VHR seismic imaging of displacem nt along an active off-shore fault syst m of the Adriatic foreland

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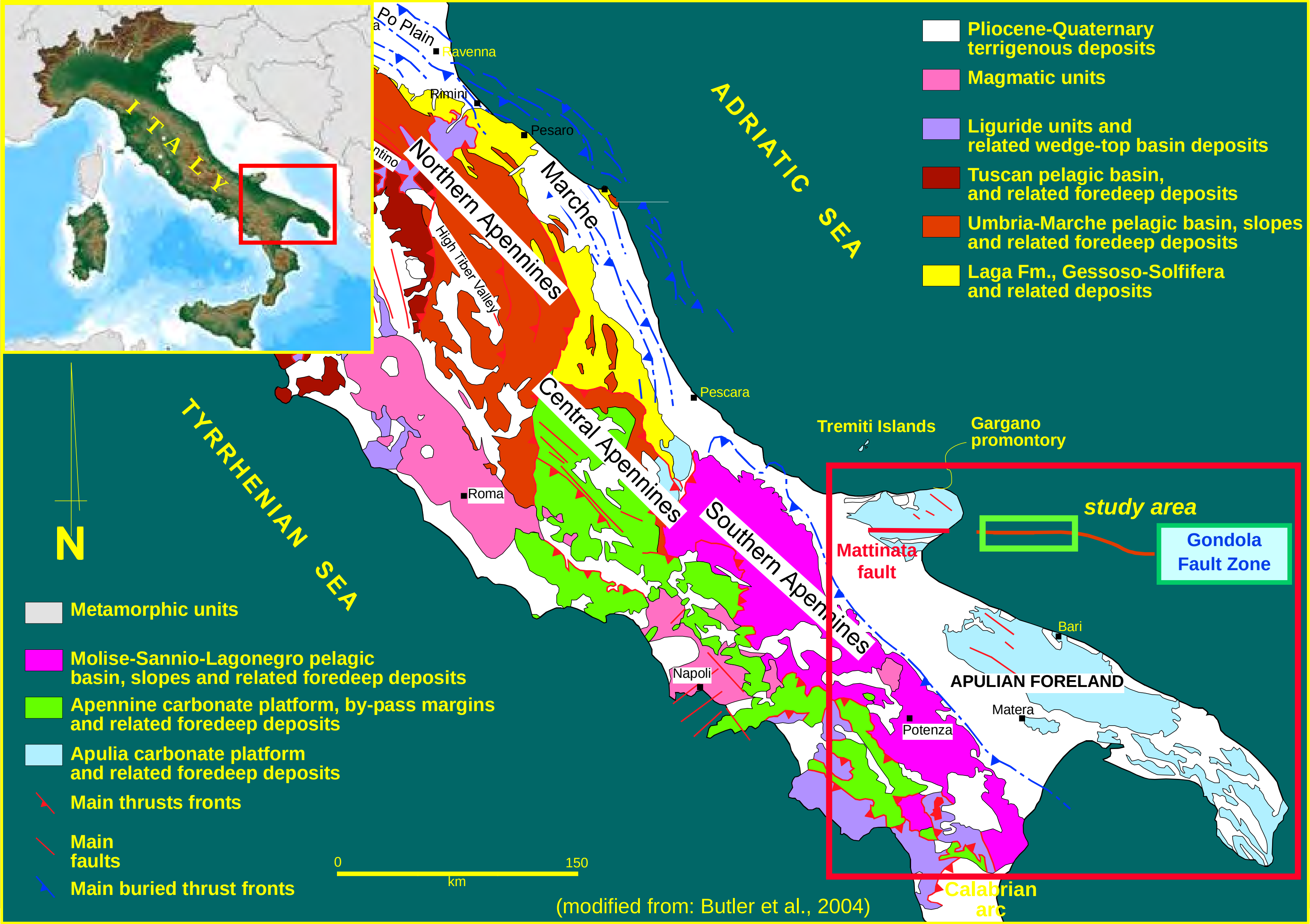
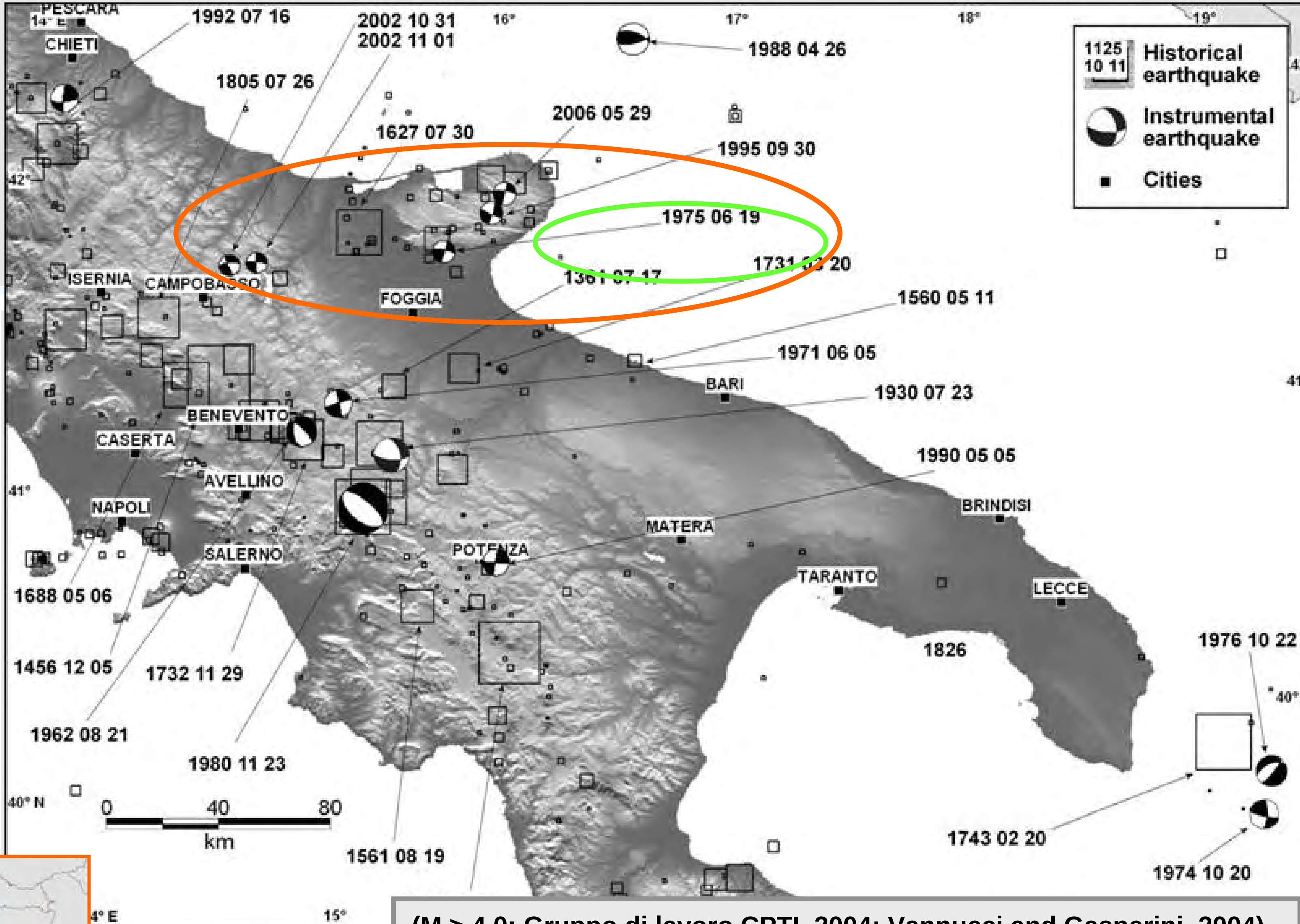
GRUPPO NAZIONALE DI GEOFISICA DELLA TERRA SOLIDA
26° Convegno Nazionale

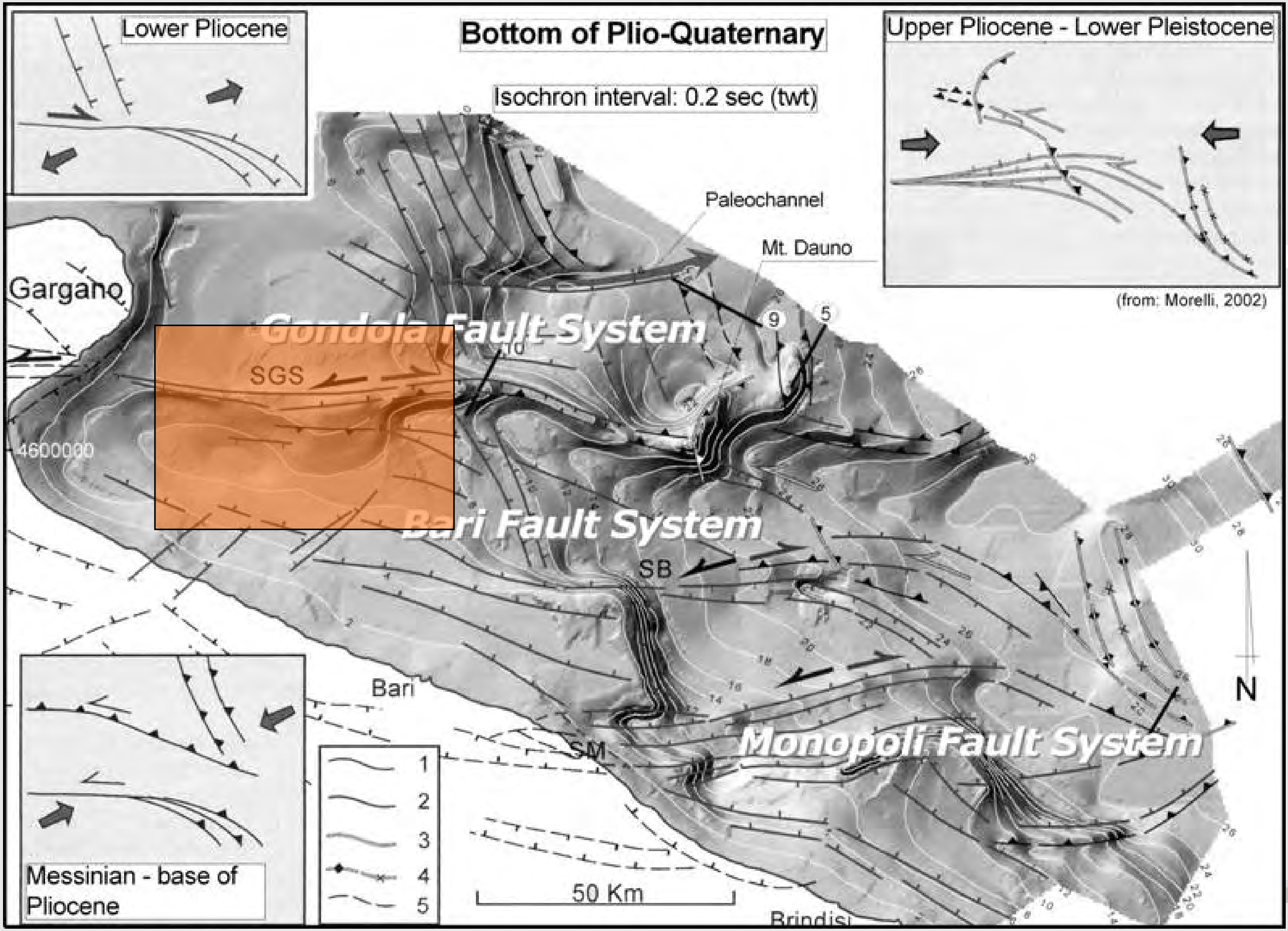


Study area and regional geological setting



(M > 4.0; Gruppo di lavoro CPTI, 2004; Vannucci and Gasperini, 2004). The size of the square symbols is proportional to an equivalent magnitude derived from intensity data.

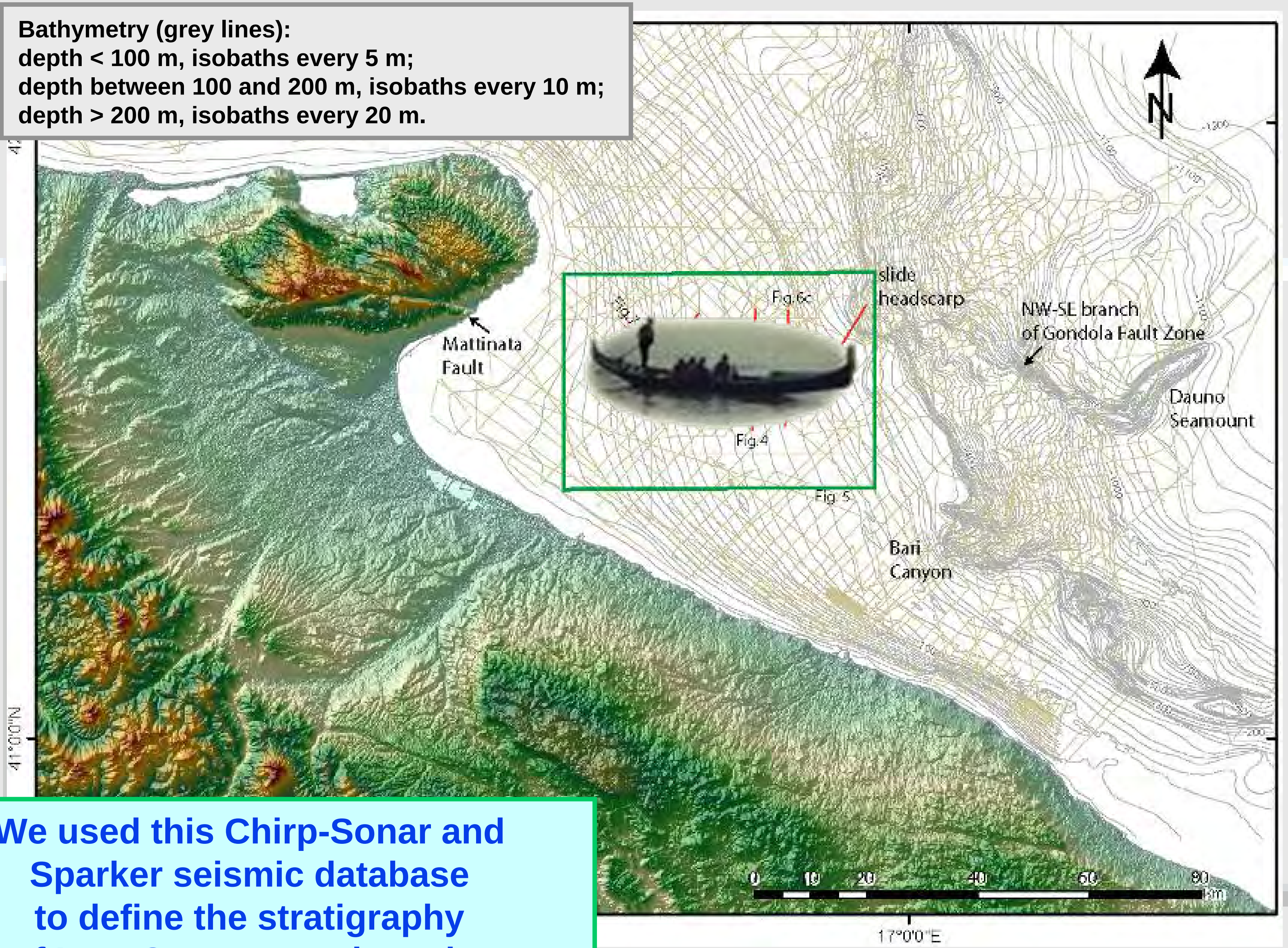
Historical and instrumental earthquakes of the Central and Southern Apennines



Structural setting of the Gondola Fault Zone and nearby areas

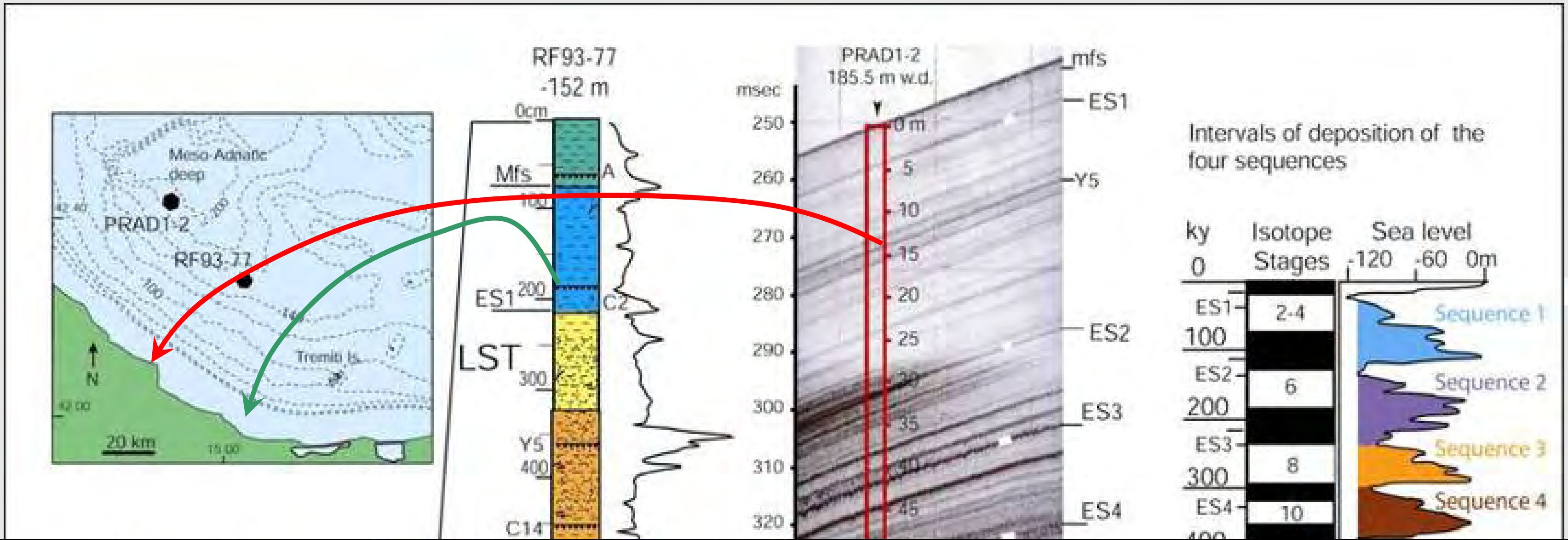
based on high-penetration/low-resolution seismic data

Bathymetry (grey lines):
depth < 100 m, isobaths every 5 m;
depth between 100 and 200 m, isobaths every 10 m;
depth > 200 m, isobaths every 20 m.



We used this Chirp-Sonar and Sparker seismic database to define the stratigraphy of Late Quaternary deposits and the pattern of active deformation

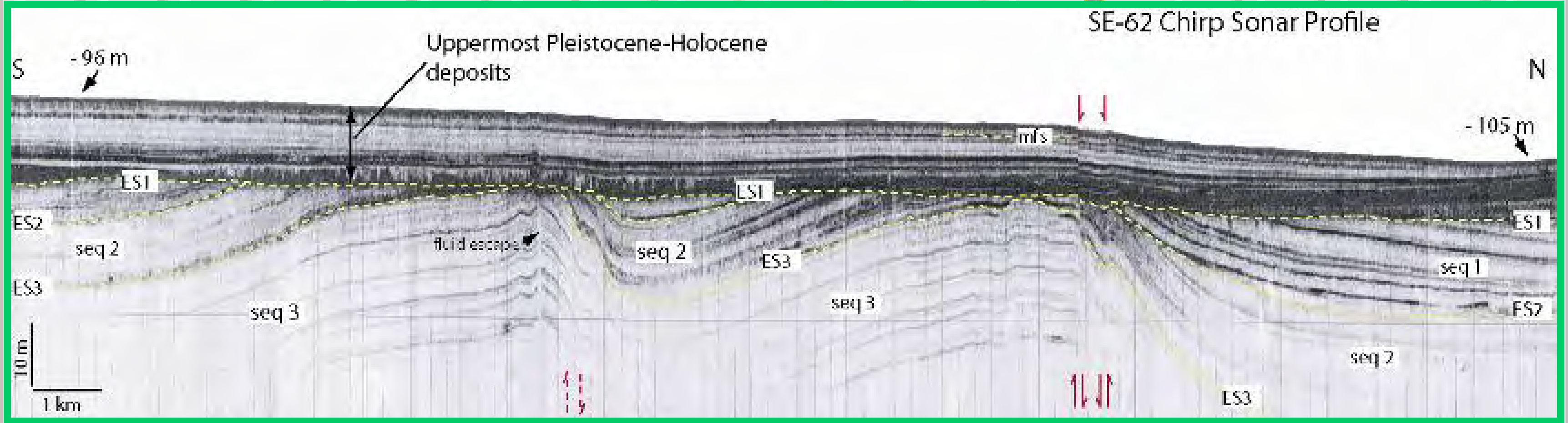
High-resolution seismic database



Sequence	**Oxygen Isotope** Stage	**Age (ka)**	**Erosional Surface**
		Present-day – 20/30	ES1
Sequence 1	OIS 2-6	20/30 – 130/140	ES2
Sequence 2	OIS 6-8	130/140 – 230/250	ES3
Sequence 3	OIS 8-10	230/250 – 330/350	ES4
Sequence 4	OIS 10-12	330/350 – 430/450	ES5

Depositional sequences and time lapses

All along the E-W segment of the Gondola Fault Zone, late Quaternary deposits appear folded and faulted (locally up to seafloor).

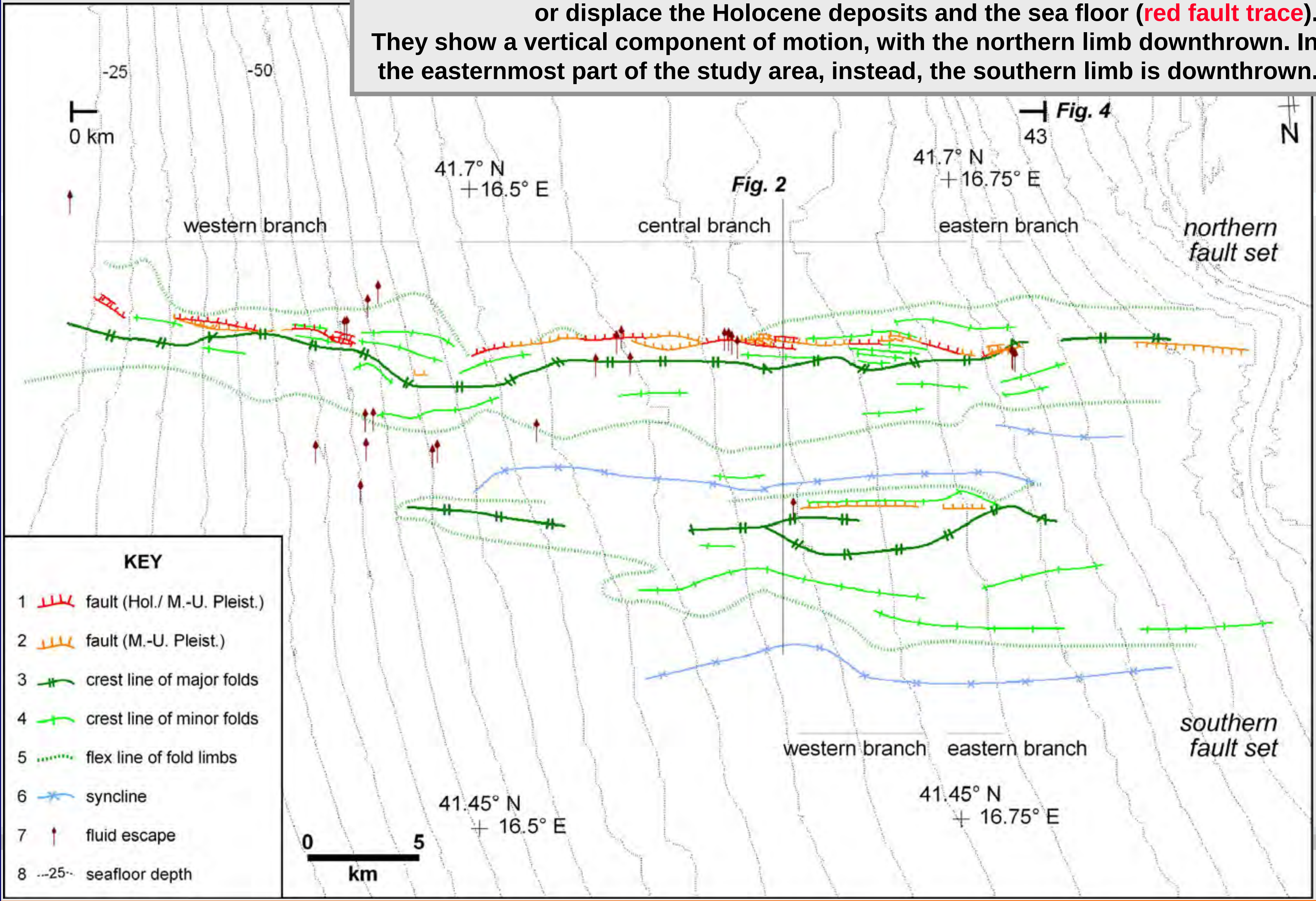


notice the vertical exaggeration

mfs = 5.5 ka maximum flooding surface

Key stratigraphic and structural features of the study area

Two major anticlines affected by a fault system can be identified. The faults may appear sealed by the ES1 surface (orange fault trace) or displace the Holocene deposits and the sea floor (red fault trace). They show a vertical component of motion, with the northern limb downthrown. In the easternmost part of the study area, instead, the southern limb is downthrown.

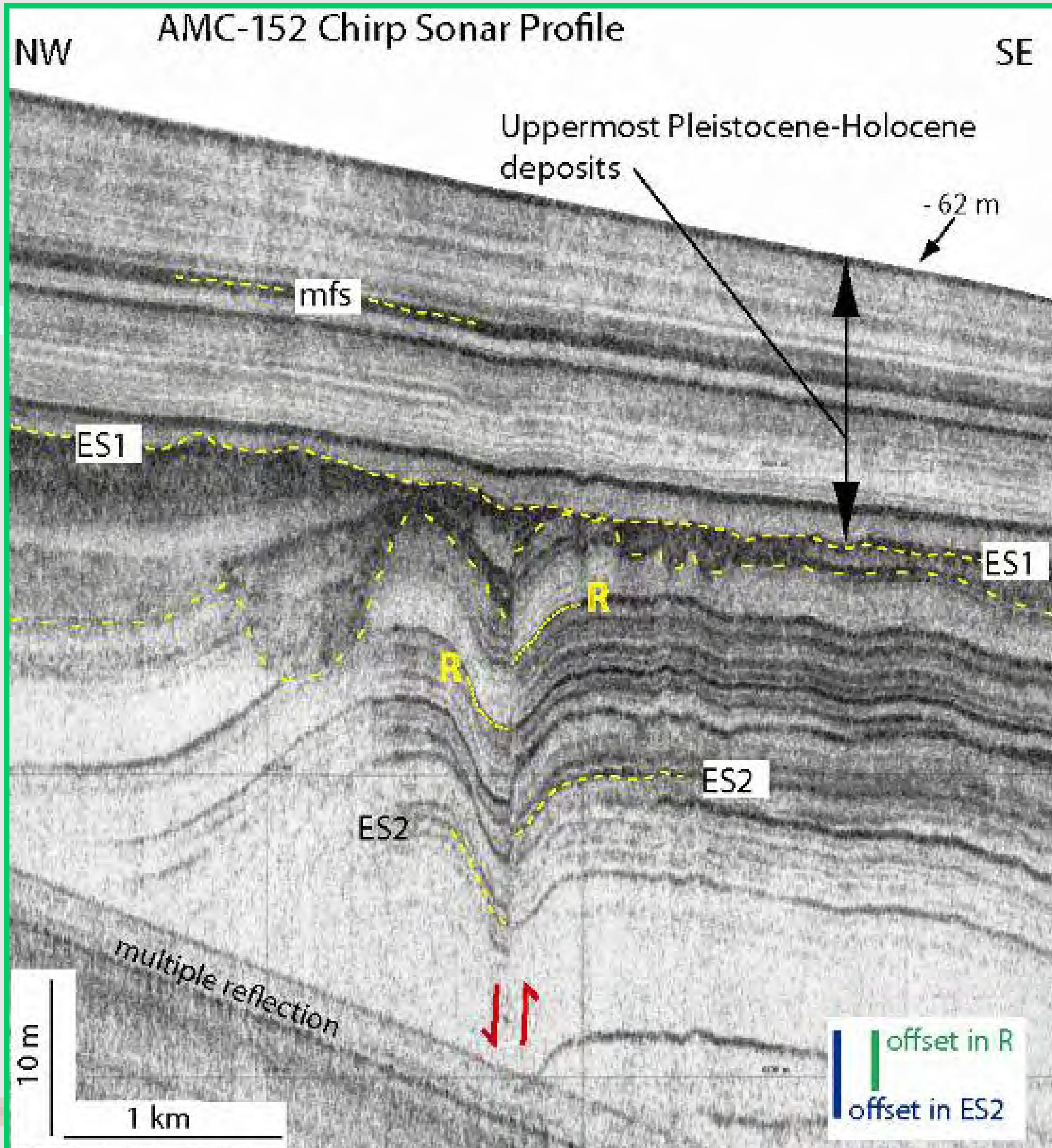


Structural map of the Gondola Fault Zone

Evidence of a secondary fold on the downthrown (northern) limb of the northern fault.

We interpreted this kind of features as the expression of an unresolved strike-slip component of motion.

Also notice the variable offset of reflectors along the fault plane.



An example of Chirp Sonar seismic profile

The entire deformation pattern of the Gondola Fault Zone suggests a significant strike-slip component of motion. Also at local scale, near-fault hanging-wall deformation suggests that the observed faults may well slip with an unresolved lateral component of motion.

The overall geometry, formed by fault segments with minor vertical separation, connected by non-faulted sections where the anticline is better developed, supports dextral slip.

Unfortunately, our data did not allow us to estimate the horizontal displacement.

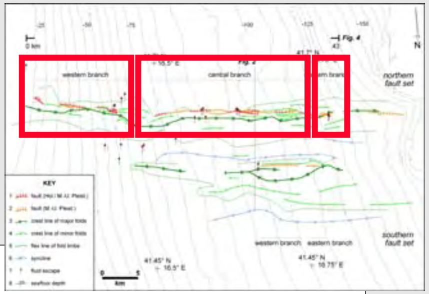
We further integrated our studies with the analysis of new and closely-spaced (ca. 500-600 m) VHR seismic lines acquired during a 2006 cruise. The density of the data set allowed us to focus on the distribution in space and time of the

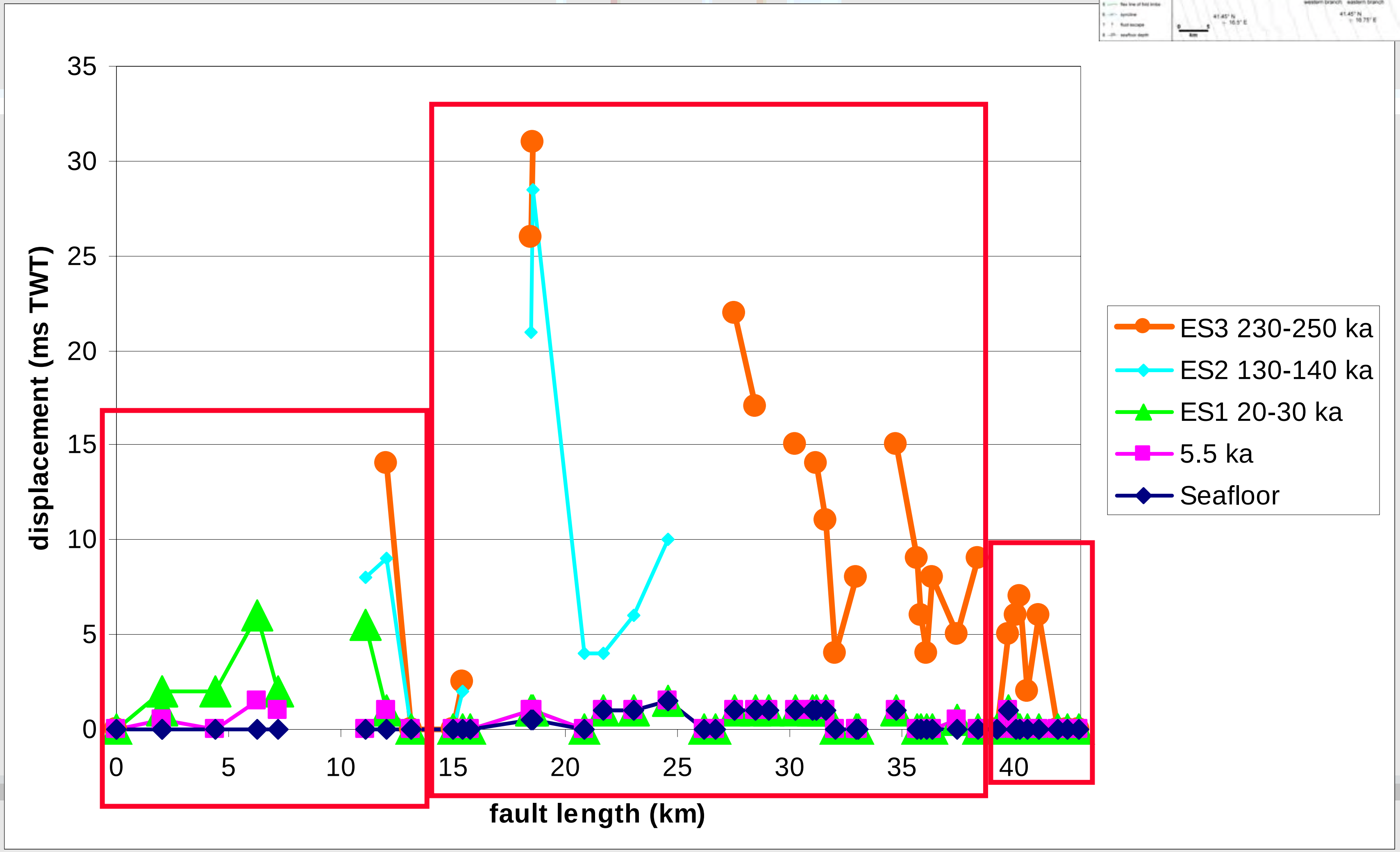
vertical displacement

measured on the fault planes dissecting shallow deposits up to the seafloor along the E-W branch of the Gondola Fault Zone.

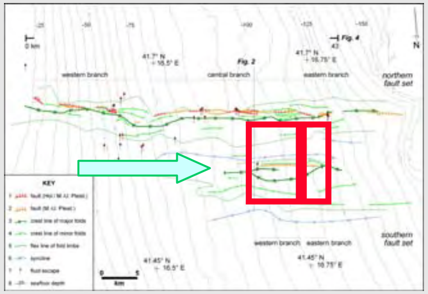
1 ms TWT = ca. 0.75 m

W E

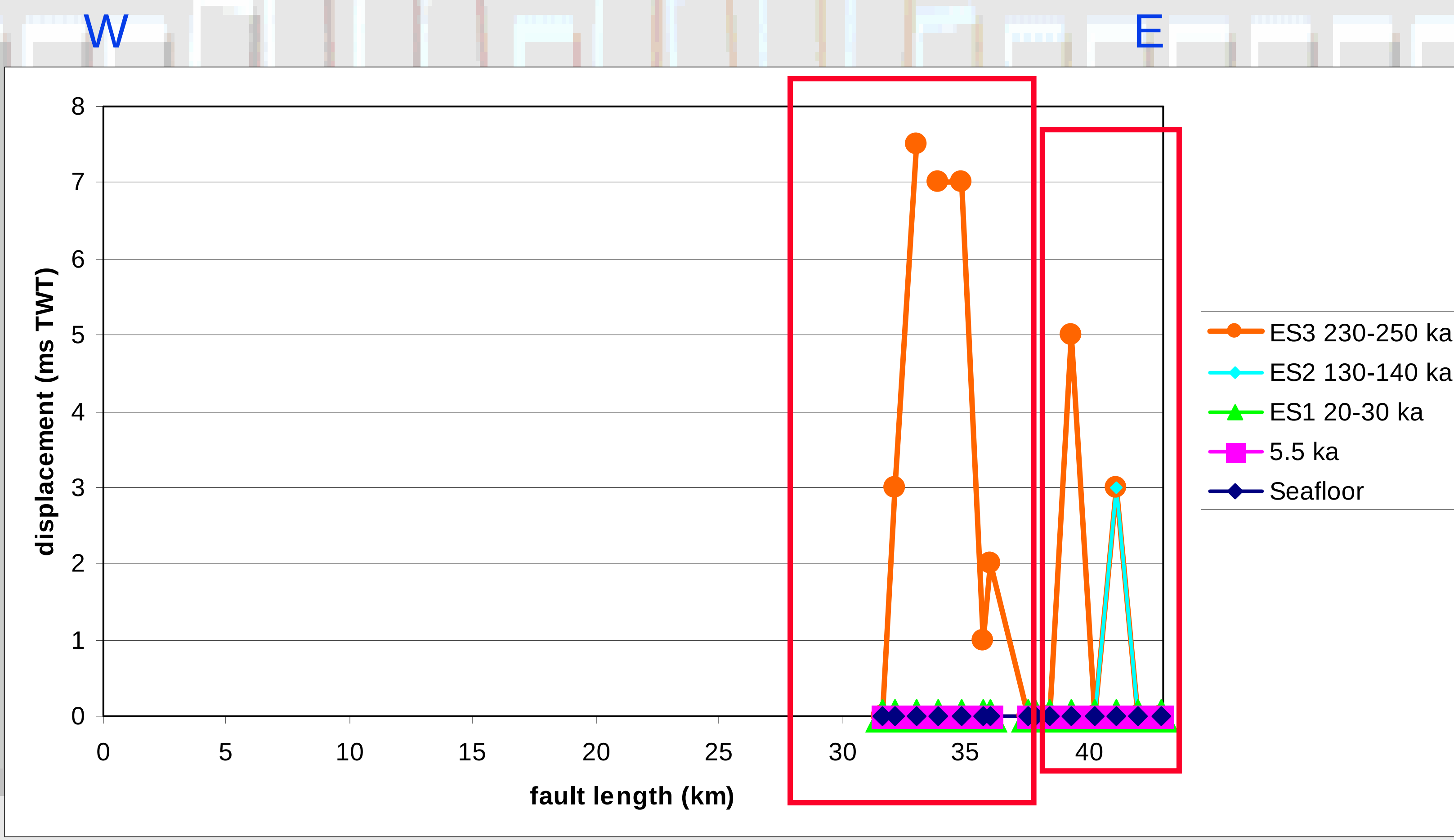




Vertical displacement along the northern fault set



1 ms TWT = ca. 0.75 m

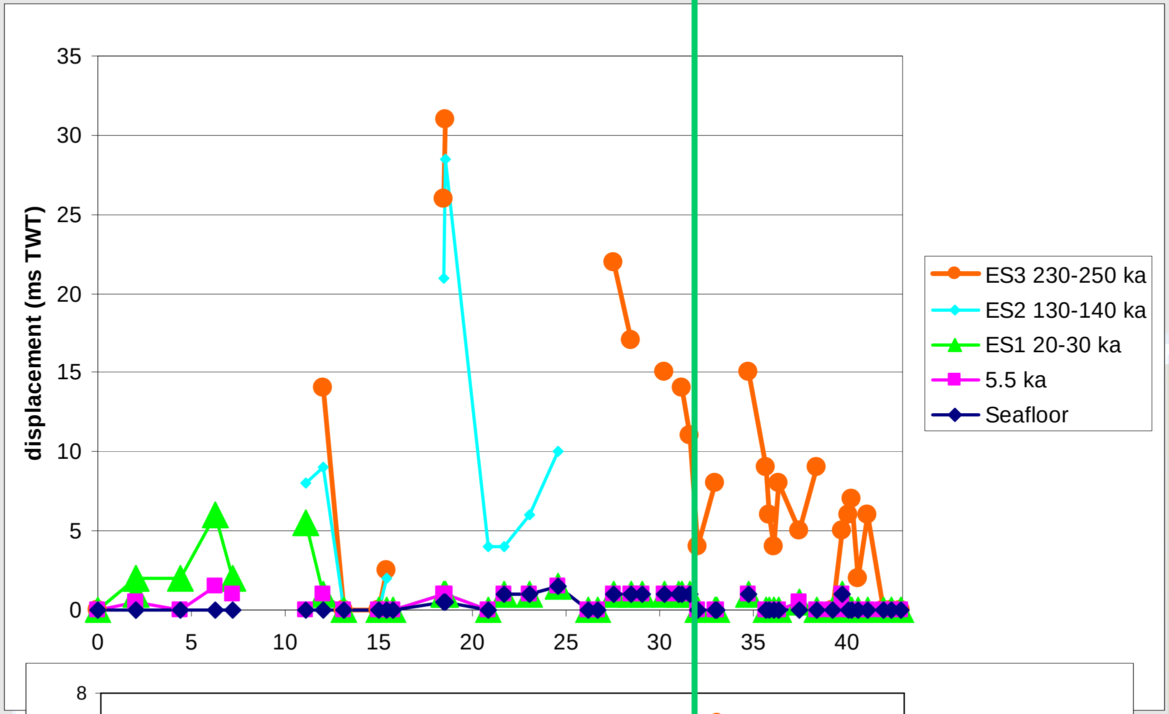


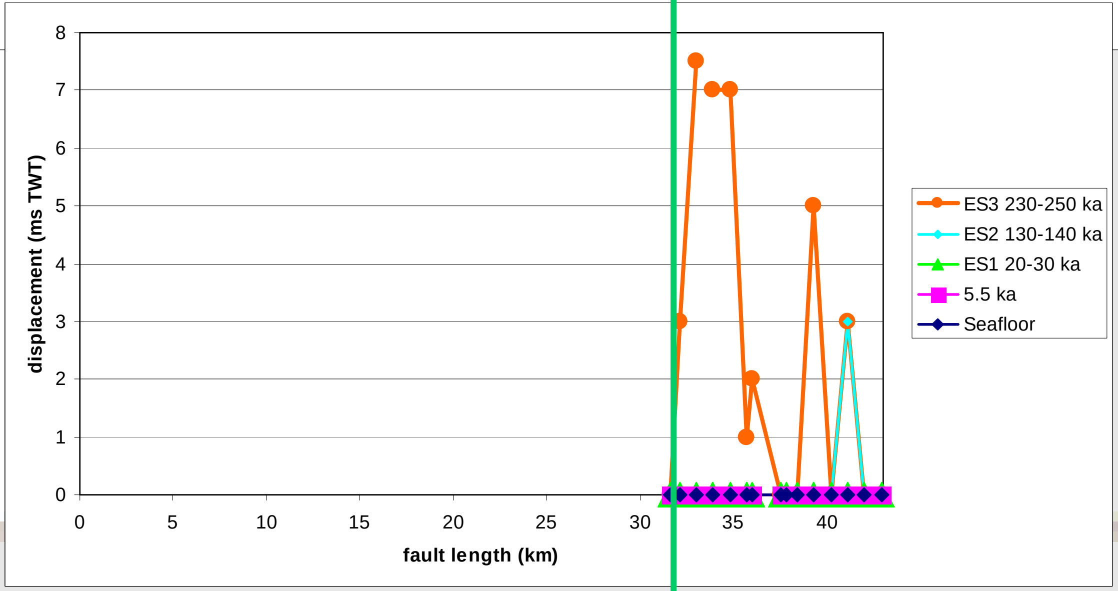
Vertical displacement along the southern fault set

W

E

different vertical scales





1 ms TWT = ca. 0.75 m

Comparison

D = cumulative values of displacement

ΔD = differential values of displacement

	Northern fault set (from W to E)			Marker surface (mean age)	Southern fault set (from W to E)	
Branch length (km)	*11.60*	*23.65*	*2.02*		*4.90*	*2.70*
D (ms TWT)	14	31	7	**ES3 (240 ka)**	7.5	5
D (m)	10.5	23.25	5.25		5.65	3.75
Slip rate (mm/a)	**0.04**	**0.10**	**0.02**		**0.02**	**0.02**
D (ms TWT)	9	28.5	-	**ES2 (135 ka)**	-	3
D (m)	6.75	21.38	-		-	2.25
Slip rate (mm/a)	**0.05**	**0.16**	**-**		**-**	**0.02**
D (ms TWT)	6	1.5	1	**ES1 (25 ka)**	0	0
D (m)	4.5	1.13	0.75		0	0
Slip rate (mm/a)	**0.18**	**0.05**	**0.03**		**0**	**0**

	Northern fault set (from W to E)			Time interval (mean age)	Southern fault set (from W to E)	
Branch length (km)	*11.60*	*23.65*	*2.02*		*4.90*	*2.70*
Δ D (m)	3.75	1.87	4.50	**ES3-ES2 (105 ka)**	5.65	1.50
Δ Slip rate (mm/a)	**0.04**	**0.02**	**0.04**		**0.05**	**0.01**
Δ D (m)	2.25	20.25	-	**ES2-ES1 (105 ka)**	-	2.25
Δ Slip rate (mm/a)	**0.02**	**0.19**	**-**		**-**	**0.02**
Δ D (m)	4.5	1.13	0.75	**ES1-present (25 ka)**	0	0
Δ Slip rate (mm/a)	**0.18**	**0.05**	**0.03**		**0**	**0**

Vertical slip rates

• **The bell-shaped distribution of the displacements suggests a long-term behavior of the GFZ as a single structure.**

• **However, the irregular displacement distribution on the different branches and the related slip rates, i.e. the evidence of distinct deformation histories, implies that this single structure is composed of fault segments that can slip independently.**

•**A long-term homogeneous behavior of the GFZ, operating as a single structure, is also supported by the evidence of comparable and low values within a limited range (0 - 0.18 mm/a) for all branches.**

- Apart from the differentiated deformation rates, our data are strikingly similar to those acquired with comparable methods along well-known, major seismogenic fault systems, e.g. along the North Anatolian Fault (Polonia et al., 2004) or in the Panama Canal (Pratt et al., 2003).

- Moreover, the vertical slip rates here presented are comparable with those calculated from surface geological data along the Mattinata Fault (0.2-0.3 mm/a; Tondi et al., 2005), a known seismogenic source sharing the same tectonic environment of the GFZ.

- Surface evidence thus suggests that the GFZ as well may be seismogenic. Defining the structural relationships between its shallower and deeper portions, up to typical hypocentral depth, is therefore fundamental for a correct assessment of its seismogenic potential.

Thank you!