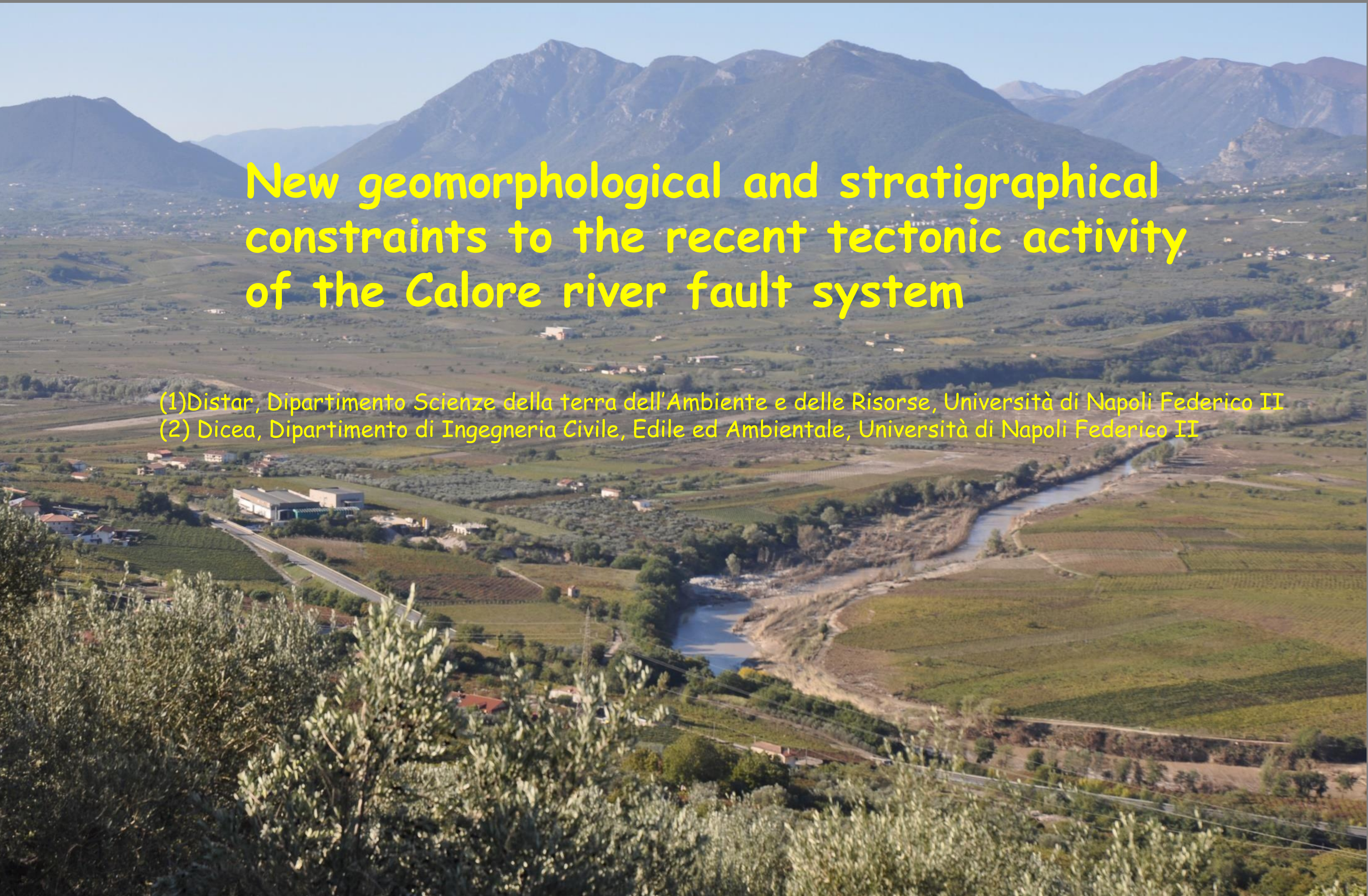
Santangelo N. (1) , Ascione A. (1),
Petrosino P.(1), Puoti M.(1), Santo A. (2)

35° Convegno Nazionale
Lecce 22-24 novembre 2016



New geomorphological and stratigraphical constraints to the recent tectonic activity of the Calore river fault system

(1)Distar, Dipartimento Scienze della terra dell'Ambiente e delle Risorse, Università di Napoli Federico II
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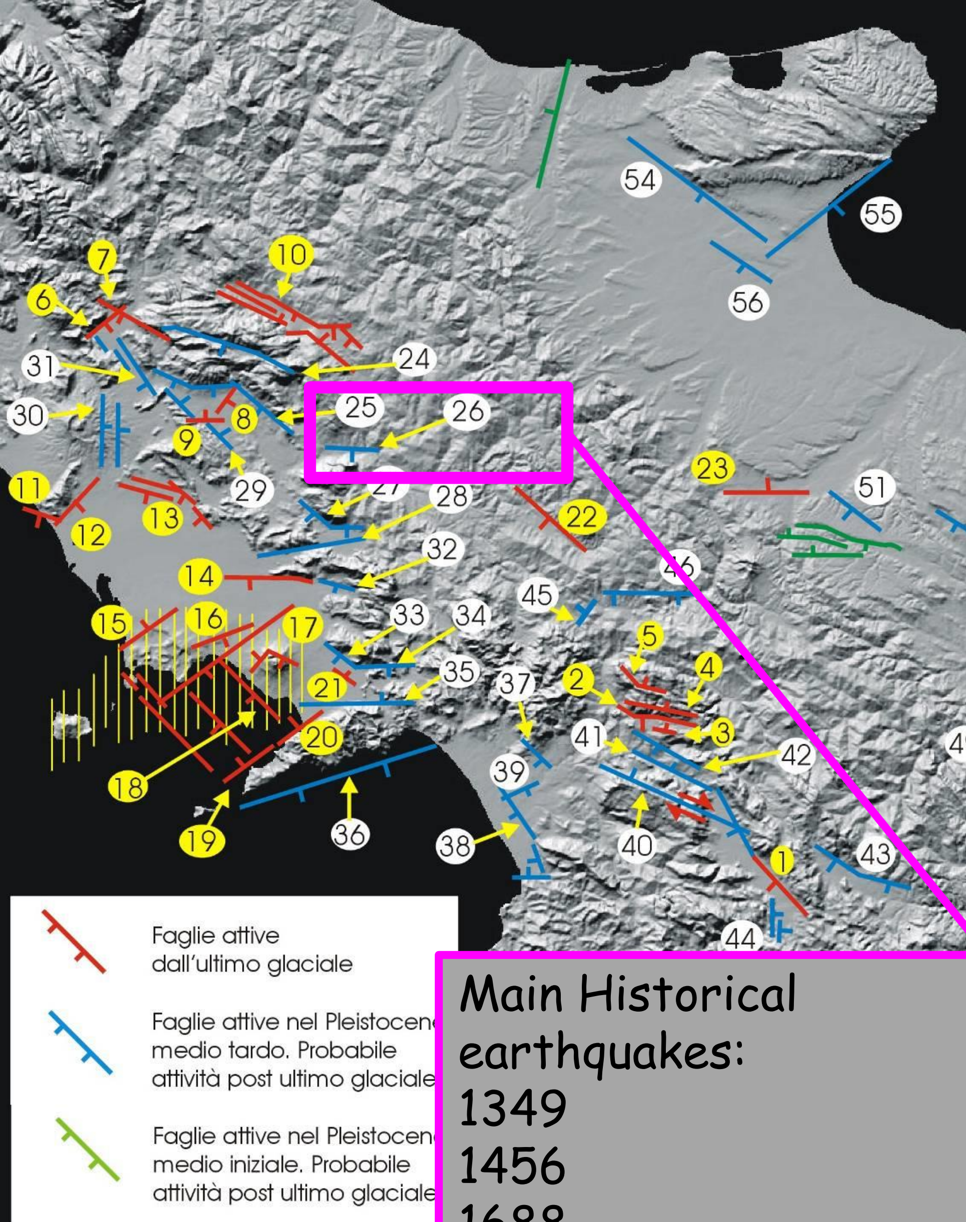

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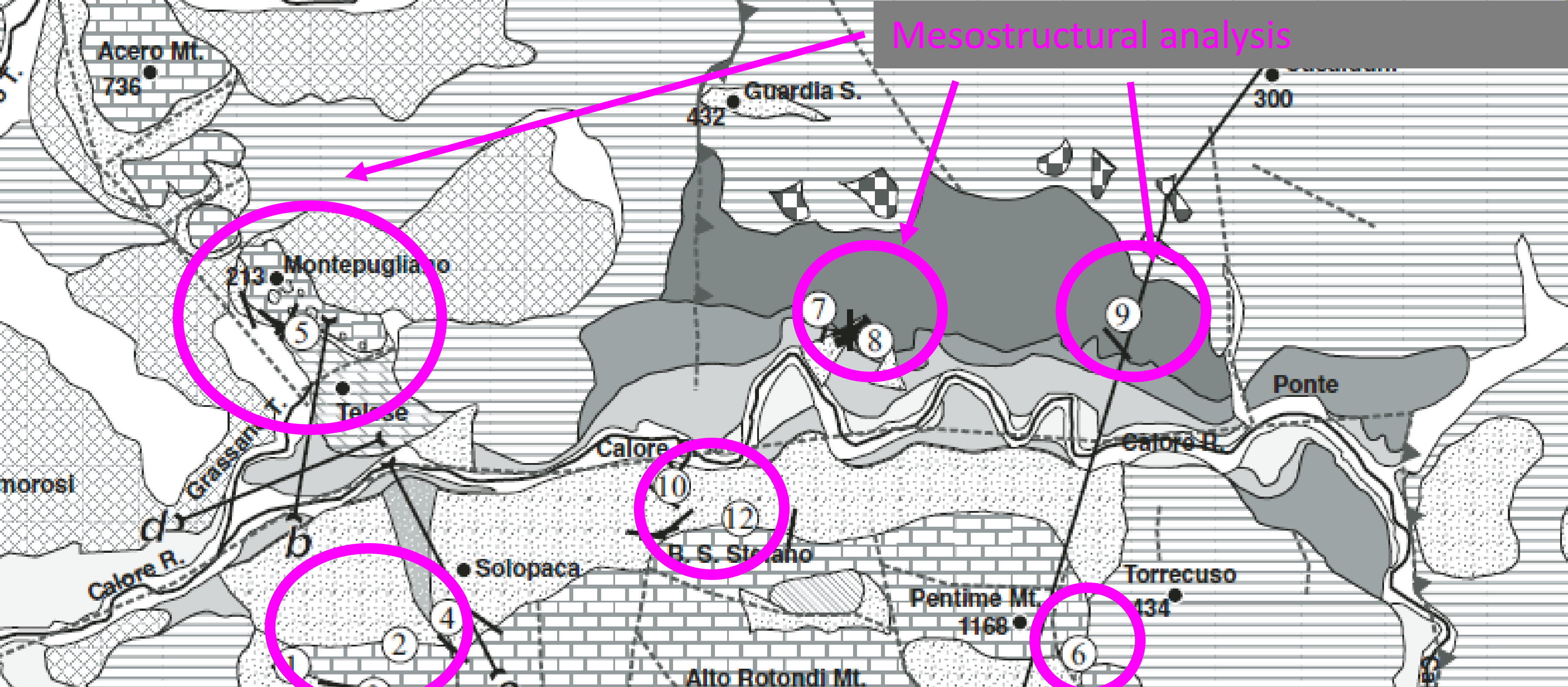
FAGLIE E SISTEMI DI FAGLIE	L (km)	Slip rate verticale (mm/a)	Intervalli cronologici	Intervallo di ricorrenza per eventi di fagliazione di superficie (anni)	T (km)
1 Vallo di Diano	31	* 0,5 - 1 ° 1	*Quaternario ° 0,4 - 0,6 Ma	-	-
2 S.Gregorio Magno (bordiera)	17	< 0,5	Quaternario	-	-
3 S.Gregorio Magno (sisma irpino 1980)	4	[1]0,17 - 0,4	[1]19660 yr cal B.P. - Attuale	[1]2206 - 3104	[2]8-12
4 M. Ogna	13	< 0,5	Ultimo Glaciale - Attuale	-	-
5 Piano di Pecore	8	[1]0,29 - 0,4	[1]8600 yr cal B.P. - Attuale	[1]1684 - 2150	[2]8-12
6 Venafro	12	> 0,25; < 1	Pleistocene medio - Attuale	-	-
7 Pozzilli – Capriati	22	0,2 - 0,4	Pleistocene medio - Attuale	-	-
8 Alife	6	0,5	36ka - Attuale	-	-
9 Baia e Latina	3,5	0,2 - 0,3	36ka - Attuale	-	-
10 Boiano	35	0,1 - 0,5	Ultimo Glaciale - Attuale	-	-
11 Mondragone	6	0,1 - 0,5	36ka - Attuale	-	-
12 M. Massico	10	*2 - 2,5 °0,2 - 0,5	*1,45 Ma - Attuale °36ka - Attuale	-	-
13 Piana Volturno (sciame)	34	*0,5 - 1,5 °0,2 - 0,5	*1,45 Ma -Attuale °36ka - Attuale	-	-
14 Cancello	9	*0,4 - 0,6 °1	*1,45 - Attuale °0,13 Ma - Attuale	-	-
15 nord Campi Flegrei	13	0,2	Ultimo Glaciale - Attuale	-	-
16 Napoli	12	3 - 10	36ka - Attuale	-	-
17 Posillipo	30	*7 °3	*11ka - Attuale °Tardo Olocene - Attuale	-	-
18 Golfo di Napoli	27	4	36ka - Attuale	-	-
19 Vico Equense	15	4	36ka - Attuale	-	-
20 Castellammare	5	< 2	tardo Olocene - Attuale	-	-
21 Sarno	7	> 0,5	Olocene	-	-
22 Valle Ufita	22	0,2	Ultimo Glaciale - Attuale	-	-
23 Valle Ofanto	18	0,5	Ultimo Glaciale - Attuale	-	-
24 Lag[illegible] Matese	25	-		-	-
[illegible]	[illegible]	[illegible]	[illegible]		
26 Valle Calore	15	~ 0.1 – 0.2	Pleistocene medio - Attuale?	-	-
[illegible]	[illegible]				
28 Maddaloni - Valle Caudina	20			-	-
29 M.ti di Baia e Latina	16	~ 0.1	Pleistocene inferiore - Attuale?	-	-
30 Roccamonfina (sciame)	15	~ 0.1	tardo Pleistocene medio – Attuale?	-	-

Main Historical earthquakes:
1349
1456
1688
1732
1805

After Cinque et al., 2000, *CNR-GNDT Spec. Publ., 203-218*, Roma



Fluvial and lacustrine deposits (Middle Pleistocene - Holocene).

Second order of debris fans (early Holocene).

Slope deposits and first order of debris fans (Upper Pleistocene).

Order V terraced deposits of the Calore River (Holocene; < 0.007 Ma).

Order IV terraced deposits of the Calore River (Holocene - late Upper Pleistocene; < 0.007 Ma - 0.039 Ma).

Order III terraced deposits of the Calore River (Upper Pleistocene; 0.039 Ma - 0.097 Ma).

Order II terraced deposits of the Calore River (early Upper Pleistocene; > 0.097 Ma).

Order I terraced deposits of the Calore River (Middle Pleistocene).

Gray volcanic tuff ("Ignimbrite Campana", Auct.) (Upper Pleistocene; 0.039 Ma after De Vivo et al., 2001).

Travertine deposits (Upper Pleistocene - Holocene).

Karst deposits (Upper Pleistocene - Holocene).

Terrigenous substratum (Mesozoic - Cenozoic).

Carbonate substratum (Mesozoic - Cenozoic).

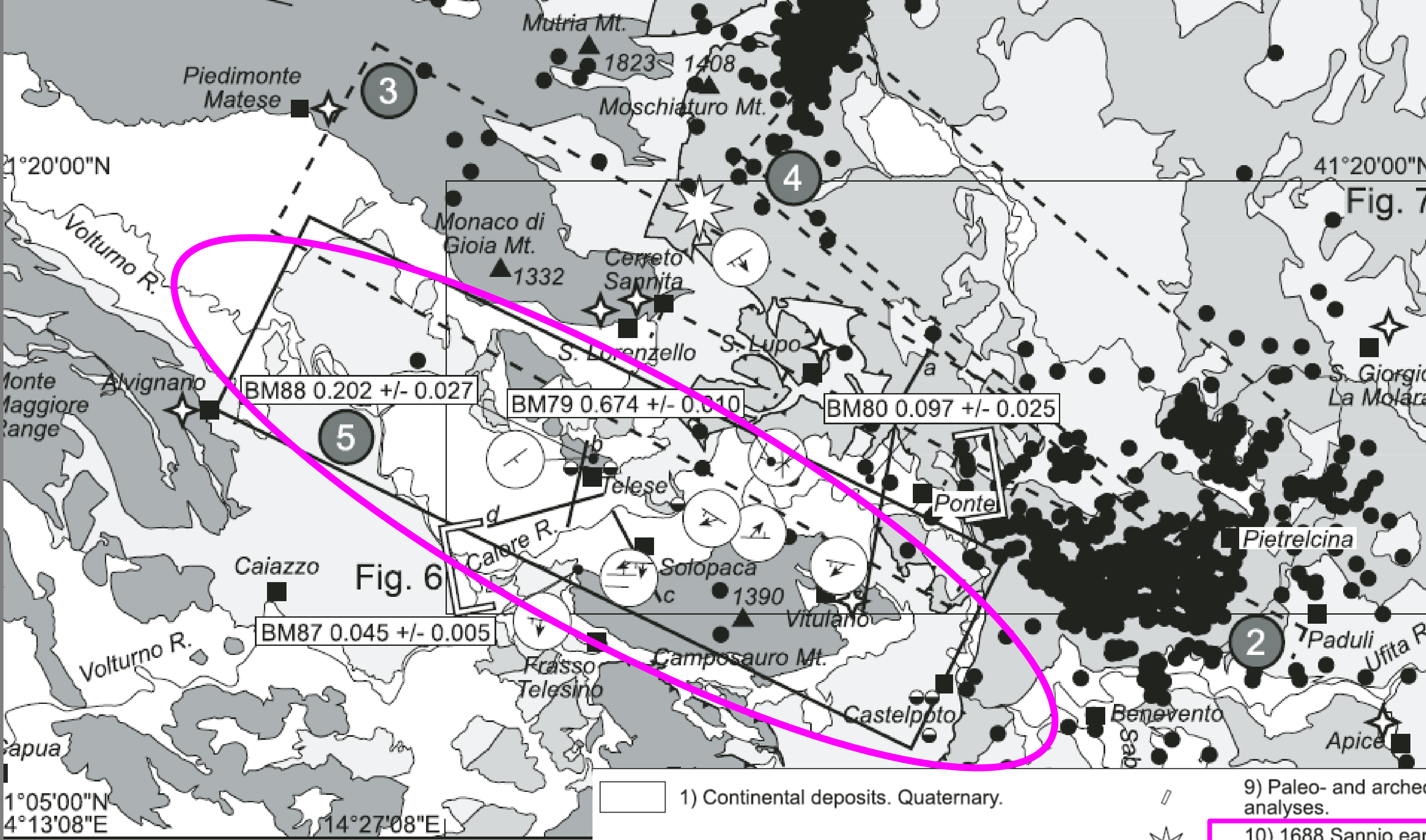
Main mesoscale Quaternary faults.

Pre-Quaternary faults and main thrusts.

(9) Main mesostructural survey sites (see plots below).

a Section traces (see Fig. 5).

After Di Bucci et al., *Geological Society of America Bulletin 2006;118;430-448*



1) Continental deposits. Quaternary.

2) Siliciclastic deposits of foredeep and thrust-top basin. Miocene-Pliocene.

3) Mainly terrigenous deposits of the Molise-Sannio-Lagonegro pelagic basin and related transitional facies. Meso-Cenozoic.

4) Carbonate deposits of the Apennine carbonate platform and related transitional facies. Meso-Cenozoic.

5) Active faults.

6) Main thrusts.

7) Other faults.

8) Thermal-mineral springs.

9) Paleo- and archeoseismological analyses.

10) 1688 Sannio earthquake macroseismic epicenter.

11) 1688 Sannio earthquake field effects (surface ruptures, variation of chemical-physical properties of springs, rock falls and landslides).

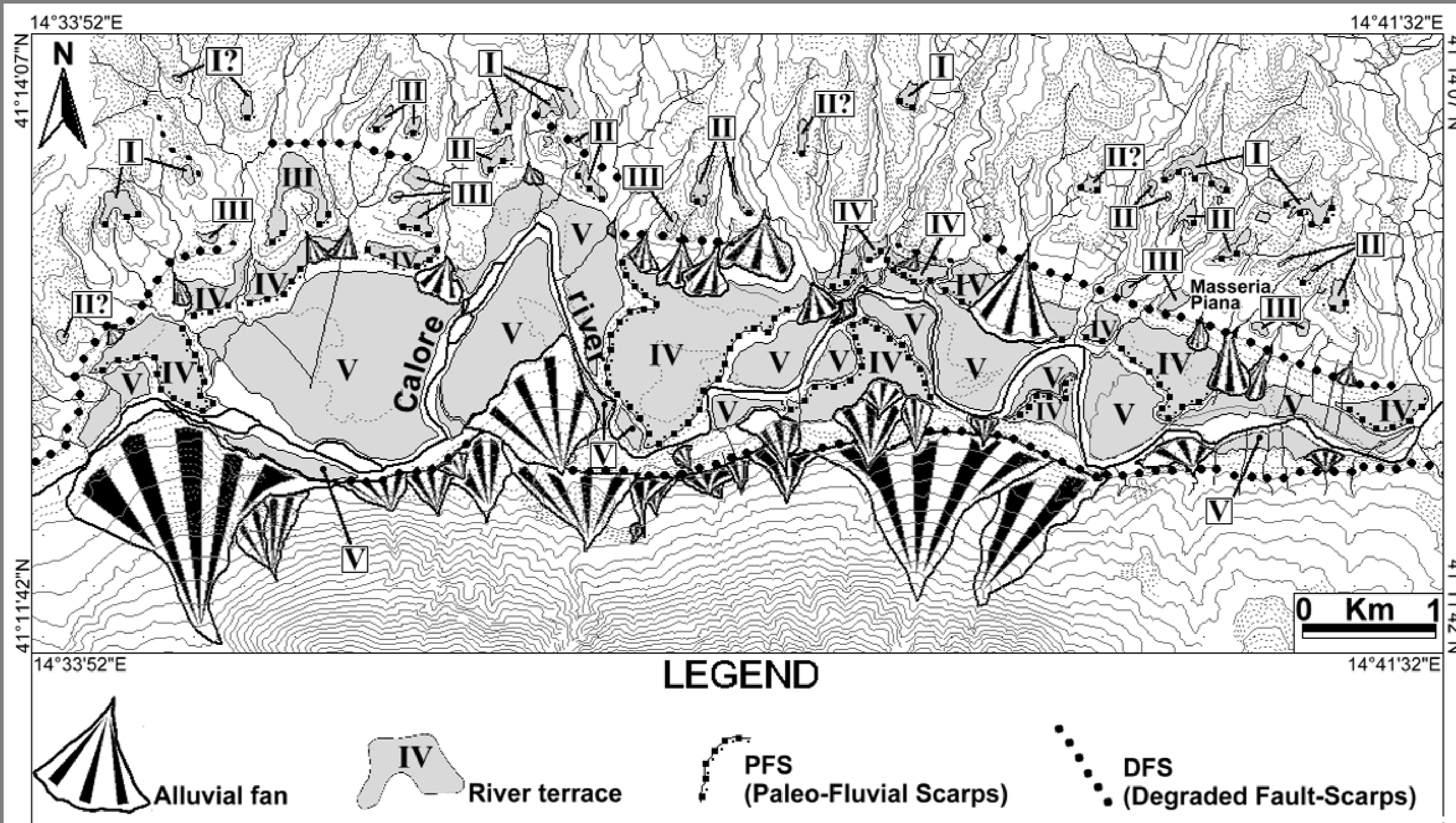
12) 1990 and 1997seismic sequences.

13) Seismogenic sources (solid line: present work; dashed line: previous works).

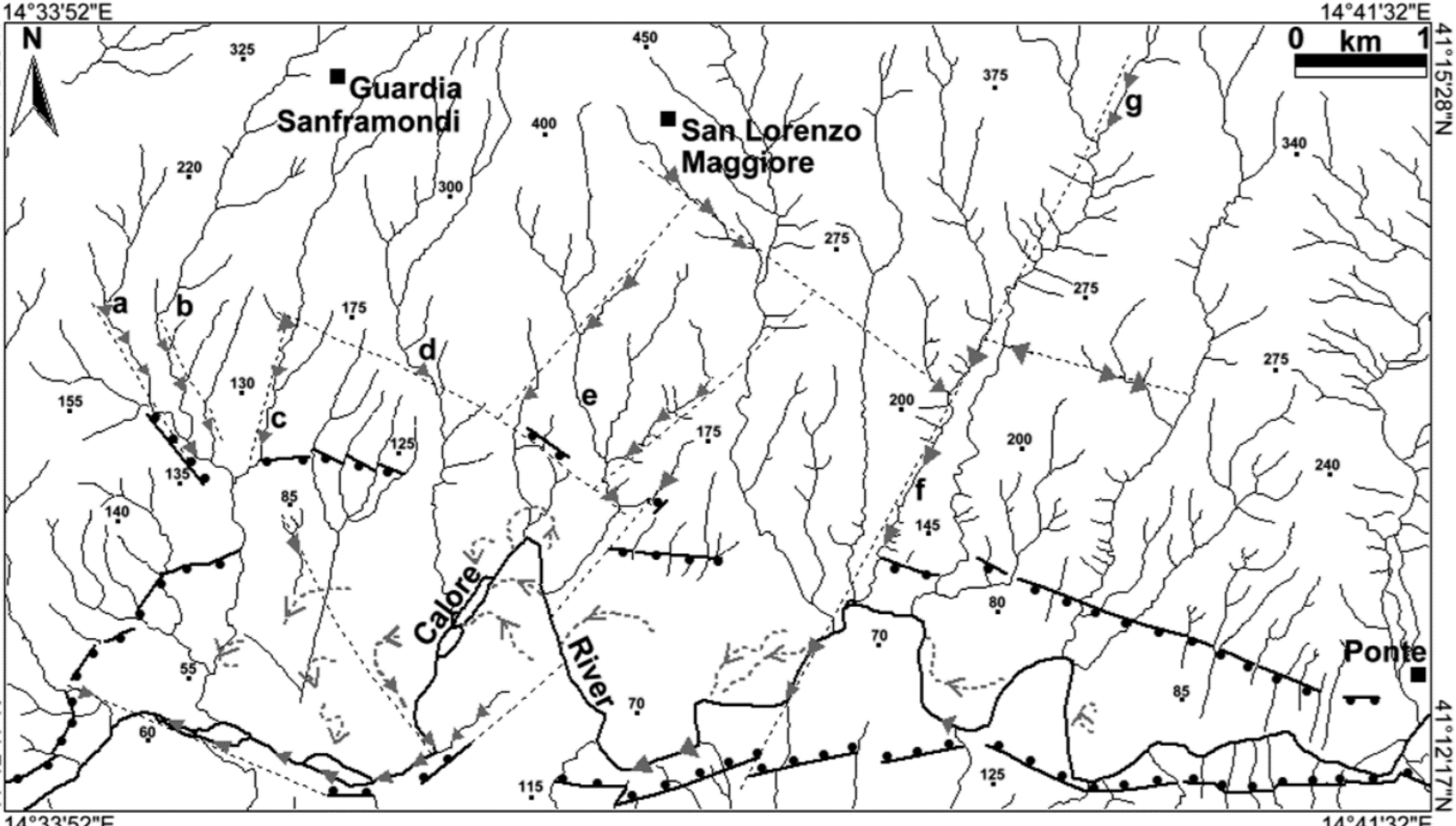
BM87 0.045 +/- 0.005 14) $^{39}Ar/^{40}Ar$ radiometric dating presented in this work (in Ma).

15) Simplified mesostructural data (sense of slip shown by arrowheads pointing in the direction of motion of the hanging wall).

After Di Bucci et al., *Geological Society of America Bulletin 2006;118;430-448*



After Magliulo et al., 2007, *Italian Journal of Geosciences*, 126, 397-409



(1) Fault scarps

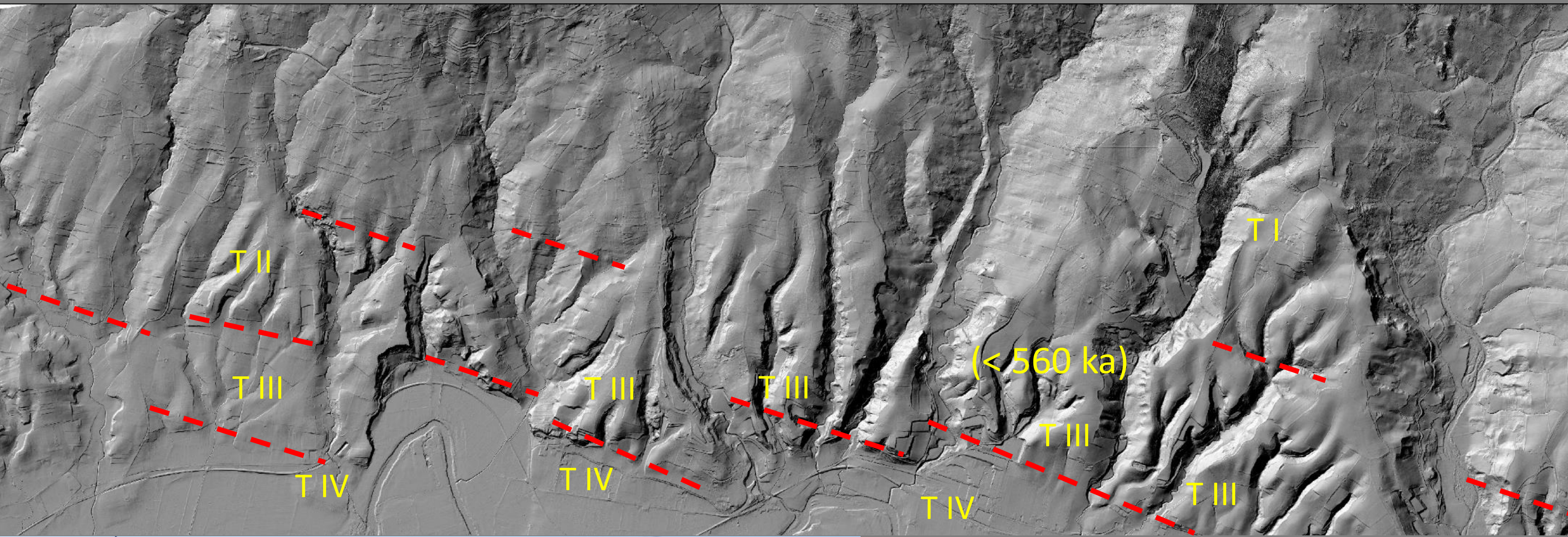
(2) Subsequent rivers

(3) River network anomalies

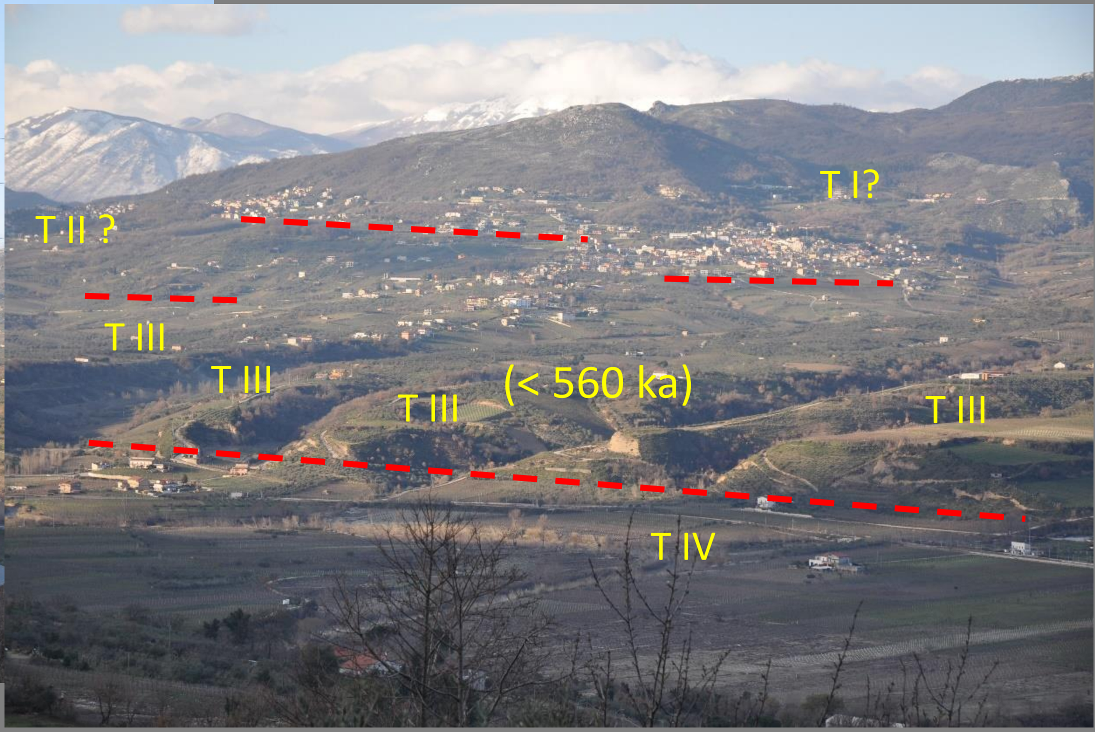
(4)

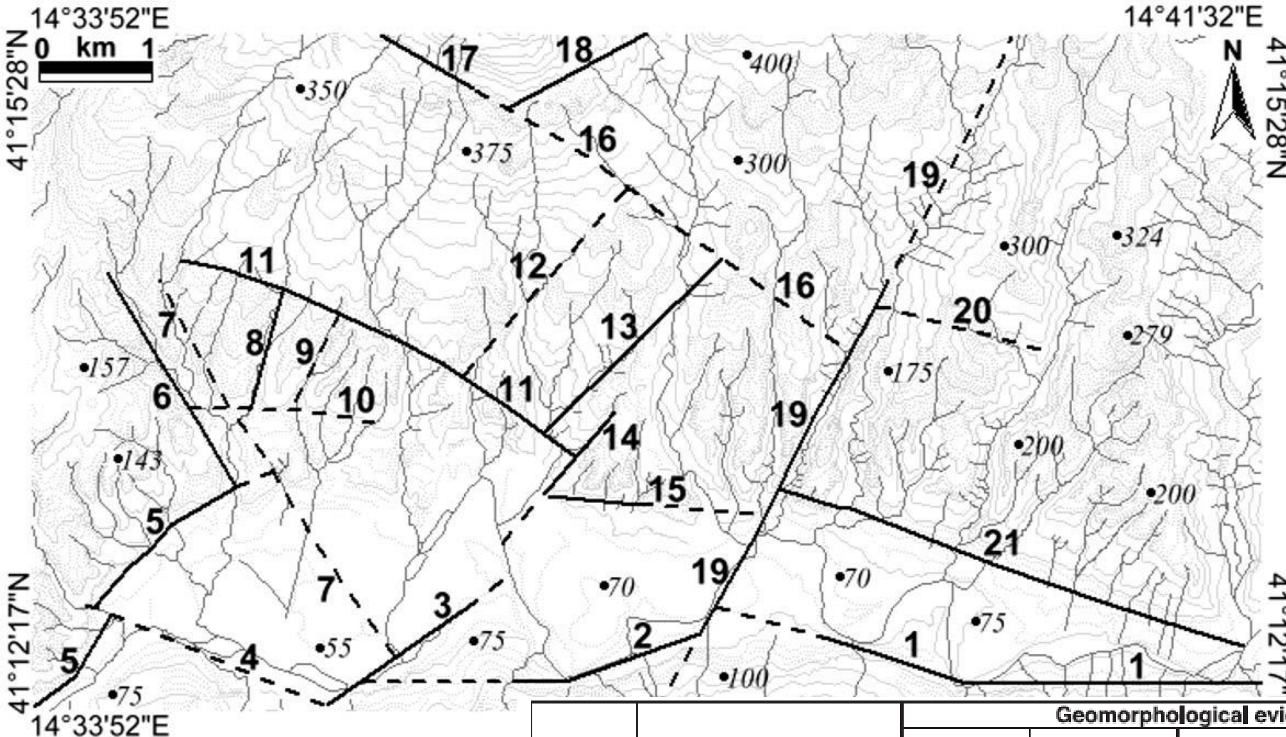
a, b, ... (5)

After Magliulo et al., 2007, *Italian Journal of Geosciences*, 126, 397-409


T II
T I
(< 560 ka)
T III
T III
T III
T III
T III
T IV
T IV
T IV

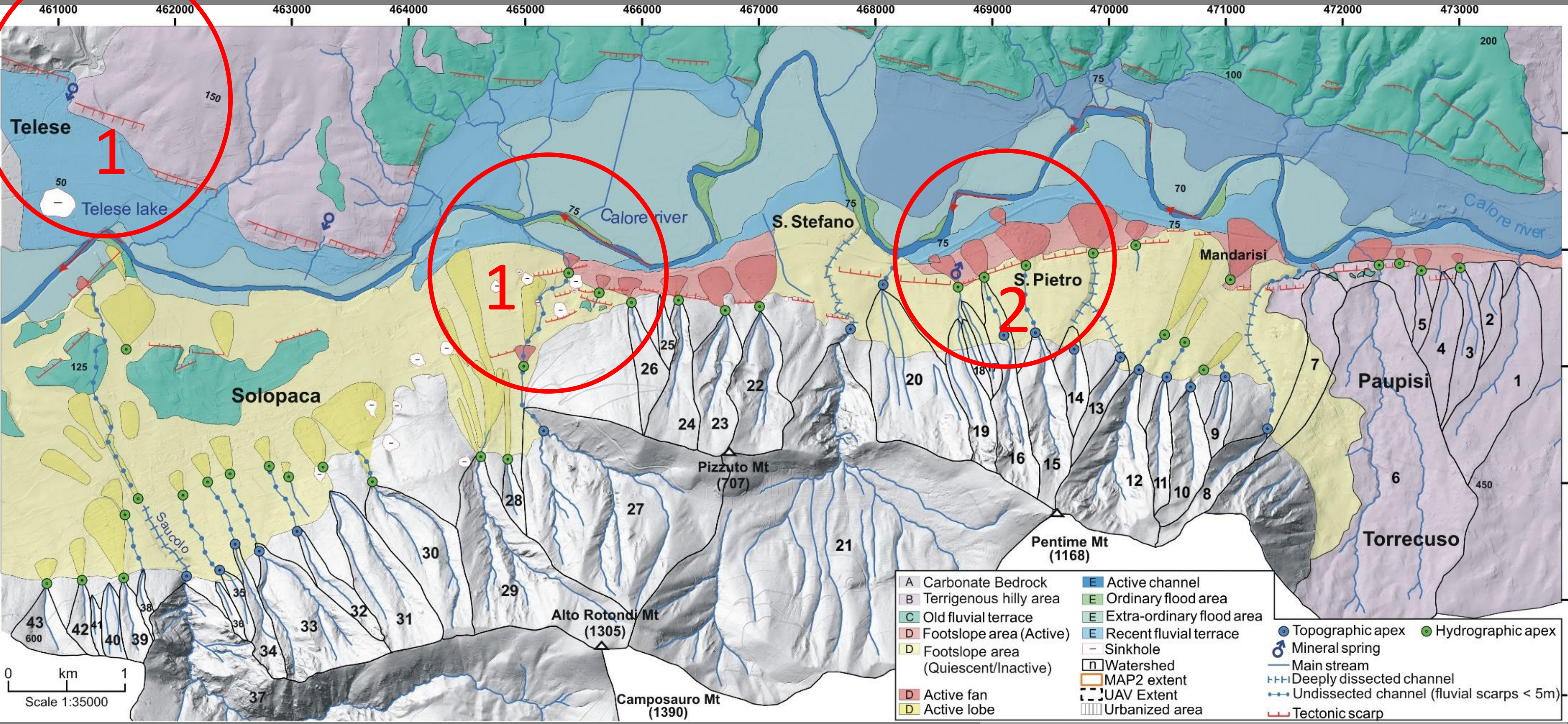

T III
T IV
T III


T II ?
T I?
T III
T III
(< 560 ka)
T III
T III
T IV



After Magliulo et al., 2007, *Italian Journal of Geosciences*, 126, 397-409

Fault N° (see fig. 11)	Toponym	Geomorphological evidence of tectonics				Statigraphic evidence	Literature data
		DFS (see figs. 4 and 8)	Subsequent reaches of streams (see fig. 8)	Anomalies in the channel geometry of the Calore River (see fig. 9)	Displacement of terraces (see fig. 7)		
1	Camposauro-1	+	+	+			+
2	Camposauro-2	+	+				+
3	Camposauro-3	+	+	+			+
4	Camposauro-4		+				
5	Solopaca Scalo	+			+		
6	Vallone Ariola	+	+				
7	Rio Stream		+		+	+	
8	Ratello Stream		+			+	
9	Galano					+	
10	Colle dell'Aria	+					
11	Acquafredda Stream	+	+				+
12	Pietra del Tesoro		+				
13	Vallone Codacchio		+		+	+	
14	Fontana S. Marzano-1	+	+		+		+
15	Fontana S. Marzano-2	+					
16	Masseria Laureto		+				
17	Guardia Sanframondi					+	+
18	San Lorenzo Maggiore					+	+
19	Vallone del Lago		+	+	+		
20	Paparella		+				
21	Masseria Piana	+		+			+



After Santo et al., 2016, *Journal of map*, doi: 10.1080/17445647.2016.1249034

We will discuss about:

1 . High sinkhole concentration along the Calore river valley

2. New stratigraphic constraints for the S. Pietro fault

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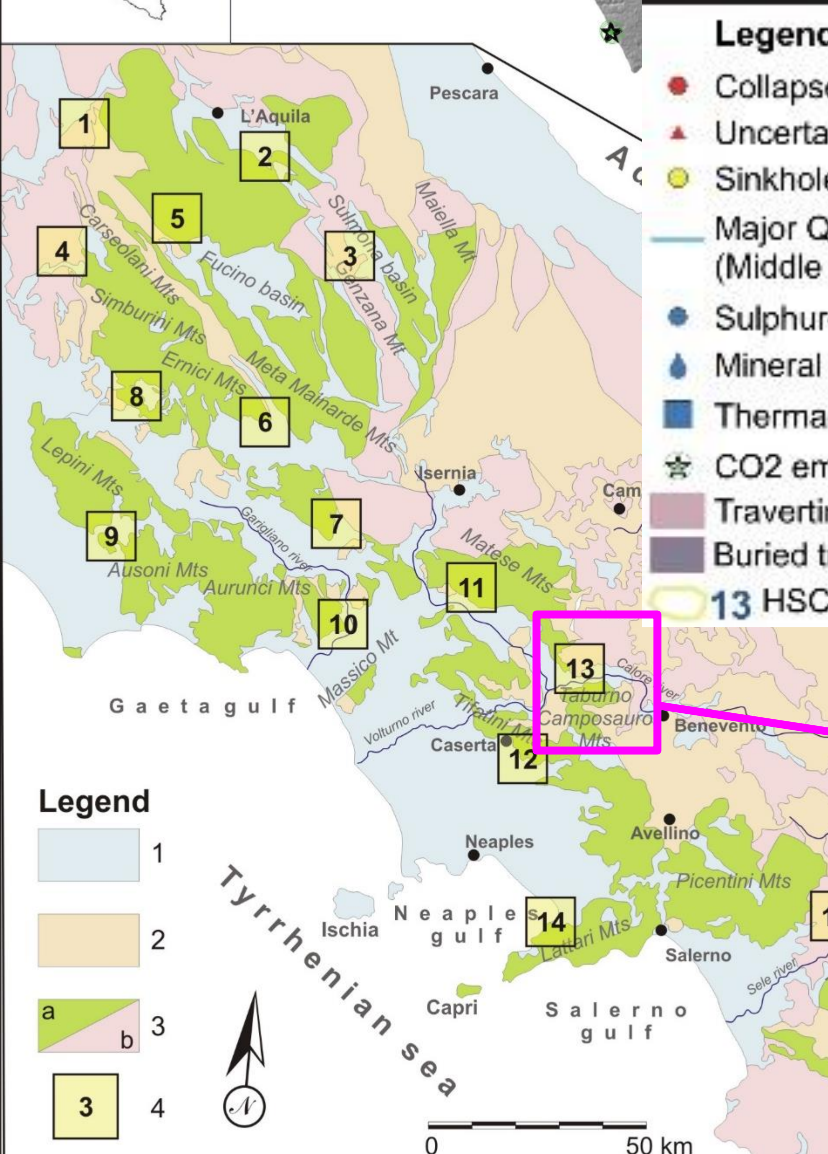
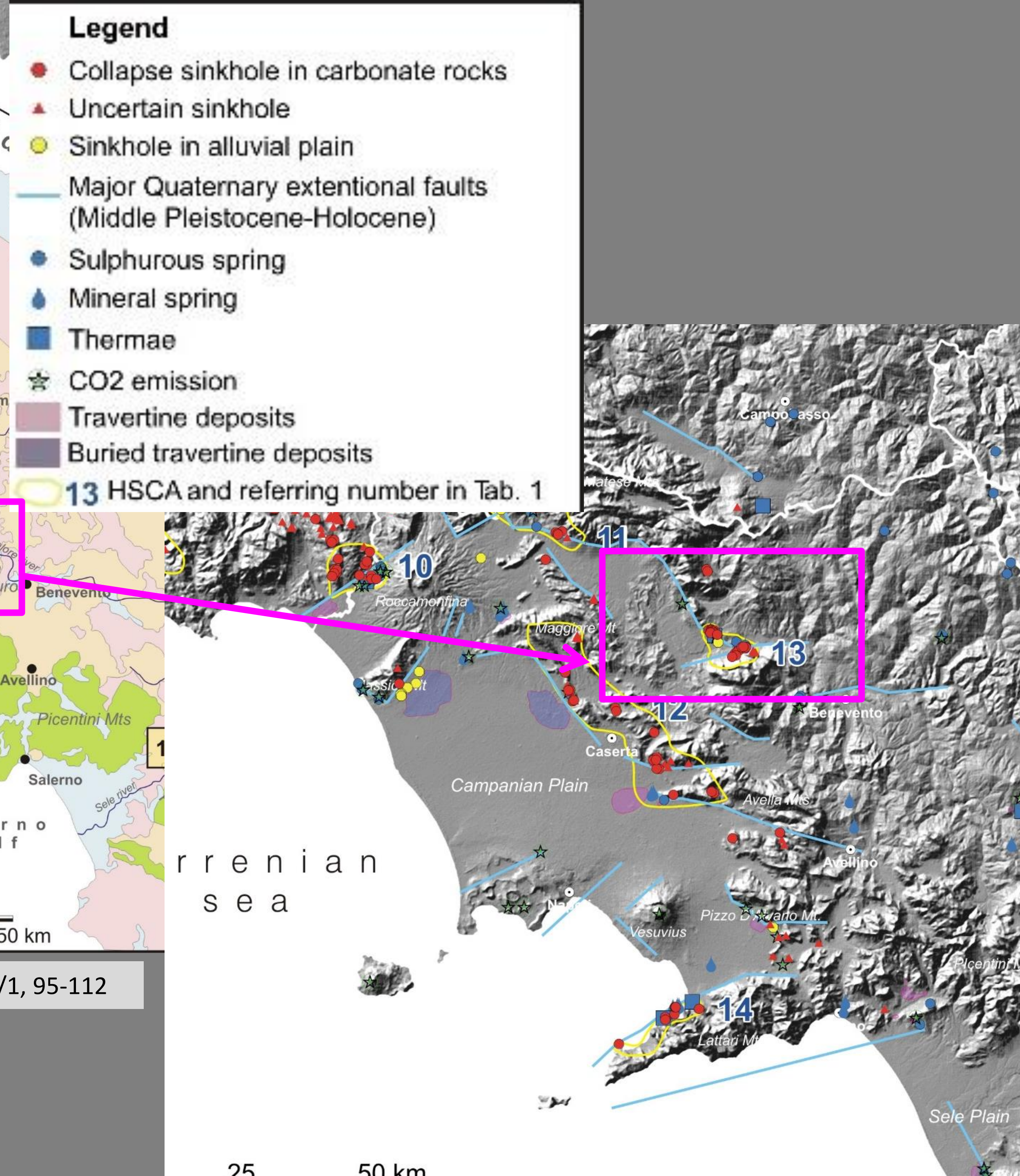
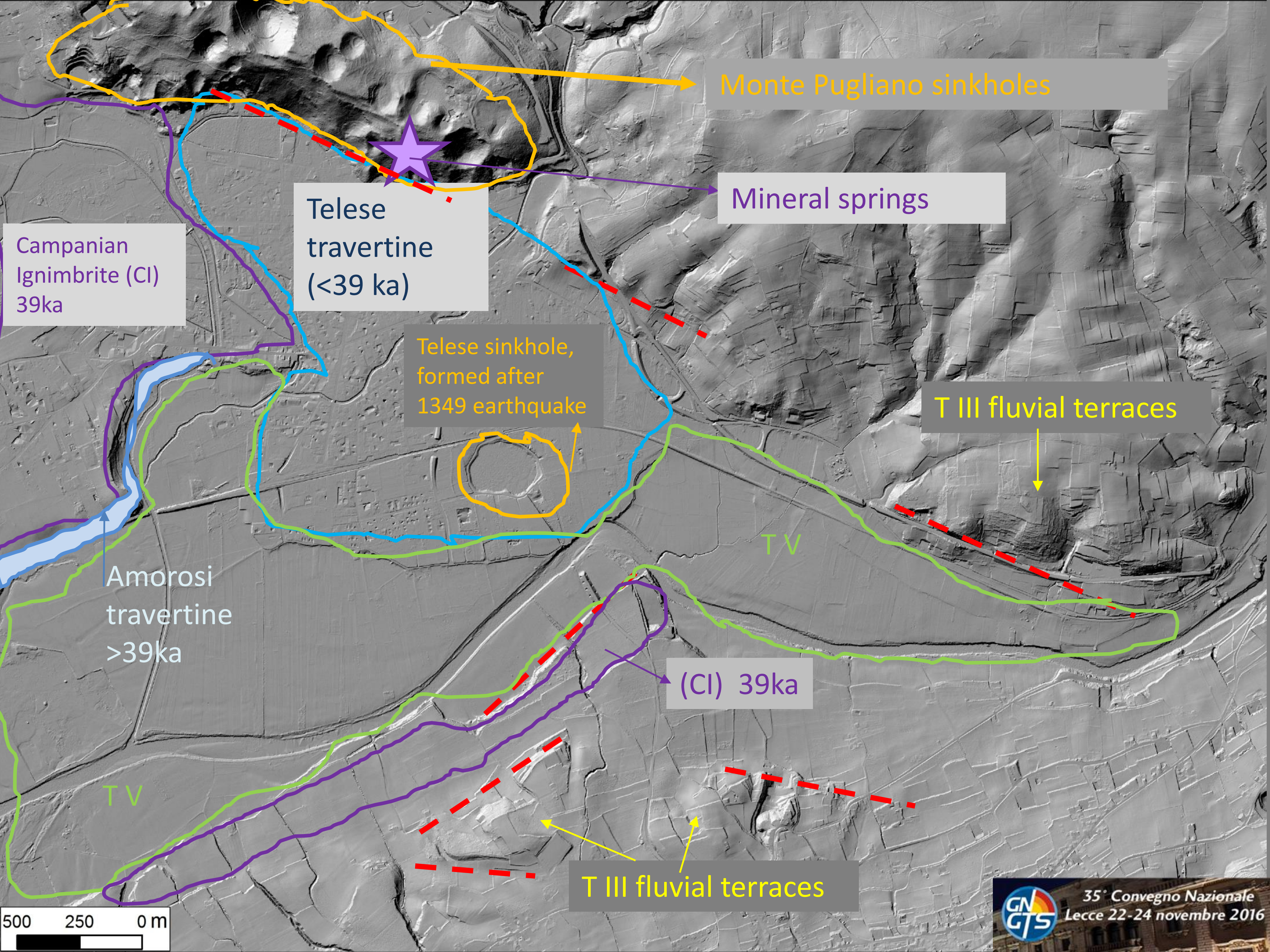
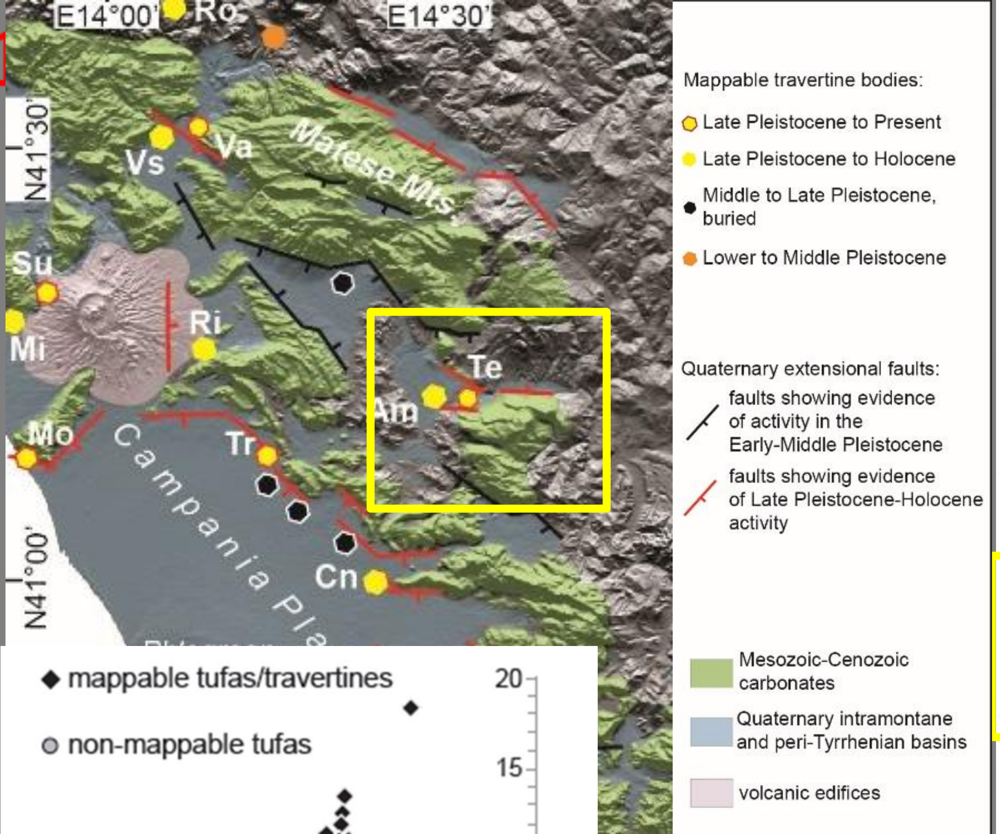
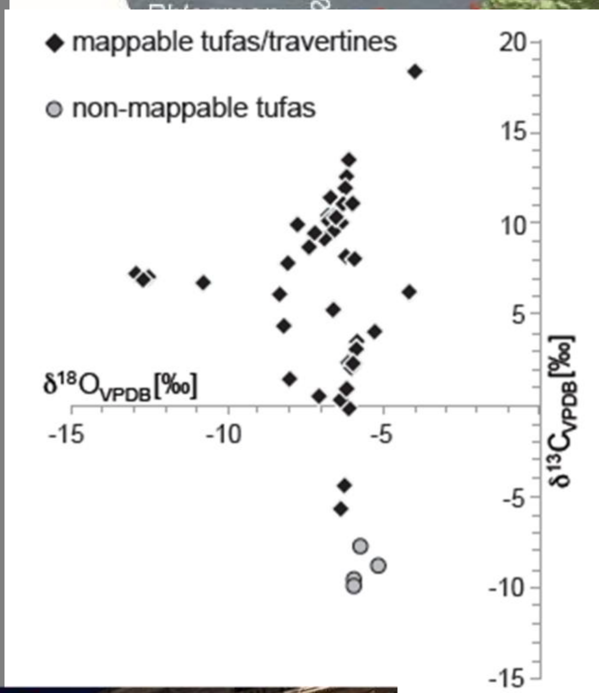


After Santo et al., (2011) Acta carso logica, 40/1, 95-112




Monte Pugliano sinkholes
Mineral springs
Telese travertine (<39 ka)
Campanian Ignimbrite (CI) 39ka
Telese sinkhole, formed after 1349 earthquake
T III fluvial terraces
T V
Amorosi travertine >39ka
(CI) 39ka
T V
T III fluvial terraces
500 250 0 m
GNGTS
35° Convegno Nazionale
Lecce 22-24 novembre 2016





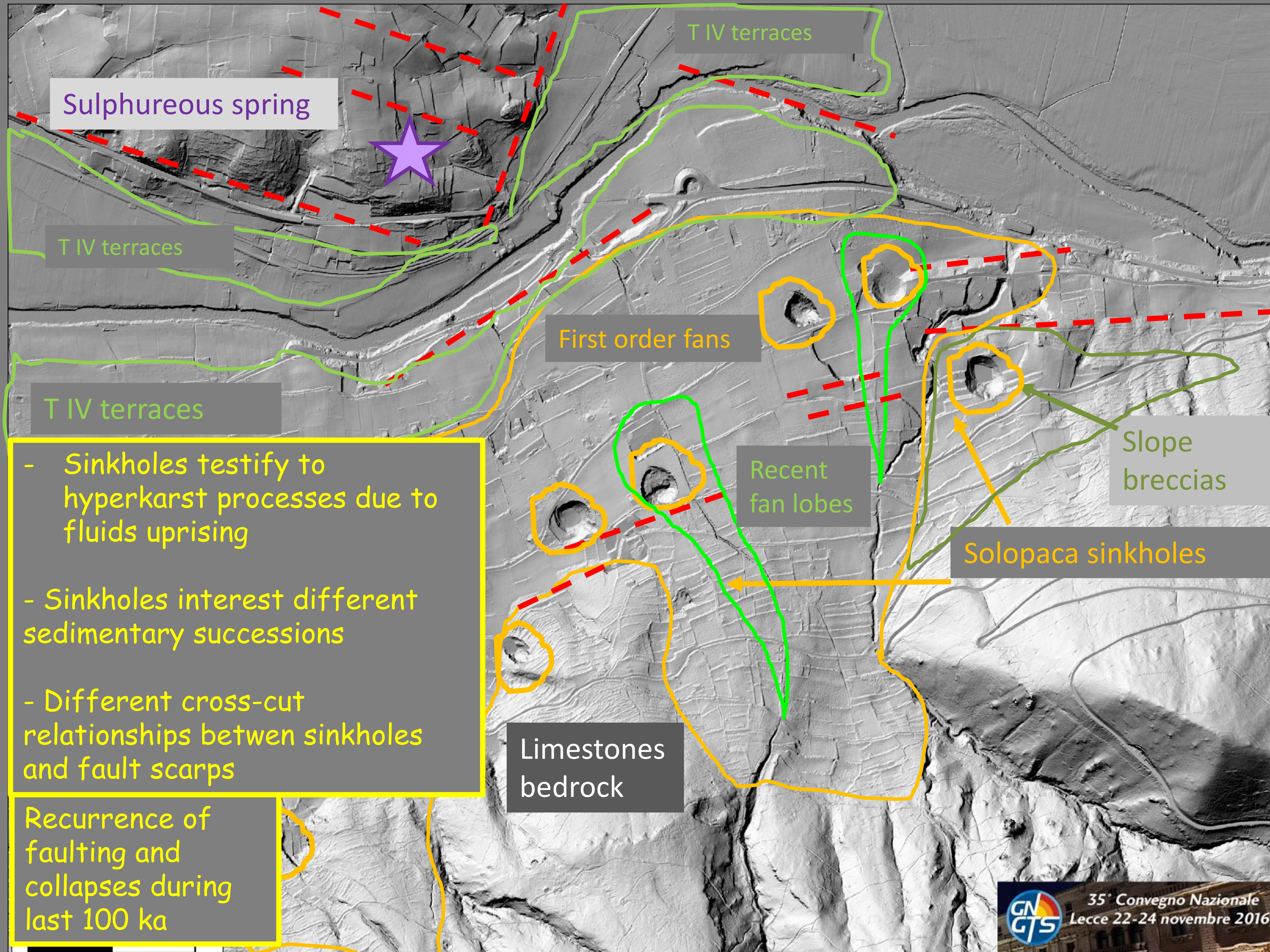
the highly positive $\delta^{13}C$ values are compatible with a crustal or mantle derived carbon source

TABLE 1. STABLE ISOTOPE DATA

	Site	Sample label	$\delta^{18}O_{PDB}$ [‰]	$\delta^{13}C_{PDB}$ [‰]	Location Latitude	Location Longitude
Ro	Rocchetta al Voltumo	Ro1	-8,05	1.51	41°38'19,064"N	14°4'19,186"E
Vs	Venafro Santa Cristina	Vs1]	-5,98	2,35	41°29'37,718"N	14°4'27,664"E
		Vs2]	-6,07	2.15		
		Vs3]	-6,40	0,23	41°29'12,951"N	14°5'17,898"E
		Vs4]	-6,16	-0,17		
Va	Venafro Terme di Agrippa	Va1]	-6,25	11,92	41°30'11,253"N	14°7'0,990"E
		Va2]	-6,22	12,56		
		Va3	-6,14	13,44	41°30'4,608"N	14°6'53,777"E
		Va4 #	-3,97	18,34	41°30'4,042"N	14°6'51,594"E
Su	Suio	Su1 #	-7,77	9,85	41°19'57,826"N	13°52'31,801"E
		Su2 #	-12,93	7,21	41°18'46,794"N	13°53'35,657"E
		Su3	-12,58	7,06	41°18'36,662"N	13°53'38,524"E
		Su4	-12,7	6,88	41°18'36,538"N	13°53'38,741"E
Mi	Minturno	Mi1	-4,2	6,26	41°18'36,538"N	13°53'38,741"E
Ri	Riardo	Ri1	-6,00	11,13	41°14'39,643"N	14°7'41,494"E
		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Te	Telese	Te1	-6,64	5,22		
		Te2]	-7,23	9.45	41°12'40,503"N	14°32'6,483"E
		Te3]	-7,40	8.74		
		Te4 #	-6,65	9,62	41°13'28,554"N	14°31'30,154"E
Am	Amorosi	Am1	-7,08	0.46	41°12'12,748"N	14°30'29,115"E
Mo	Mondragone	Mo1 #	[illegible]	[illegible]	[illegible]	[illegible]
Sa	Sarno	Sa1	-5,86	3.57	40°48'9,405"N	14°37'41,851"E
Ma	Pontecagnano Malche	Ma1	-6,27	-4,33	40°41'31,354"N	14°53'23,251"E
		Ma2	-6,36	-5,71	40°41'30,428"N	14°53'23,456"E
Fa	Faiano	Fa1 #	-5,85	3,04	40°39'56,729"N	14°54'16,738"E
		Fa2 #	-5,33	4.02	40°39'56,613"N	14°54'16,625"E
Co	Contursi	Co1	-6,79	10,45		
		Co2]	-6,54	10,38	40°40'22,237"N	15°14'46,427"E
		Co3]	-6,76	10,32		
		Co4	-6,59	10,32	40°40'21,280"N	15°14'46,822"E
		Co5 #	-6,78	10,28	40°40'29,374"N	15°14'47,861"E
		Co6 #	-6,88	9,11	40°40'21,280"N	15°14'46,822"E
		Co7	-10,77	6.78	40°41'21,416"N	15°14'55,222"E
Pa	Paestum	Pa1 #	-6,20	0,93	40°25'15,302"N	14°59'48,437"E
Ca	Capaccio	Ca1	-6,13	2.31	40°26'52,820"N	15°2'37,309"E
Vi	Villamaina	Vi1	-8,32	6,14	40°59'14,620"N	15°3'10,190"E
		Vi2	-8,23	4,41	40°59'17,450"N	15°3'9,840"E
Li	Lioni	Li1	-6,22	8,12	40°52'31,209"N	15°11'21,136"E
		Li2	-6,3	11,13	40°52'42,047"N	15°11'4,853"E
Mc	Monticchio Bagni	Mc1	-5,94	8,03	40°57'10,078"N	15°33'31,313"E
		Mc2 #	-8,07	7,89	40°57'1,936"N	15°35'16,709"E

sample from Present-day deposits

After Ascione,et al., (2014), *Terra Nova*, 26, 1, p. 1-13.



Sulphureous spring
T IV terraces
T IV terraces
T IV terraces
First order fans
Recent fan lobes
Slope breccias
Solopaca sinkholes
Limestones bedrock
- Sinkholes testify to hyperkarst processes due to fluids uprising
- Sinkholes interest different sedimentary successions
- Different cross-cut relationships betwen sinkholes and fault scarps
Recurrence of faulting and collapses during last 100 ka
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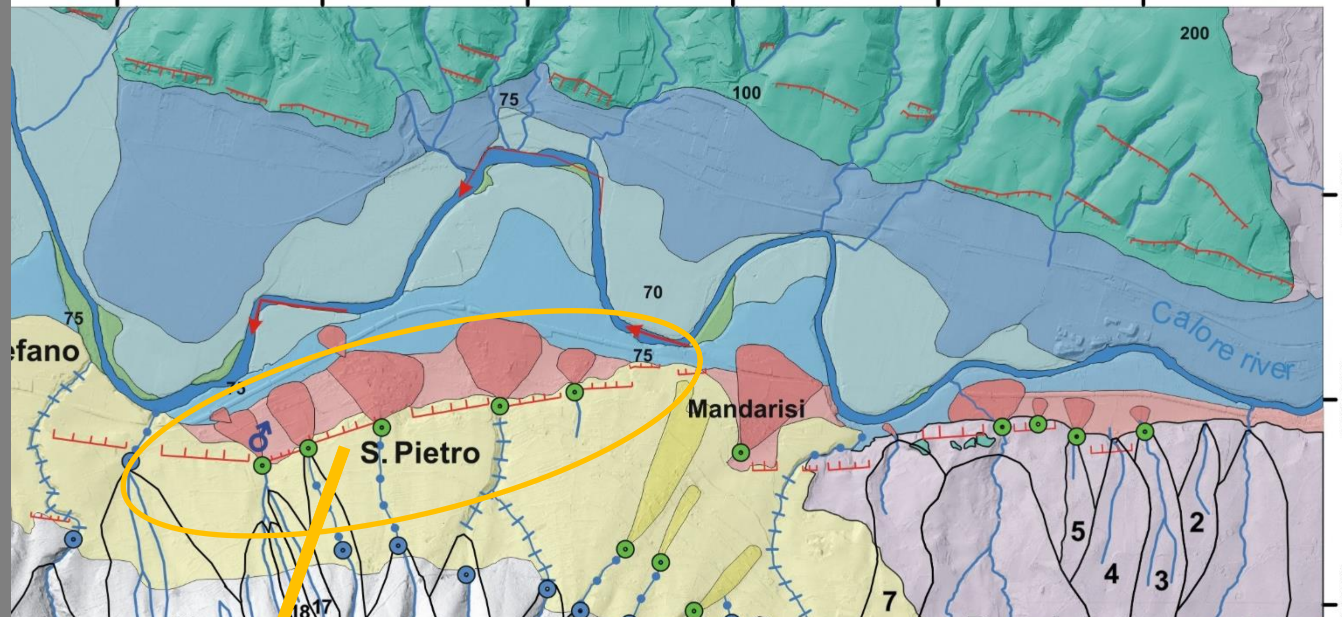
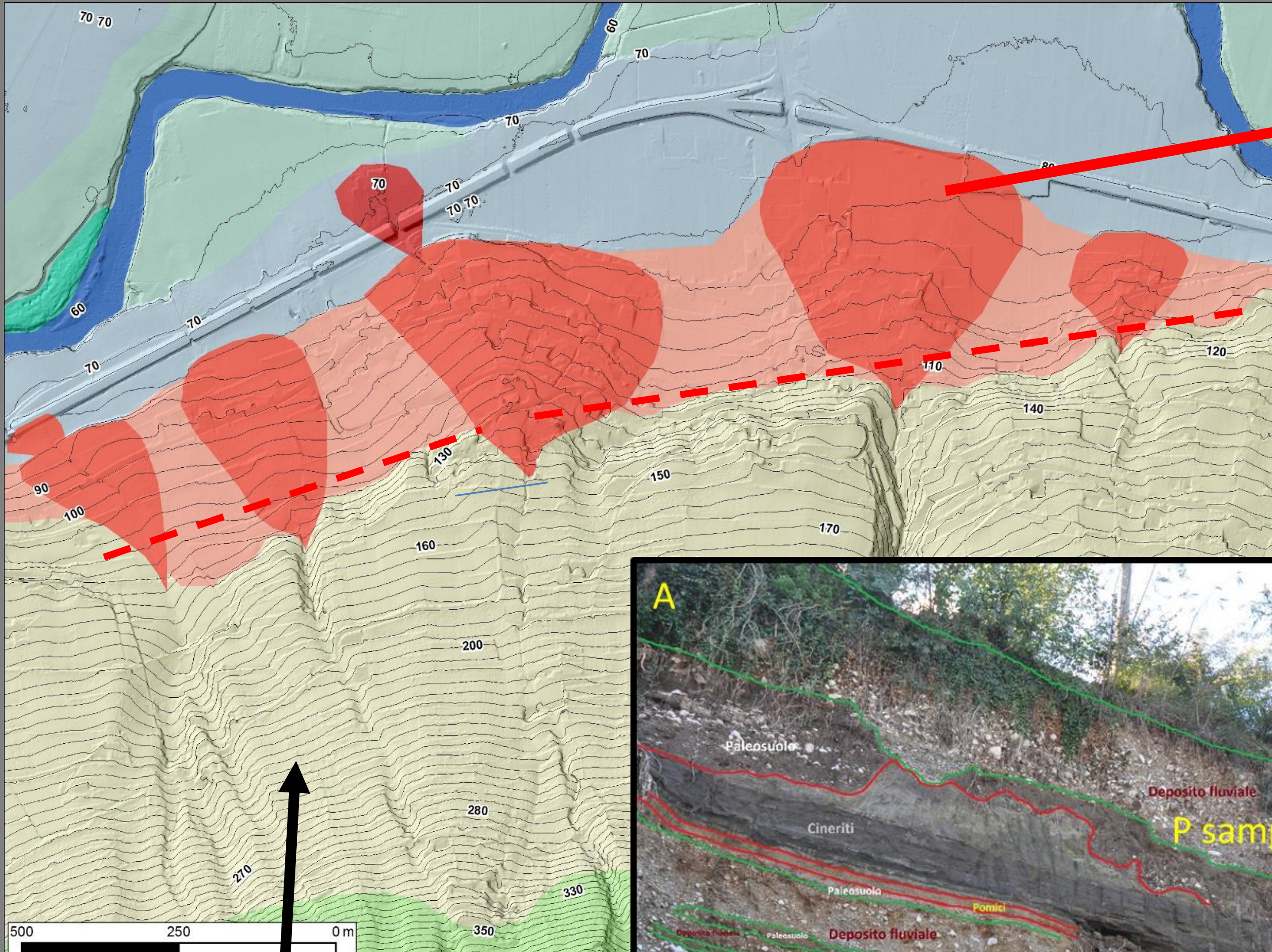

200
100
75
70
75
efano
75
S. Pietro
Mandarisi
Calore river
4563000
4562000
5
4
3
2
7

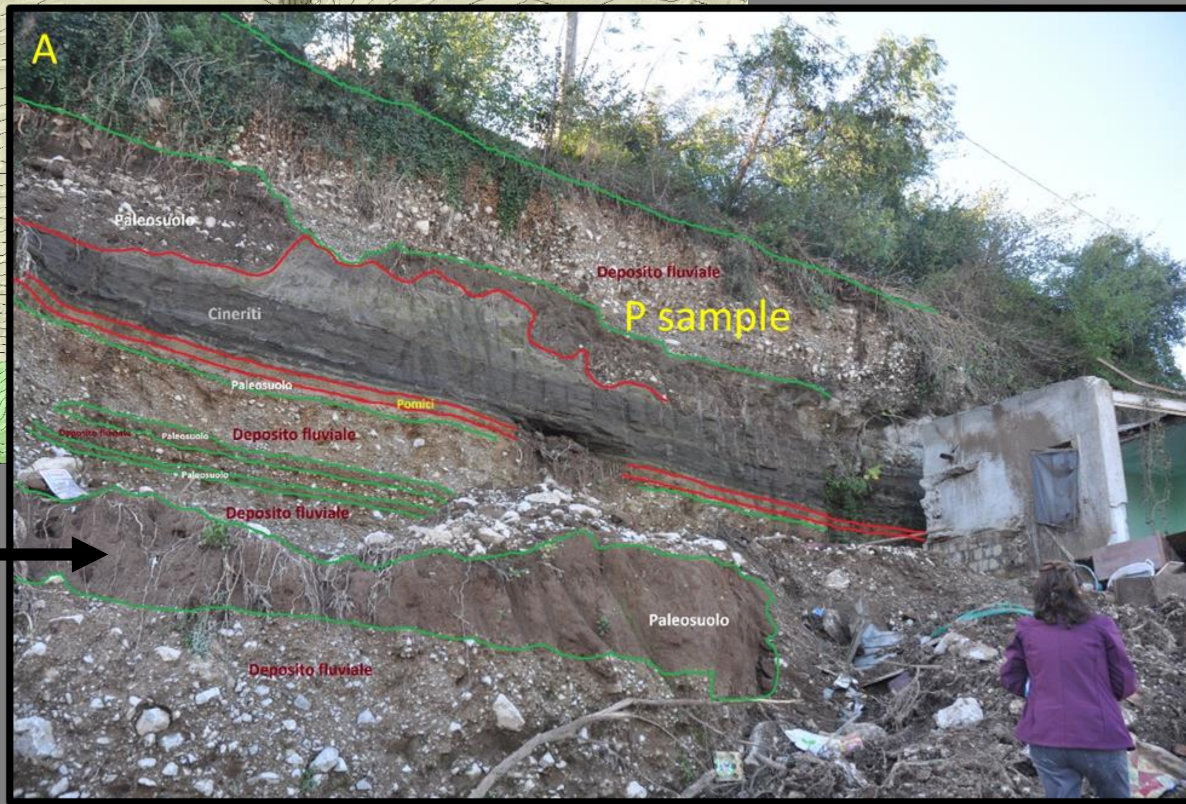

JAV ORTHOMOSAIC
Scale 1:9000
Calore river
anto Stefano
Calore river
San Pietro
Site P
Site P1
Pau
15
16
17
18
19
20
21
14
13
12
11



Second order of fan

The scarp is between 30 and 50 meters high

First order of fan



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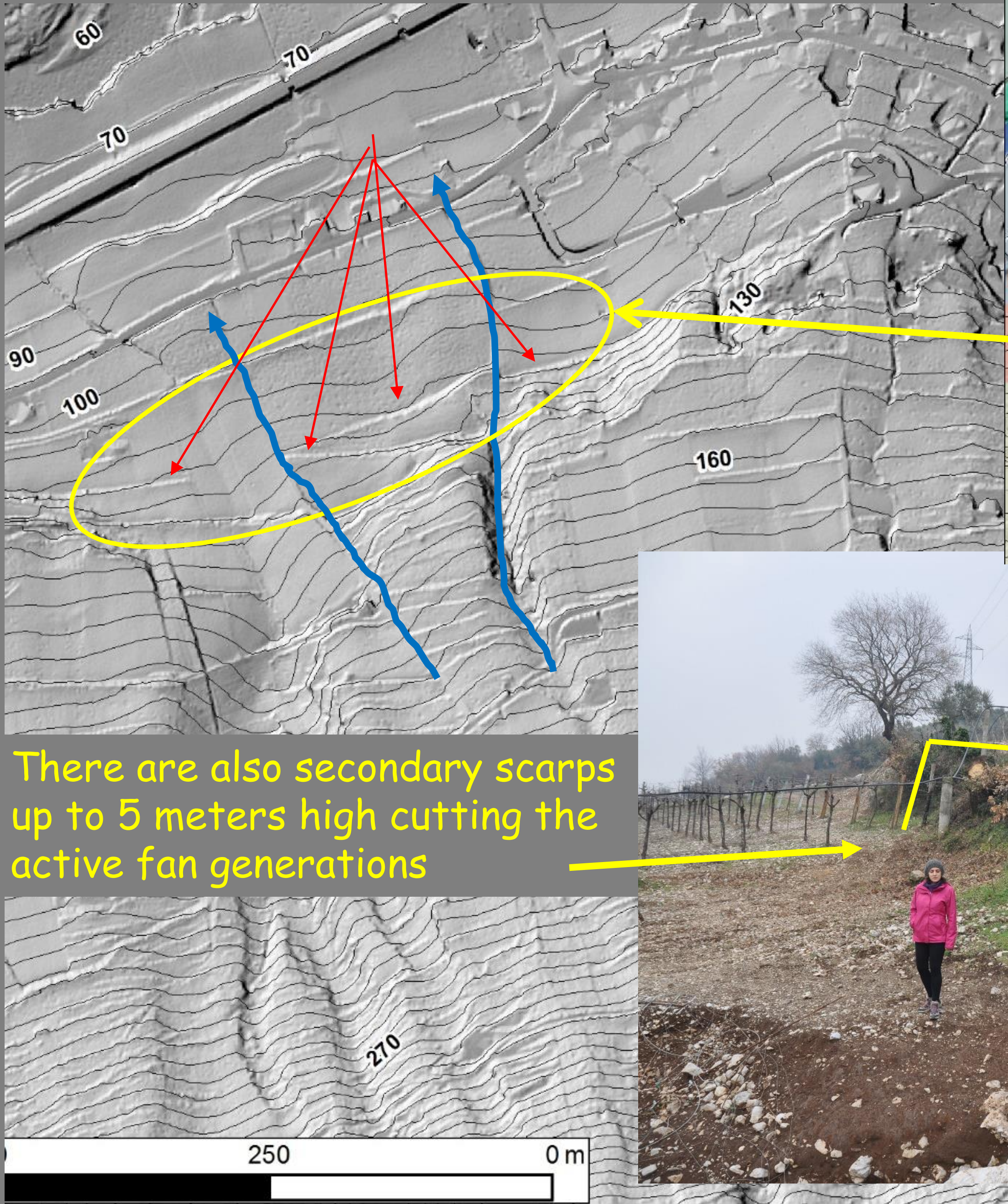
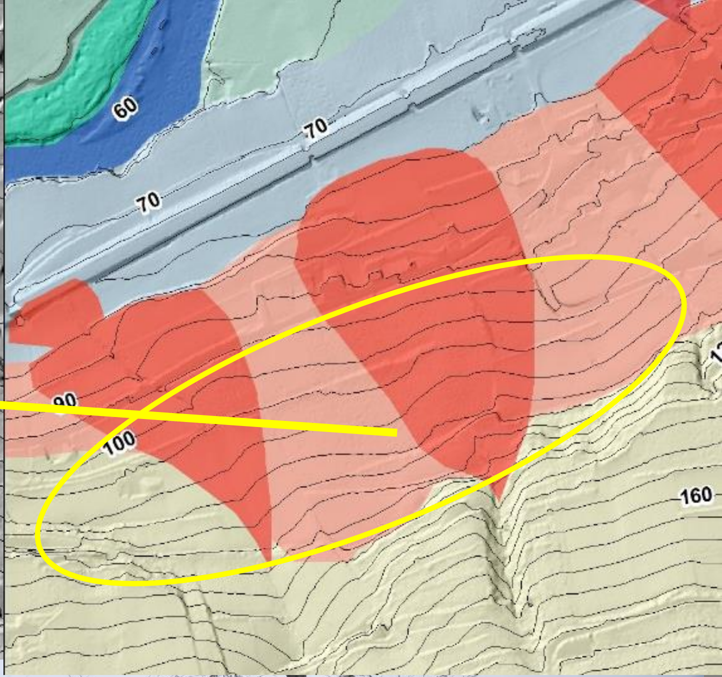
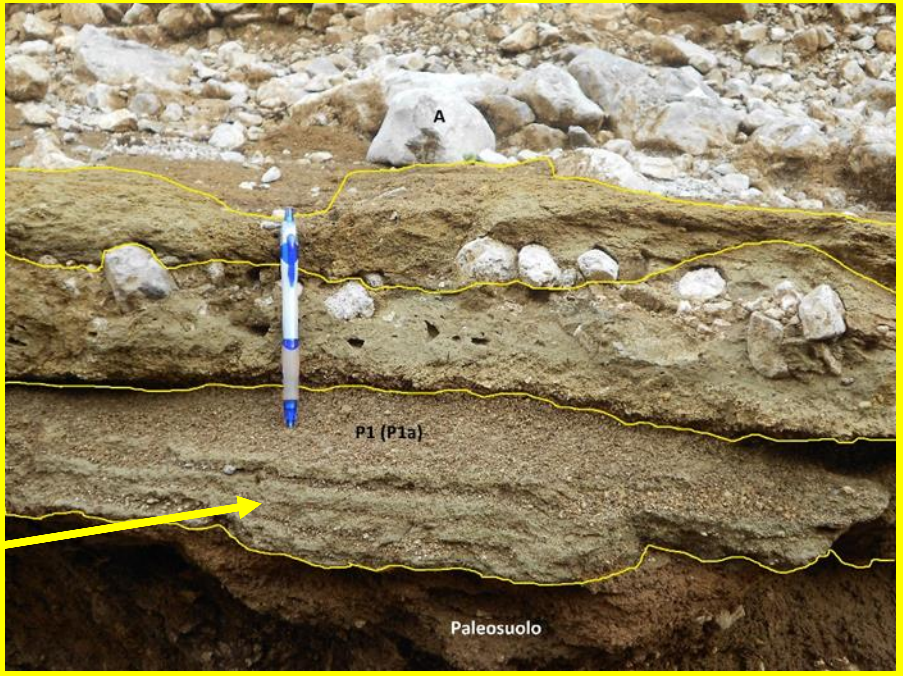




There are also secondary scarps up to 5 meters high cutting the active fan generations


Main fault scarp
Secondary fault scarp



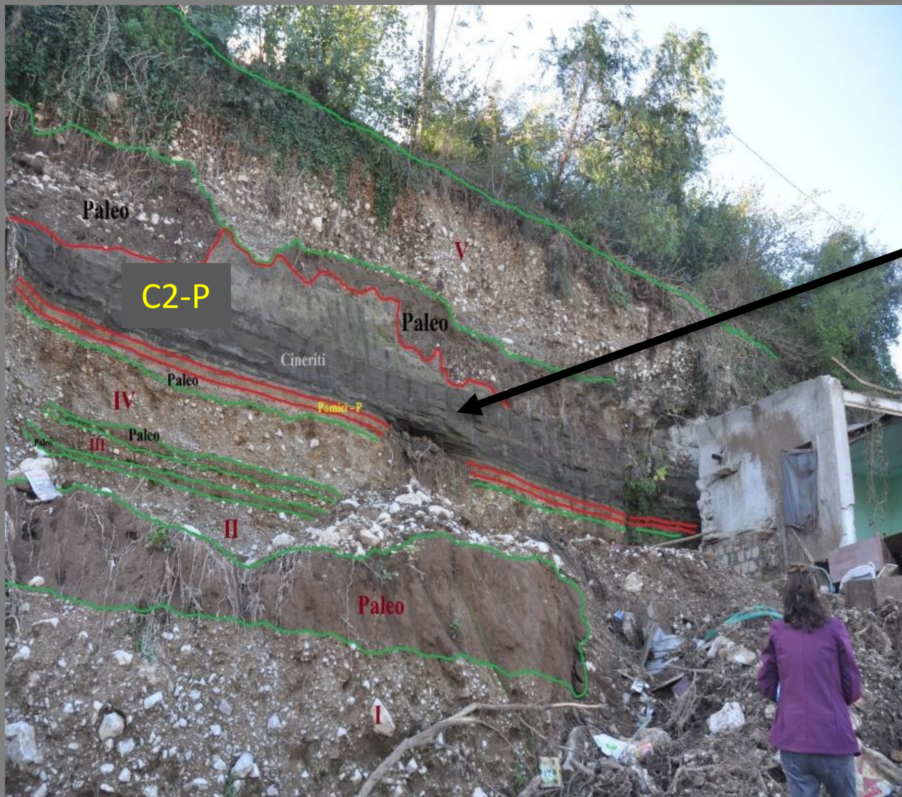
These secondary scarps cuts the active fan generation and produce anomalies in stream longitudinal profiles, controlling erosion and deposition processes

Also the active fans contain marker pyroclastic layers

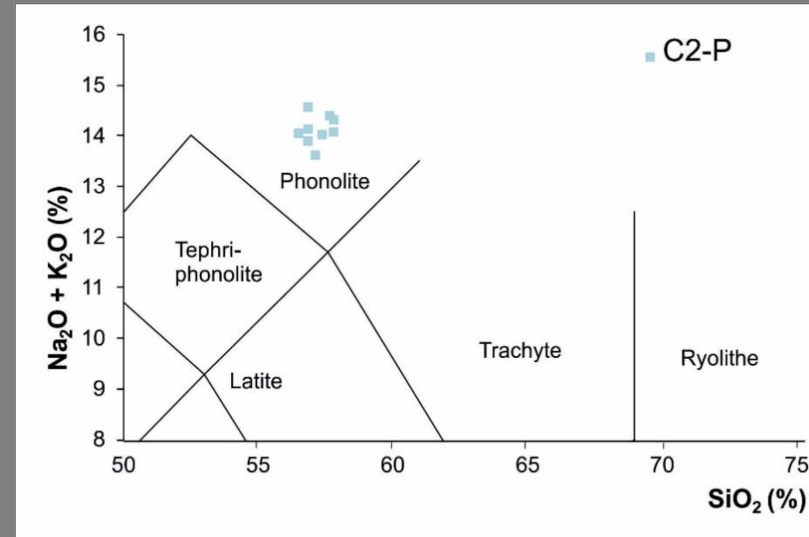
Trace of jointing at the mesoscale

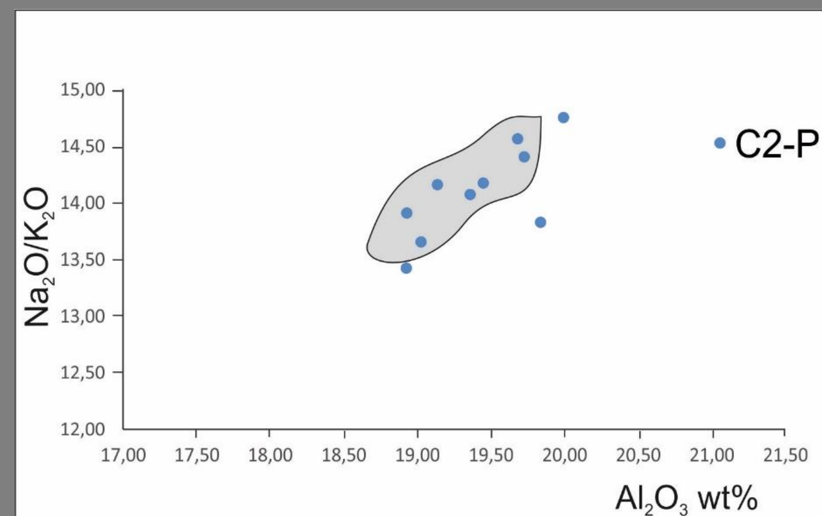
Trace of faulting at the mesoscale

Distal tephra layers



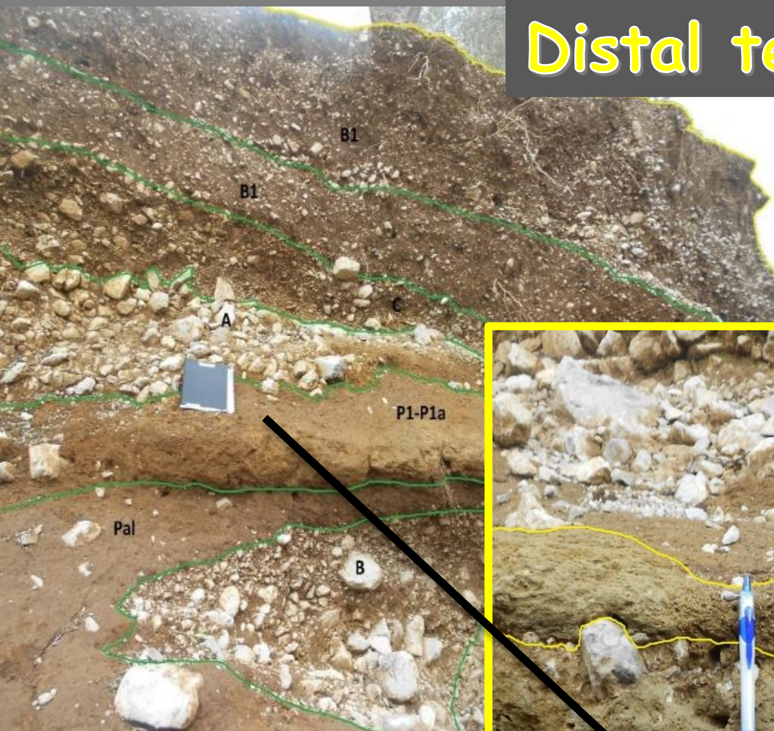
The phonolitic composition of layer C2-P is quite typical, since it shows an Al_2O_3 wt% fairly exceeding 19% and a Na_2O content around 5%. This composition has been already recorded in tephra Sep5 from San Marco Evangelista drill hole (Santangelo et al., 2010), whose age was stratigraphically constrained <u>between 105 and 130 ka.</u>

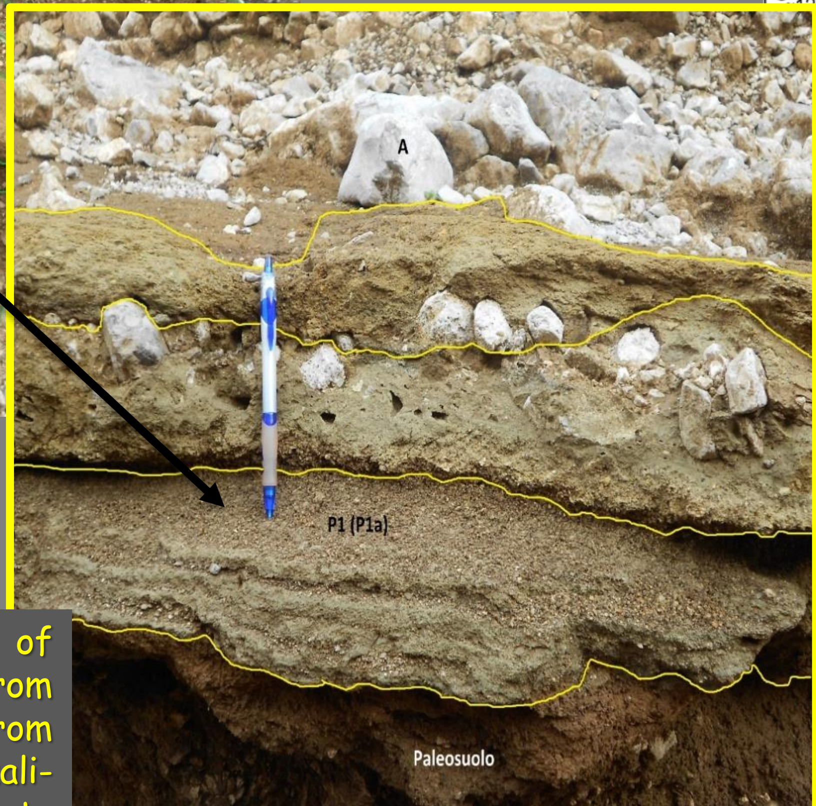




TAS diagram and compositional field of tephra Sep5 from San Marco Evangelista, used for comparison.

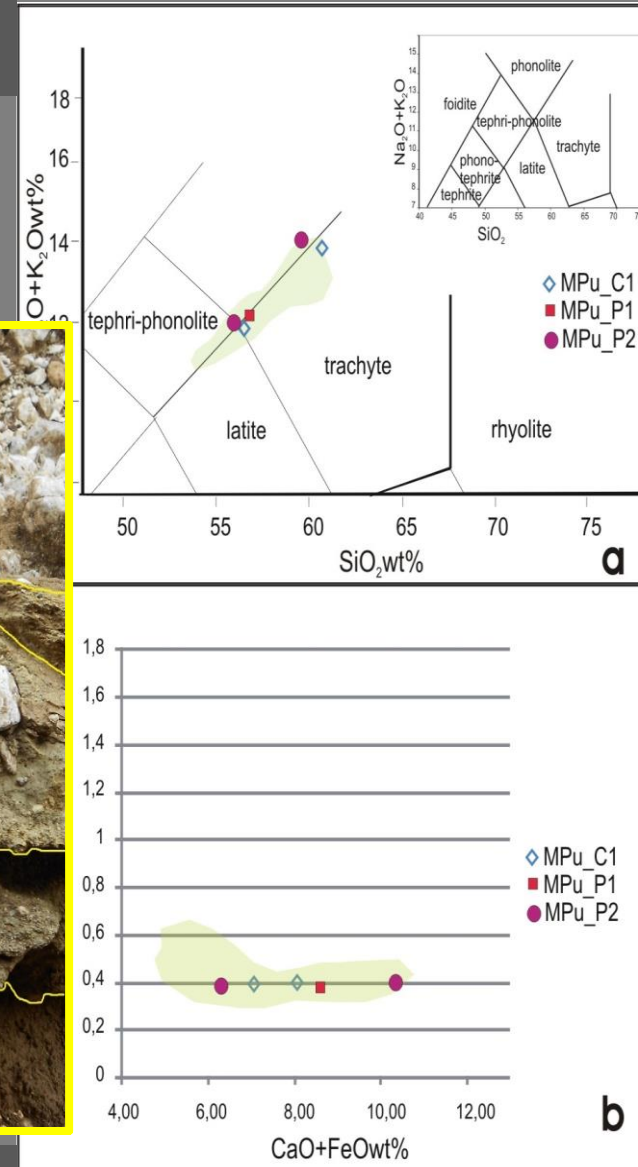
Distal tephra layers



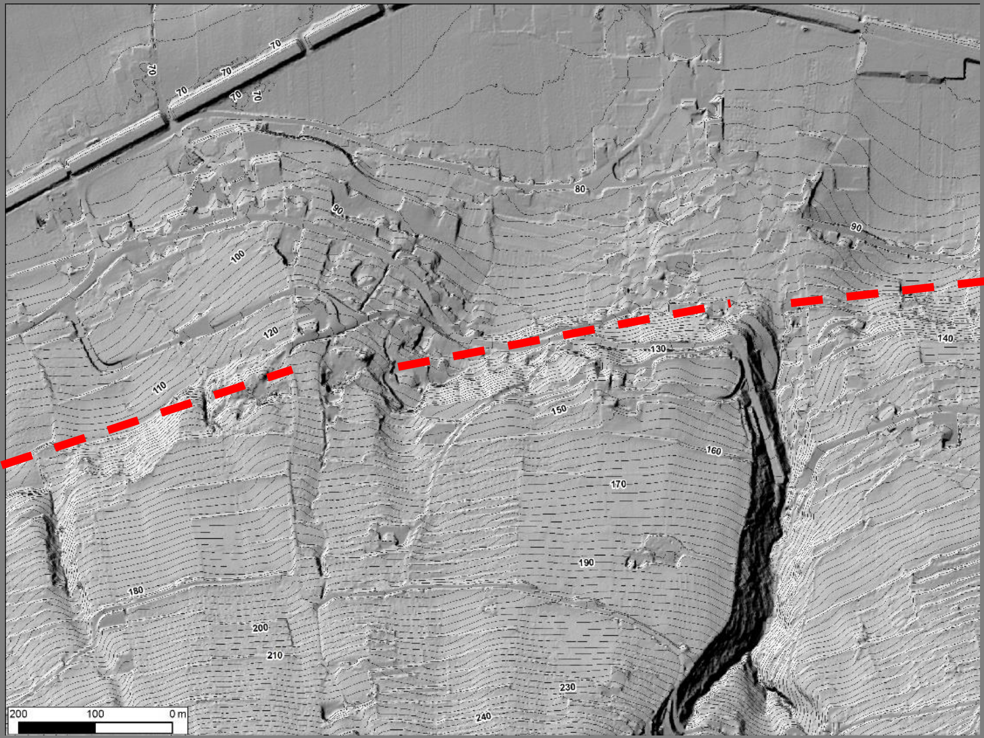


Compositional variability of glasses extracted from younger tephra layers (from tephri-phonolite to alkali-trachyte) allows us to correlate them to the Neapolitan Yellow Tuff, a huge explosive event from Campi Flegrei aged ca. 15 ka.

Tephra layer P1 where fine whitish pumice fragments and good sorting are well evident.



Compositional fields of Neapolitan Yellow Tuff and correlated samples.



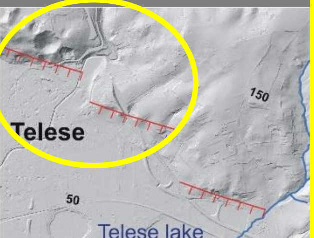
Main scarp:
40 meters
Aged 105 ka>x>15ka

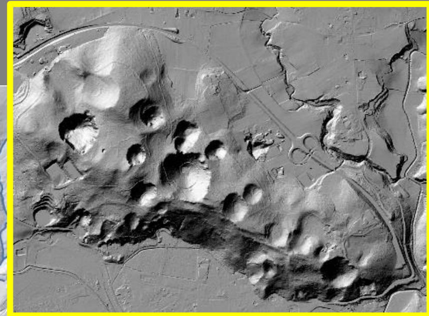
Mean rate: 0,4 mm/y

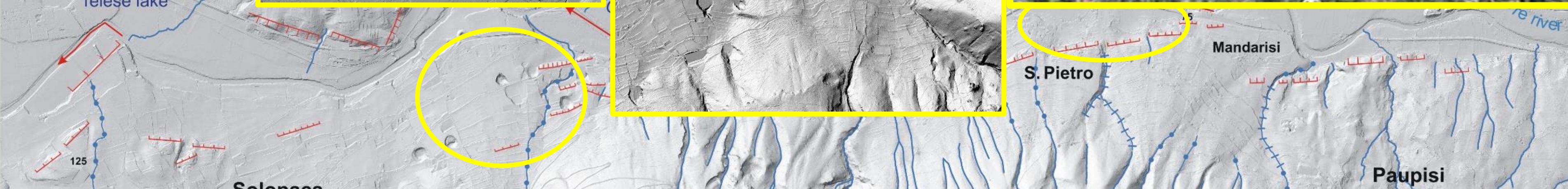
Secondary scarp
4 meters
Aged <15 ka

Mean rate 0,26 mm/yr

In conclusion:







The Calore river fault system is characterized by the presence of several geomorphological indicators of active faulting ranging from fault scarps, to river network anomalies

The high concentration of sinkholes and the presence of travertines testify to the uprising of deep fluids along the western termination of this system

The tectonic scarp located in the surrounding of Paupisi is around 2 kilometers long, and represent one of the best preserved surface expression of the Calore river Fault system.

This scarp is at least 40 meters high and the collected data testify to an age younger than 100 ka. It also shows clear evidence of recent tectonic activity (younger than 15 ka), represented by minor scarps up to 4 m high, cutting the youngest fan generation.

The collected data suggest that the area has been repeatedly interested in the past by strong earthquakes capable to originated significant surface effects such as surface faulting and ground collapses

…………………Thank you for your kind attention