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TNO BGS 1835 Staatliche Geologische Dienste Deutschlands Sub-Urban cost EUROPEAN COOPERATION IN SCIENCE AND TECHNOLOGY

COST-is-supported-by-the-EU-RTD-Framework-Programme

2nd European meeting on 3D geological modelling

BGS Murchison House – Edinburgh
20th – 21th November 2014

Subsurface geopotentials vs geological risks: enhancements from 3D model analysis

Chiara D'Ambrogi & Francesco E. Maesano
Servizio Geologico d'Italia - ISPRA

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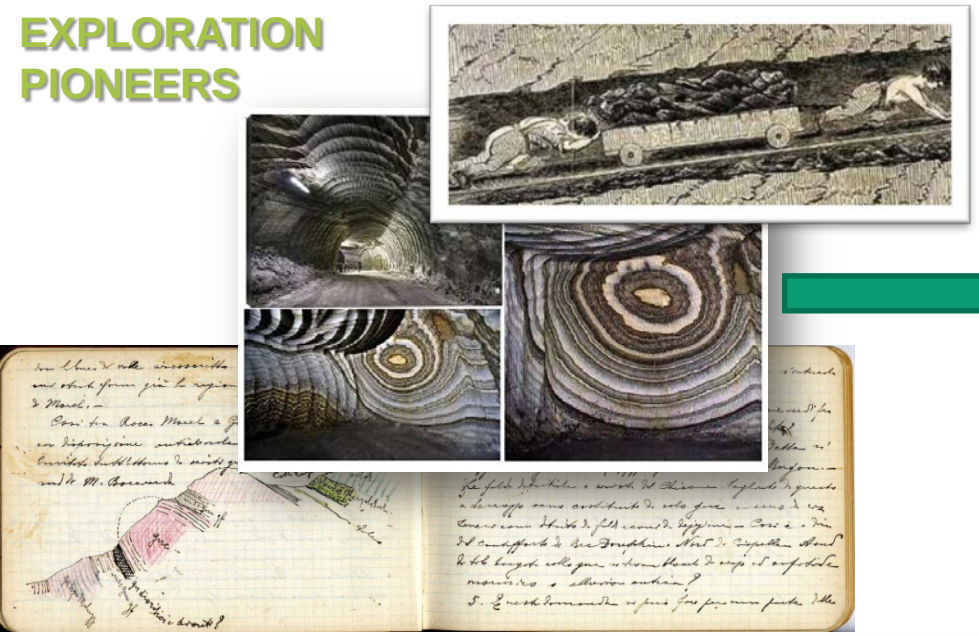
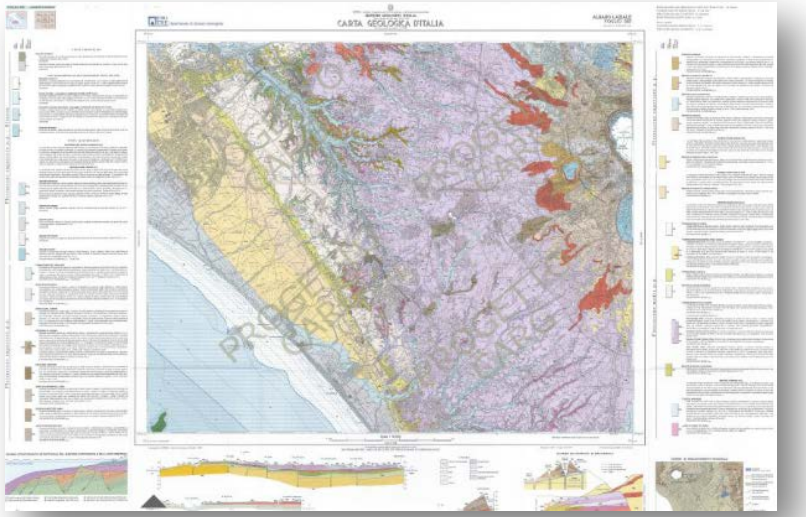
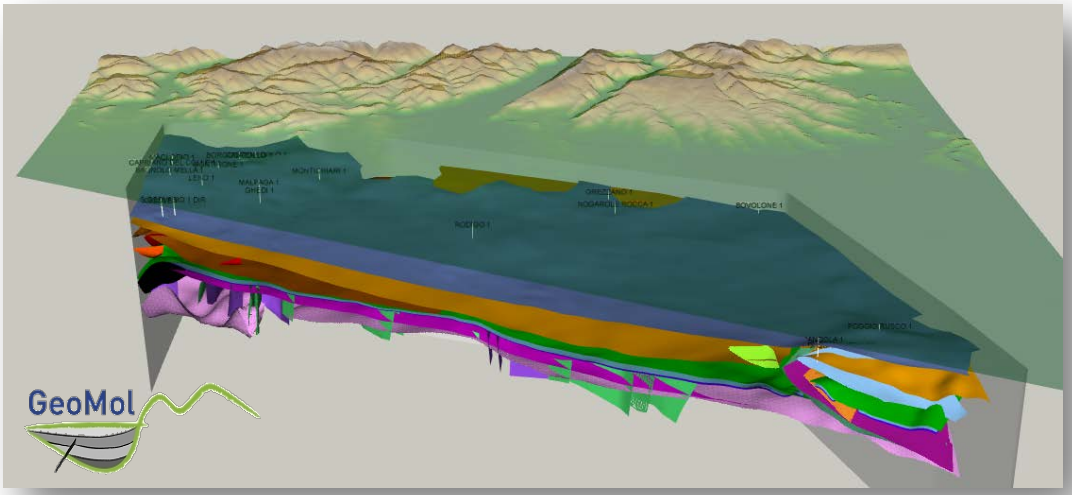
EXPLORATION PIONEERS



GEOLOGICAL MAPPING





3D MODELLING

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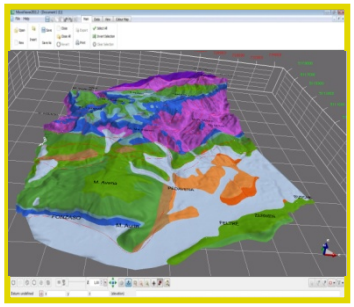
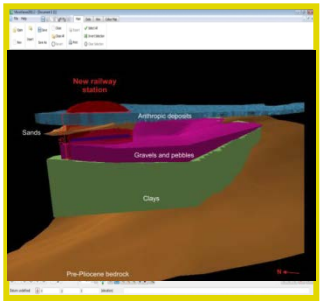
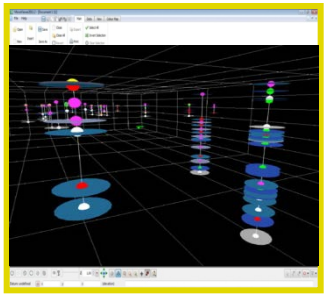
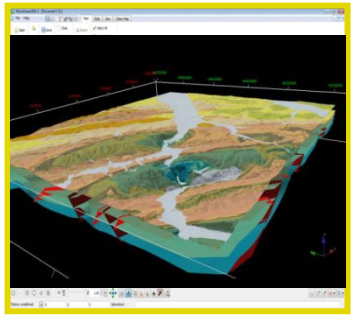
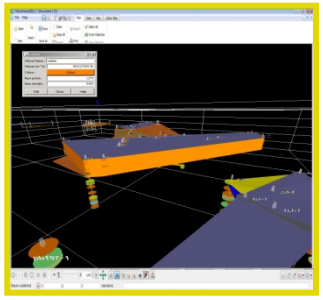


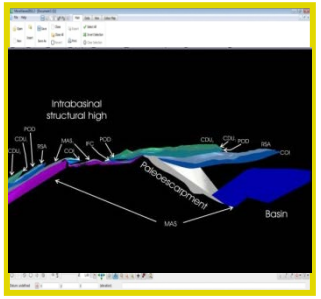


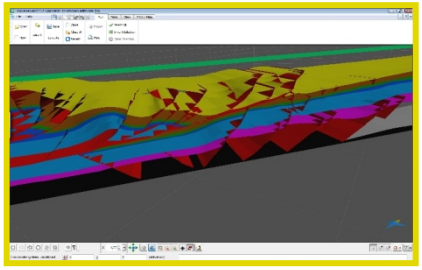


3D Models	Area (km²)	depth (m)	Data input	
			surface	subsurface
FOSSOMBRONE	600	3,500	Geological sheet - 3D	
FIRENZE	25	100	Analysis of rock volumes	
POLINO	18	400	Paleogeographic reconstruction	
CIMINI	250	3,000	Hydrogeological complexes	
FIUMICINO	80	100	Subsoil geological sheet - 3D	
VETTE FELTRINE	300	2,500	Structural restoration	
PO PLAIN	6,000	10,000	Geopotentials, Slip rates calculation	









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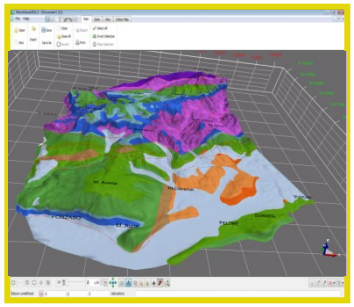

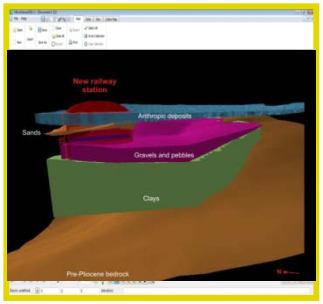

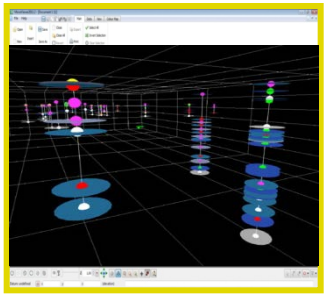

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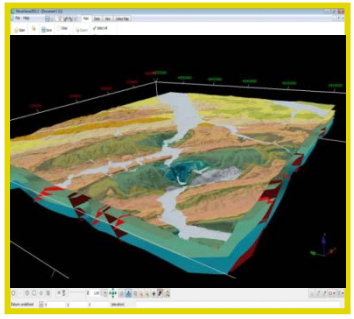

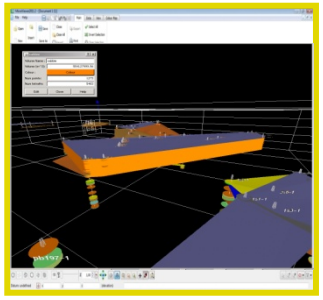

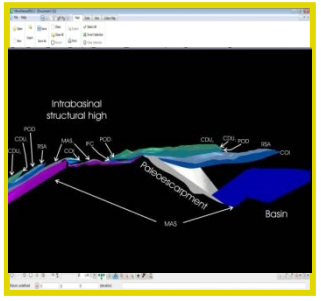

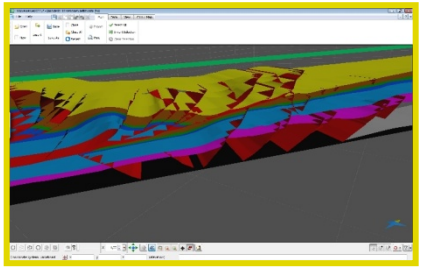

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SUBSURFACE IS….

Resources

- groundwater
- geothermal energy
- oil and gas production and storage
- Carbon Capture and Storage
- .....

Risks

- earthquake
- subsidence
- sinkhole
- human effects
- .....

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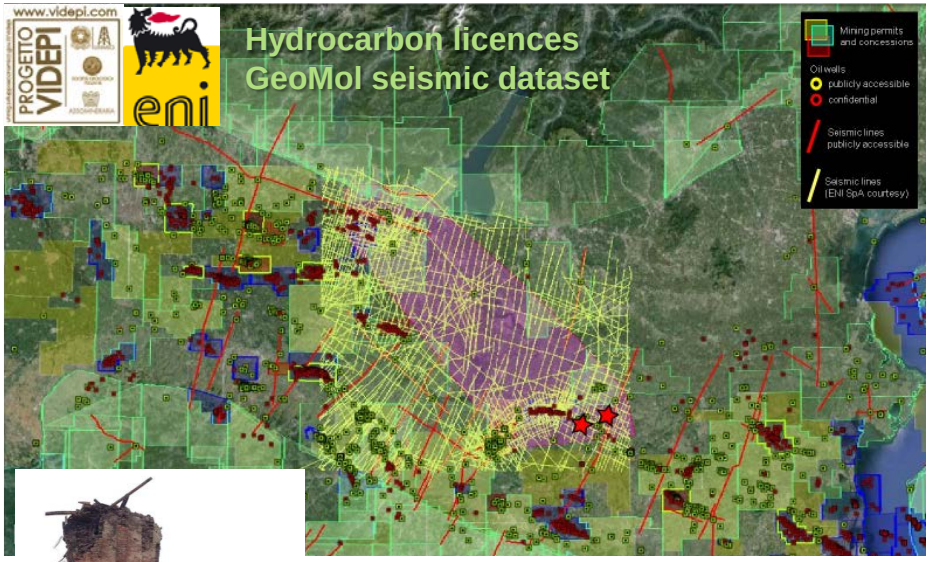
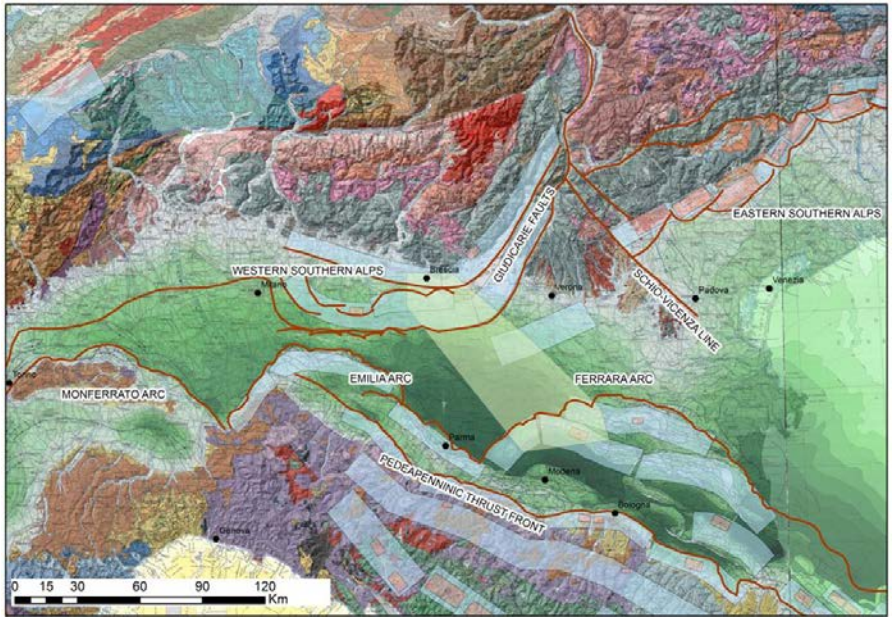
UNDERGROUD RESOURCES



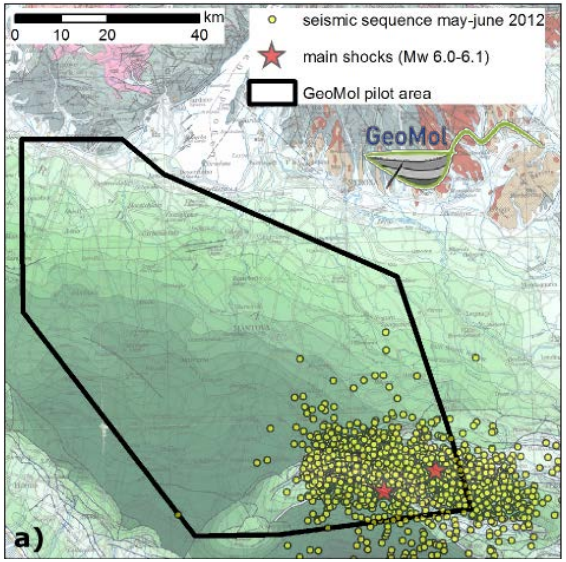


GEOLOGICAL HAZARDS

Plain, but not Stable

SEISMOLOGY

Human Activity May Have Triggered Fatal Italian Earthquakes, Panel Says



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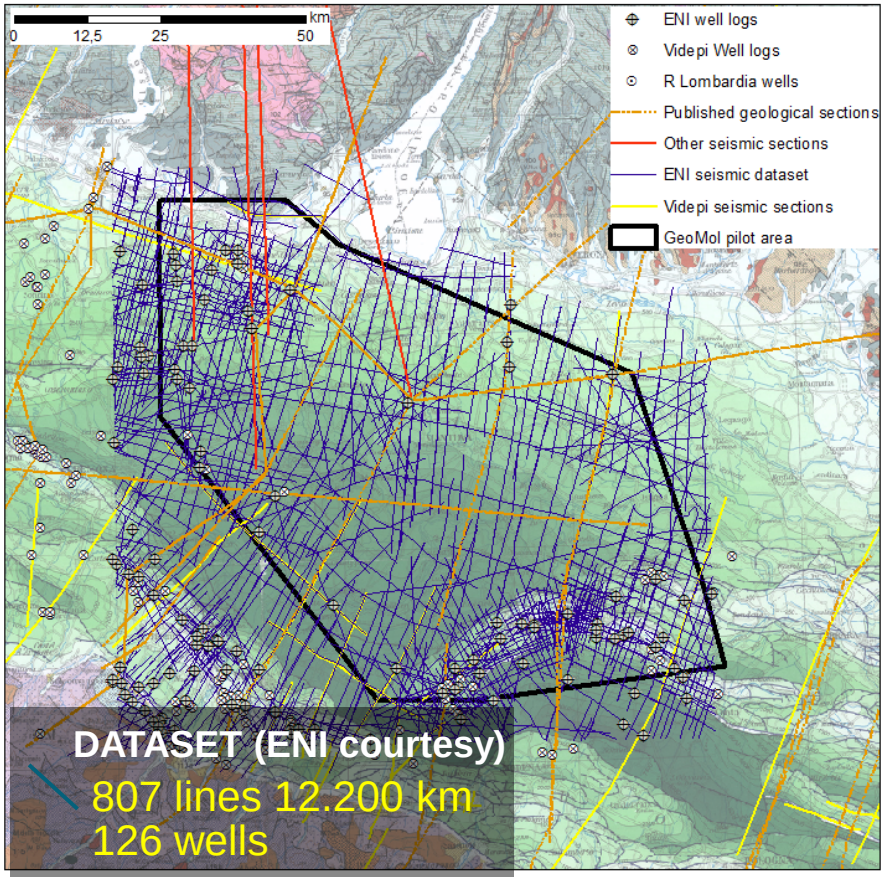

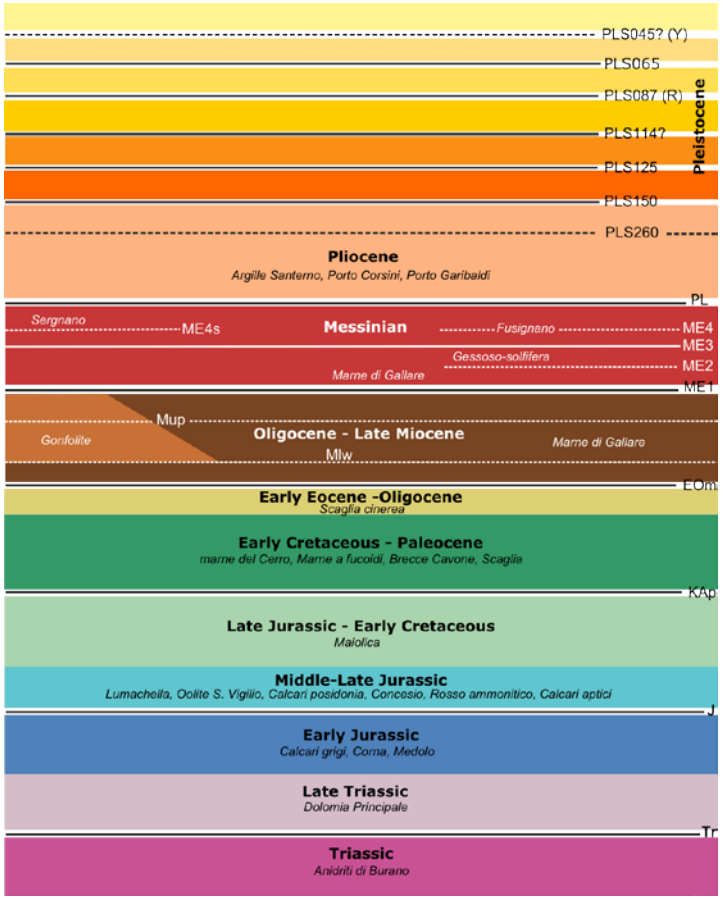

GeoMol
Assessing subsurface potentials of the Alpine Foreland Basins for sustainable planning and use of natural resources

Alpine SPACE
THIS PROJECT IS CO-FUNDED BY THE EUROPEAN REGIONAL DEVELOPMENT FUND
EUROPEAN TERRITORIAL COOPERATION
investing in your future

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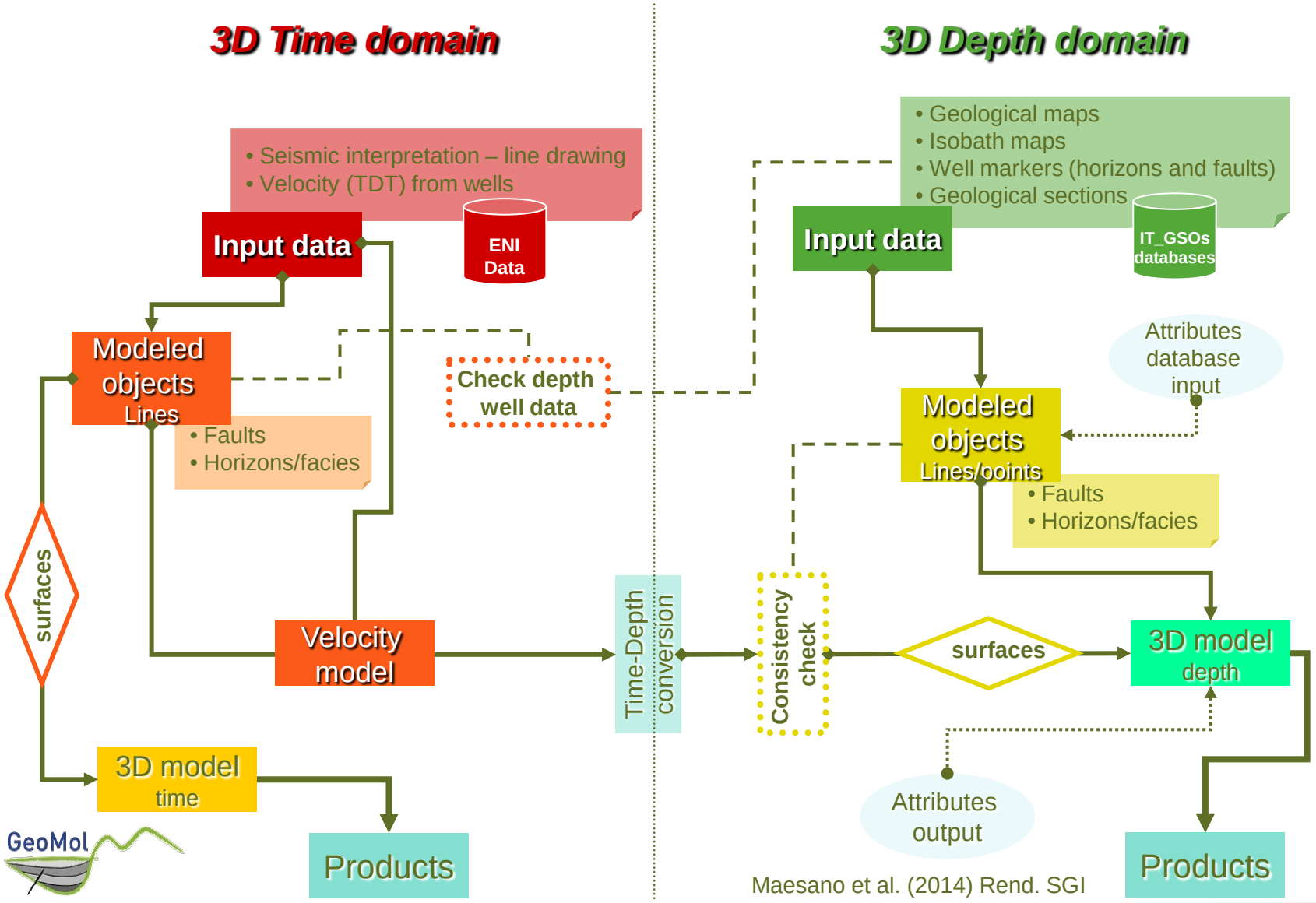
WORKFLOW



Maesano et al. (2014) Rend. SGI

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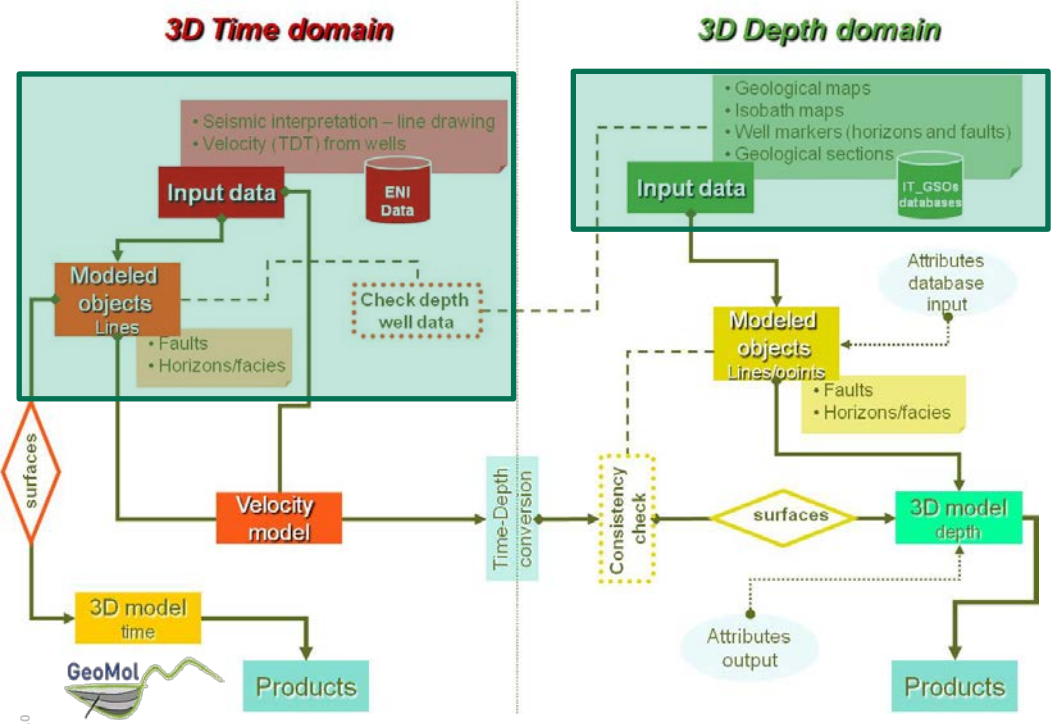
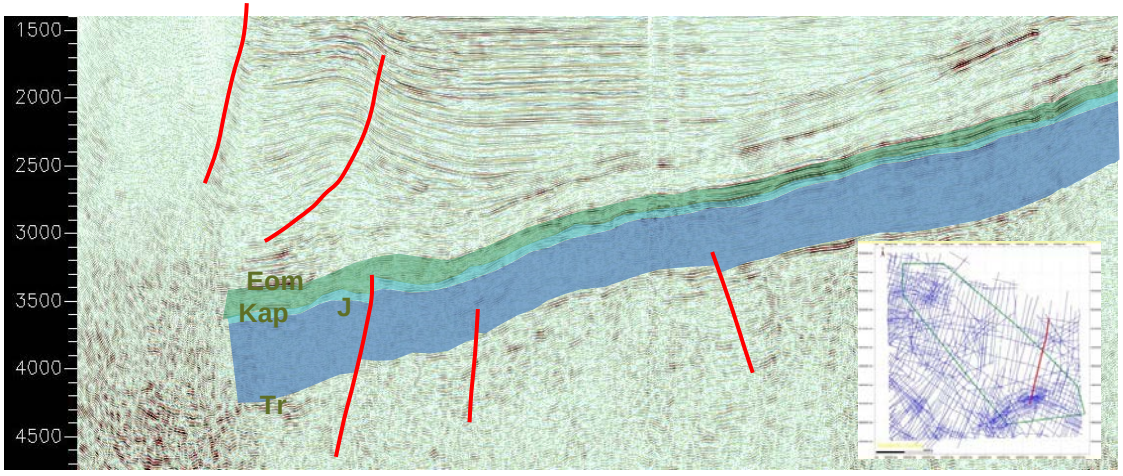
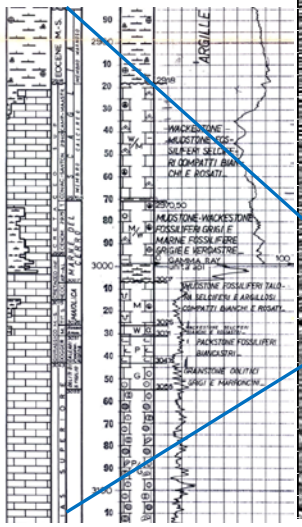
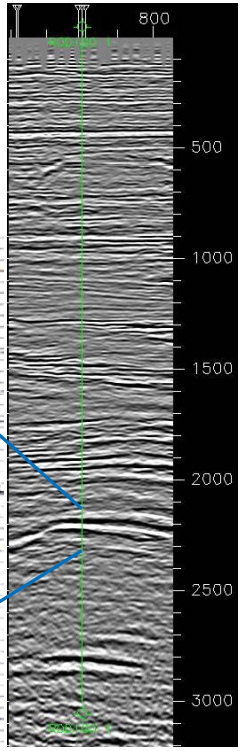


Type	N. records
Stratigraphic	559
Age	661
Unconformity and faults	89
Dip and azimuth	614
Biostratigraphic	419
Fluids density	707
Mineralization	2910
Permeability	7
Porosity	18
Salinity	15
Temperature	57
Velocity	1926







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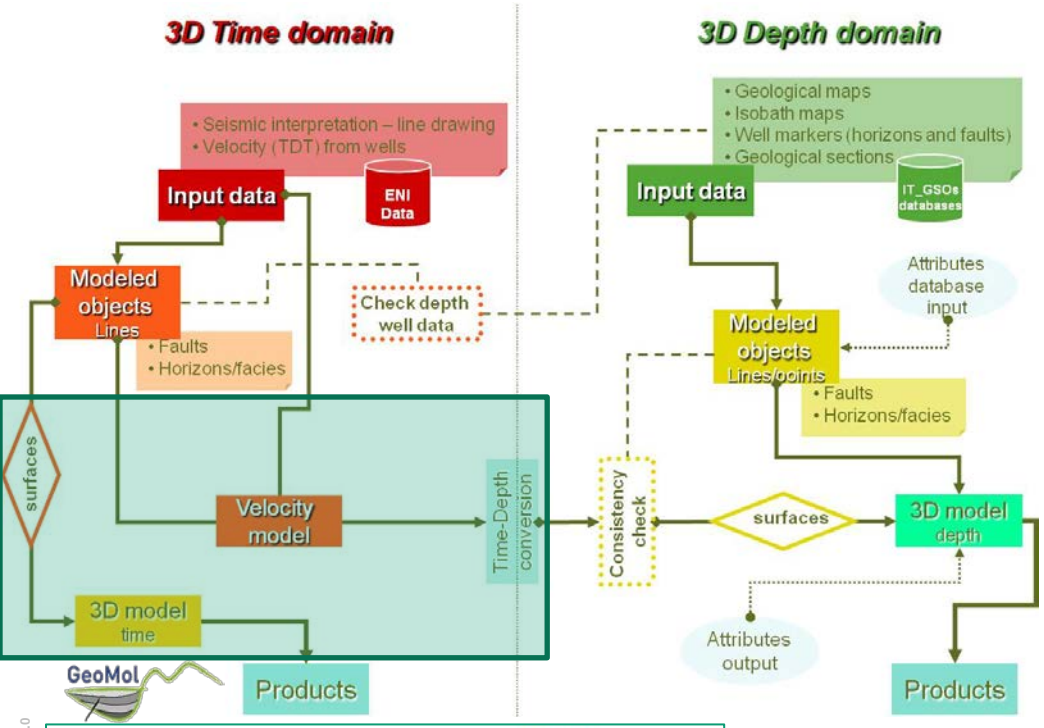
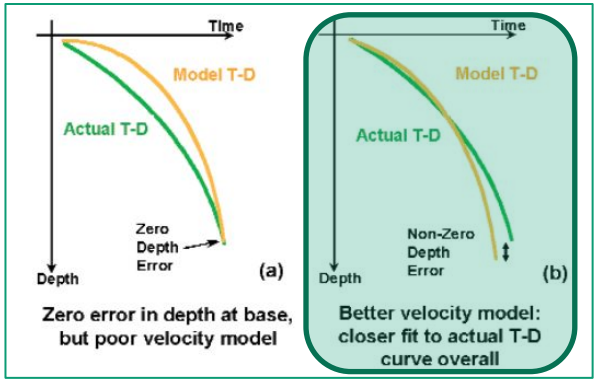
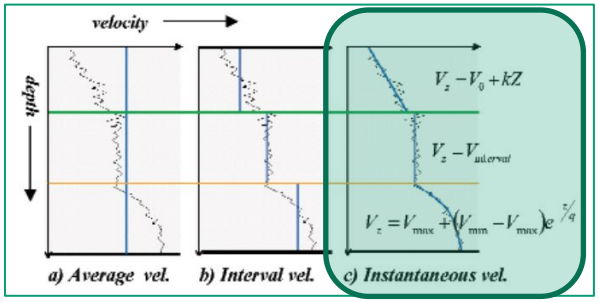
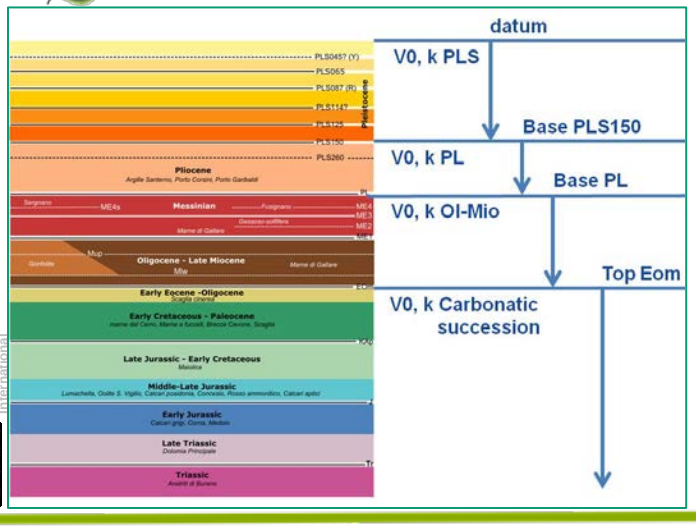




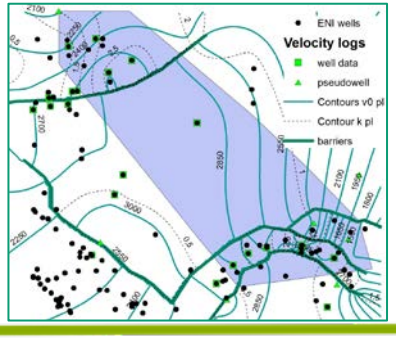
Etris et al. (2001)

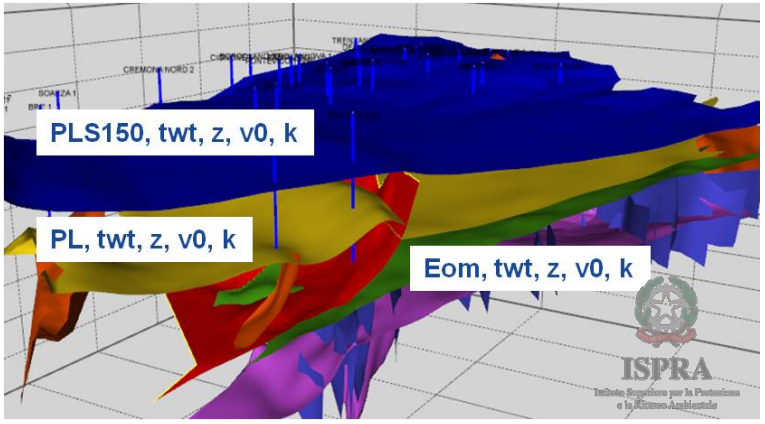




$$Z_n = Z_{n-1} + V_{0n}(e^{k_n \Delta t} - 1)/k_n$$

Marsden 1992





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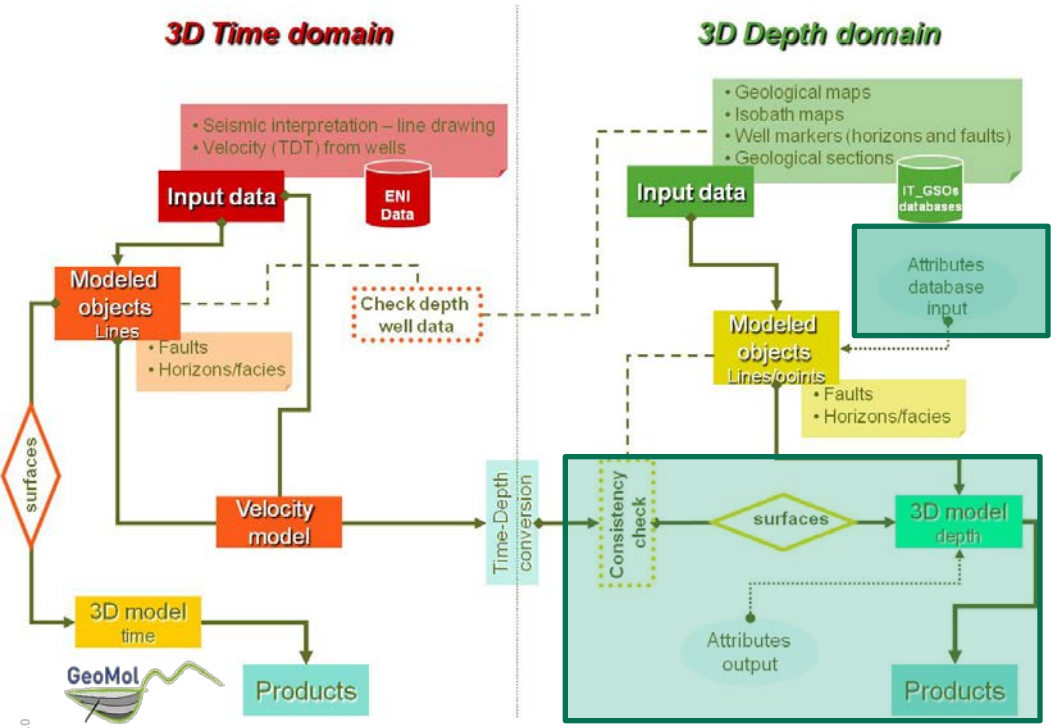
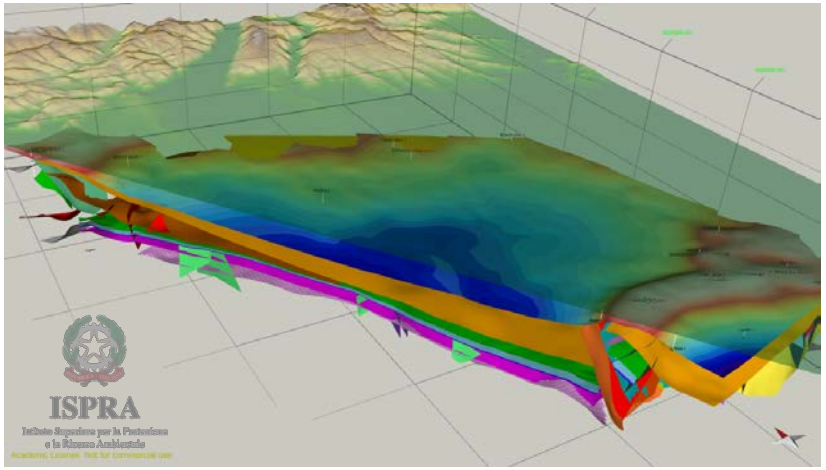


ATTRIBUTES INPUT

TEMPERATURE

BIGNARDI 1 DIR	3145	3145	82,2
BIGNARDI 1 DIR	3479	3479	78,3
BIGNARDI 1	755	755	59,7
BIGNARDI 1	3129	3129	76,6
BIGNARDI 1	3338	3338	75,4
BOSCO ROSSO 1	2047,9	2048,7	46
BOSCO ROSSO 1	3394	3408	68
BOSCO ROSSO 1	5414,9	5430,9	100
BOVOLONE 1	305,4	305,4	30
BOVOLONE 1	1502,4	1502,4	41
BOVOLONE 1	1501,9	1501,9	41
BOVOLONE 1	1893,9	1893,9	32
CAMPAZZO 1	2180	2180	56,5
CANTONI 1	2018,9	2018,9	49,5
CANTONI 1	2011	2011	60
CANTONI 1	3402,9	3402,9	67
CANTONI 1	3402,9	3402,9	70
CANTONI 1	4771	4771	86
CANTONI 1	4766	4766	88



3D MODEL ATTRIBUTES OUTPUT

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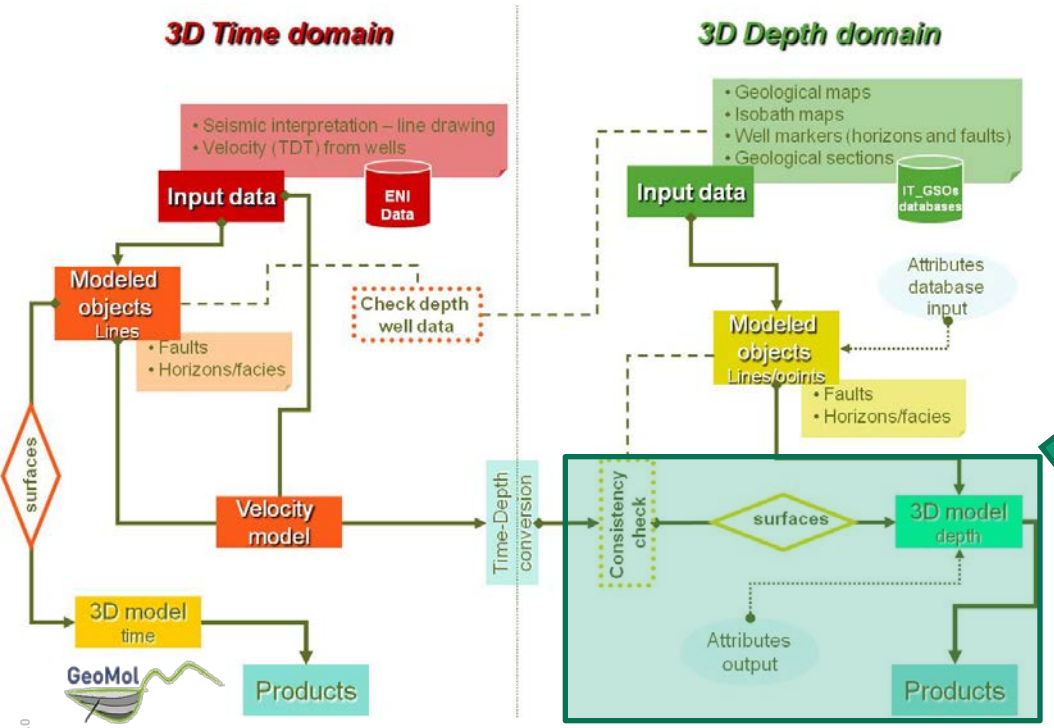
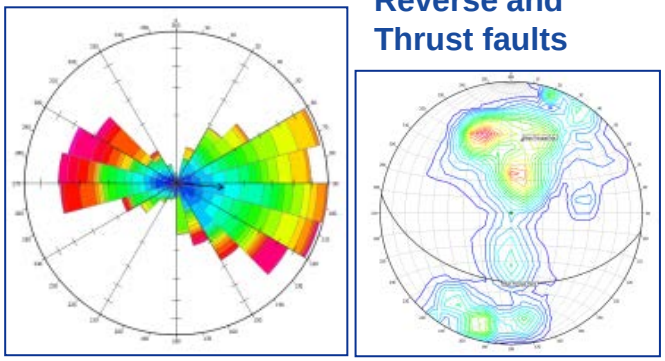
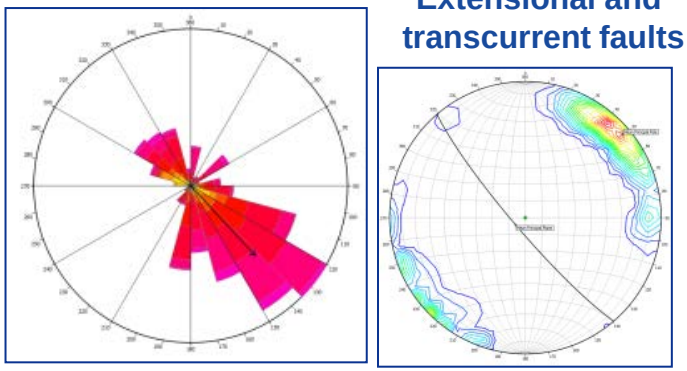


3D MODEL

Reverse and Thrust faults



Extensional and transcurrent faults



3D STRUCTURAL ANALYSIS

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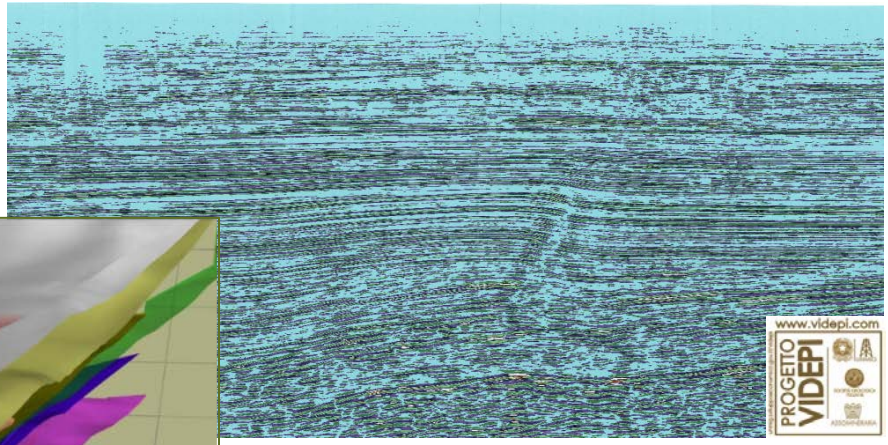
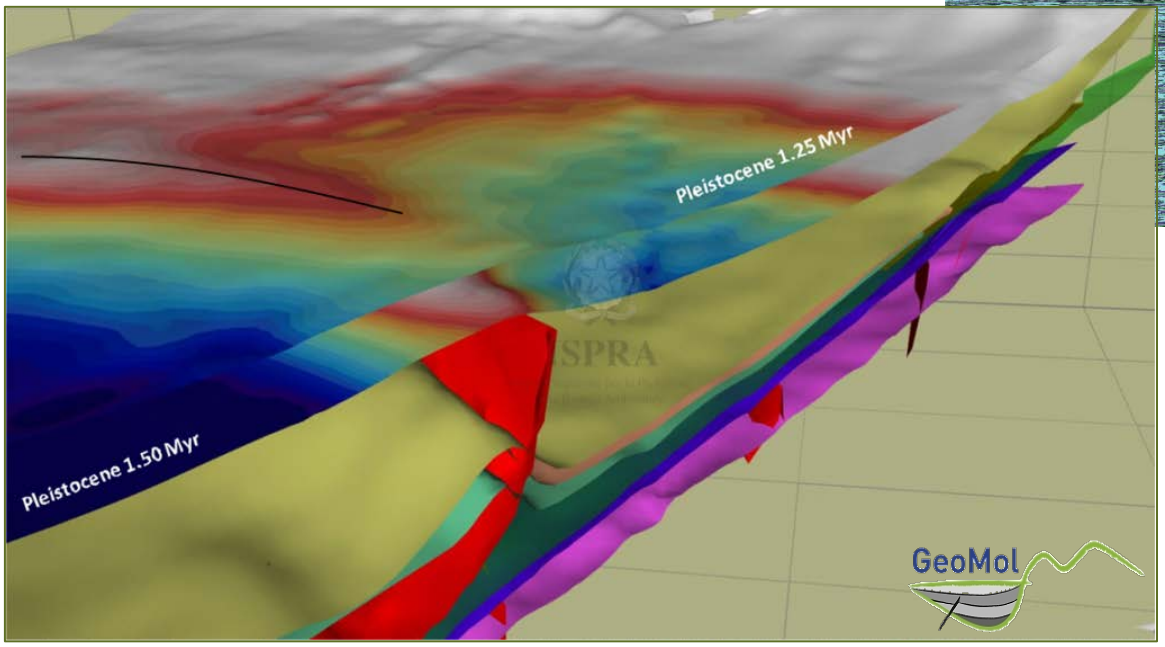
Criteria for the identification of active faults:

-Orientation compatible with present day field stress

-Dislocation or deformation of horizons younger than 1.6 Myr

-Evidence of growth strata





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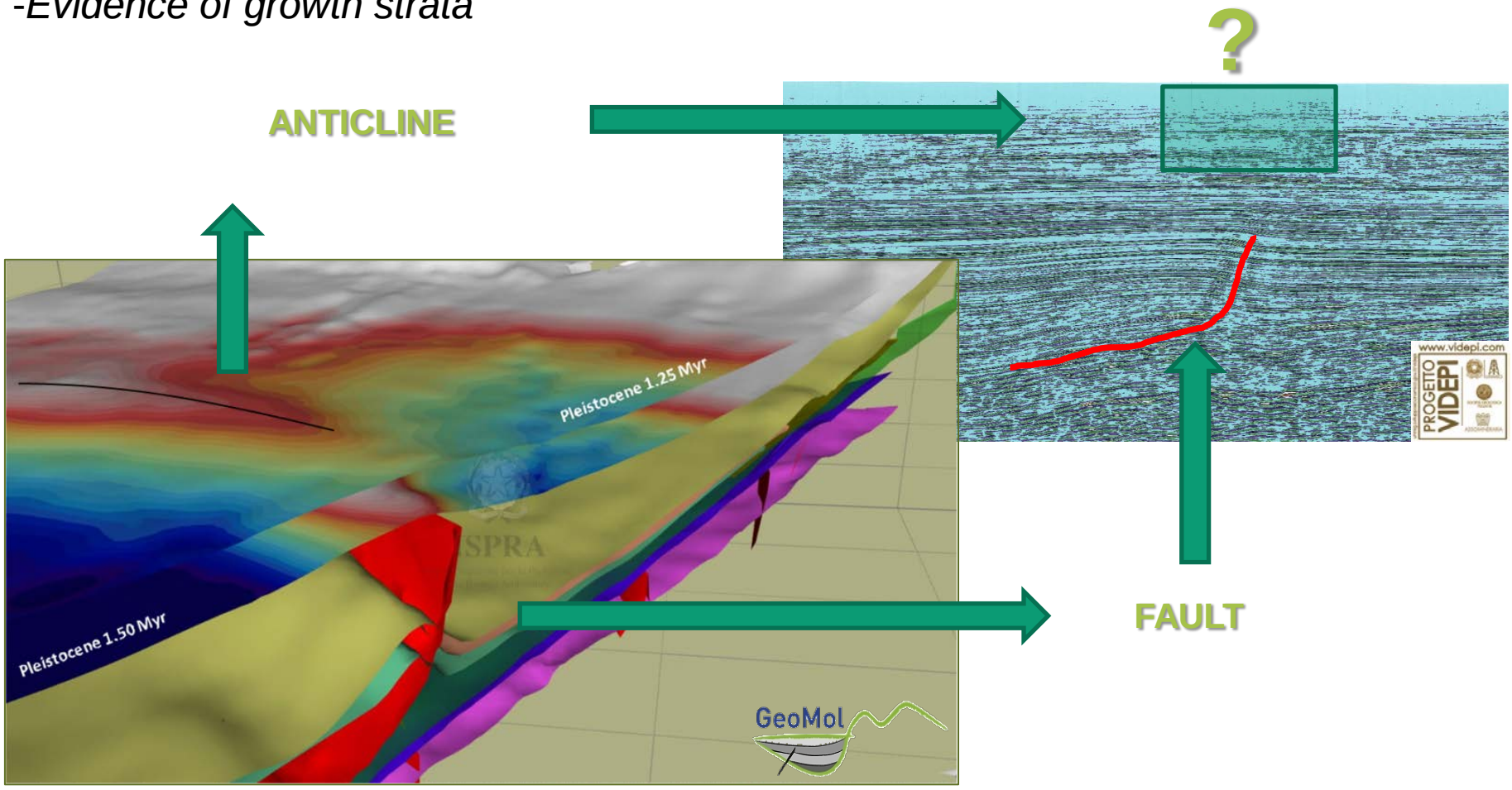

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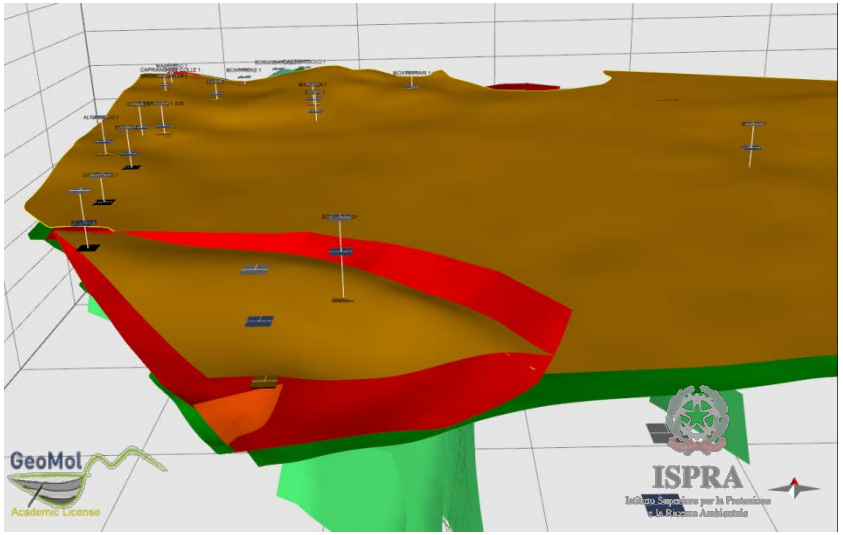
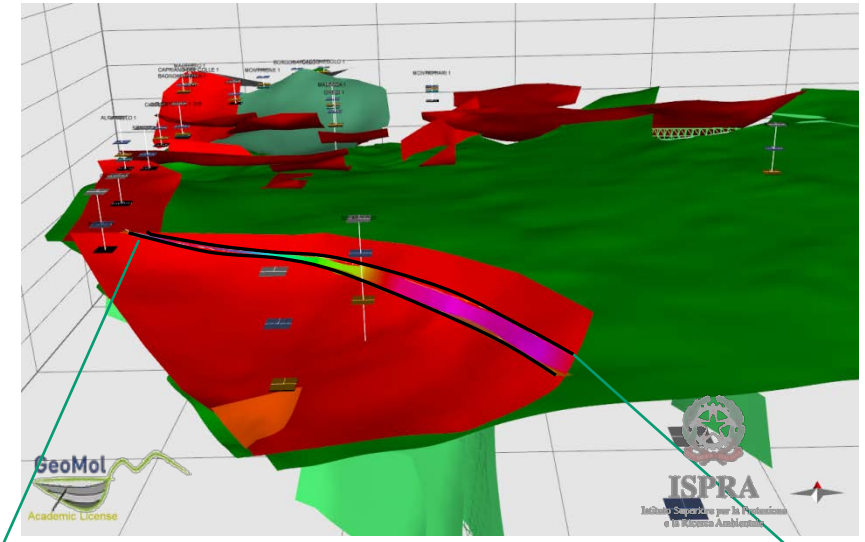
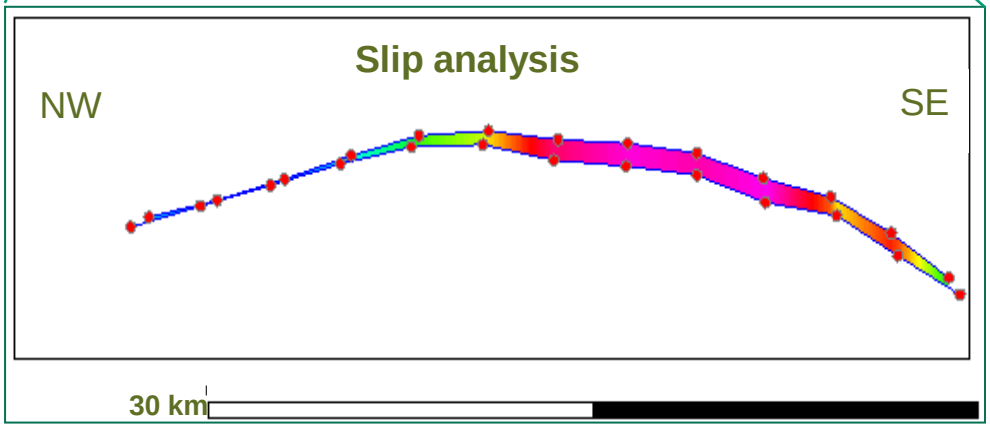




3D DISPLACEMENT

3D SLIP RATE



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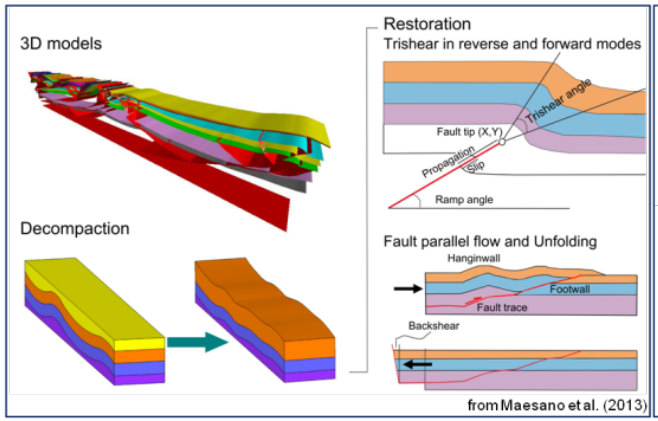
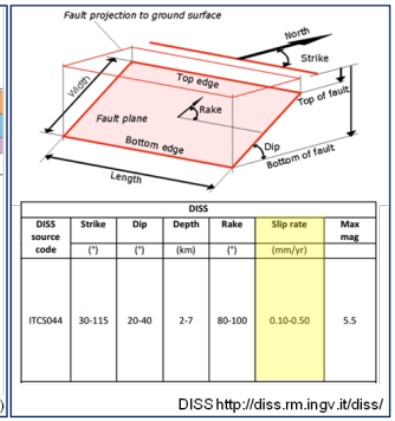
Restoration and slip rate calculation





DISS

DISS source code	Strike (°)	Dip (°)	Depth (km)	Rake (°)	Slip rate (mm/yr)	Max mag
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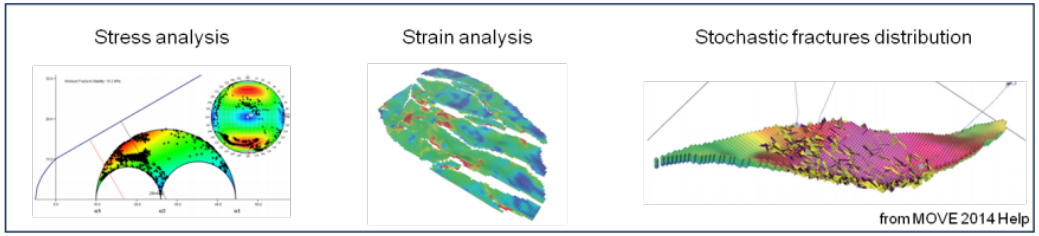
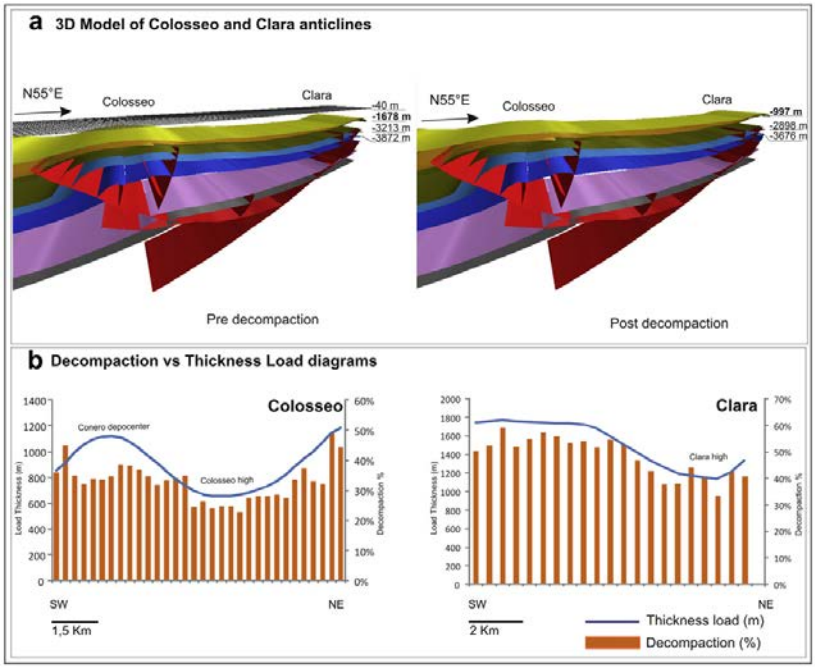
DISS http://diss.rm.ingv.it/diss/

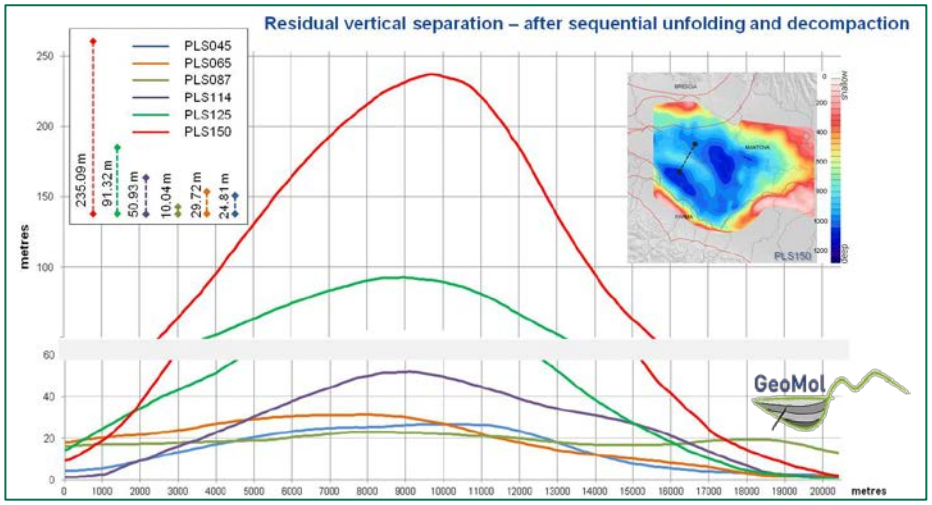
3D kinematic and mechanical analyses





D'Ambrogi & the Italian Geomol team, 2014

Maesano et al., 2013



3D DECOMPACTION

SYN TECTONIC SIGNAL VS SEDIMENTATION

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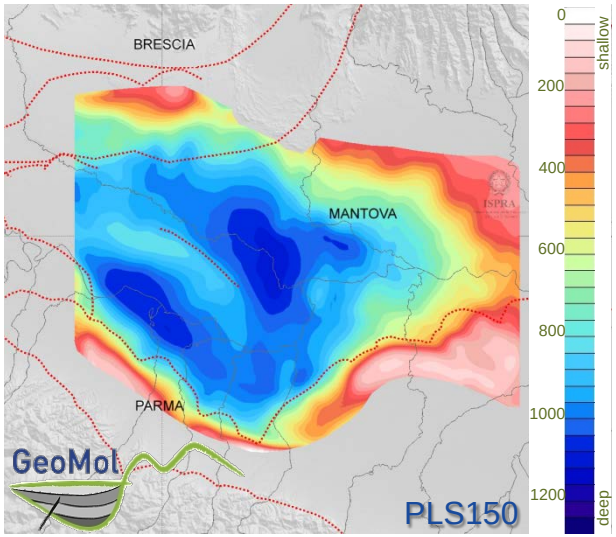
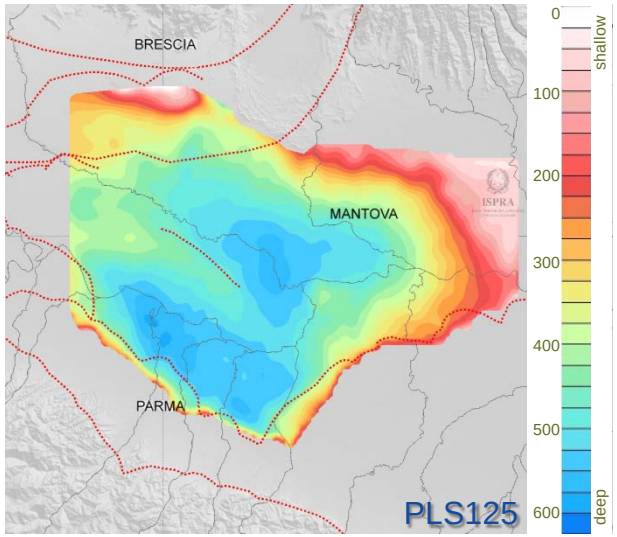
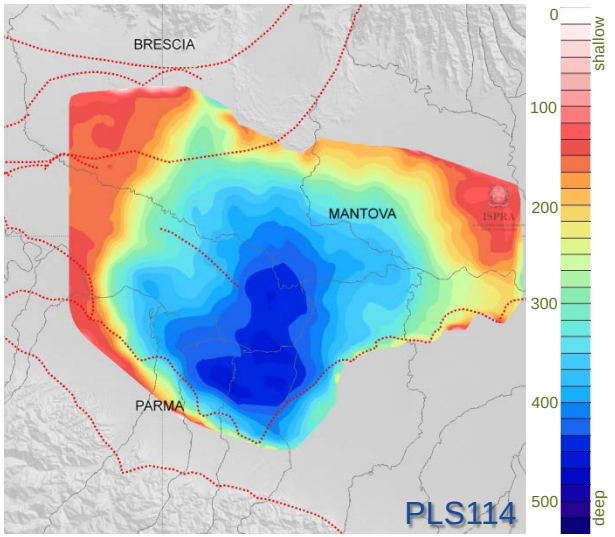
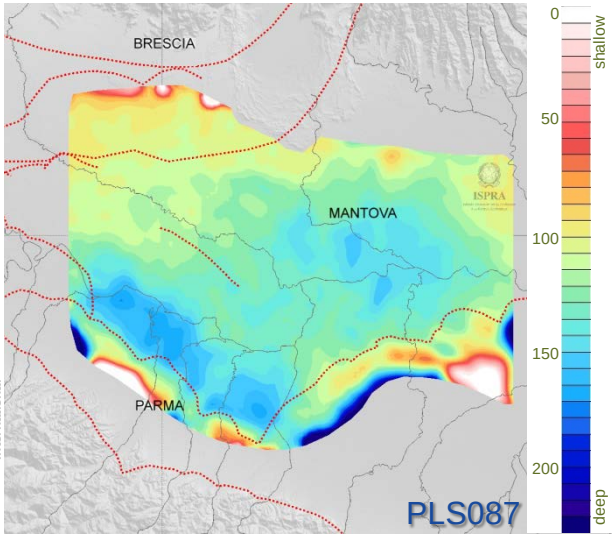
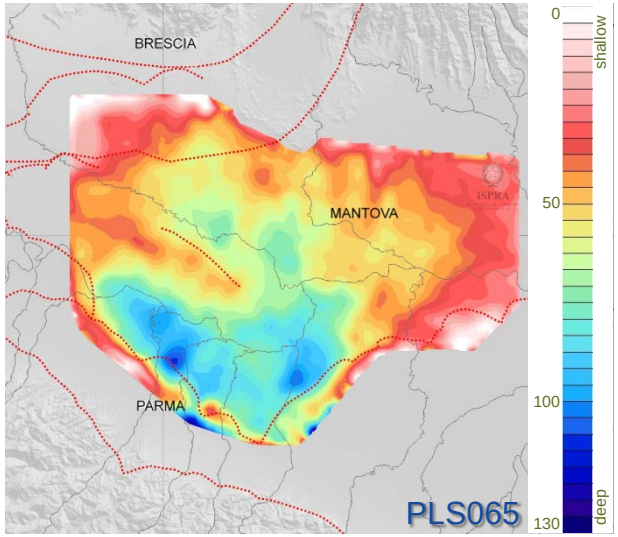
TOPOGRAPHY (AFTER UNFOLDING AND DECOMPACTION)

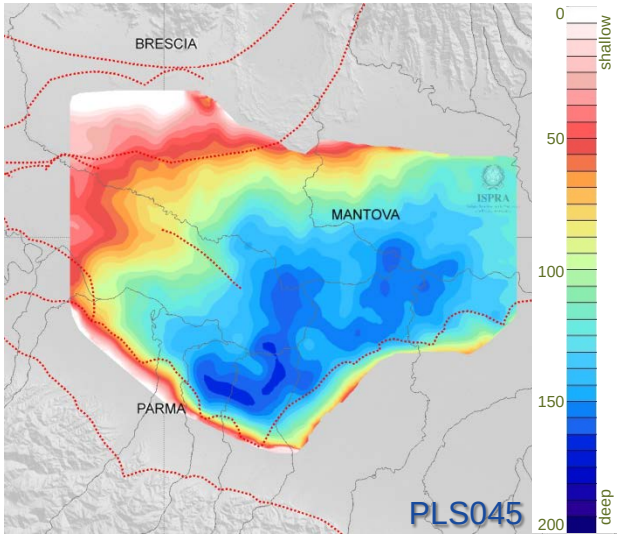












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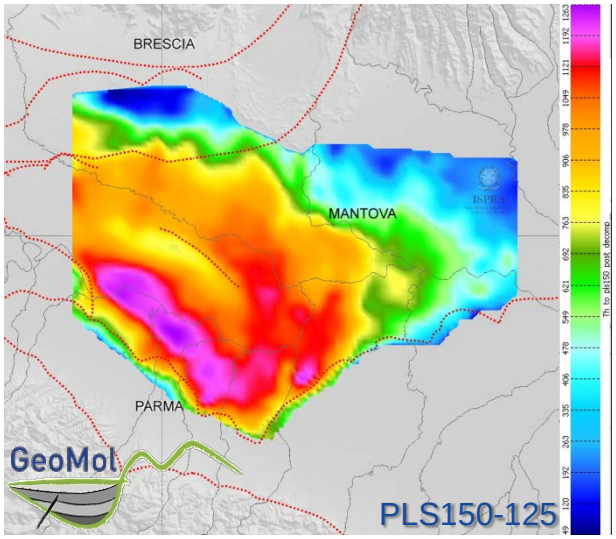
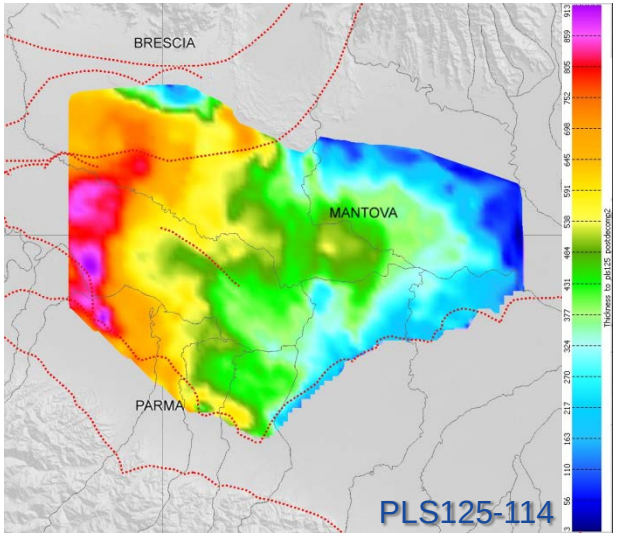
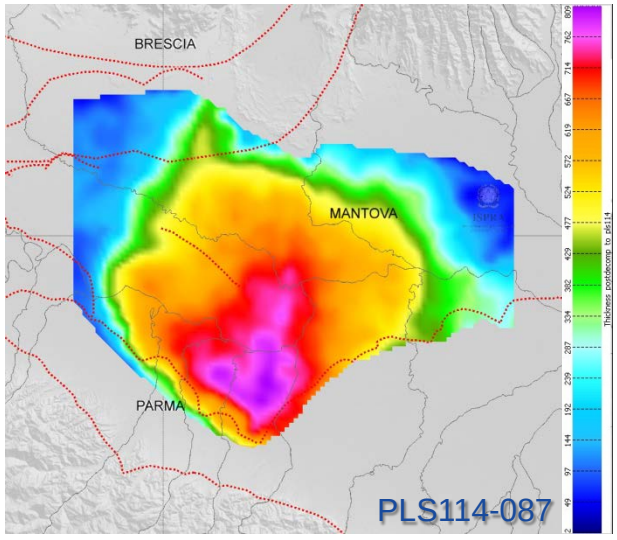
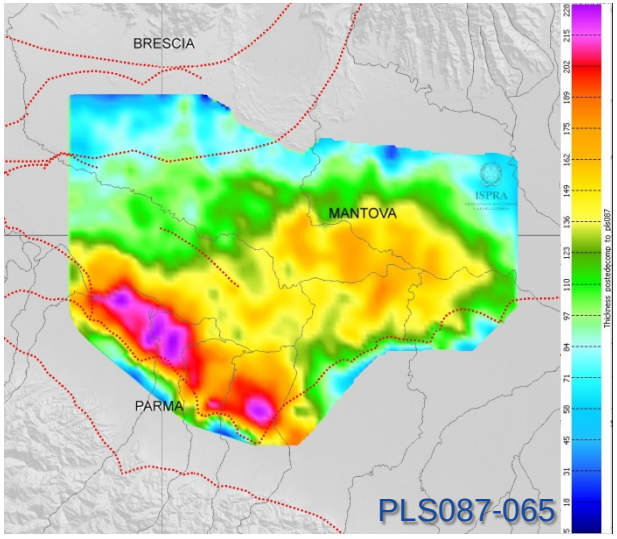
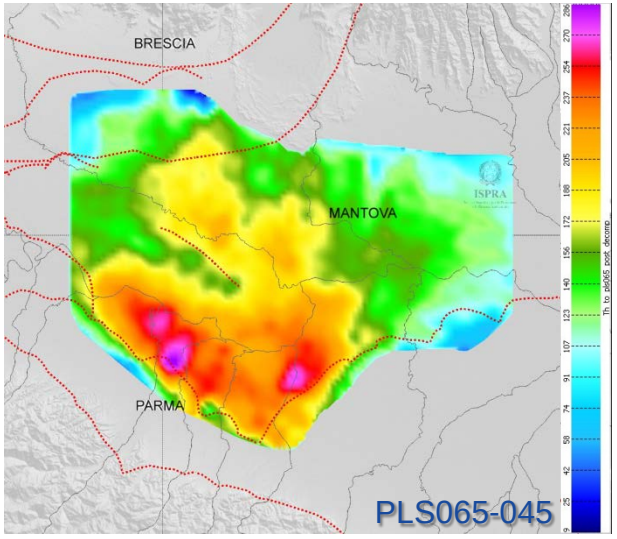
THICKNESS (AFTER DECOMPACTION AND UNFOLDING)

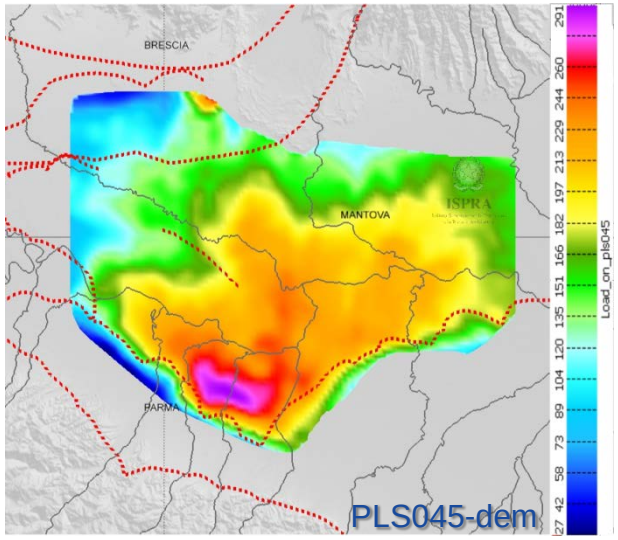












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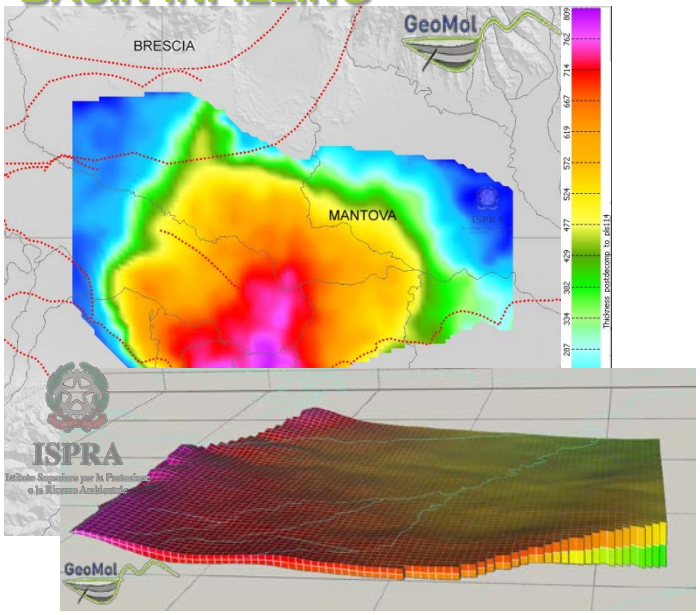
CONCLUSIONS

3D models are the starting points for specific analyses and applications:

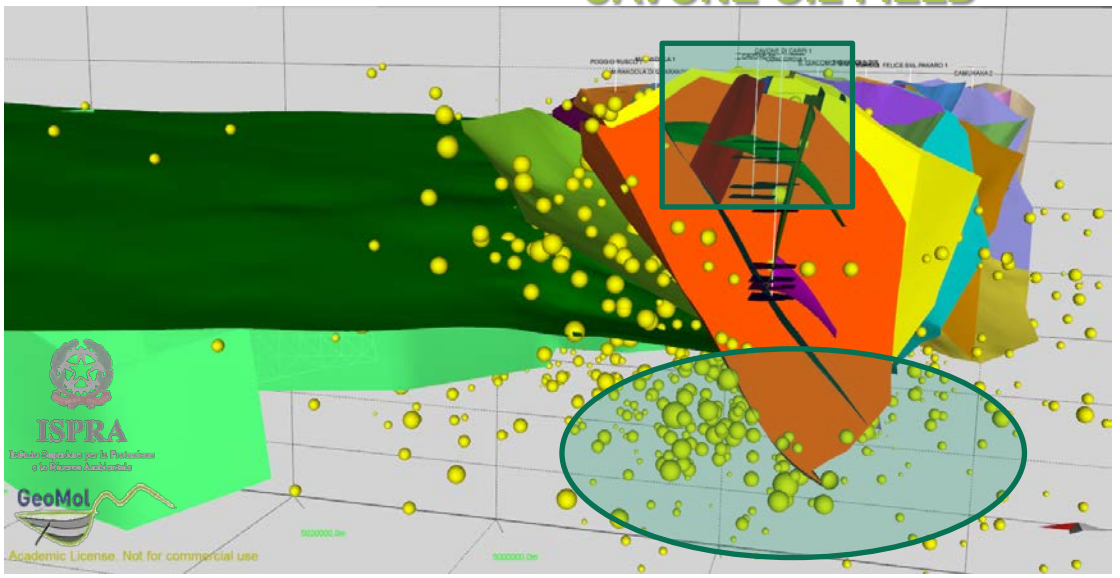
- *structural history of sedimentary basins;*
- *thickness maps and volume calculation for key stratigraphic horizons.*
- *move on fault restoration and decompaction for calculation of long term slip rates;*
- *identification of data inconsistency and support to the model validation;*

BASIN INFILLING



INFILLING VOLUMES

CAVONE OIL FIELD



MAY 2012 SEISMIC SEQUENCE

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THANK YOU

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