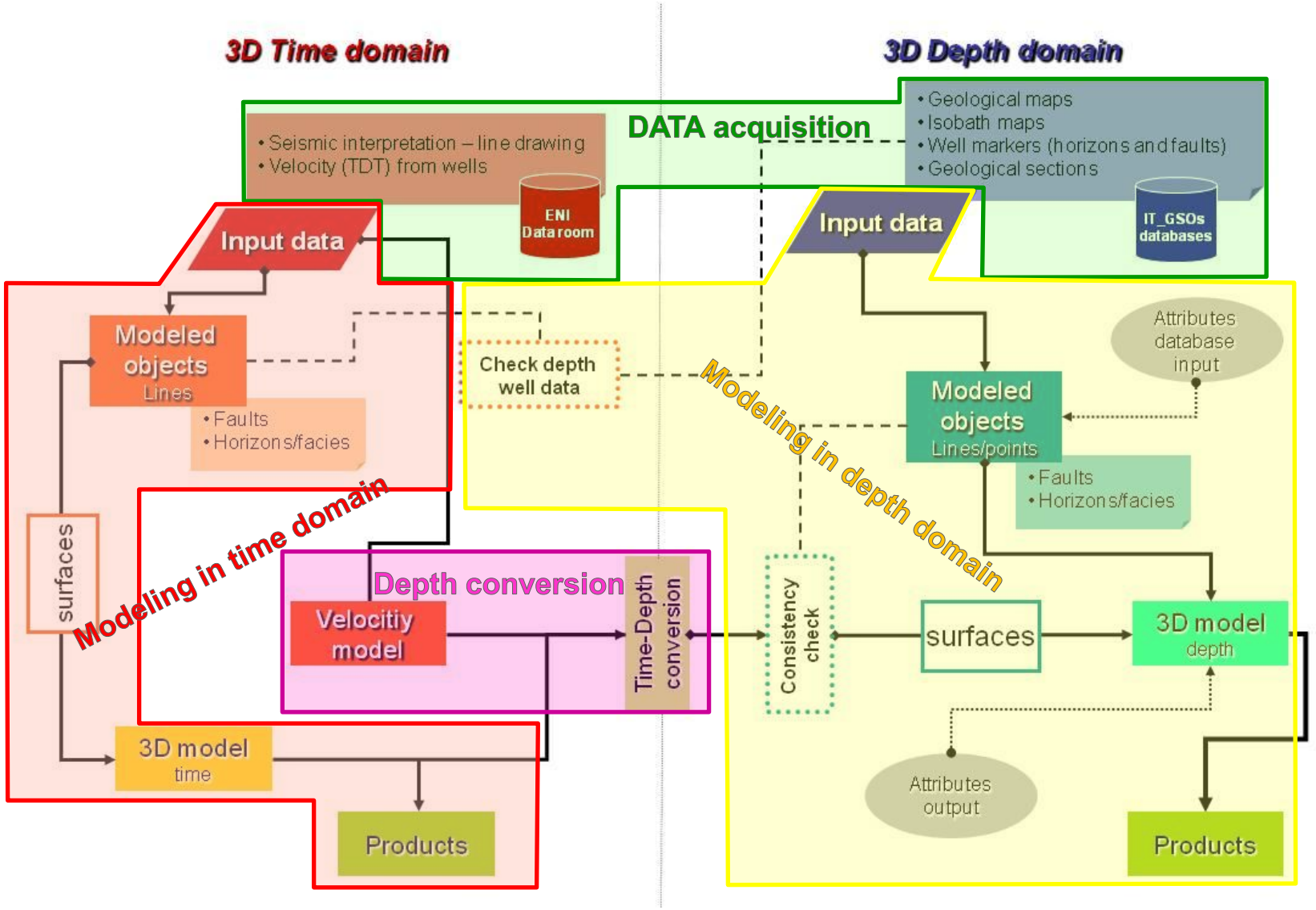
3D geological model is a pre-requisite for

- Full geometrical knowledge of geological structures (rock volumes, faults)
- Assessment of subsurface geopotentials
- Support to environmental impact evaluation

Alpine Foreland Basins – 3D models in flat areas





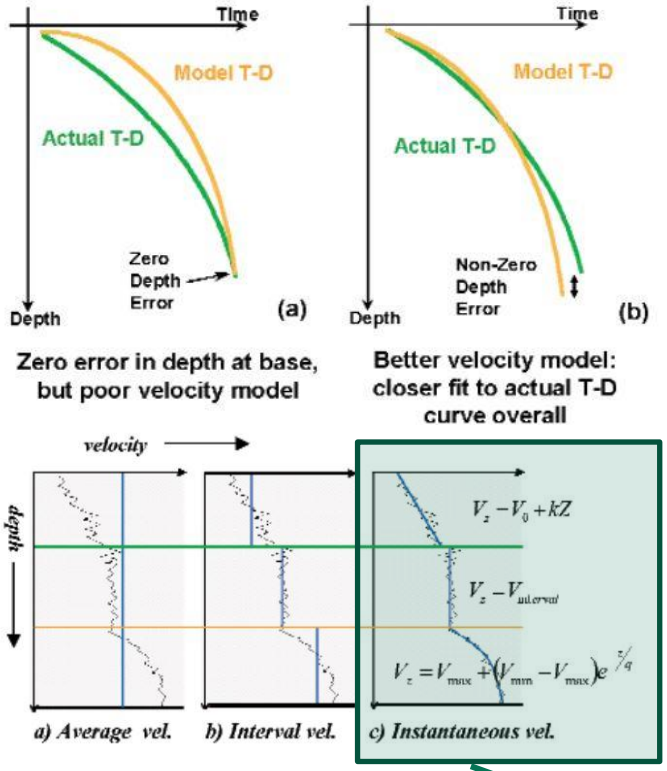


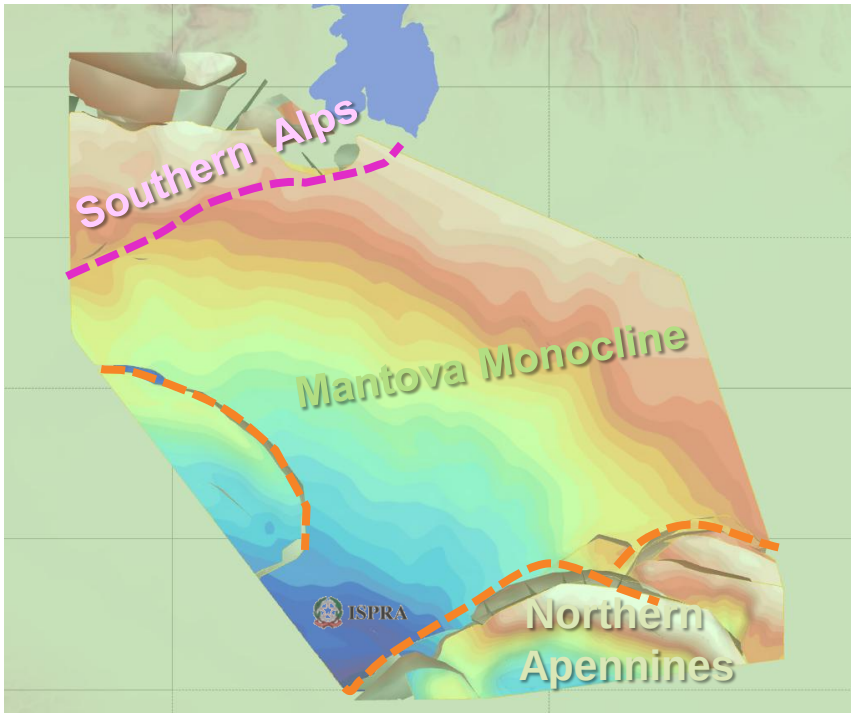
Maesano et al. (2014) Rend. SGI

Velocity model

From the model in time domain to depth domain

Depth conversion strategies

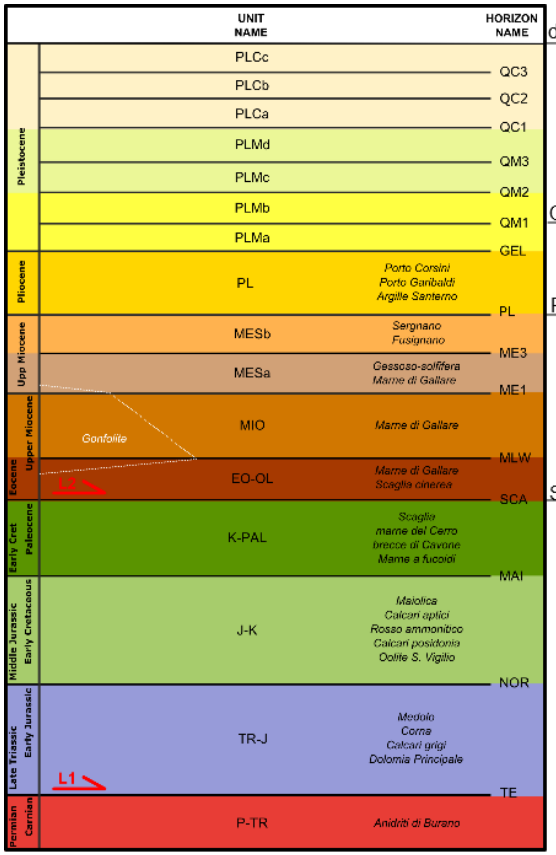


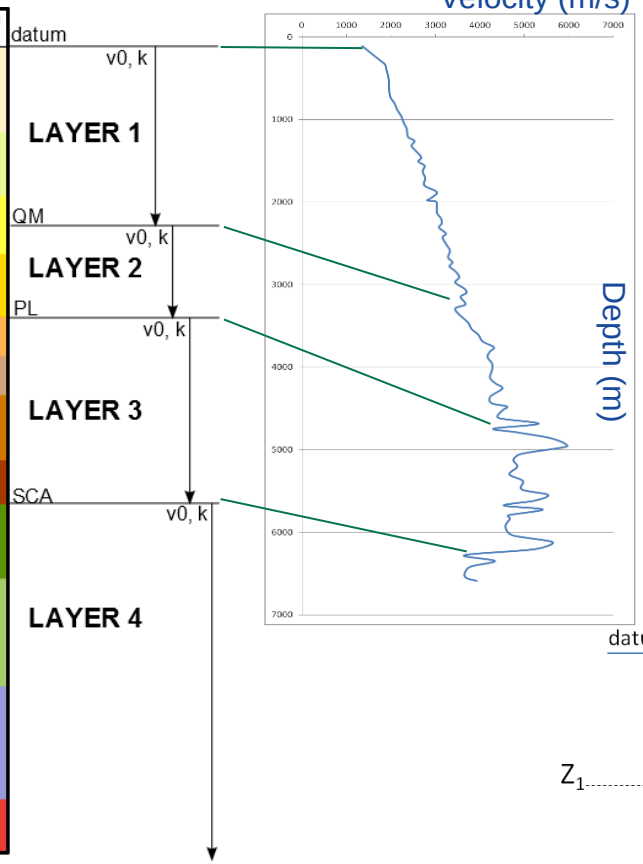


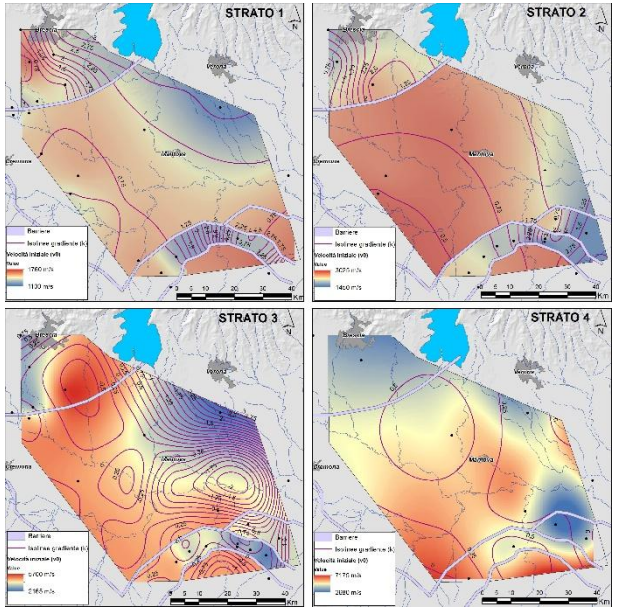
3D instantaneous velocity model

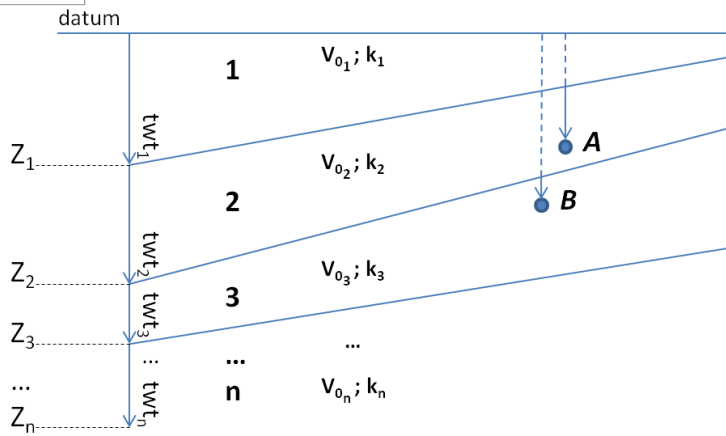
Velocity model

From the model in time domain to depth domain





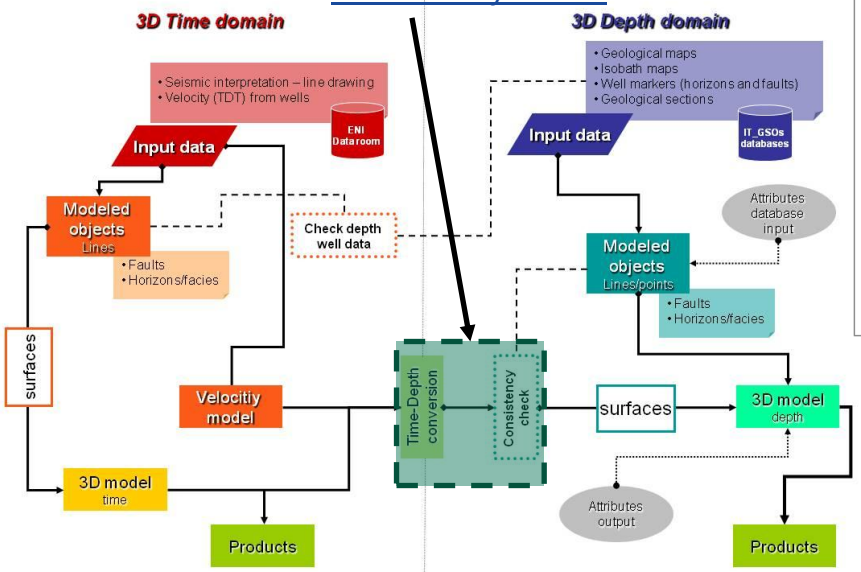




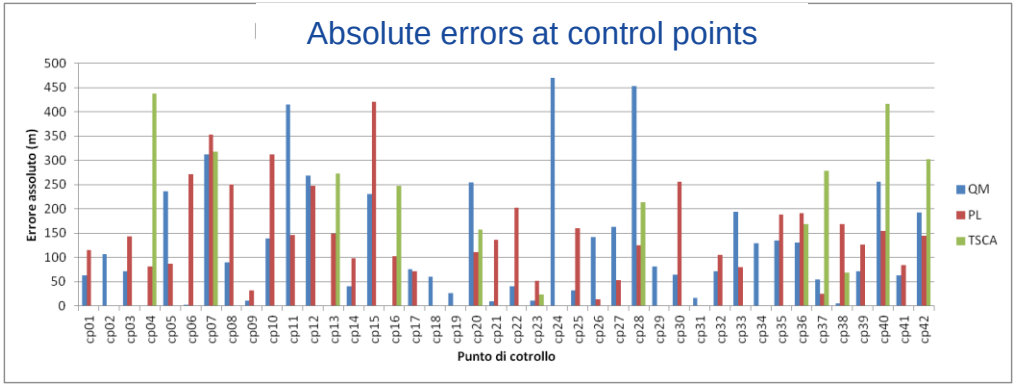
Consistency check

Validation with control points (wells) and uncertainty assessment

Consistency check



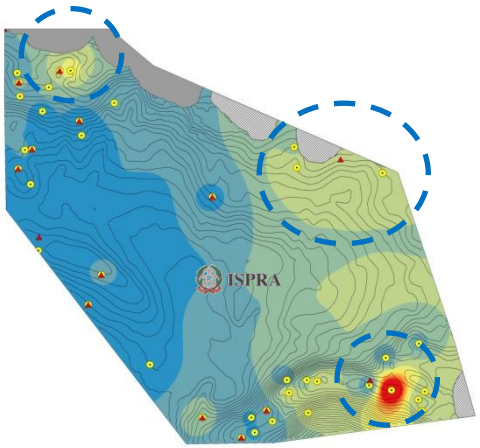
Absolute errors at control points

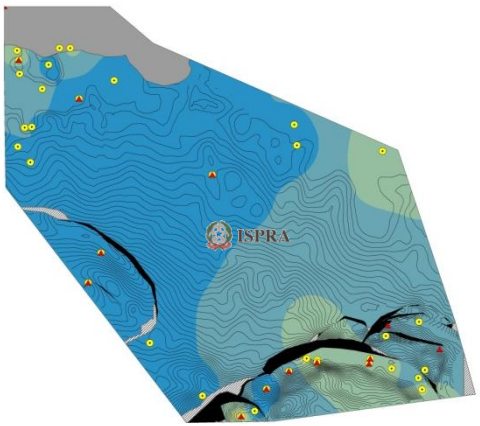


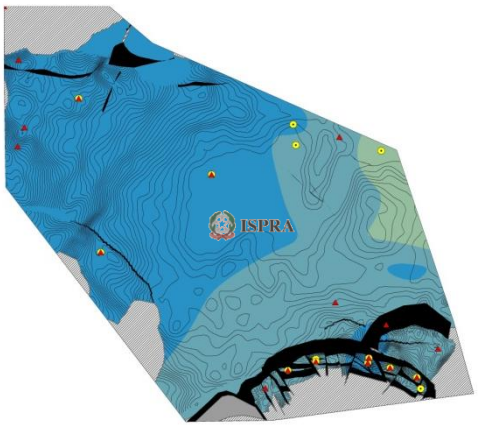
Average absolute errors

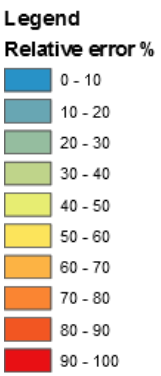
QM 130 m
PL 150 m
Top Scaglia 250 m

Uncertainty maps after depth conversion





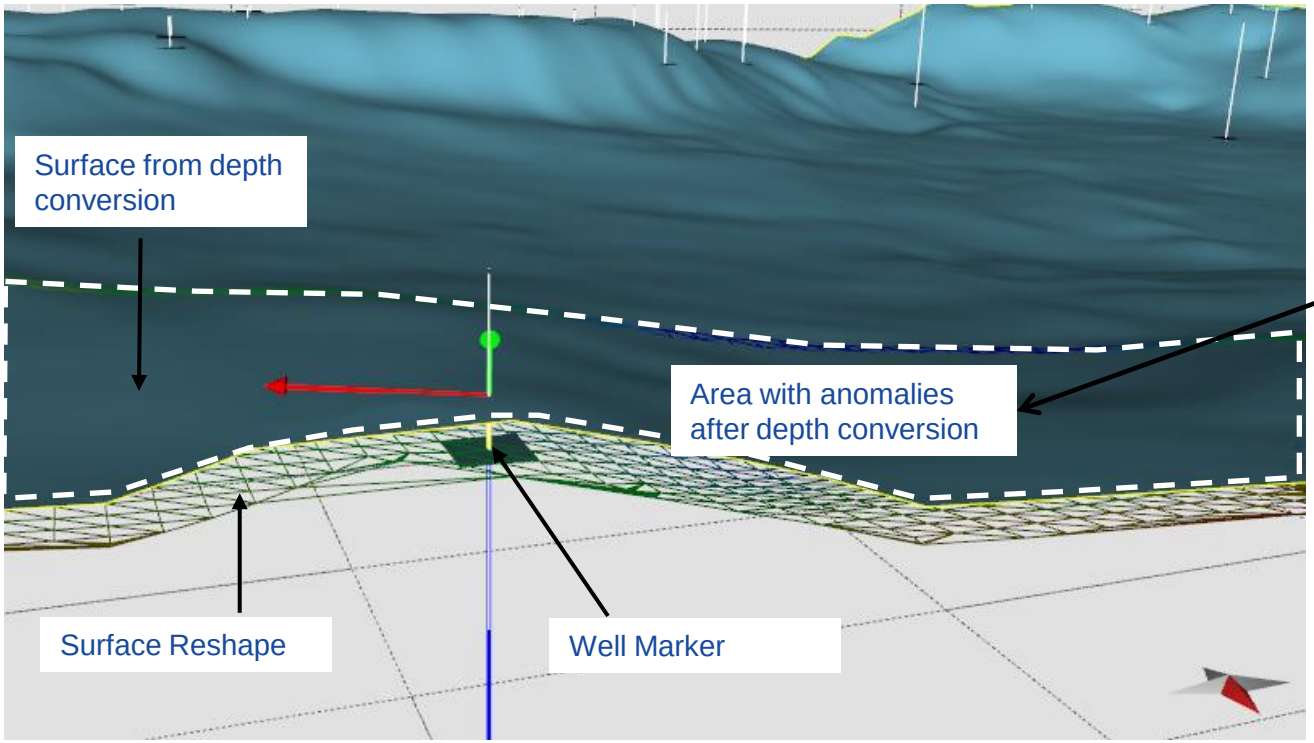


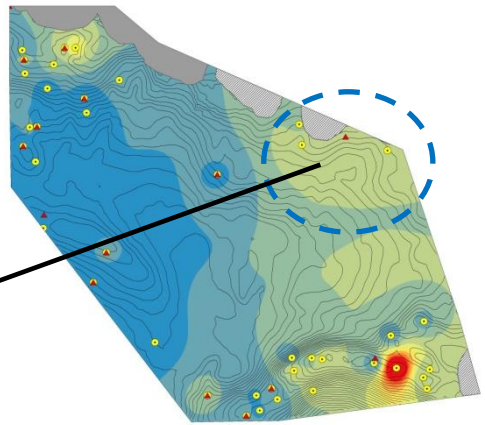


Refining

Editing surfaces in depth

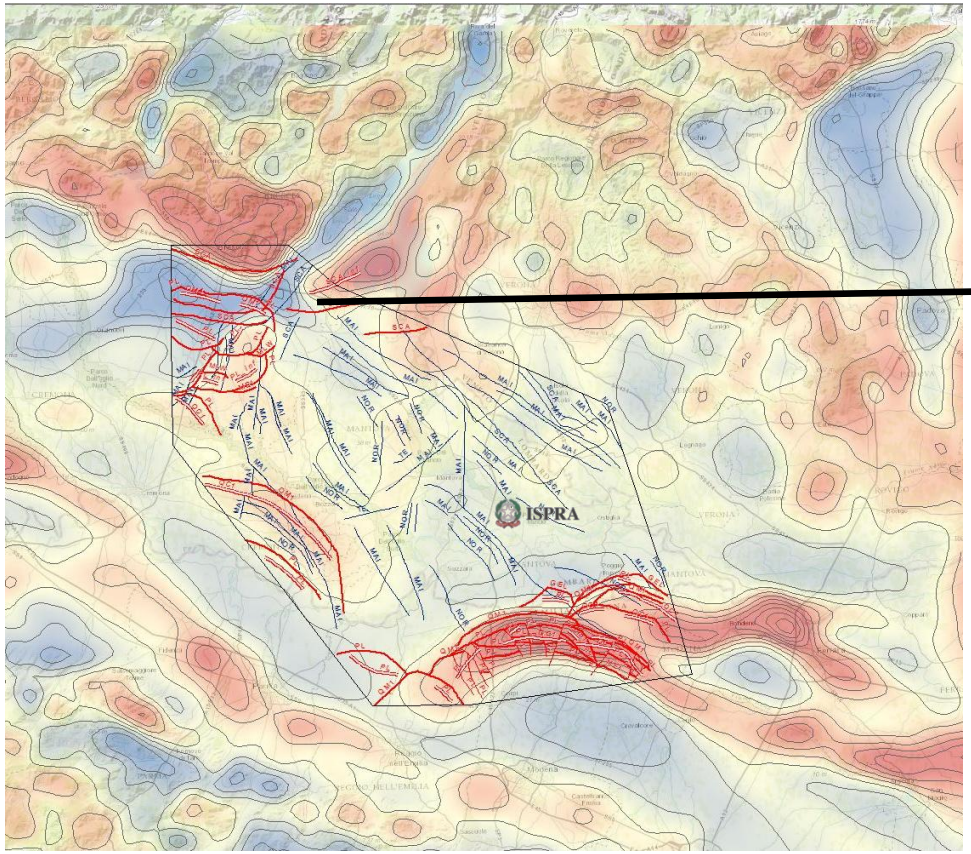
Correction of anomalies due to non-homogeneous distribution of velocity constraints

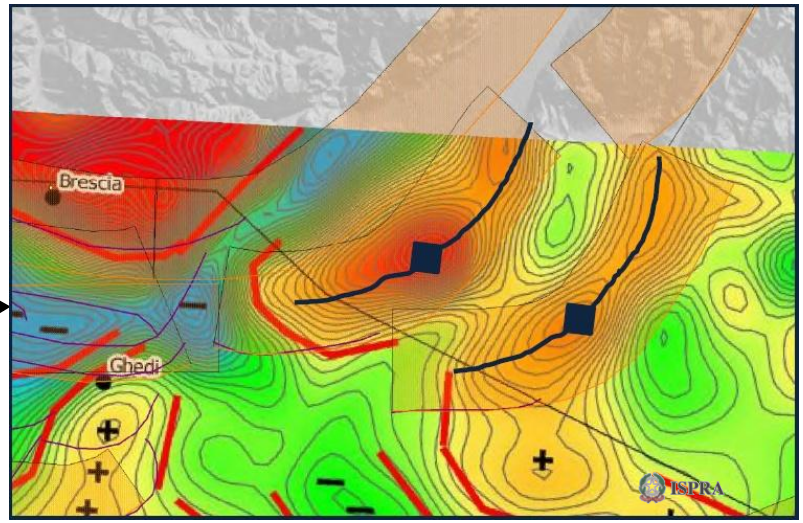




Refining and integration with independent datasets

Structural interpretation integrated with processing of gravimetric data



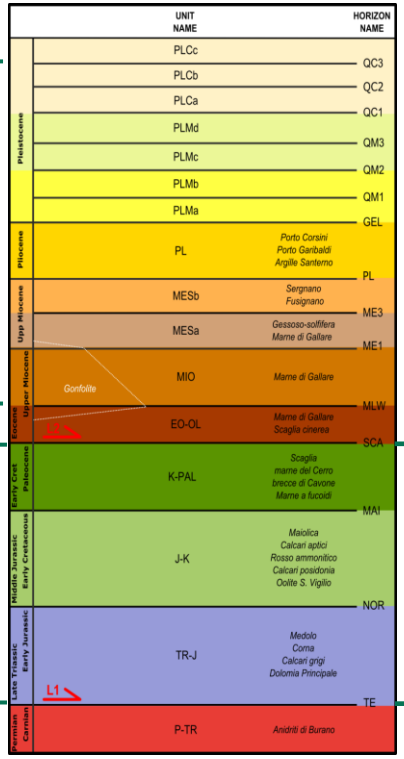


Filters applied to the gravimetric anomalies help to interpret the structural setting in problematic areas

Dataset ENI, Elaboration ISPRA – F. Ferri

The 3D model of the Italian pilot area

Stratigraphic Scheme



11 unconformity

4 Top

L2 Oligo-Miocene detachment level

L2 Upper Carnian detachment level

15 horizons

(7 horizons in the Pleistocene succession)

132 faults

500x500 m horizontal resolution

3D Model and thematic outputs

GeoMol 3D Model

Seismotectonics

Geology

Anticline axes → Most recent deformed horizon
Faults → Most recent faulted horizon
Faults → geometric and kinematic parameters (depth, azimuth, dip)

Active faults
Seismogenic sources

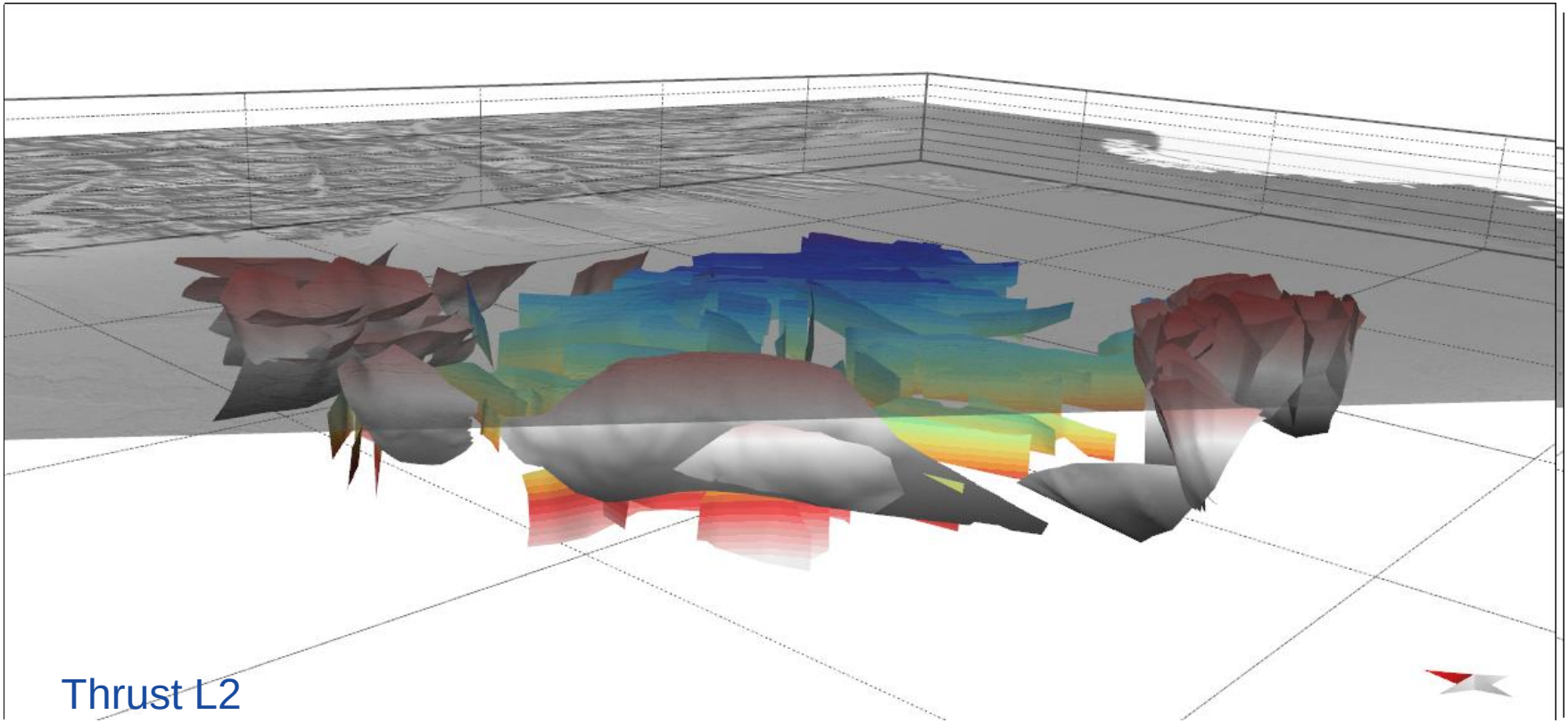
Geothermy

Geological units at X depth
Geology at isotherm
Depth of target horizons

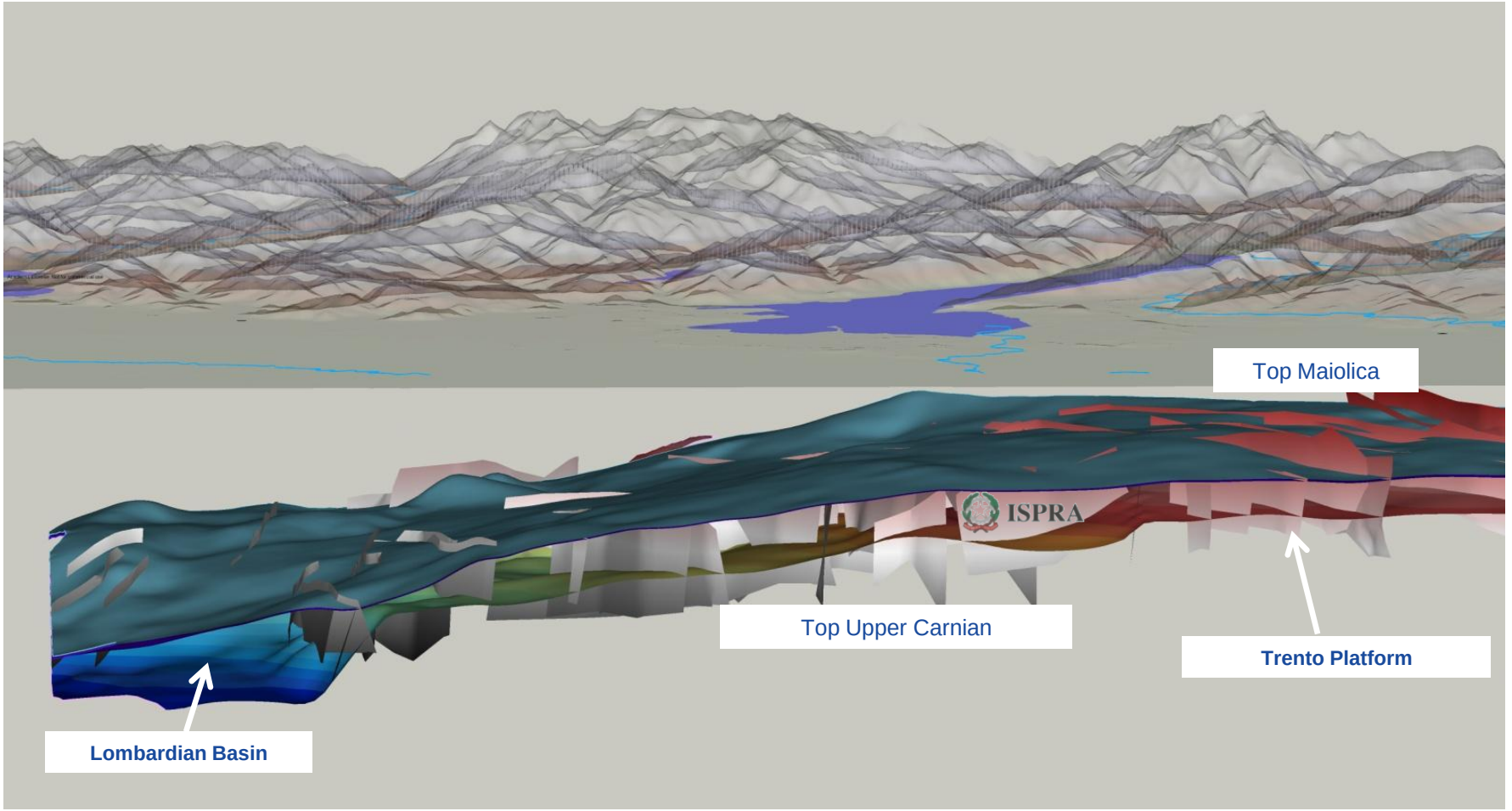
Geopotentials

Molinari, Torri, Martini & the Italian GeoMol Team. Euregeo 2015 Poster Session

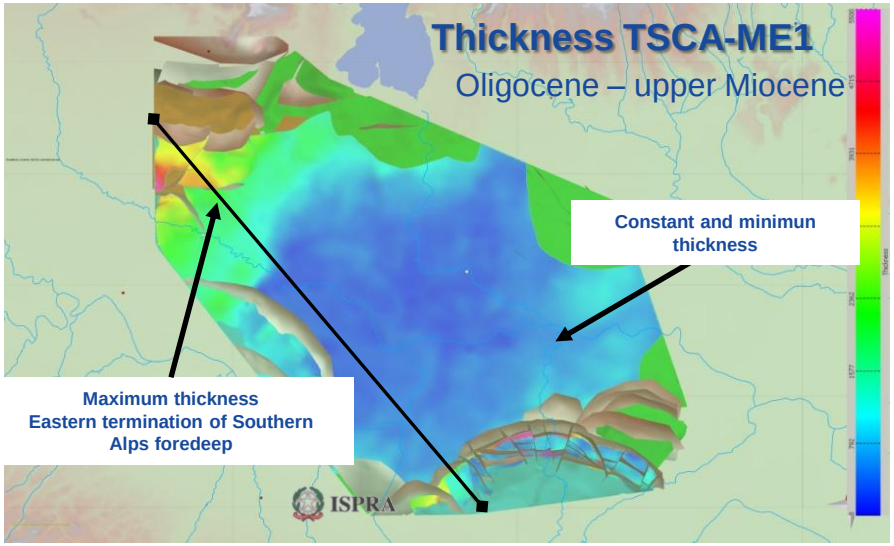
Geology: Fault sets

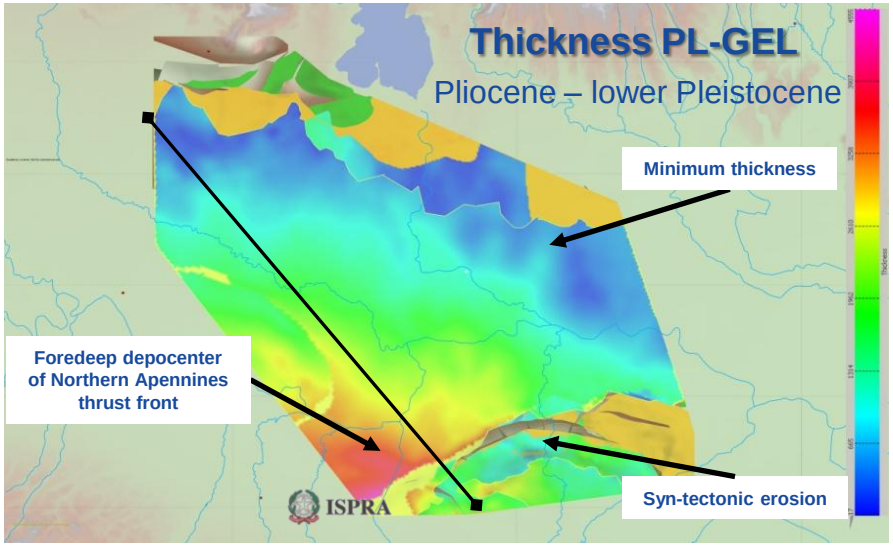


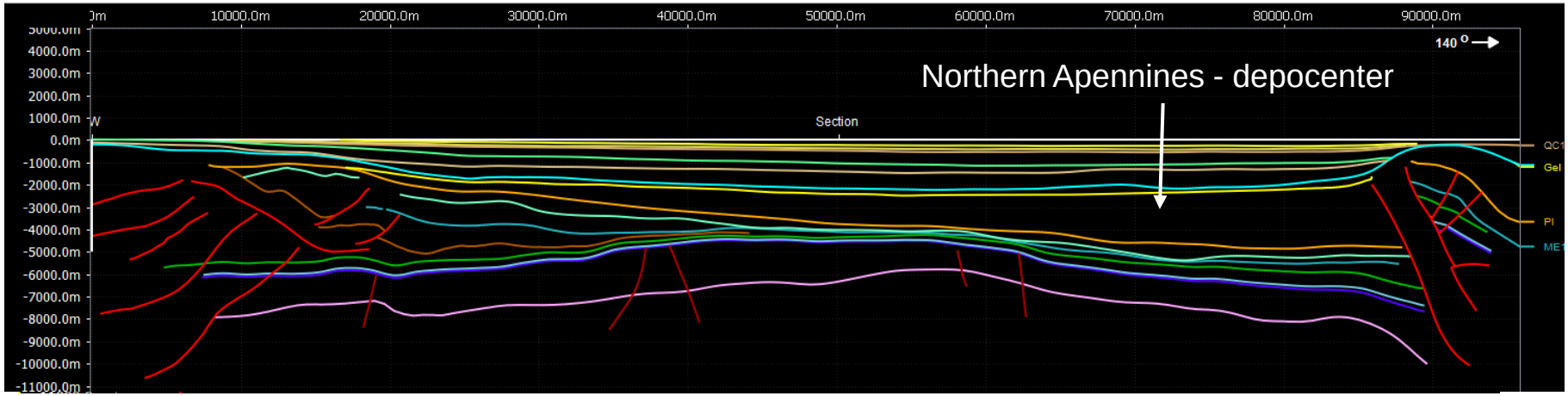
Geology: paleogeographic reconstruction



Geology: Foredeep evolution

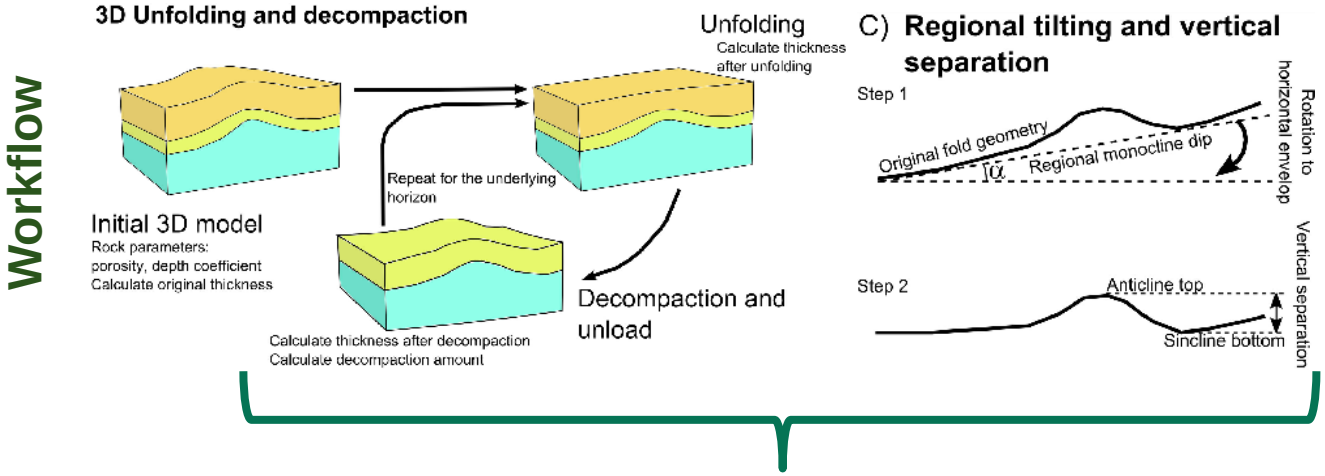


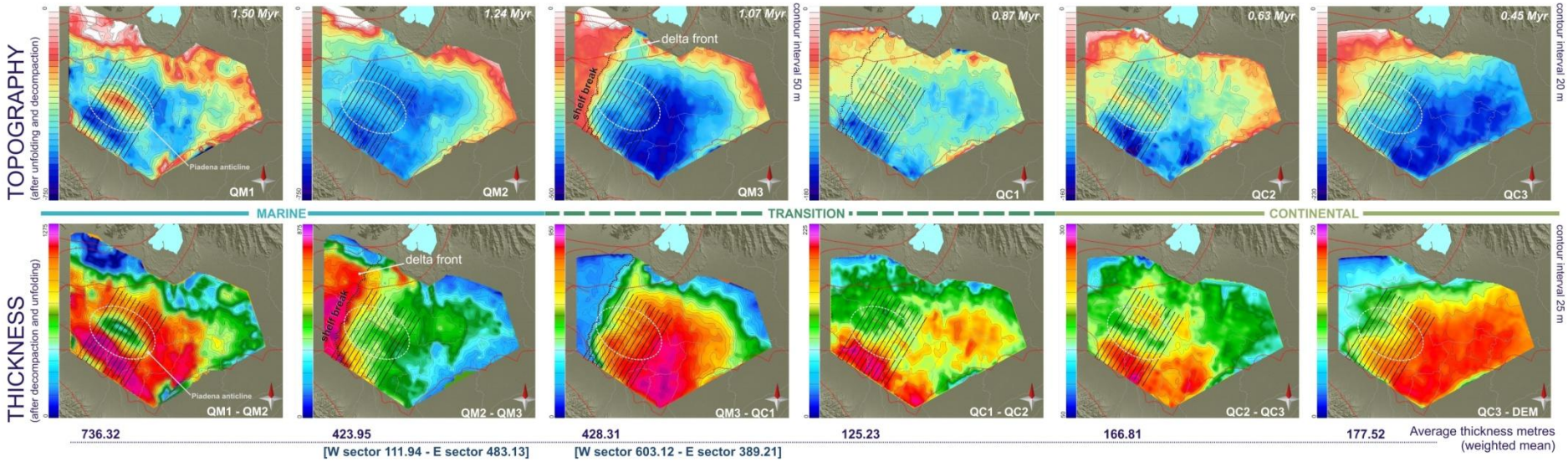




Geology: Pleistocene Basin Analysis

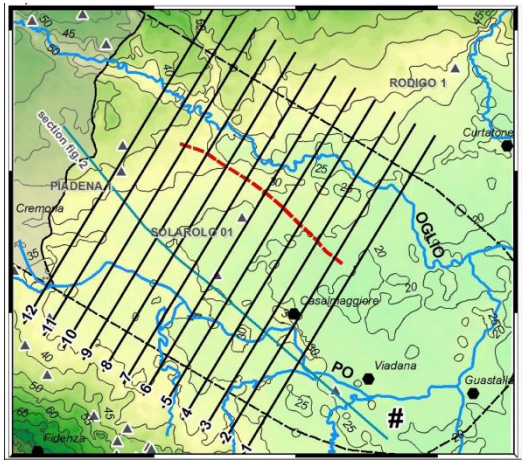
Workflow

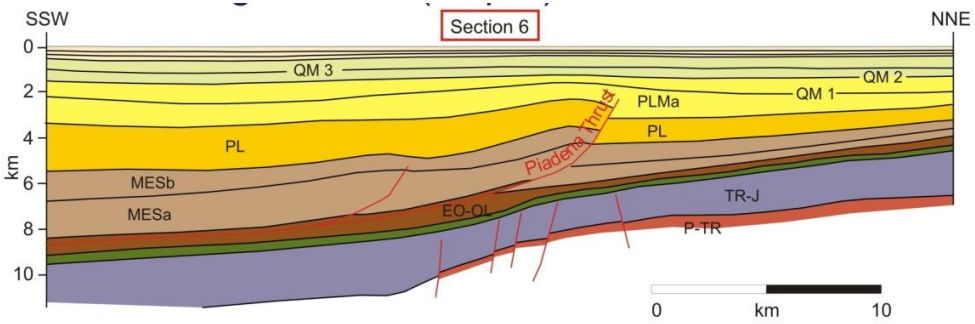




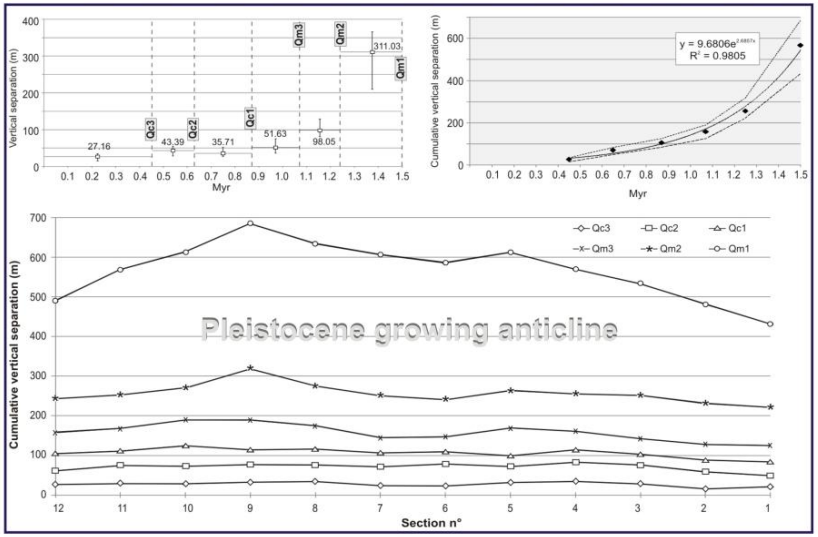
Maesano & D'Ambrogi (2015) – Coupling sedimentation and tectonic control: Pleistocene evolution of the Central Po Basin – It. Jour. Geosc.

Geology: Pleistocene sedimentation and tectonic control

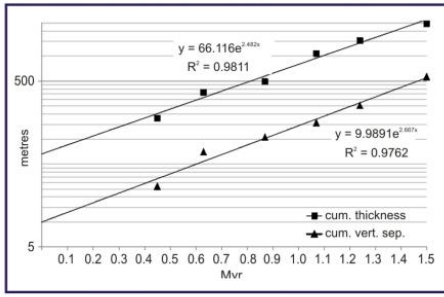




RESIDUAL VERTICAL SEPARATION



SEDIMENTATION vs UPLIFT RATE

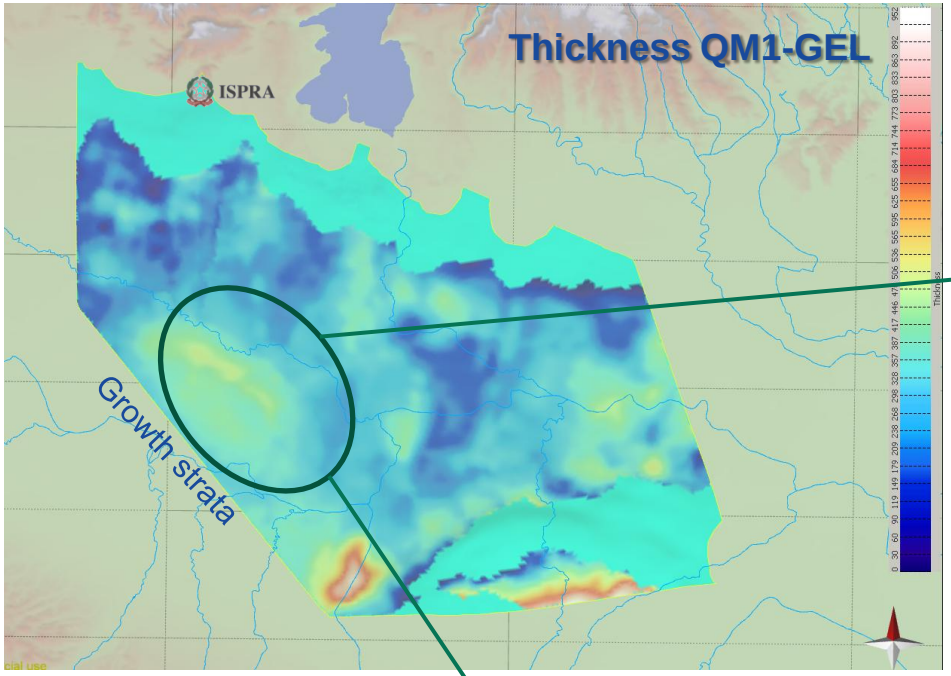


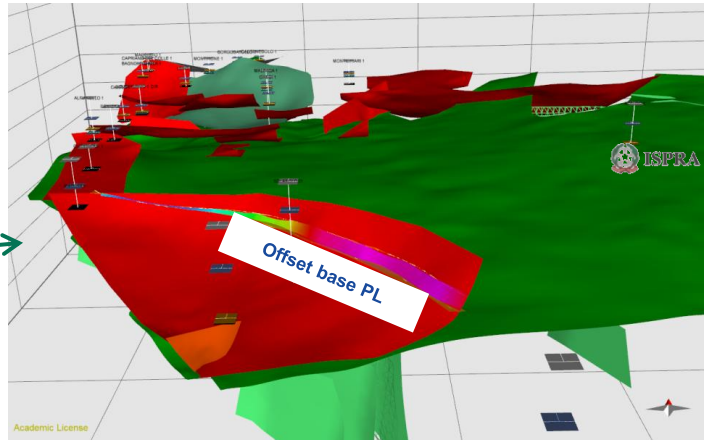
	sedim rate (mm/yr)	uplift rate (mm/yr)
Qc3-DEM	0.40 ± 0.05	0.06 ± 0.05
Qc2-Qc3	1.04 ± 0.17	0.24 ± 0.12
Qc1-Qc2	0.54 ±0.11	0.15 ± 0.09
Qm3-Qc1	2.91 ± 0.25 #	0.26 ± 0.11
Qm2-Qm3	2.71 ± 0.28 #	0.58 ± 0.15
Qm1-Qm2	3.59 ± 0.21	1.20 ± 0.12

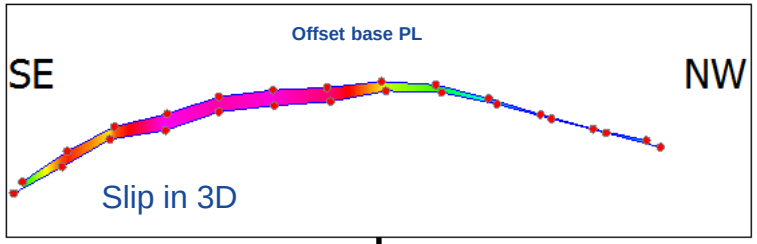
The sedimentation rates are calculated for the Piadena area

Maesano & D'Ambrogi (2015) – Coupling sedimentation and tectonic control: Pleistocene evolution of the Central Po Basin – It. Jour. Geosc.

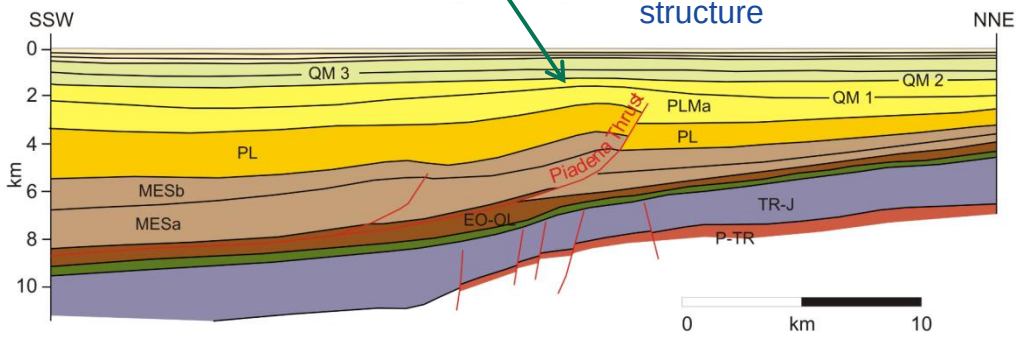
From geology to seismotectonic analysis





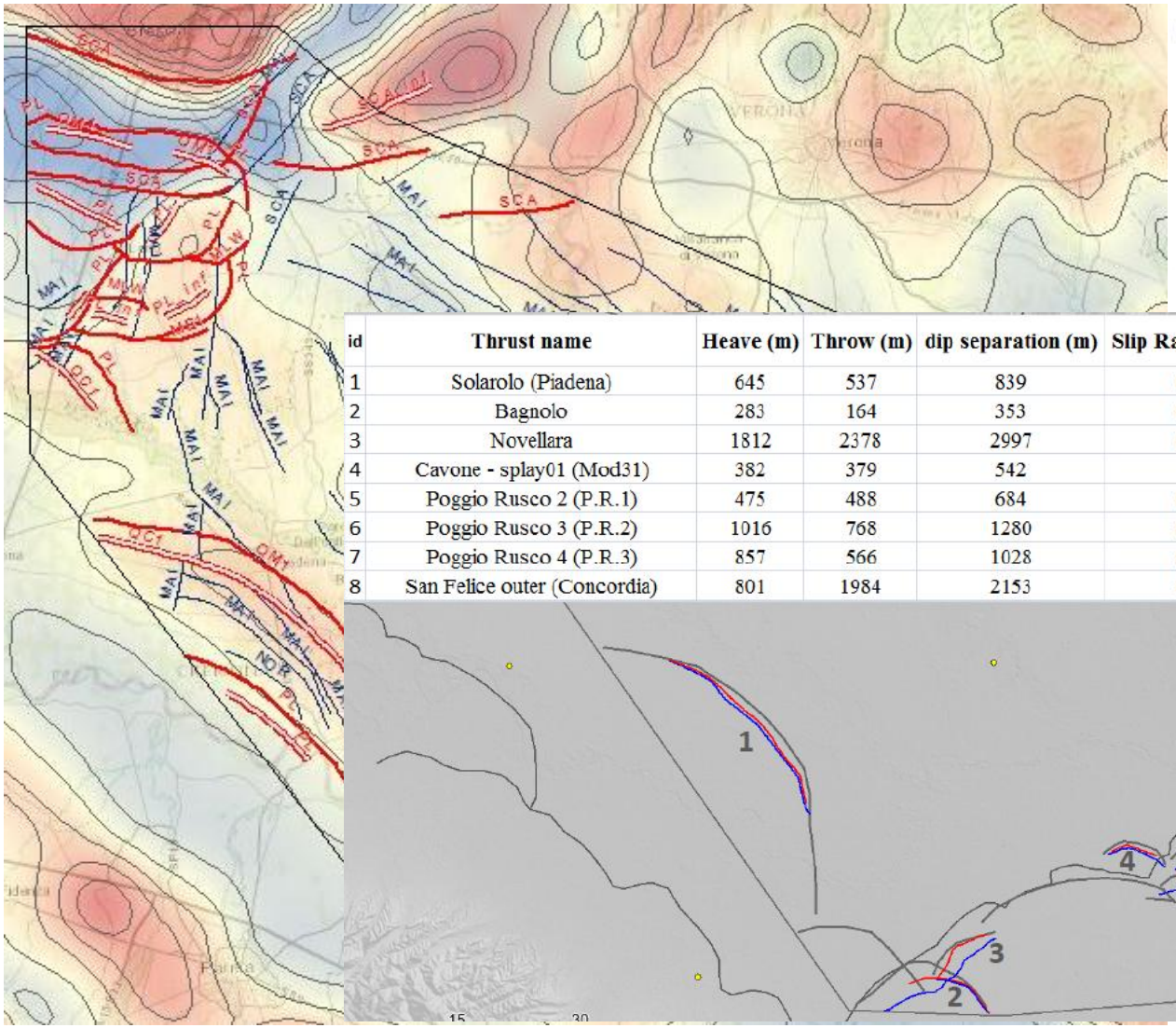


Age of inception of the structure



3D slip rates

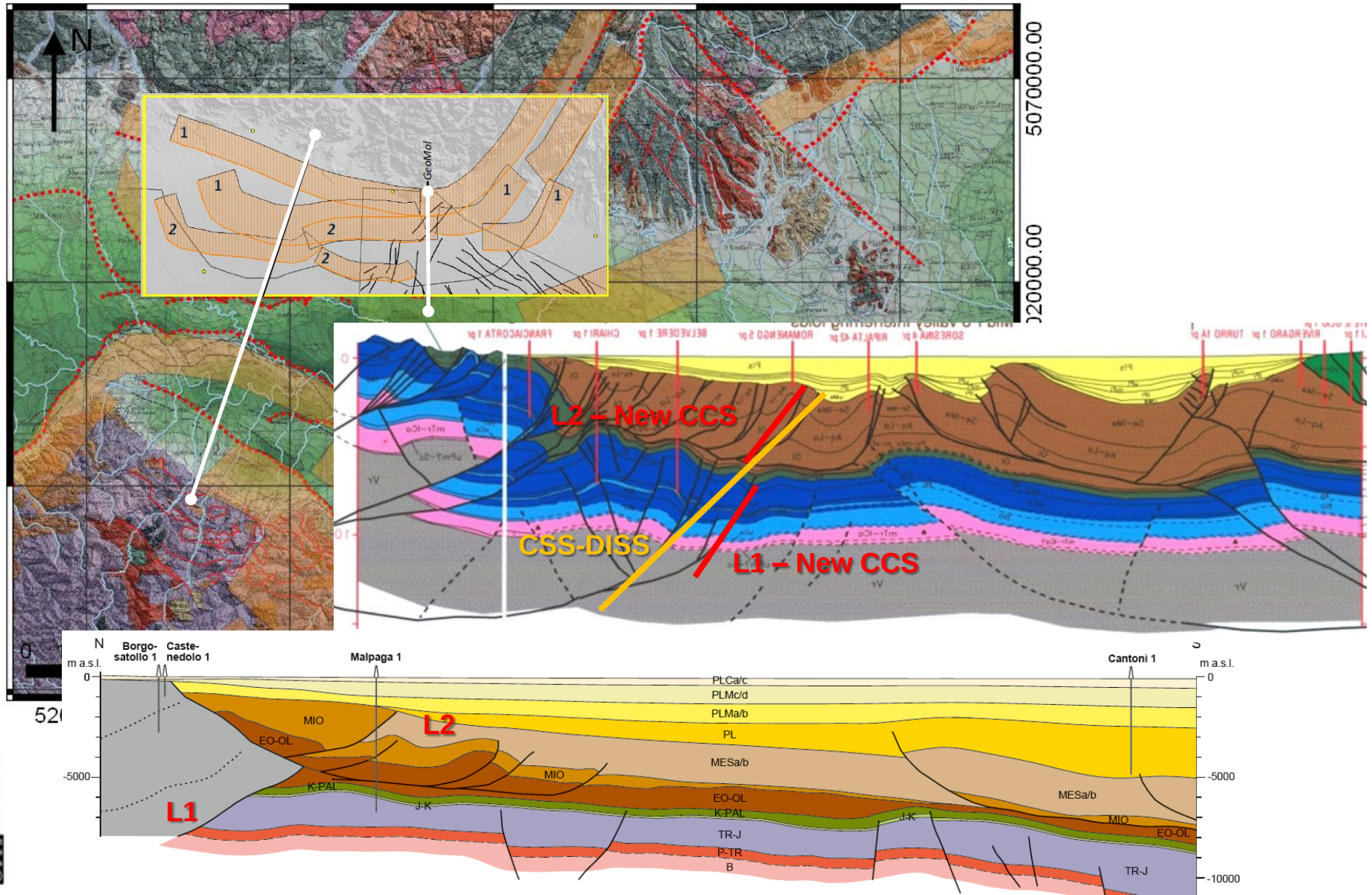
Seismotectonic



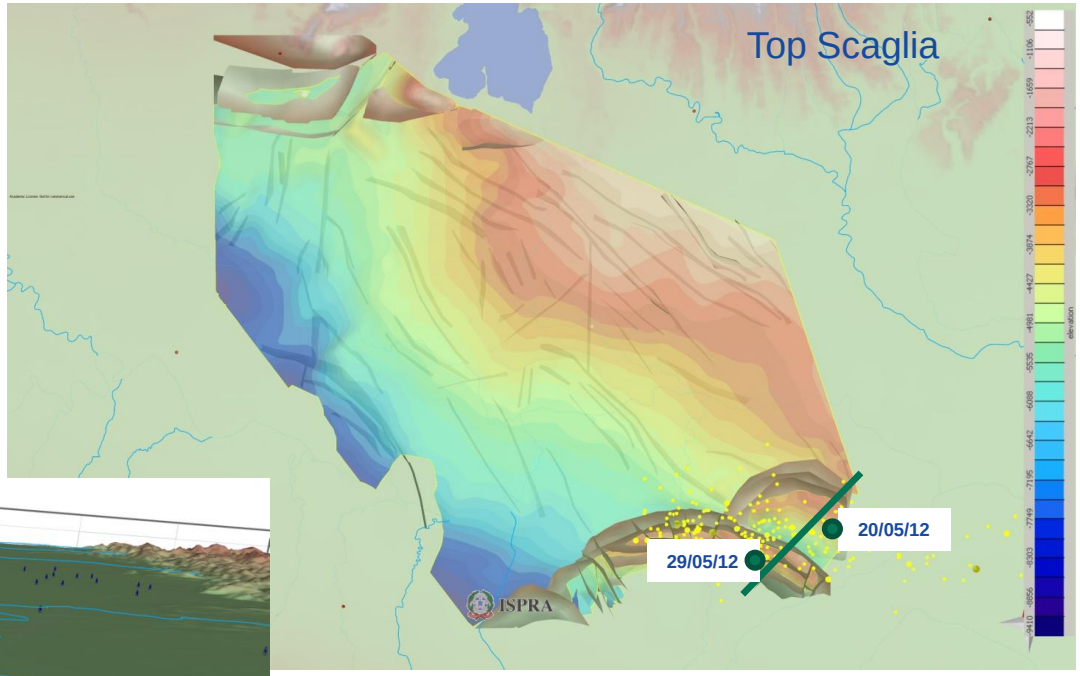
- STRUCTURAL MAP
  - Anticline axis
    - Younger deformed horizon
  - Transversal faults
    - Upper tip line [Younger displaced horizon
  - Thrust
    - Upper tip line [Younger displaced horizon
  - Extensional faults
    - Upper tip line [Younger displaced horizon

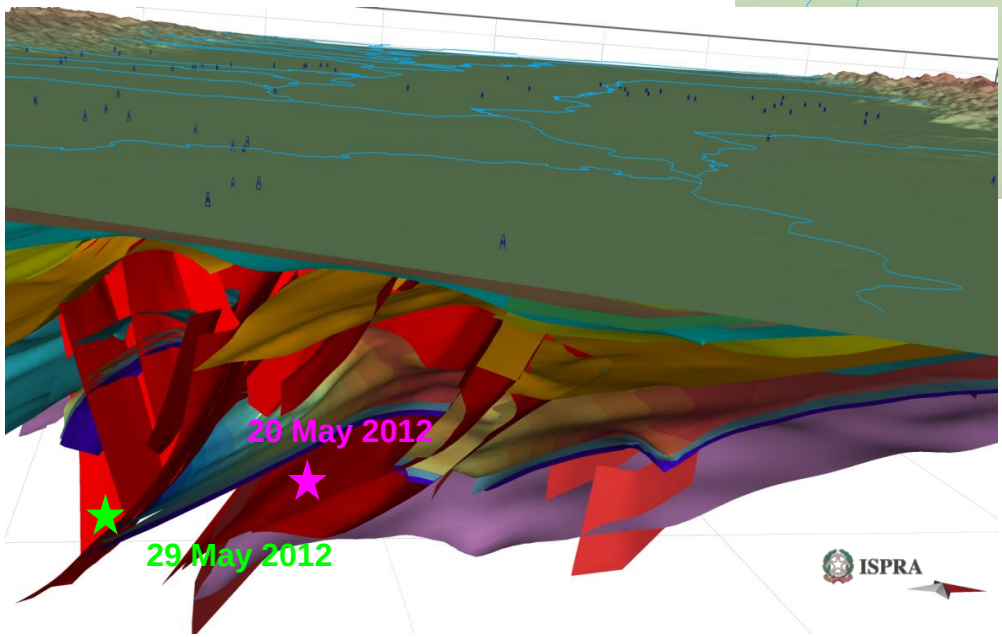
id	Thrust name	Heave (m)	Throw (m)	dip separation (m)	Slip Rate (mm/yr)	standard deviation (mm/yr)
1	Solarolo (Piadena)	645	537	839	0.16	0.05
2	Bagnolo	283	164	353	0.07	0.02
3	Novellara	1812	2378	2997	0.57	0.07
4	Cavone - splay01 (Mod31)	382	379	542	0.1	0.03
5	Poggio Rusco 2 (P.R.1)	475	488	684	0.13	0.04
6	Poggio Rusco 3 (P.R.2)	1016	768	1280	0.24	0.05
7	Poggio Rusco 4 (P.R.3)	857	566	1028	0.19	0.14
8	San Felice outer (Concordia)	801	1984	2153	0.41	0.06

Seismotectonic

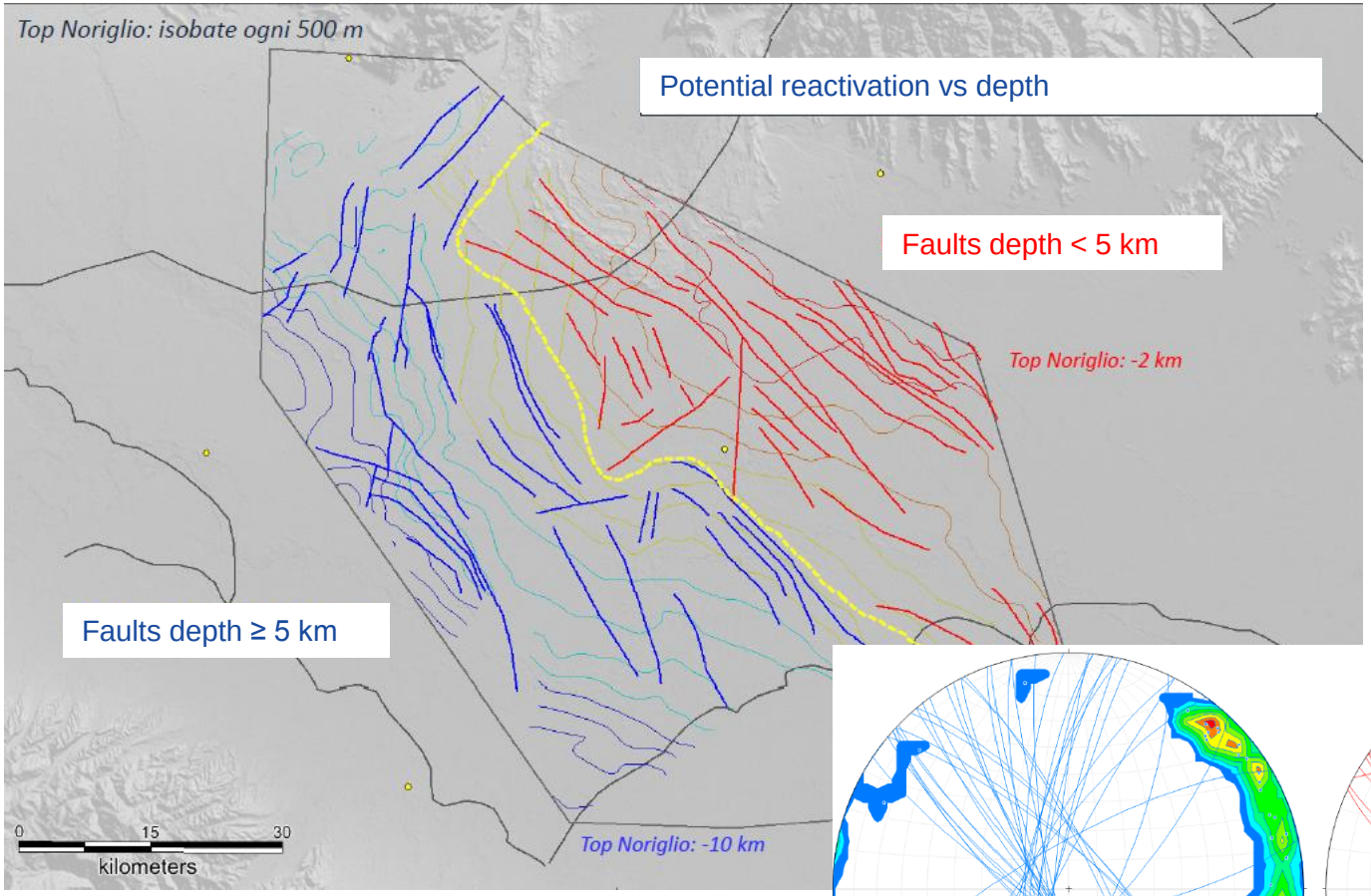


Seismotectonic: sources of 2012 seismic sequence

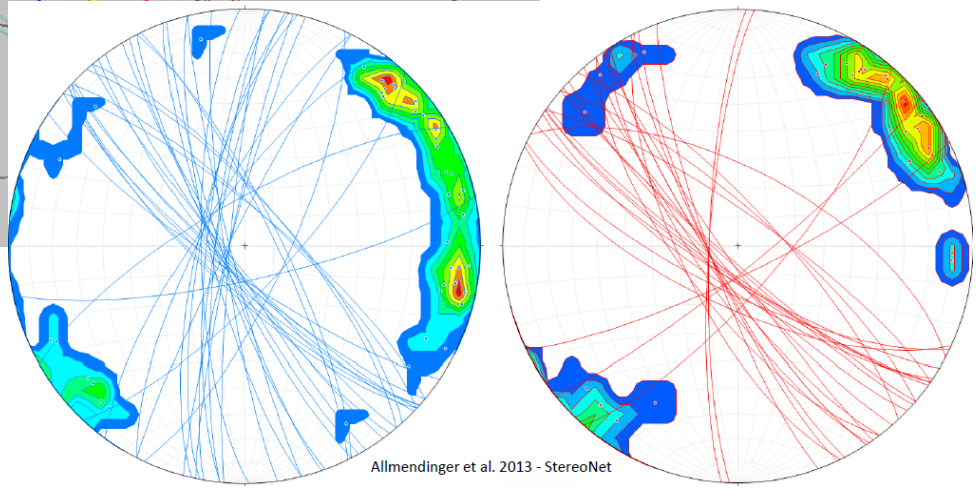




Seismotectonic



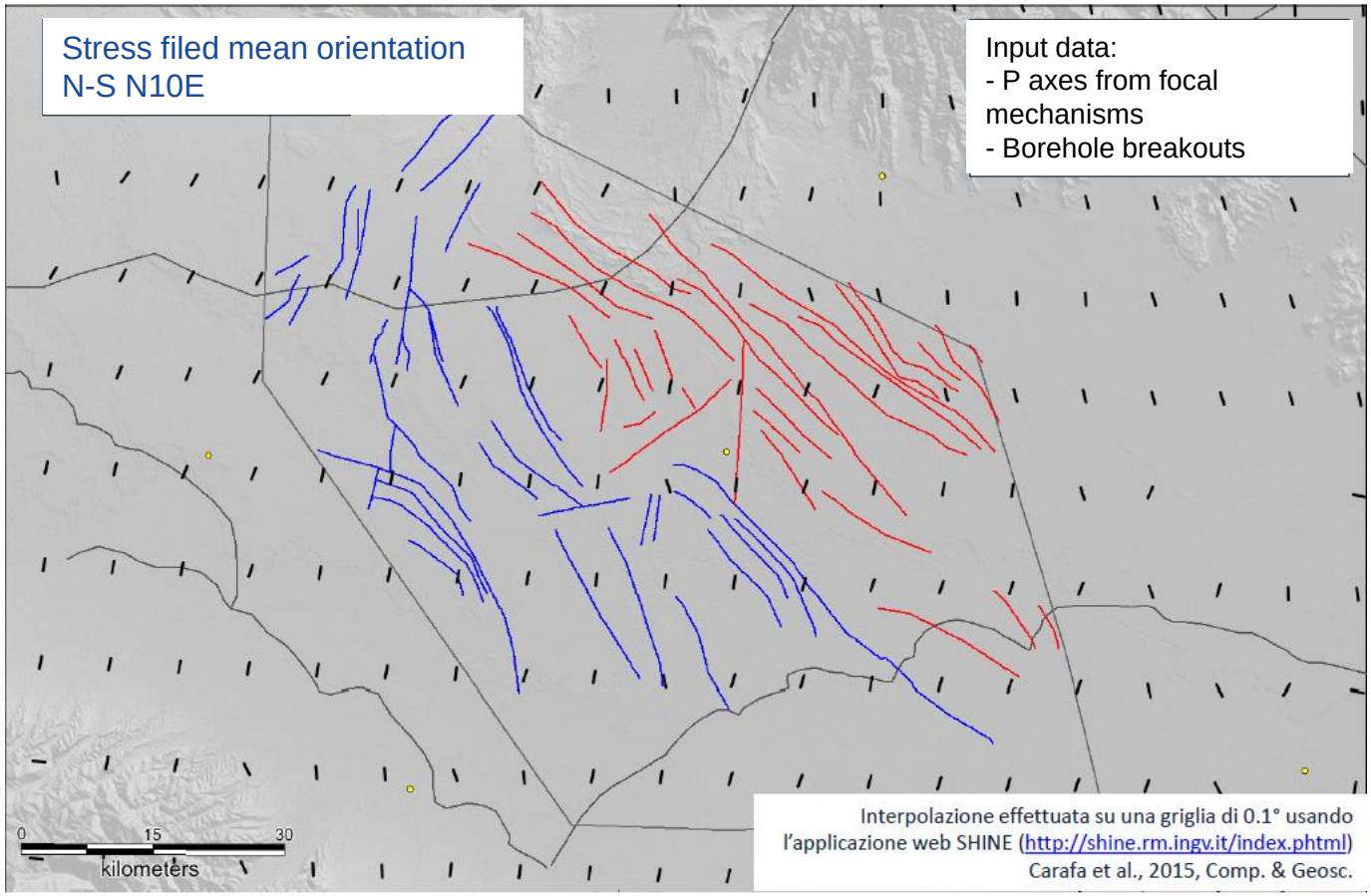
Analysis of potential reactivation



Faults depth ≥ 5 km

Faults depth < 5 km

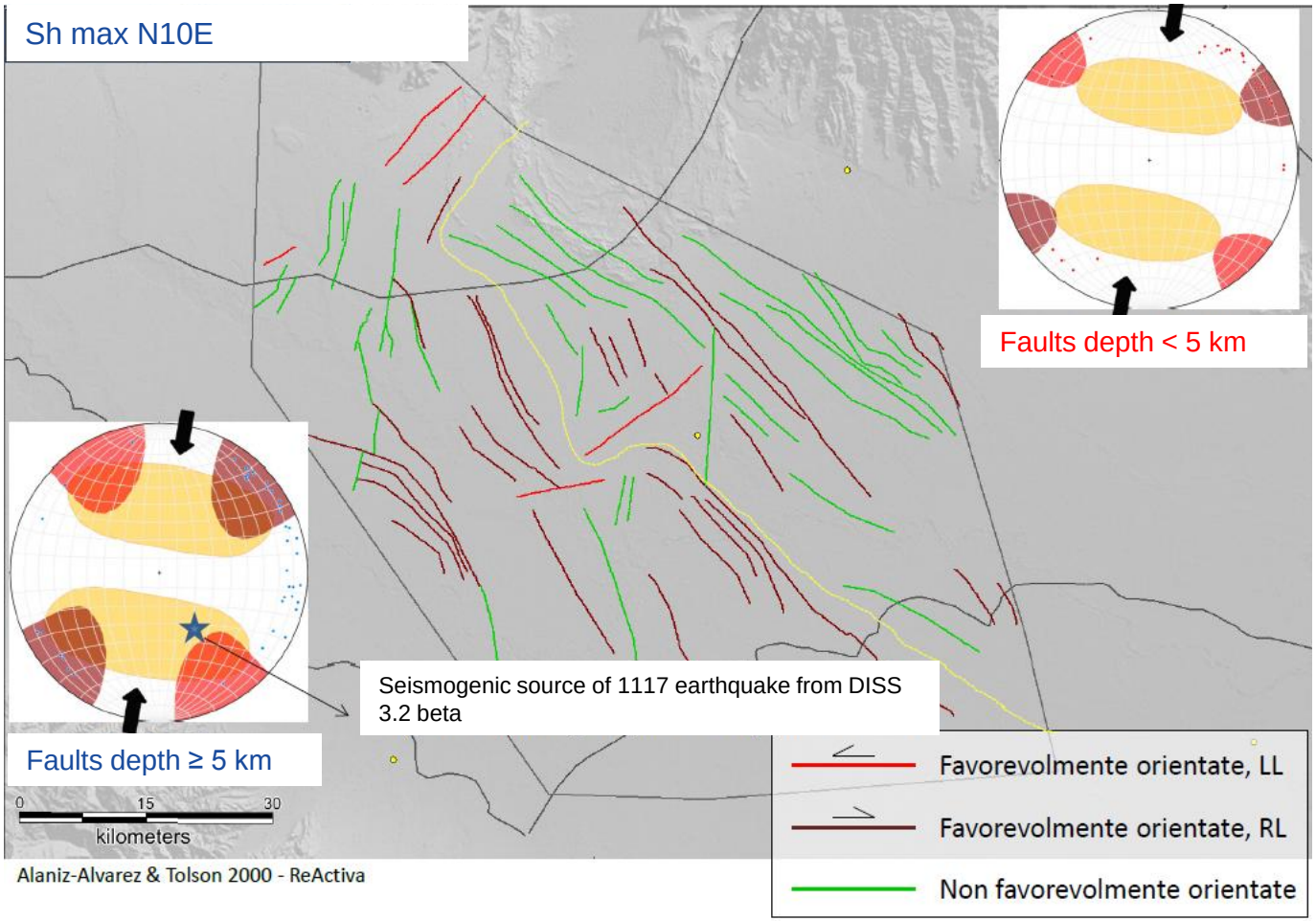
Seismotectonic



Data from: World Stress Map Project (http://dc-app3-14.gfz-potsdam.de/)

Analysis of potential reactivation

Seismotectonic



Alaniz-Alvarez & Tolson 2000 - ReActiva

Analysis of potential reactivation

Conclusions

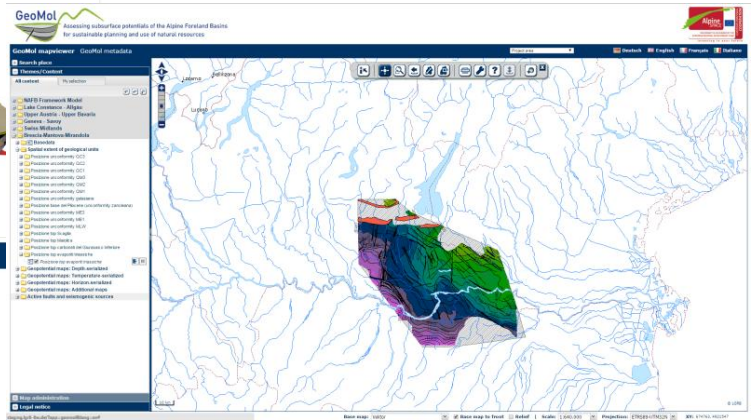
3D geological models of the GeoMol Project are:

- Synthesis and advanced management of subsurface data
- Base for various type of analysis, both for industrial and research purpose
- Results of collaboration between regional and transnational Geological Surveys, research Institutes, Industrial Companies

... and

Free accessible to the public at

www.geomol.eu



Thank you for your attention

Contact:
Francesco Maesano
francescoemanuele.maesano@isprambiente.it
framae80@gmail.com