

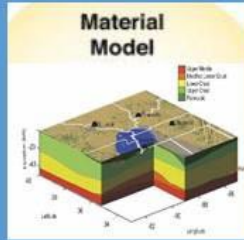
Shallow Geological Models: **Aterno Valley (Target Area #2)** **Fucino Basin (Target Area #3)**

Pierfrancesco Burrato & Paola Vannoli
WP1.3 Geological and seismotectonic input data



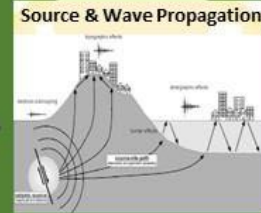
Enhancements of Existing Crustal Velocity Models and Seismic Datasets

- *Crustal Velocity Models*
- *Strong motion and macroseismic dataset*
- Geological and seismotectonic input data



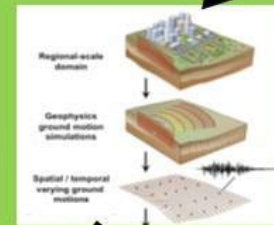
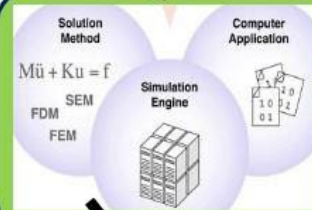
Characterization of Earthquake Source and Seismic Wave Propagation in the Central Apennines

- *Kinematic and Dynamic Earthquake Rupture Modeling*
- *Seismic Wave Attenuation Models*

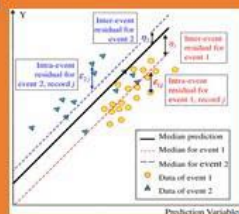


Ground Motion Predictions using Innovative Approaches

- Empirical Non-Ergodic Approaches
- Physics-based Numerical/Stochastic/Hybrid Ground Motion Simulations



Testing the Performance of Ground Motion Models and Empirical Relationships



- Website
- Meetings
- Publications



Our goals within the SECURE Project:

1. To collect and homogenize available geological data for the three study areas for defining their crustal and shallow geological structures.
2. To prepare a dedicated georeferenced repository of geological, seismotectonic, and seismological information expressly devoted to applications in the SECURE Project.
3. To parameterize all available (i.e. proposed in the literature) seismogenic sources for the three study areas, for exploring the possible influence of their geometrical and kinematic variability on ground motion calculations (***DISS style***).

This WP will furnish input data for the **WP1.1** “Crustal Velocity Models” and **WP2.1** “Kinematic and Dynamic Earthquake Rupture Modeling”.

Study areas

Central Apennines paleogeographic and tectonic overview

Area 1

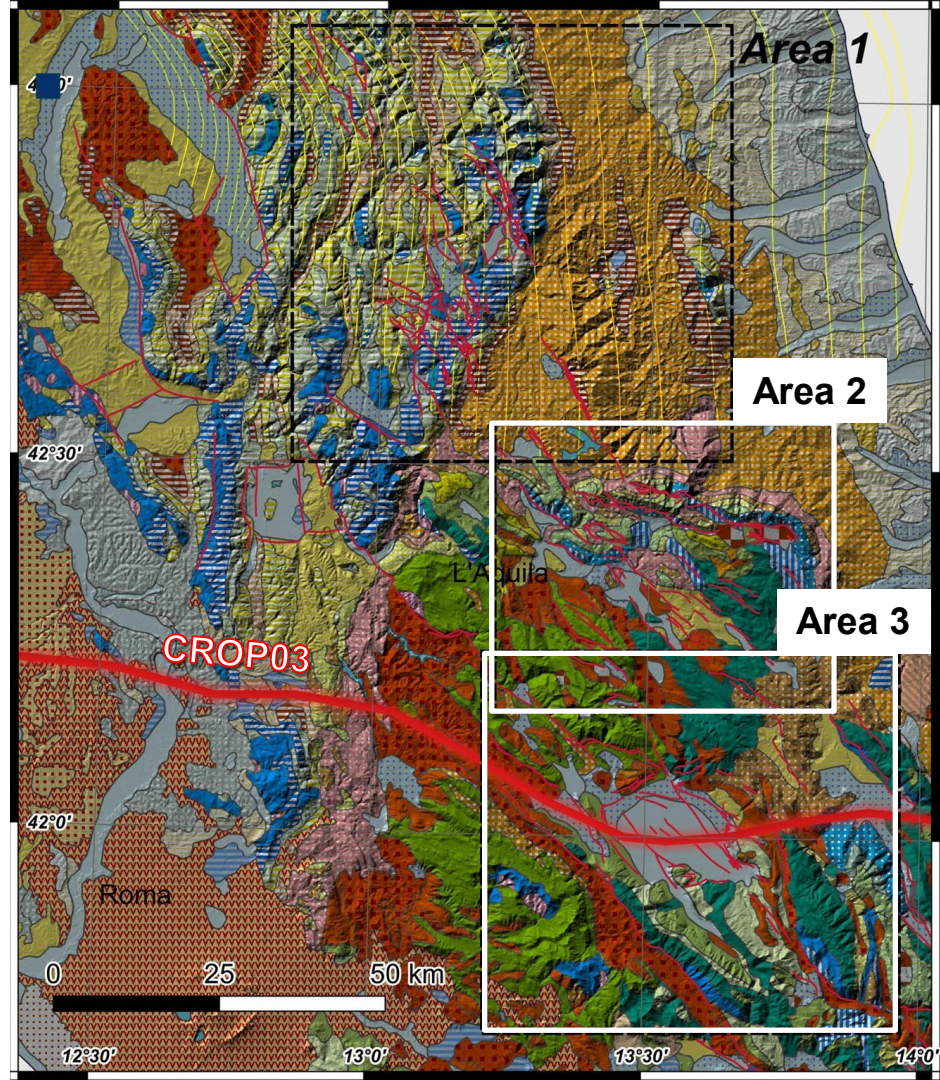
- W-dipping Adriatic monocline
- Sibillini thrust front/Olevano-Antrondoco lateral ramp
- Two W-dipping normal fault systems
- E-dipping low-angle Alto Tiberina Fault
- 5 large intermountain Q basins

Area 2

- E-W trending Gran Sasso thrust salient

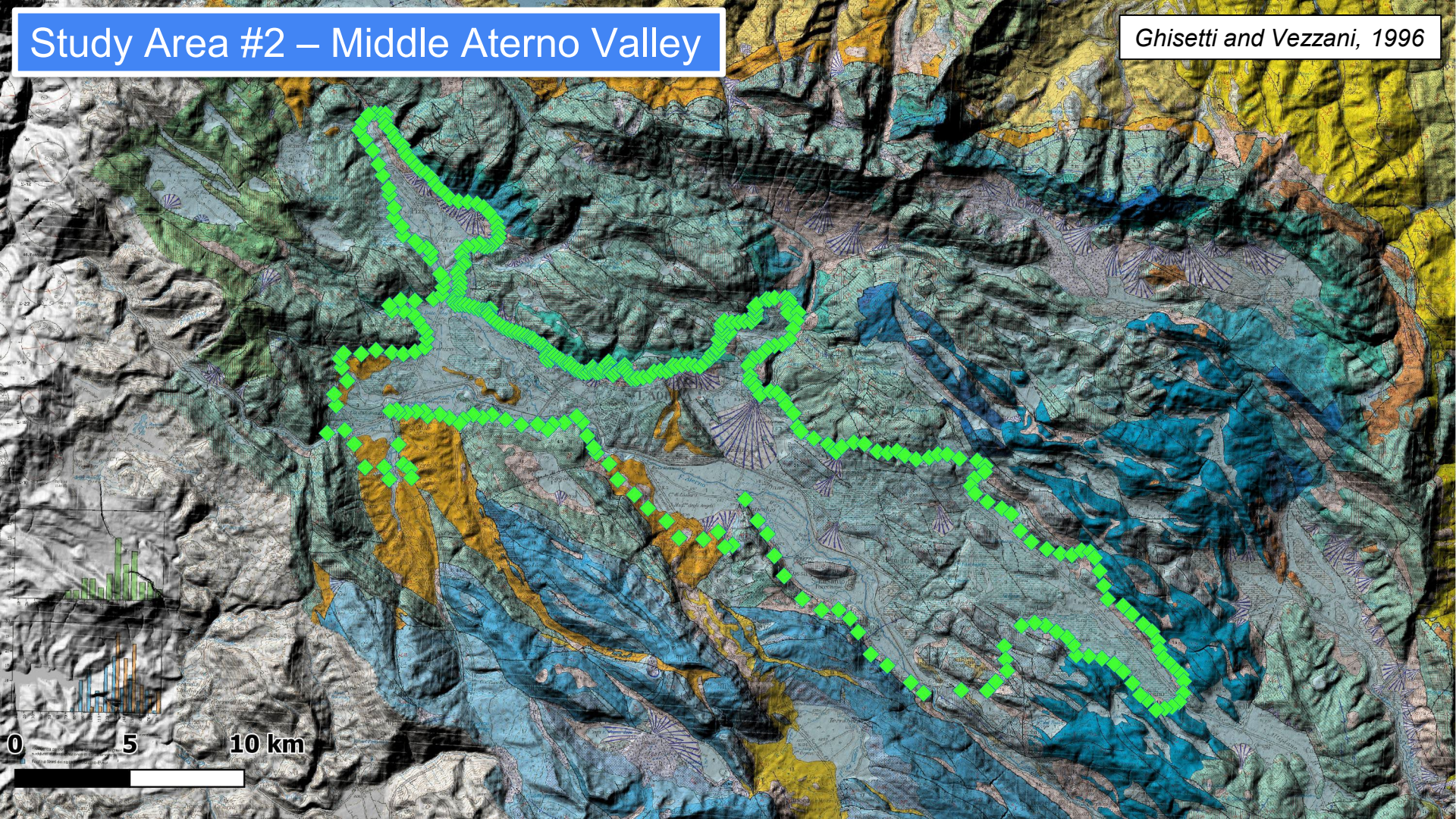
Area 3

- Fucino largest Apennines intermountain basin

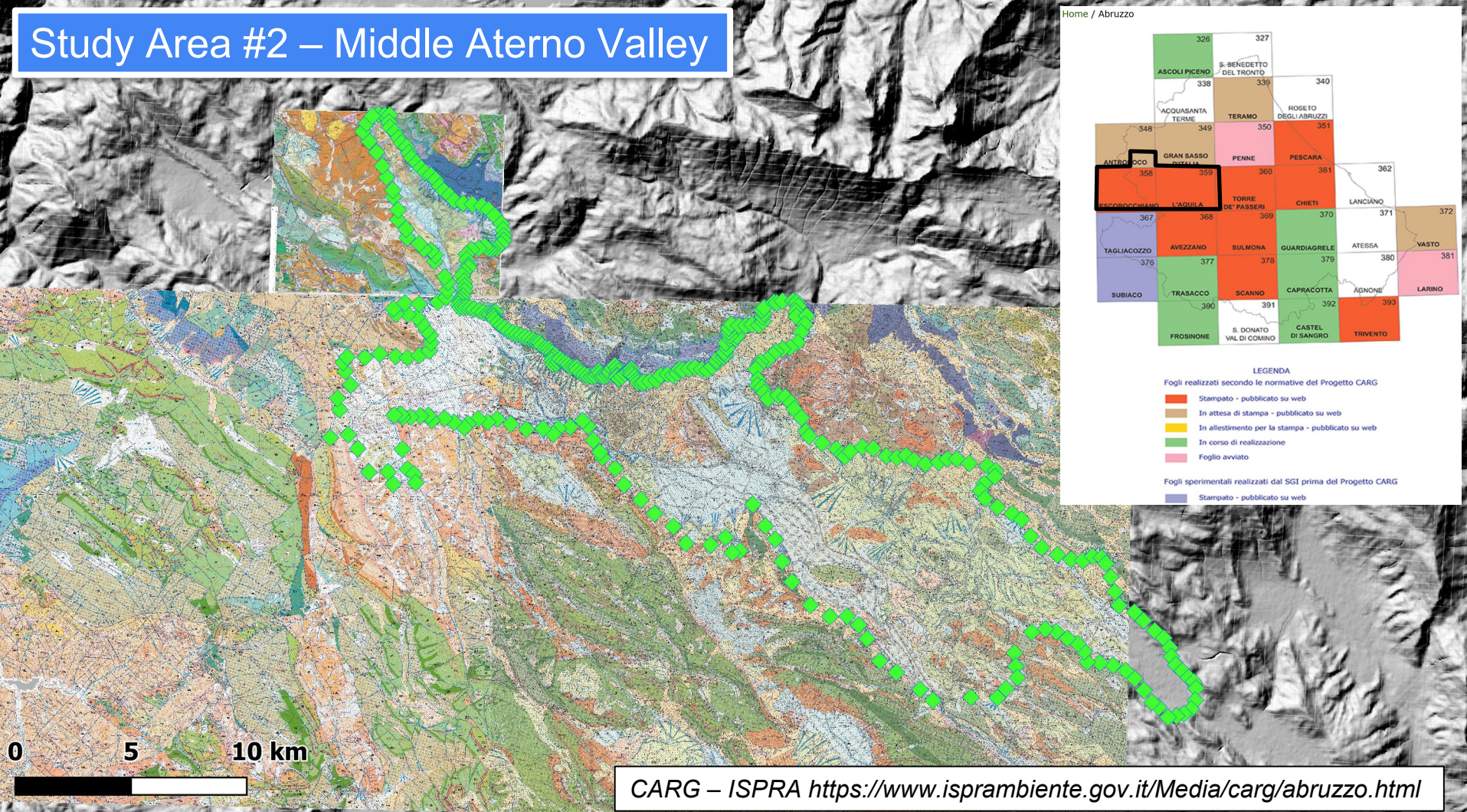


Study Area #2 – Middle Aterno Valley

Ghisetti and Vezzani, 1996



Study Area #2 – Middle Aterno Valley



Study Area #2 – Middle Aterno Valley

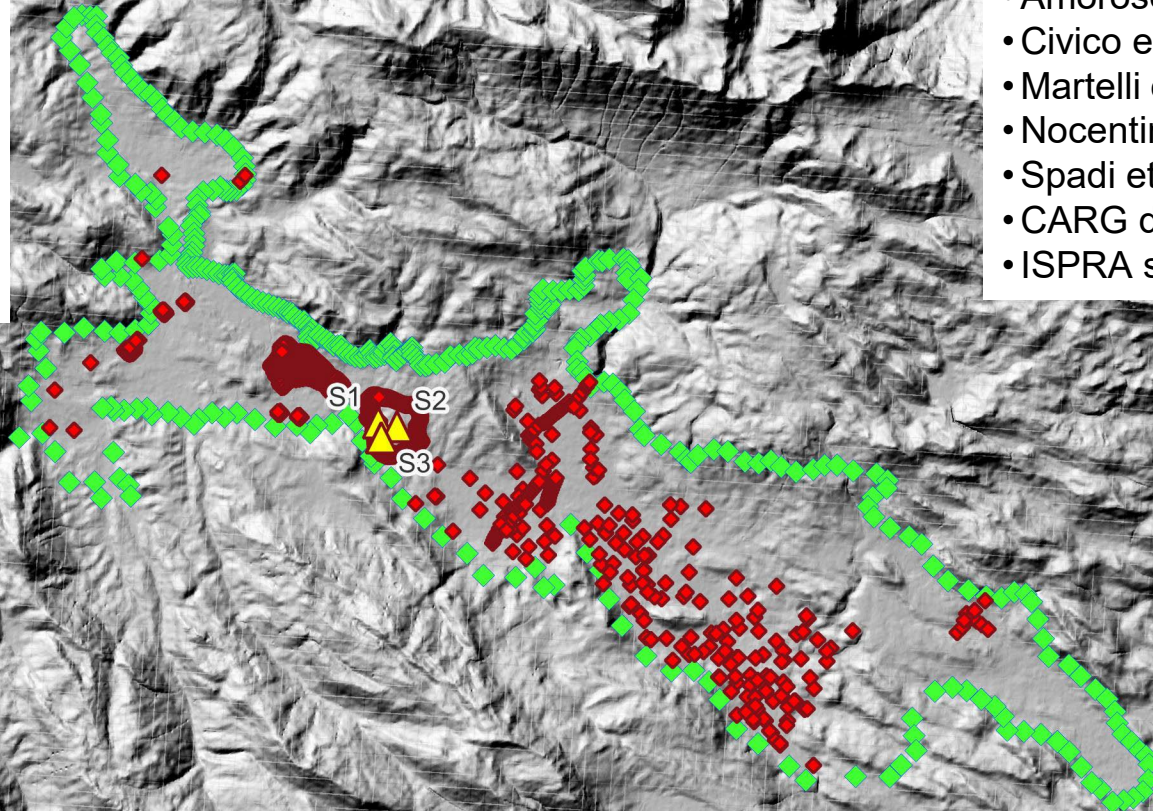
5386 data points

- borehole
- H/V
- geophysics
- MASW
- subsurface geology
- TDEM

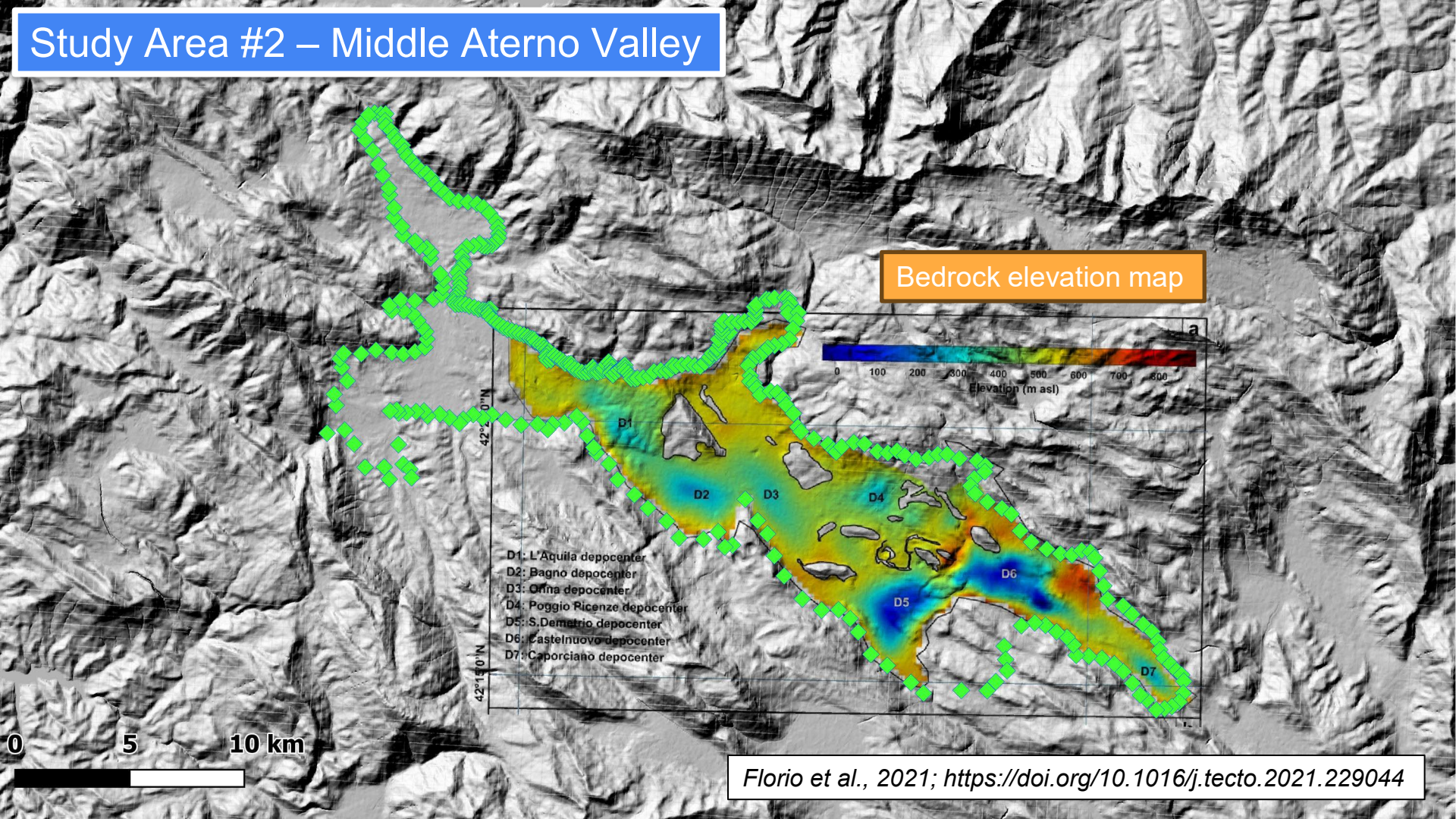
5386 data points

- Amoroso et al., 2010
- Civico et al., 2017
- Martelli et al., 2012
- Nocentini et al., 2017
- Spadi et al., 2022
- CARG database
- ISPRA shallow well data

0 5 10 km



Study Area #2 – Middle Aterno Valley



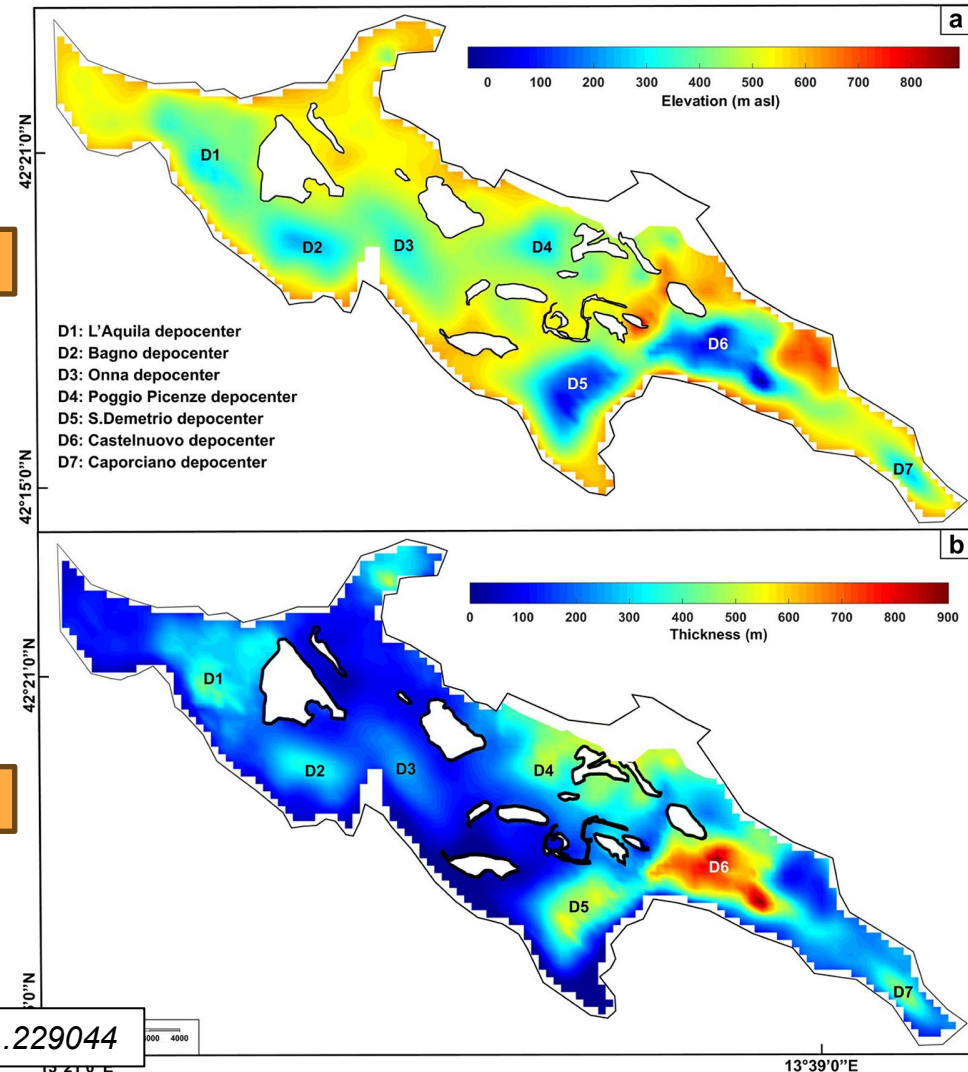
Study Area #2 – Middle Aterno Valley

Bedrock elevation map

Key observations

1. Numerous depocenters with variable thickness
2. «Islands» of outcropping bedrock
3. Bedrock morphology controlled by tectonics and karstic features

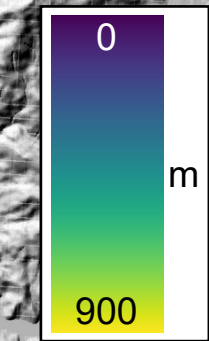
Sediment thickness map



Study Area #2 – Middle Aterno Valley

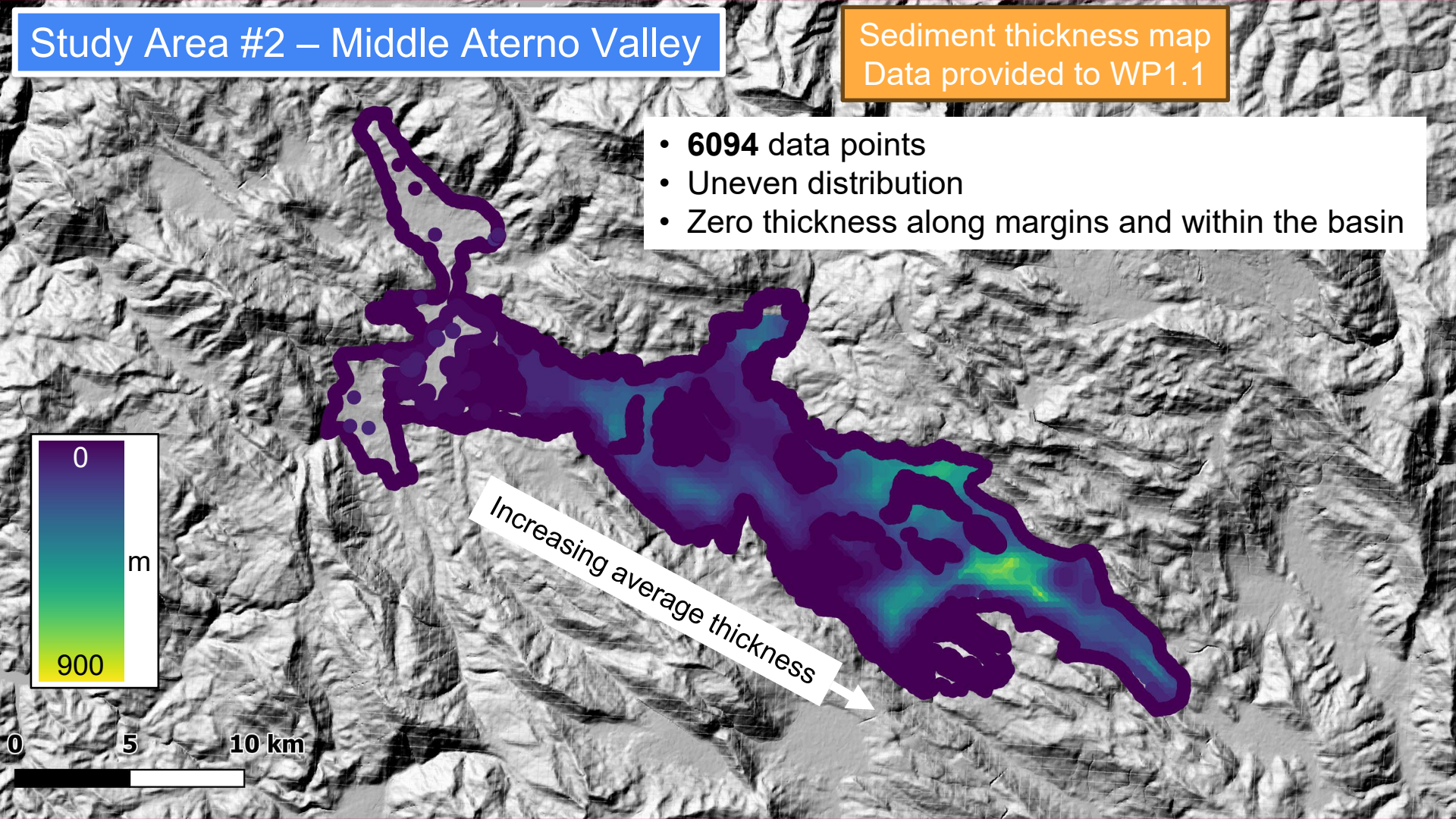
Sediment thickness map
Data provided to WP1.1

- **6094** data points
- Uneven distribution
- Zero thickness along margins and within the basin

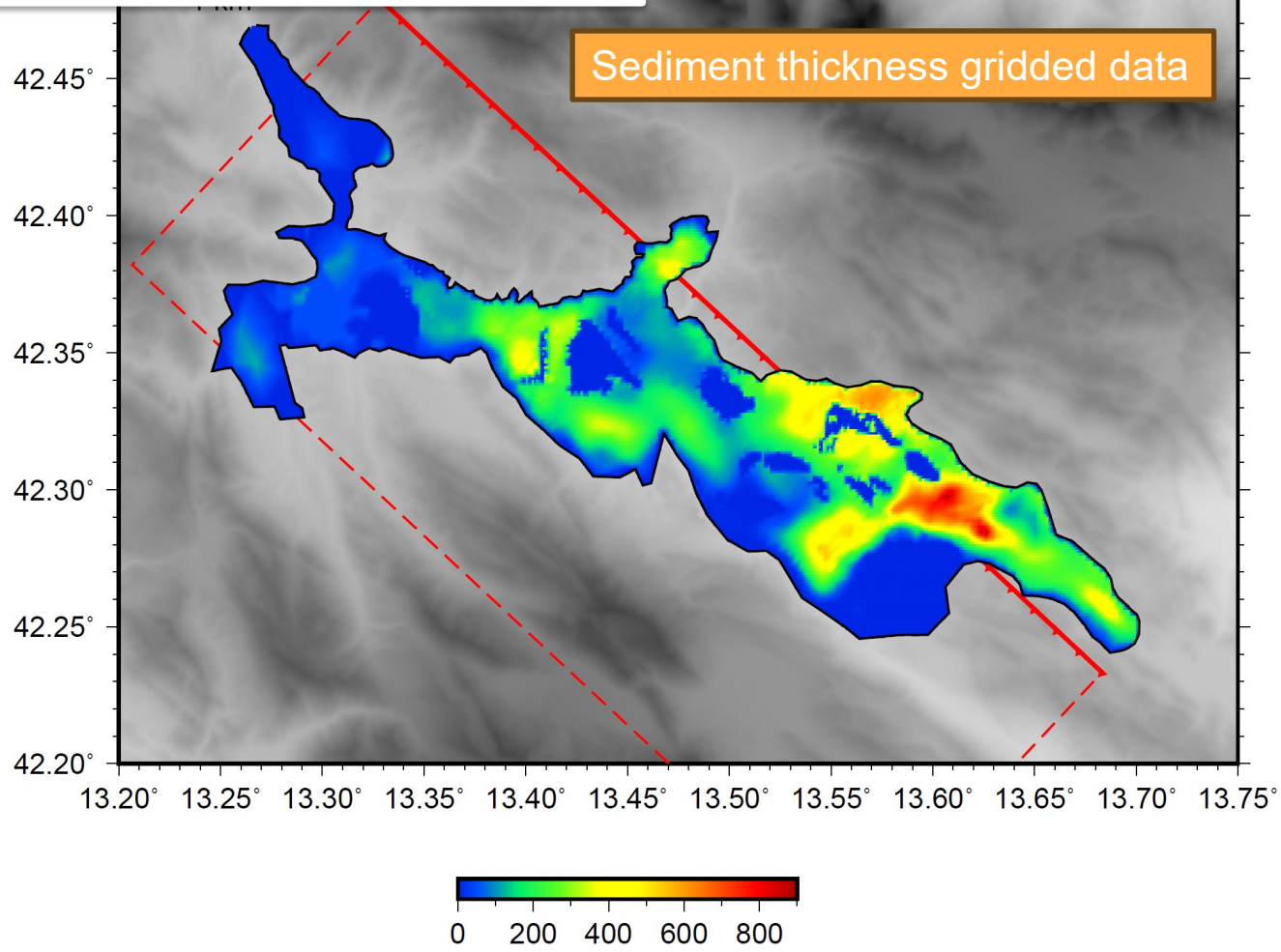


0 5 10 km

Increasing average thickness



Study Area #2 – Middle Aterno Valley



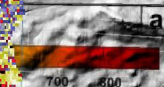
Montereale Basin
(ITIS015)

DISS v. 3.3.1

ASAR Envisat - IREA

Paganica
(ITIS131)

San Pio delle Camere
(ITIS132)



D7

5 10 km

Montereale Basin
(ITIS015)

Depocenters

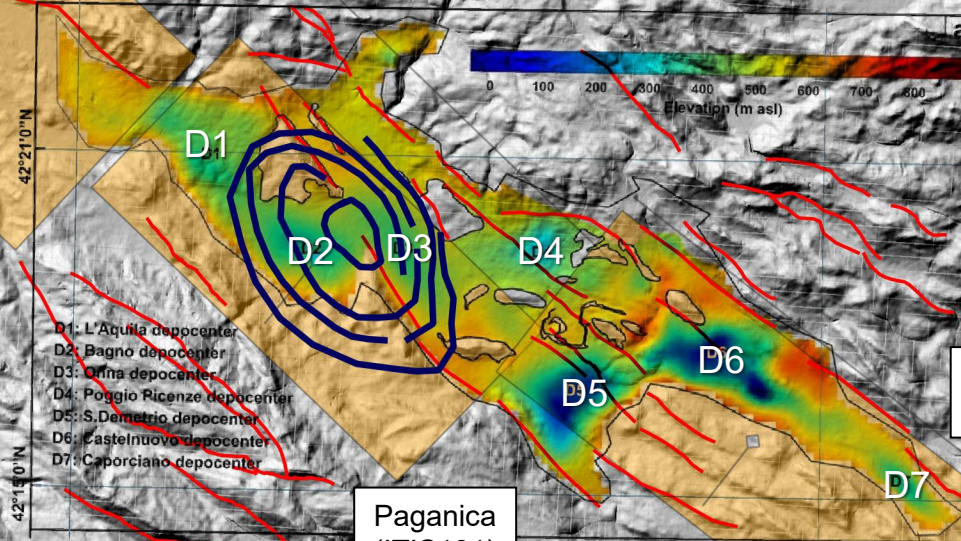
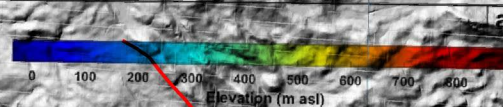
- D1: L'Aquila
- D2: Bagno
- D3: Onna
- D4: Poggio Picenze
- D5: S. Demetrio
- D6: Castelnuovo
- D7: Caporciano

D1: L'Aquila depocenter
D2: Bagno depocenter
D3: Onna depocenter
D4: Poggio Picenze depocenter
D5: S. Demetrio depocenter
D6: Castelnuovo depocenter
D7: Caporciano depocenter

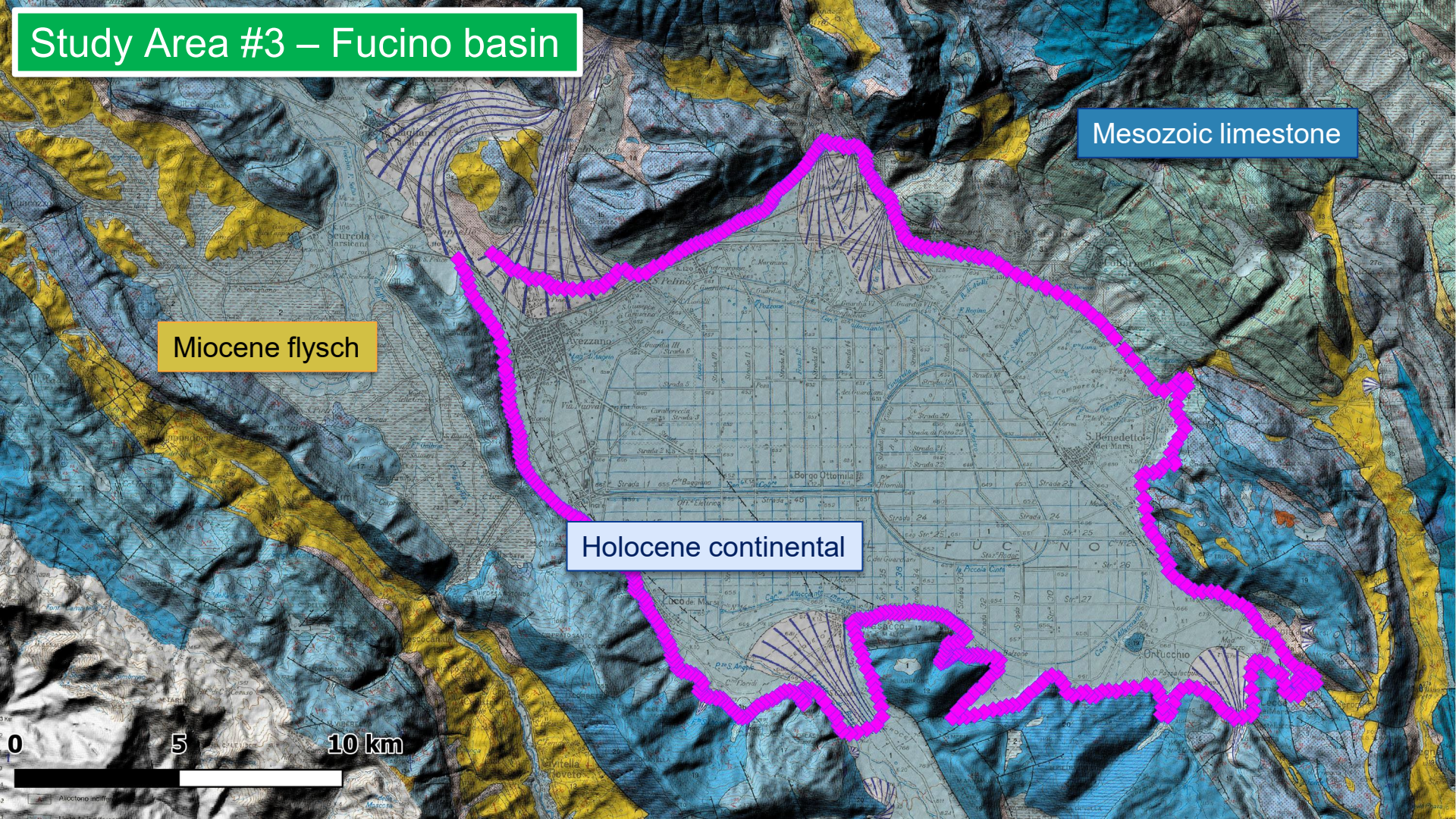
Paganica
(ITIS131)

San Pio delle Camere
(ITIS132)

0 5 10 km



Study Area #3 – Fucino basin



Mesozoic limestone

Miocene flysch

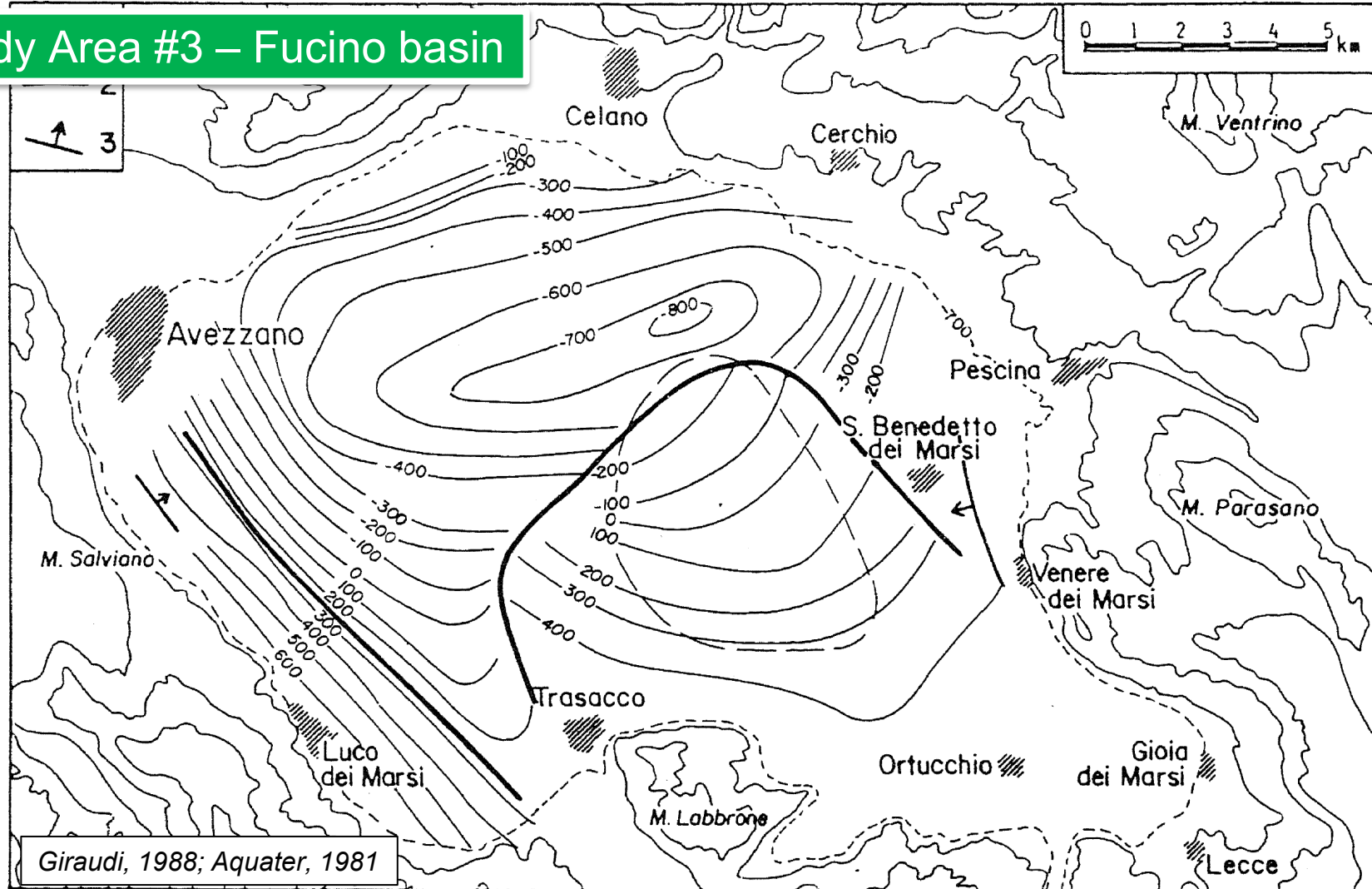
Holocene continental

0

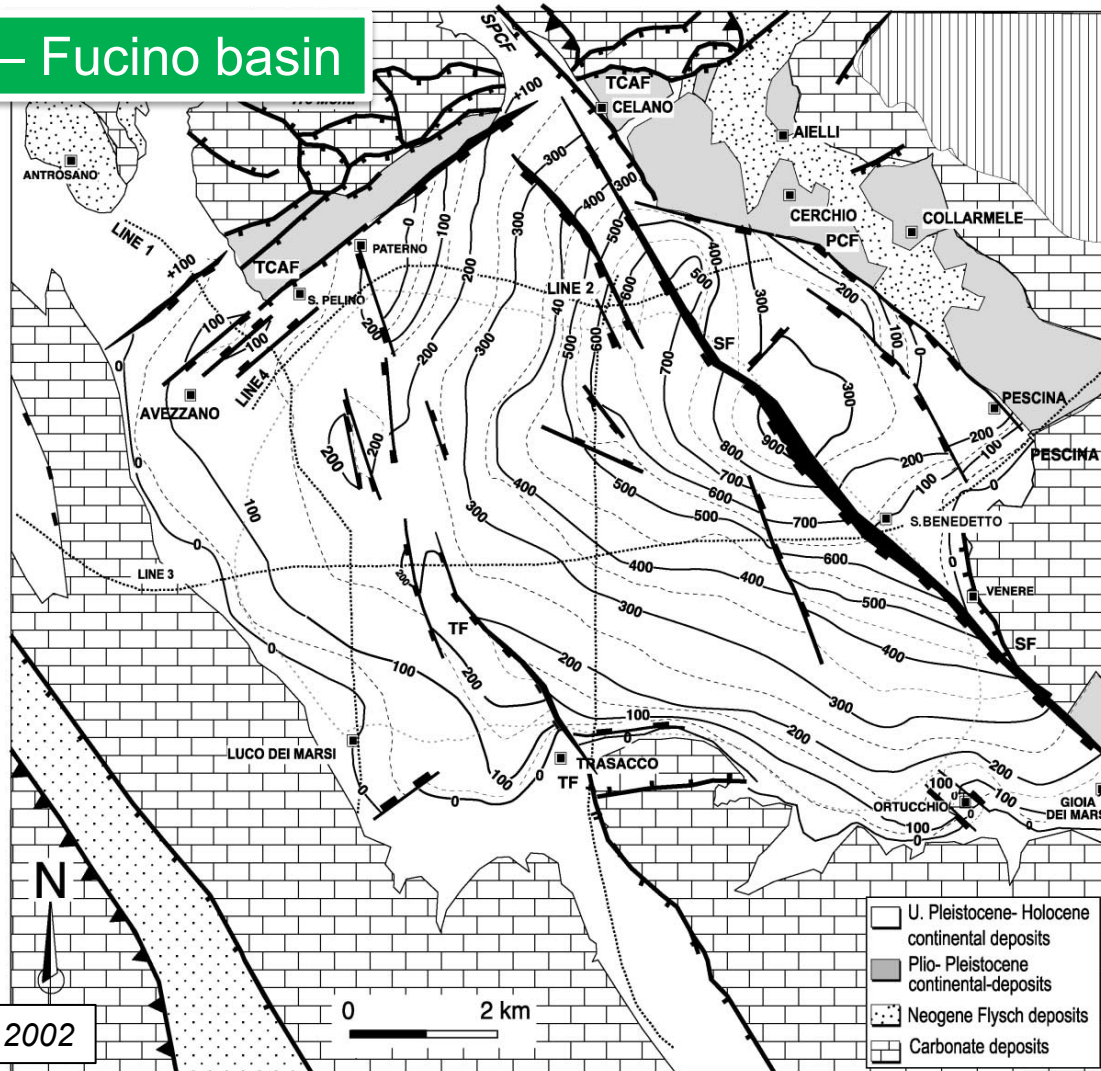
5

10 km

Study Area #3 – Fucino basin

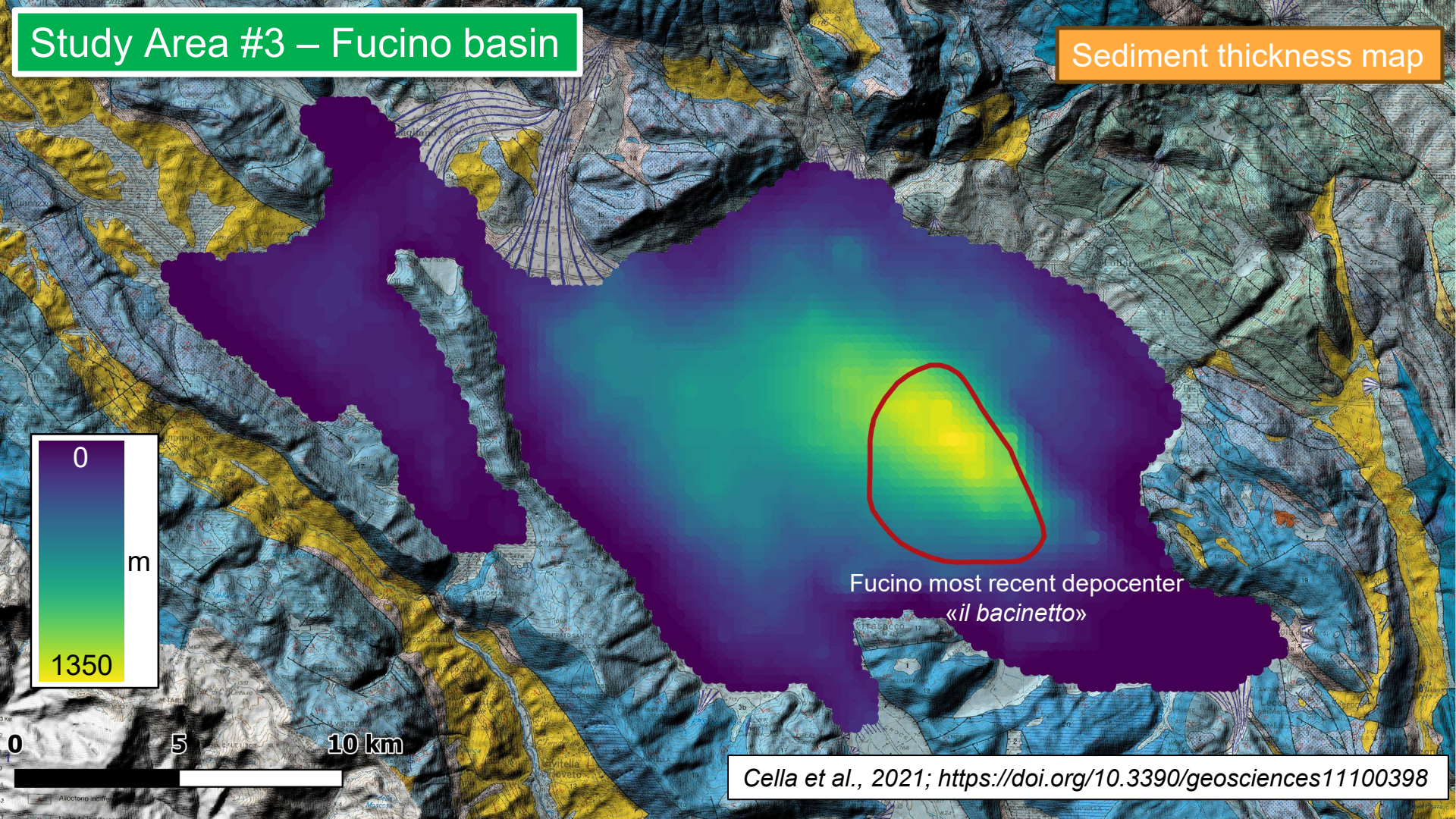


Study Area #3 – Fucino basin



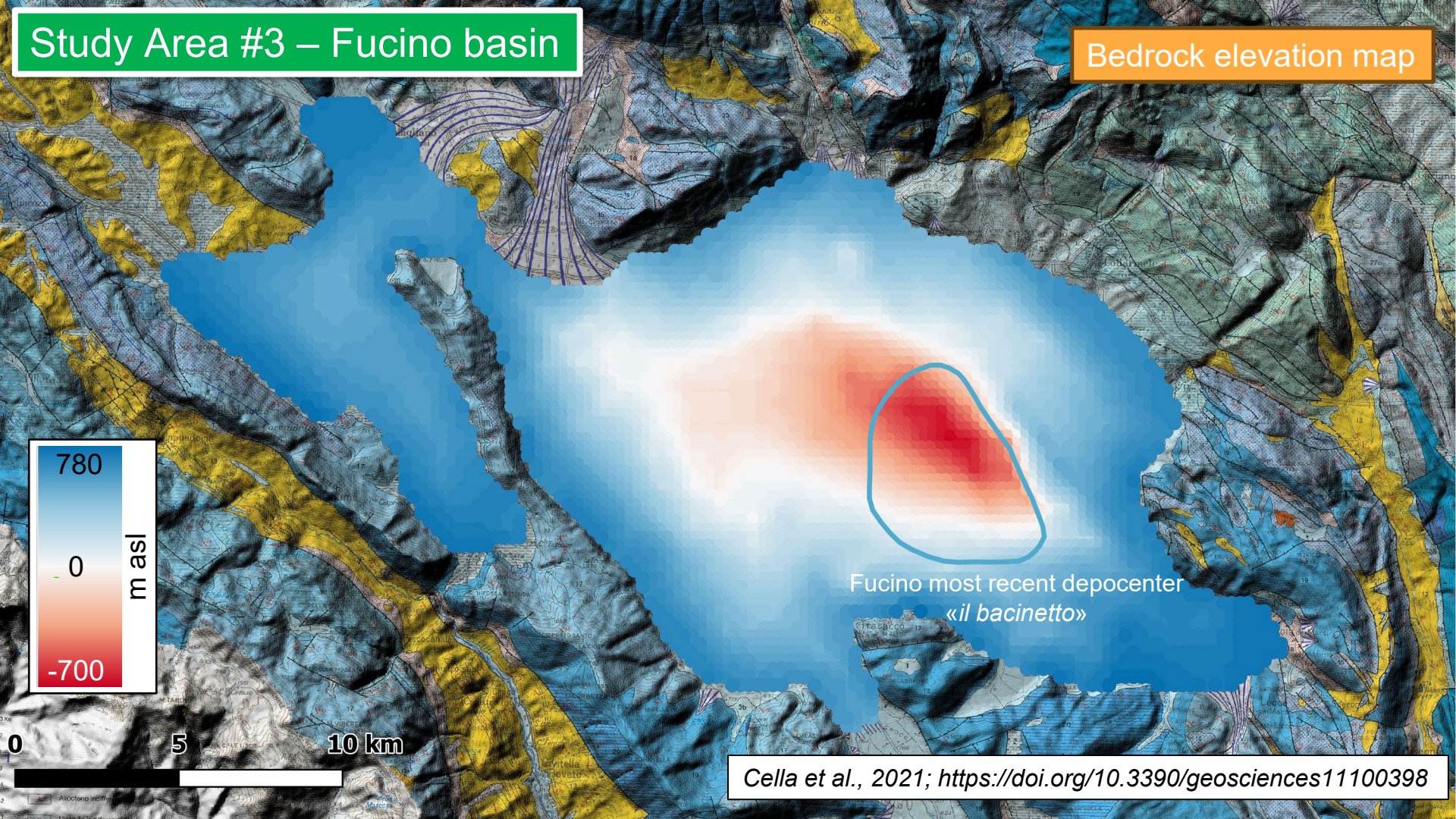
Study Area #3 – Fucino basin

Sediment thickness map



Study Area #3 – Fucino basin

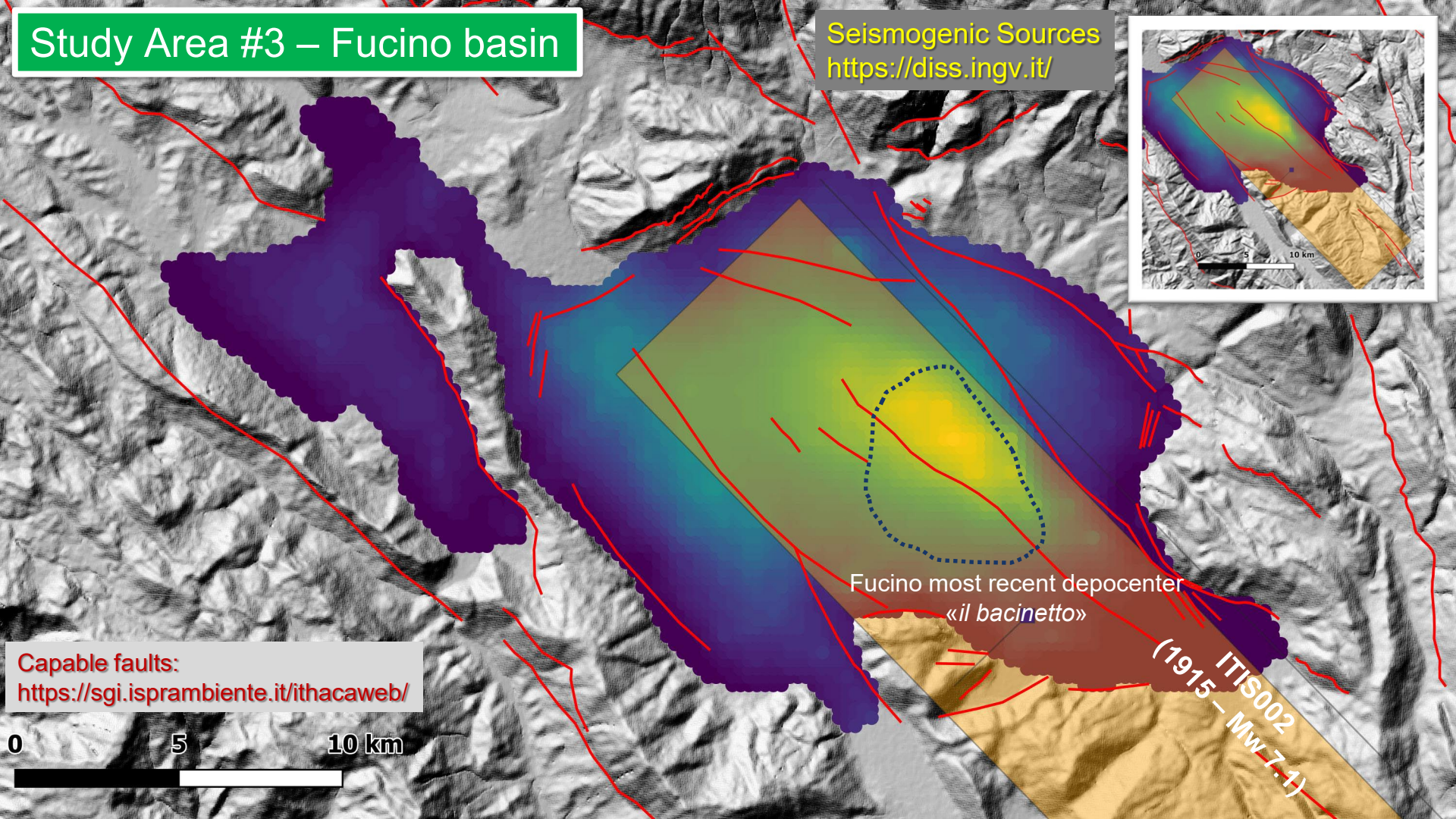
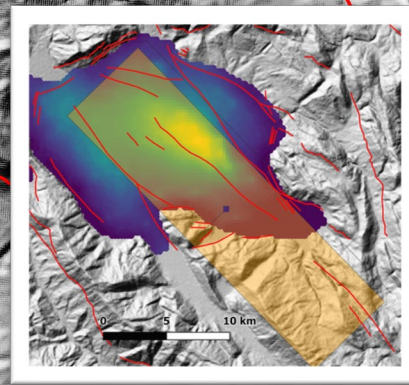
Bedrock elevation map



Fucino most recent depocenter
«il bacinetto»

Study Area #3 – Fucino basin

Seismogenic Sources
<https://diss.ingv.it/>



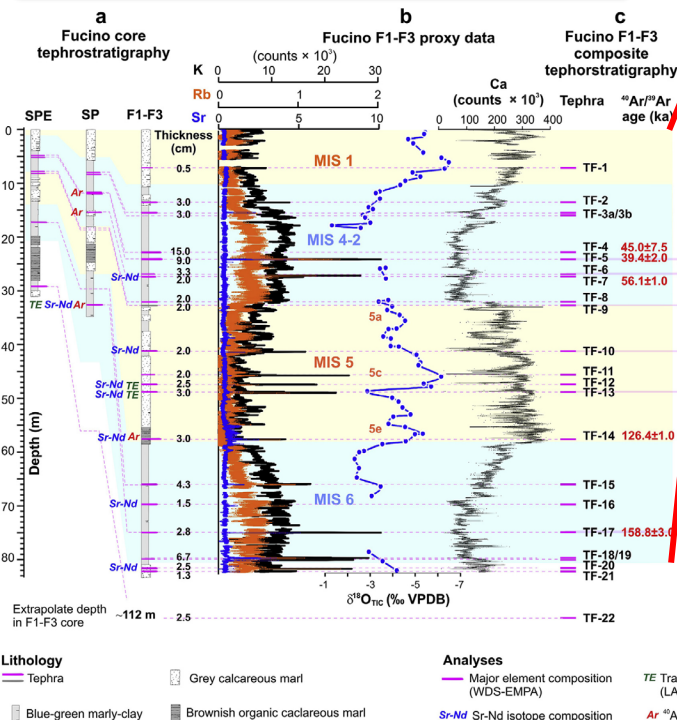
Fucino most recent depocenter
«il bacinetto»

(1915 – Mw 7.1)
ITIS002

Capable faults:
<https://sgi.isprambiente.it/ithacaweb/>



Study Area #3 – Fucino basin



Age	Geological Units (outcropping and buried)	Seismic Units according to <i>Cavinato et al., (2002)</i>	Seismic Units according to <i>Patacca et al., 2008</i>	Seismic Units according to <i>Patrino and Scisciani, 2021</i>
Holocene				
Pleistocene	Upper		4	Yellow
	Middle	Sequence 4	3	Orange
	Lower	continental Fucino deposits		
Pliocene	Upper	C	2	Blue
	Lower		1	Green
Miocene	Messinian	LeVicenne thrust-top-basin	B	
		Messinian Gypsum	Sequence 2	
		Flysch Units		Pre- and post-evaporitic Messinian sequences (<i>Mancinelli et al., 2021</i>)
Meso-Cenozoic substratum	Carbonate sequences	A	pre-Pliocene Appennine units	pre-Pliocene Appennine units

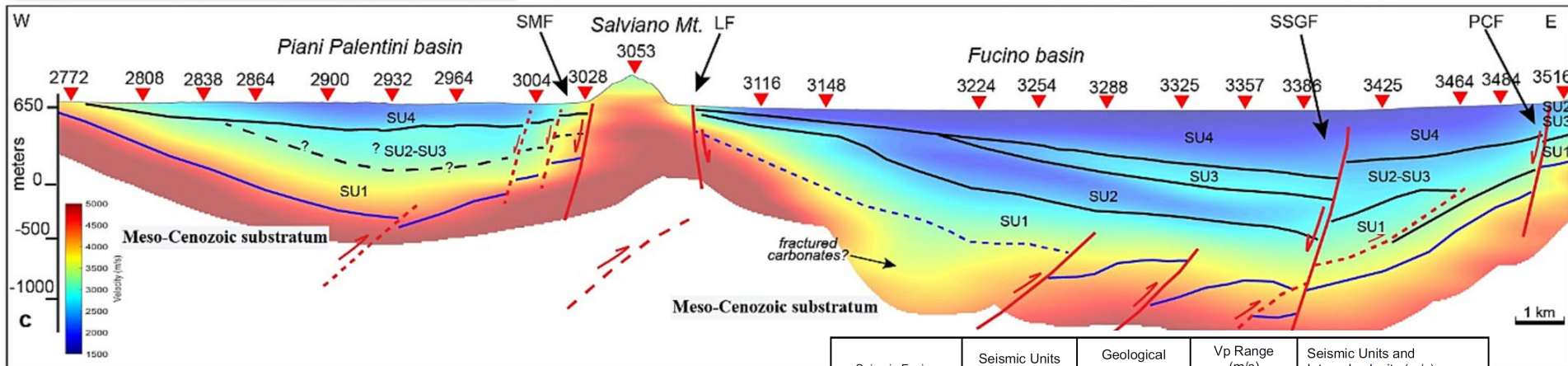
Caielli et al., 2023

<https://doi.org/10.1016/j.tecto.2023.230043>

Giaccio et al., 2017

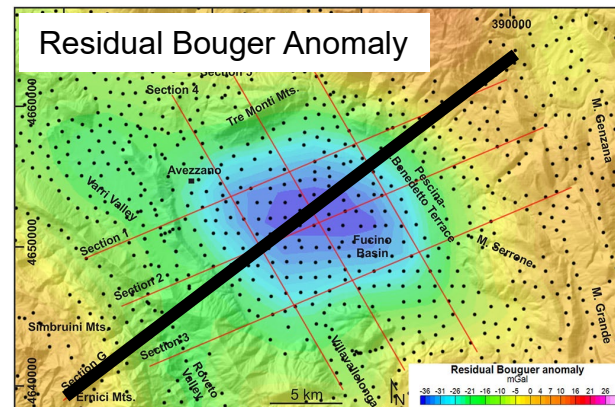
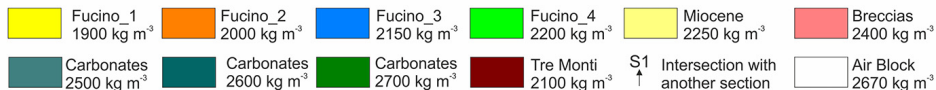
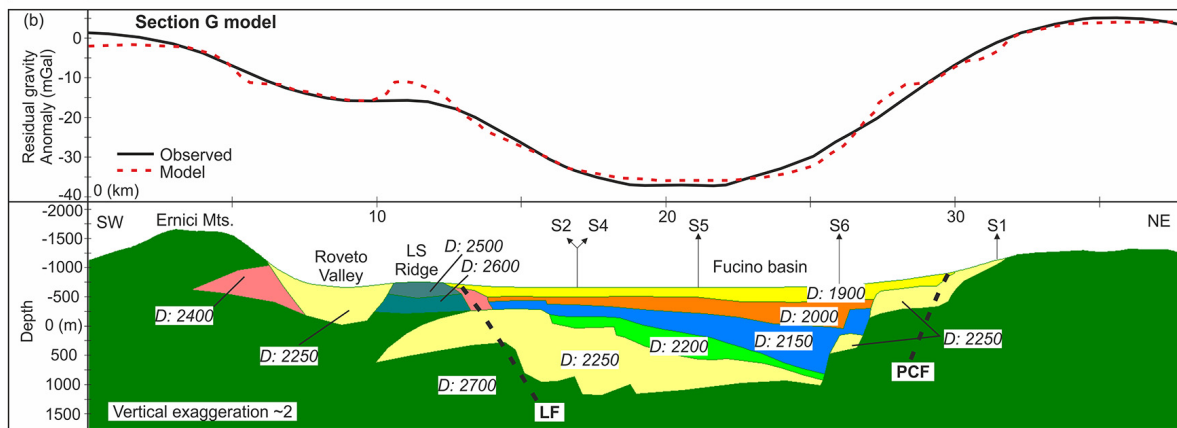
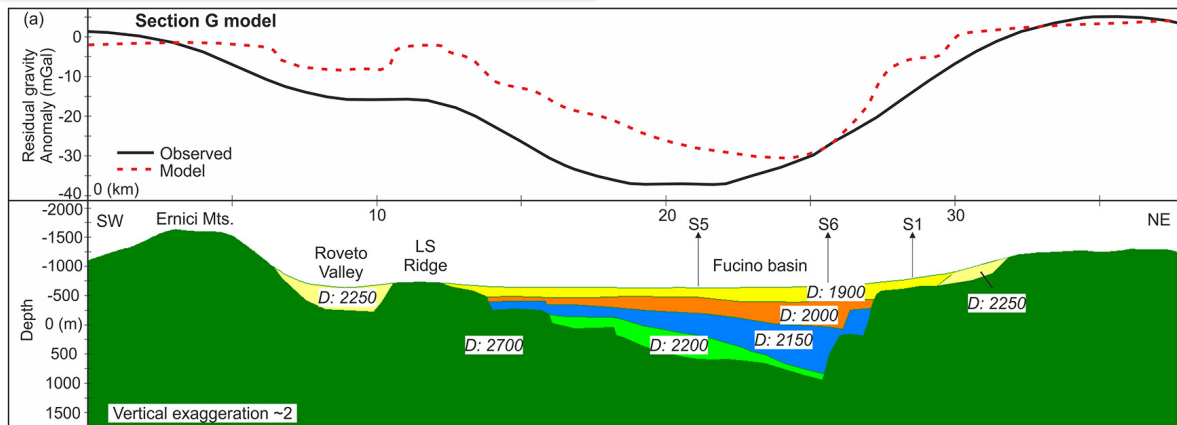
<http://dx.doi.org/10.1016/j.quascirev.2017.01.004>

Study Area #3 – Fucino basin



Seismic Facies	Seismic Units <i>-this work-</i>	Geological Interpretation	Vp Range (m/s) <i>-this work-</i>	Seismic Units and Interval velocity (m/s) <i>Patrino and Scisciani, 2021</i>
	SU4	Alluvial and lacustrine deposits (Plio-Pleistocene)	1400-2400	Yellow (1400) Orange (1800)
	SU3	Thrust-top deposits (upper Messinian)	2400-2900	Blue (2250)
	SU2		2000-2500	
	SU1	Flysch deposits (lower Messinian)	2900-4000	Green (2500)
	Meso-Cenozoic bedrock	Meso-Cenozoic bedrock	4000-5000	Pre-Pliocene Apennine units (2750)

Study Area #3 – Fucino basin



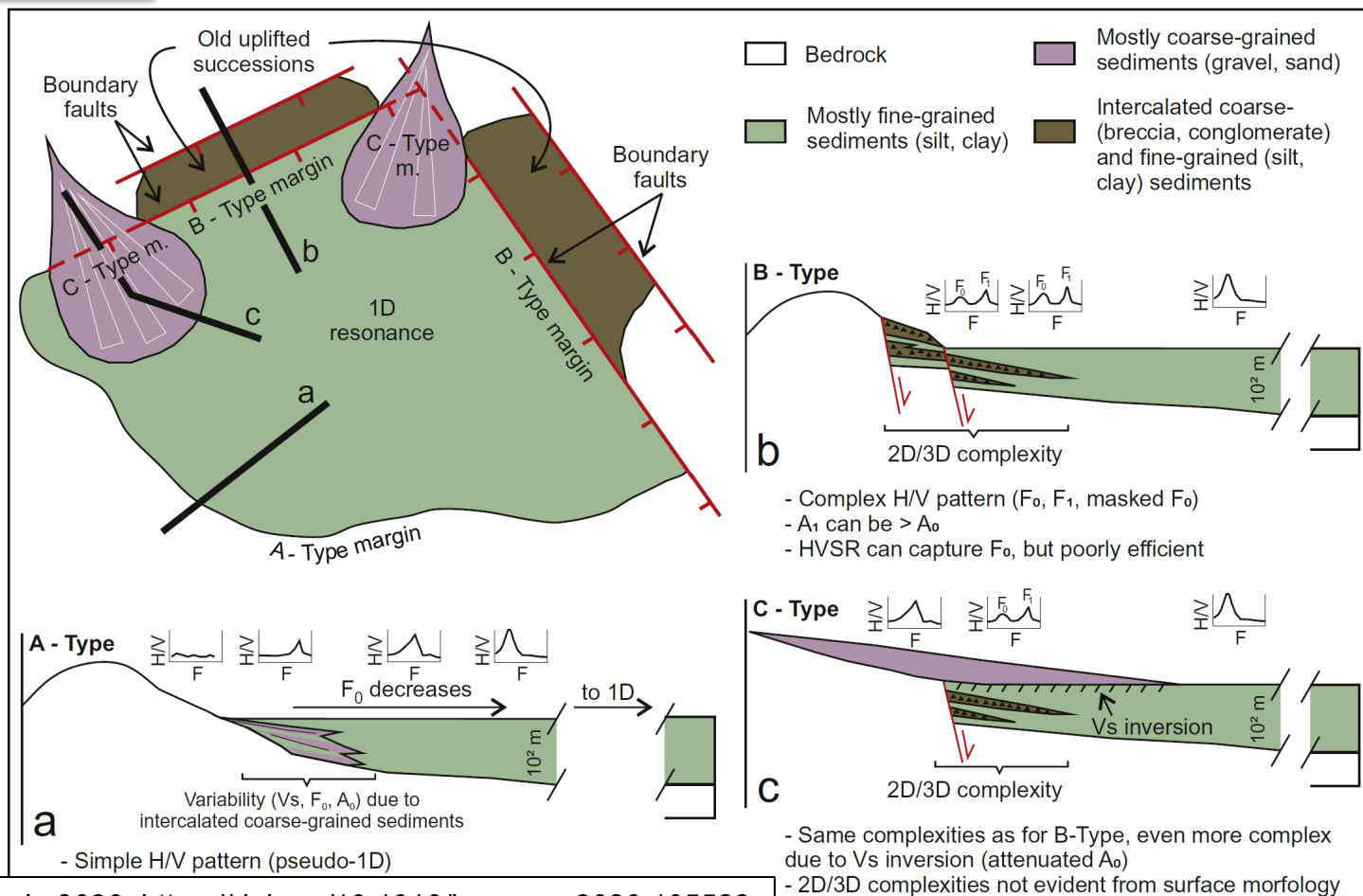
- Deep structure of the Fucino basin
- Miocene flysch depocenter (?)

Mancinelli et al., 2021
<https://doi.org/10.1016/j.tecto.2021.229144>

Florio et al., 2022
<https://doi.org/10.1016/j.tecto.2022.229540>

Key observations

1. Presence of subsurface geological complexities associated with velocity inversions (along the basin margins)

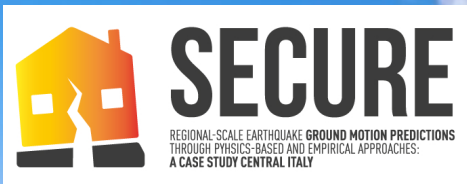


Takeaways

1. Central Apennines is not like the Basin and Range province in the western United States, where hanging-wall basins were born and evolved only under the control of extensional faults.
2. Central Apennines basins are characterized by complex geometrical and stratigraphic characteristics, due to their origin during compressional tectonic phases and their younger evolution during extension.
3. During the compressional tectonic phase, these basins formed as thrust top or shallow foredeep basins and hosted the main depocenters of flysch deposits (flysch is interlayered between the limestone bedrock and the Plio-Quaternary continental infilling).
4. The bedrock morphology is often controlled by karstic phenomena.
5. Due to their thickness, their deep geometry and sedimentary infilling is inferred from indirect geophysical interpretation.
6. Along their margins, the alluvial or lacustric infilling interfingers with coarse, often cemented, alluvial fan or slope deposits that may have mechanical characteristics similar to the limestone bedrock.

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GRAZIE PER L'ATTENZIONE!