Earthquakes of 20.05.2012 and successive

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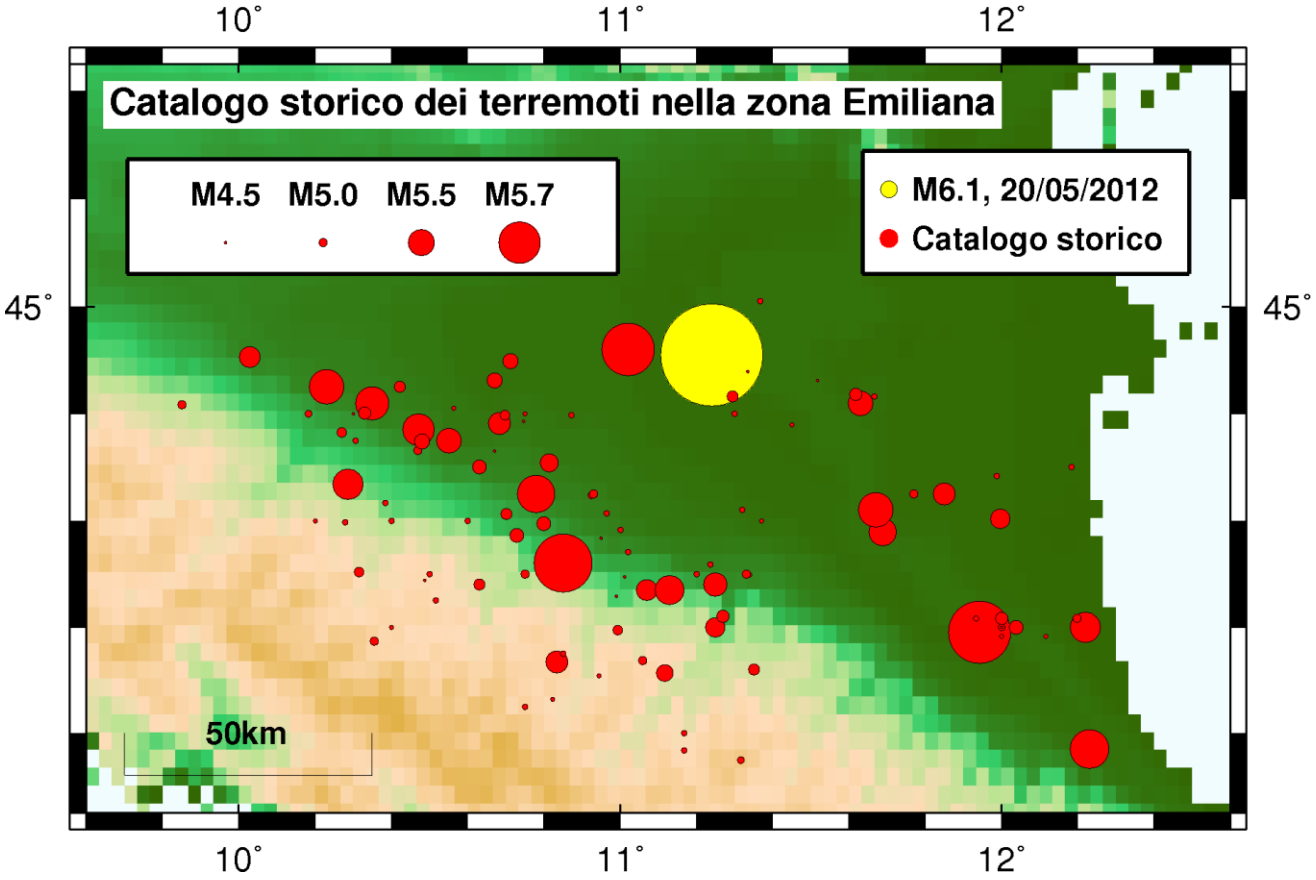
Historical Seismicity:

1234 M 5.8 +/-.2 near Ferrara

1570 M 5.5 Ferrara

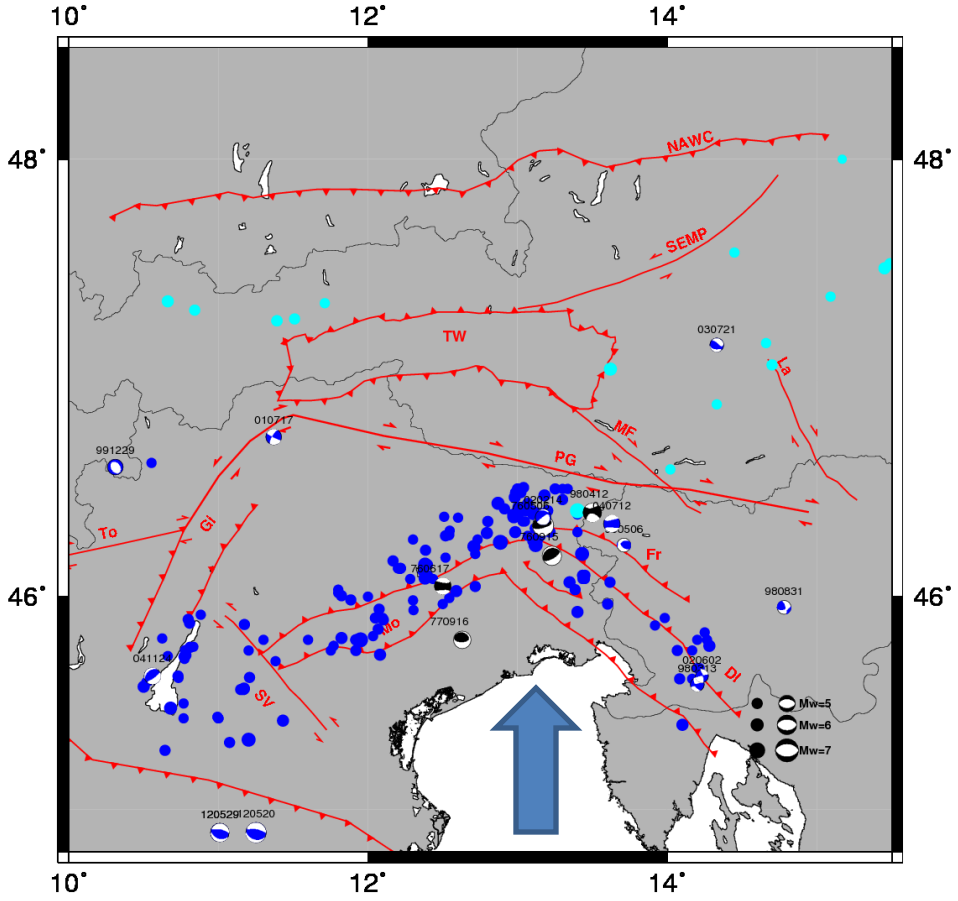
1909 M 5.5 Lower Po plain

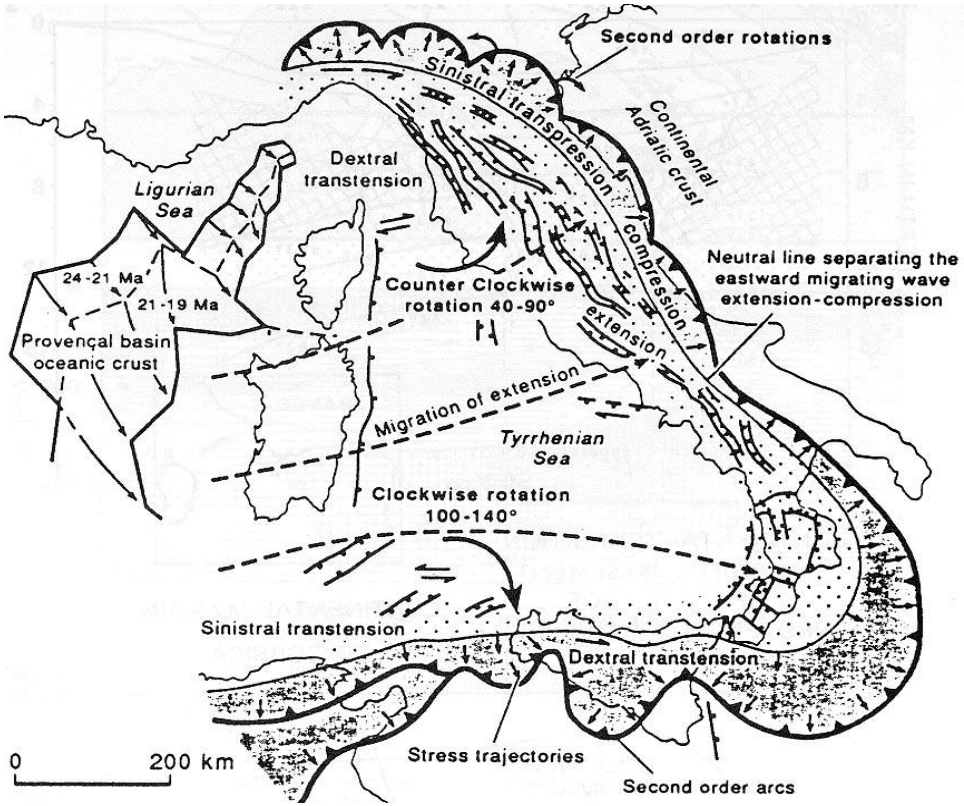


Tectonic setting

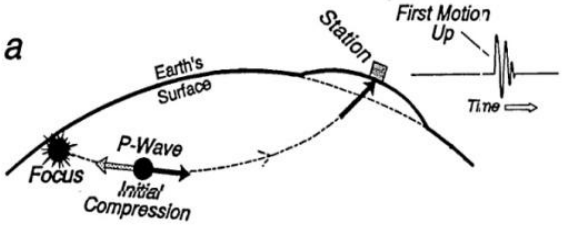
Two concurrent active processes:

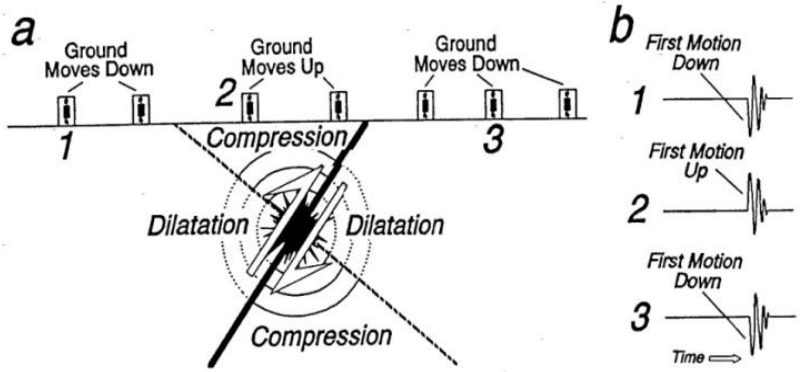
- counterclockwise rotation of the Apennines related to the opening of the Thyrrenian sea
- Northwards convergence of the Adria microplate towards the stable European foreland





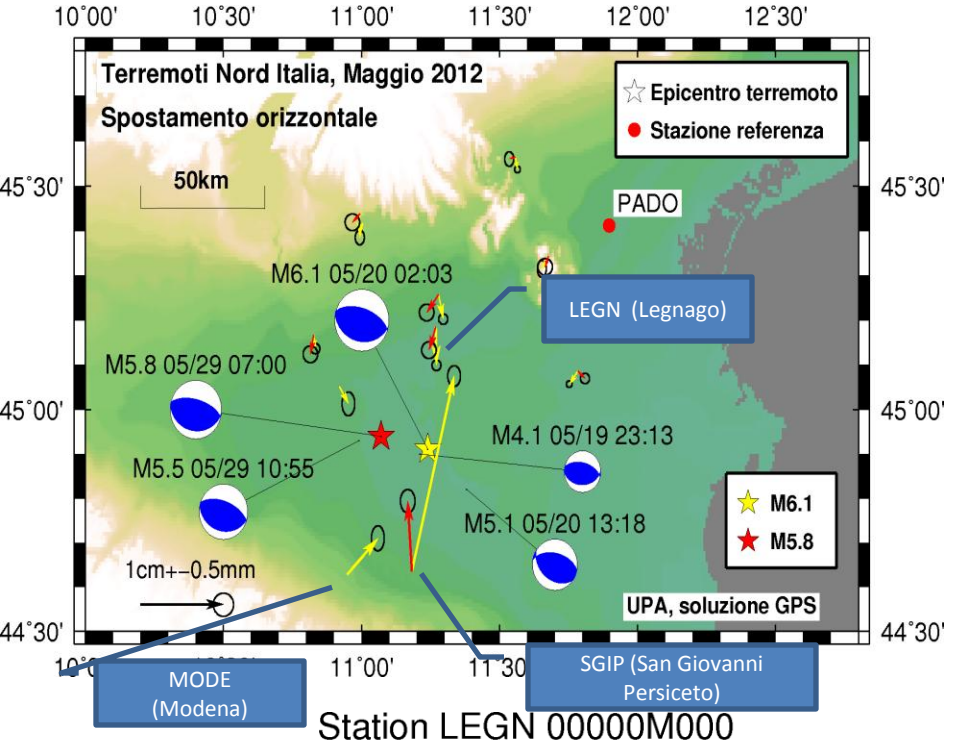
Pressure and Tension axes of the Fault Plane Solution indicate a reverse faulting: coherent with structural setting

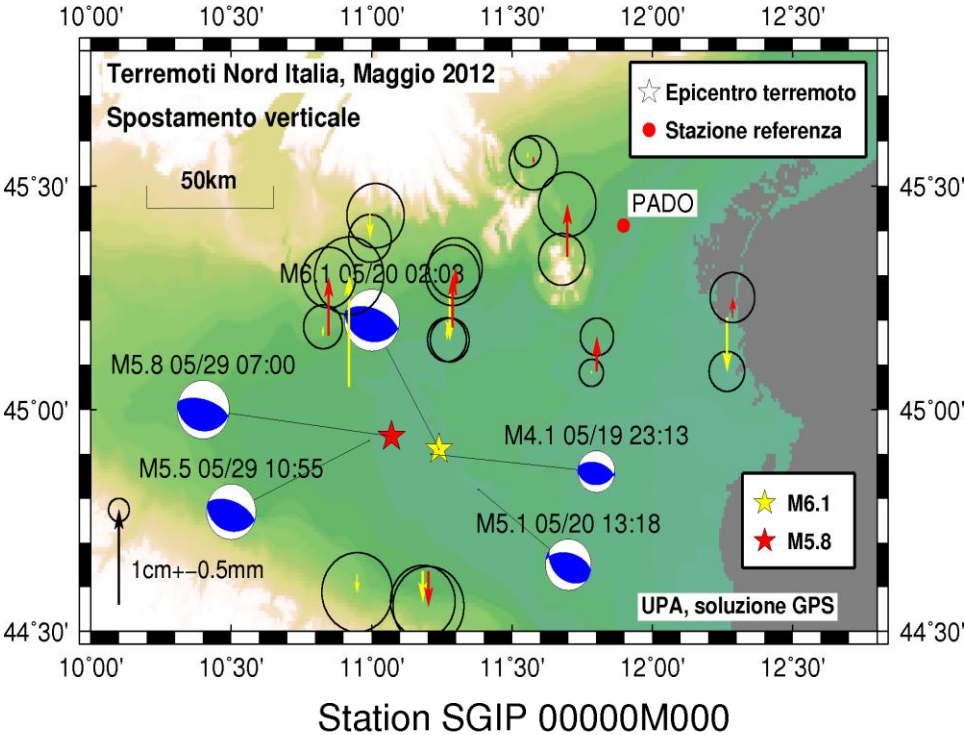


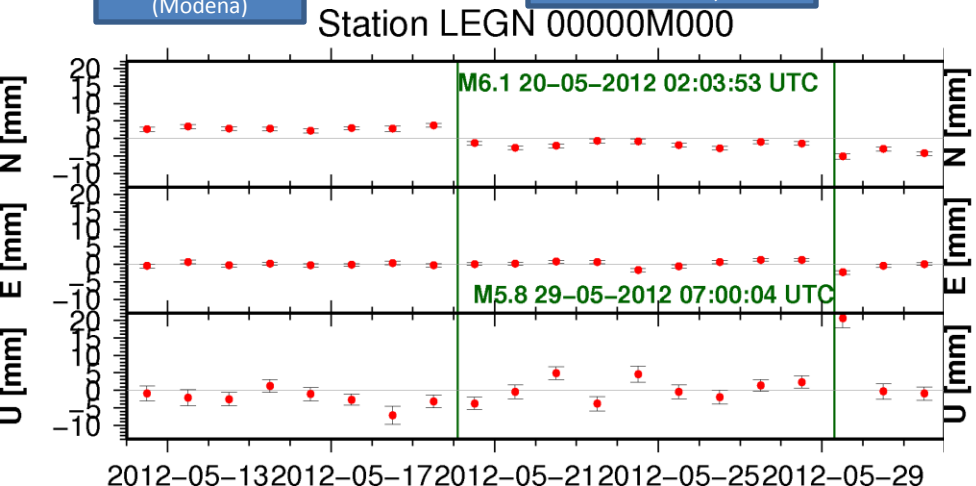


Time series of permanent GPS stations

vertical lines in the time series indicate occurrence of seismic event







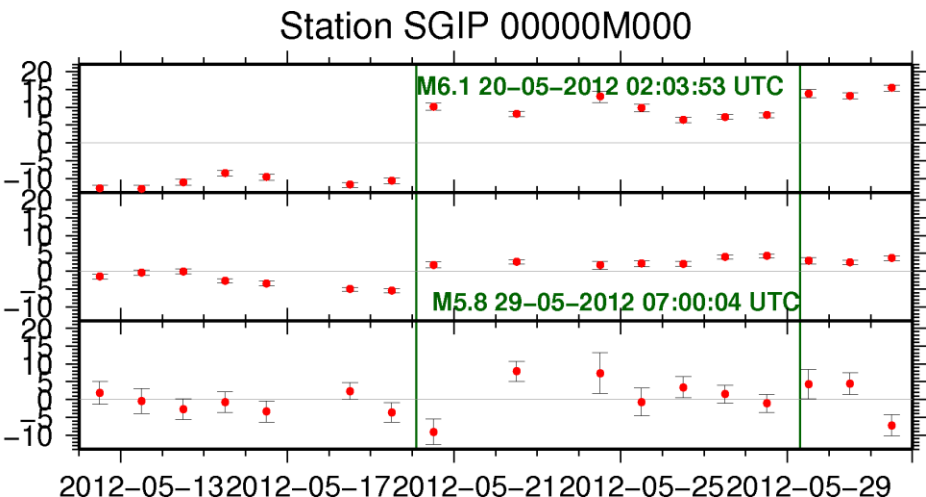


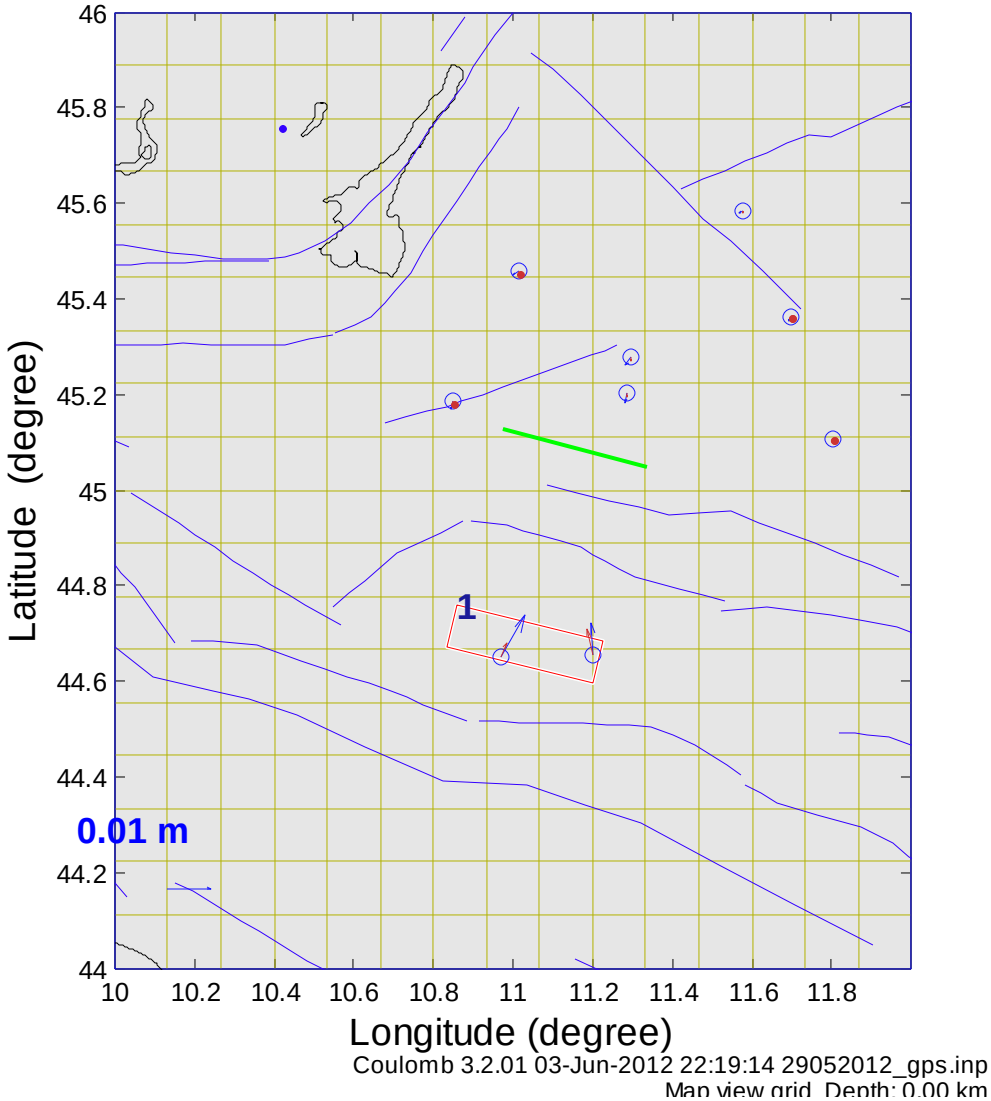
Table of displacements as a function of distance from epicenter of the 20.05.2012 event

Longitudine	Latitudine	Delta Est (m)	Delta Nord (m)	DeltaVerticale (m)	distanza da epicentro	Stazione
11.202	44.655	0.0051	0.0206	-0.0032	29	SGIP
10.940	45.071	0.0011	-0.0018	0.0117	30	SBPO
11.288	45.204	0.0001	-0.004	-0.0013	33	LEGN
10.968	44.649	0.0037	0.0038	-0.0019	36	MODE
11.298	45.278	0.0006	-0.0026	-0.0048	41	BTAC
10.847	45.186	0.0002	-0.0014	0.0009	44	LDNS
11.802	45.107	-0.001	-0.0014	-0.0002	49	ROVI
11.697	45.363	-0.0008	-0.0013	-0.0003	62	TEOL
11.014	45.458	0.0000	-0.0025	-0.0026	64	VR02
11.576	45.584	0.0003	-0.0013	0.0005	80	VICE
12.285	45.226	-0.0013	-0.0006	-0.0057	89	CGIA
11.24	44.91					epicentro

Table of displacements as a function of distance from epicenter of the 29.05.2012 event

Longitudine	Latitudine	Delta Est [m]	Delta Nort [m]	Delta Verticale [m]	Distanza da epicentro (km)	Stazione
11.288	45.204	-0.0008	-0.0024	0.0062	26	LEGN
10.847	45.186	-0.0003	-0.0019	0.0072	30	LDNS
11.298	45.278	-0.0014	-0.002	0.0041	34	BTAC
11.202	44.655	-0.0004	0.0073	-0.0028	39	SGIP
10.968	44.649	0.006	0.0099	0.0054	41	MODE
11.014	45.458	-0.0011	-0.0008	0.0011	52	VR02
11.802	45.107	0.0009	-0.0009	0.004	55	ROVI
11.697	45.363	-0.0005	-0.0011	0.0064	61	TEOL
11.576	45.584	-0.0007	-0.0004	-0.0001	74	VICE
12.285	45.226	0.001	-0.0007	0.0023	95	CGIA
11.12	45.00					epicentro

29.05.2012



For both events

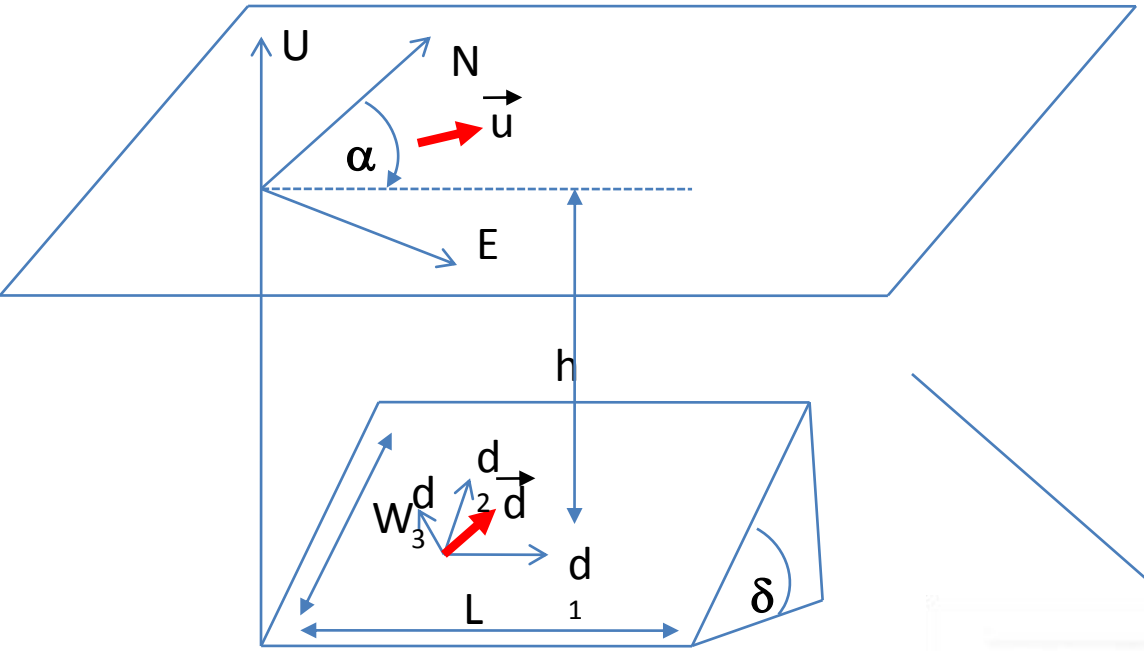
Rupture area 12x8 km
Updip slip 0.25 – 0.30 m

(constrained to keep the seismic moment)

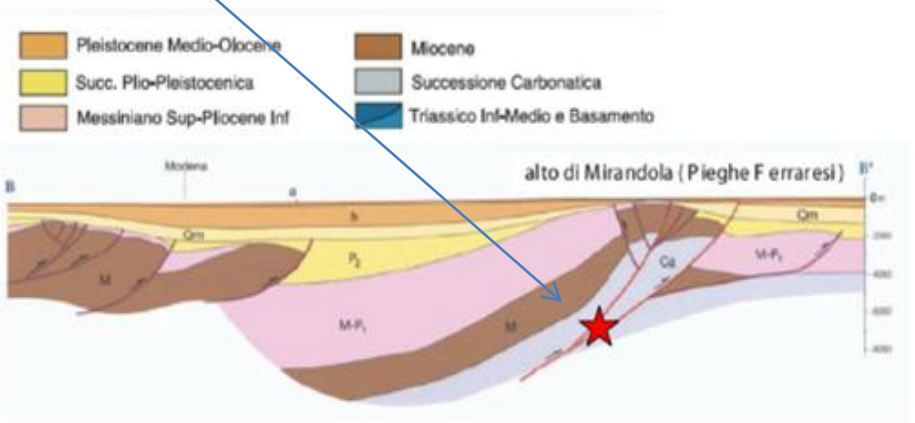
Dip angle ca 30 deg
Depth 10 km

Use GPS to adjust coordinates of epicenter

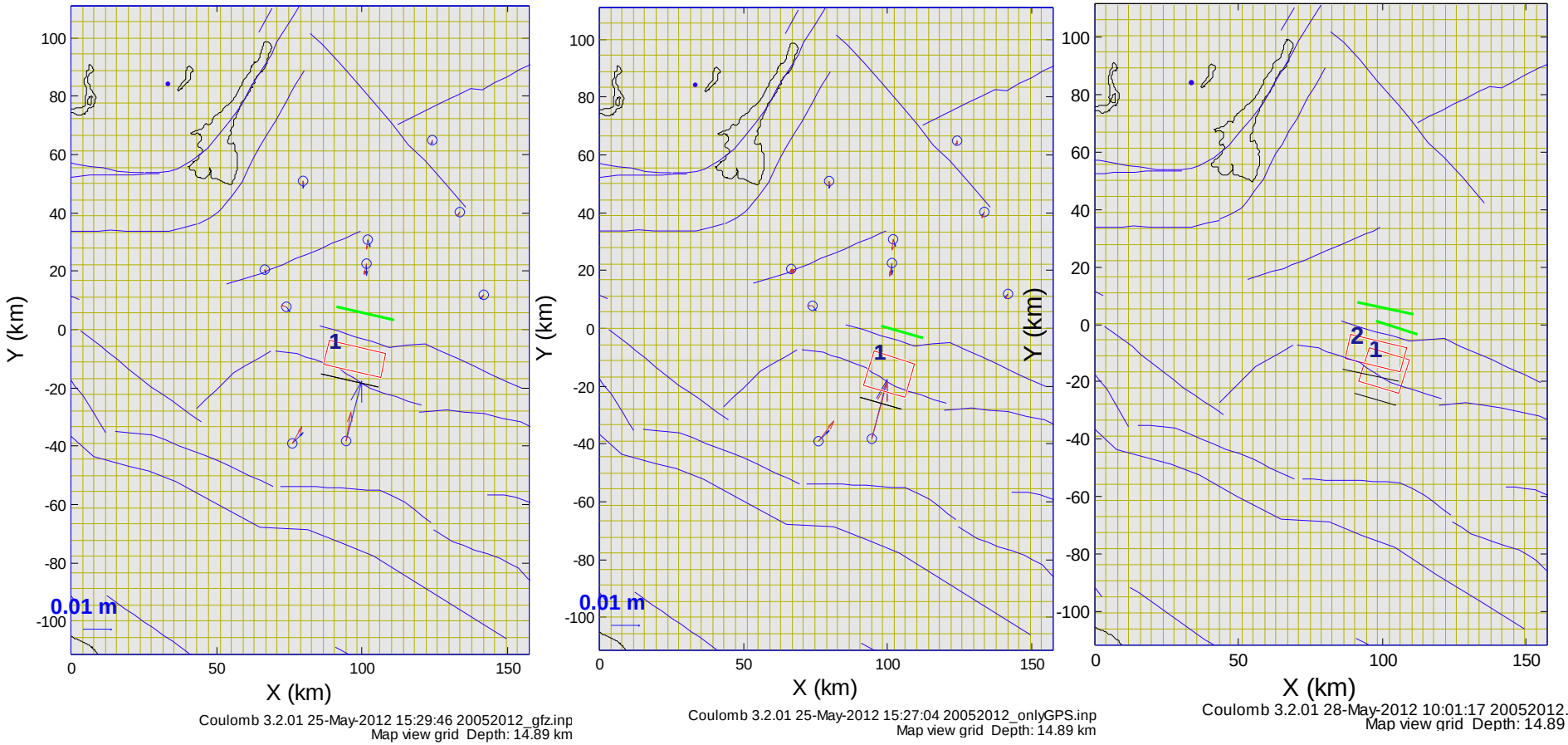
Modeling surface displacement in terms of elastic dislocation at depth



Single rectangular fault 12 x 8 km, ca 8 km deep
A constant dislocation of 35 cm along the fault plane in reverse direction generates the observed pattern of GPS displacements at the surface

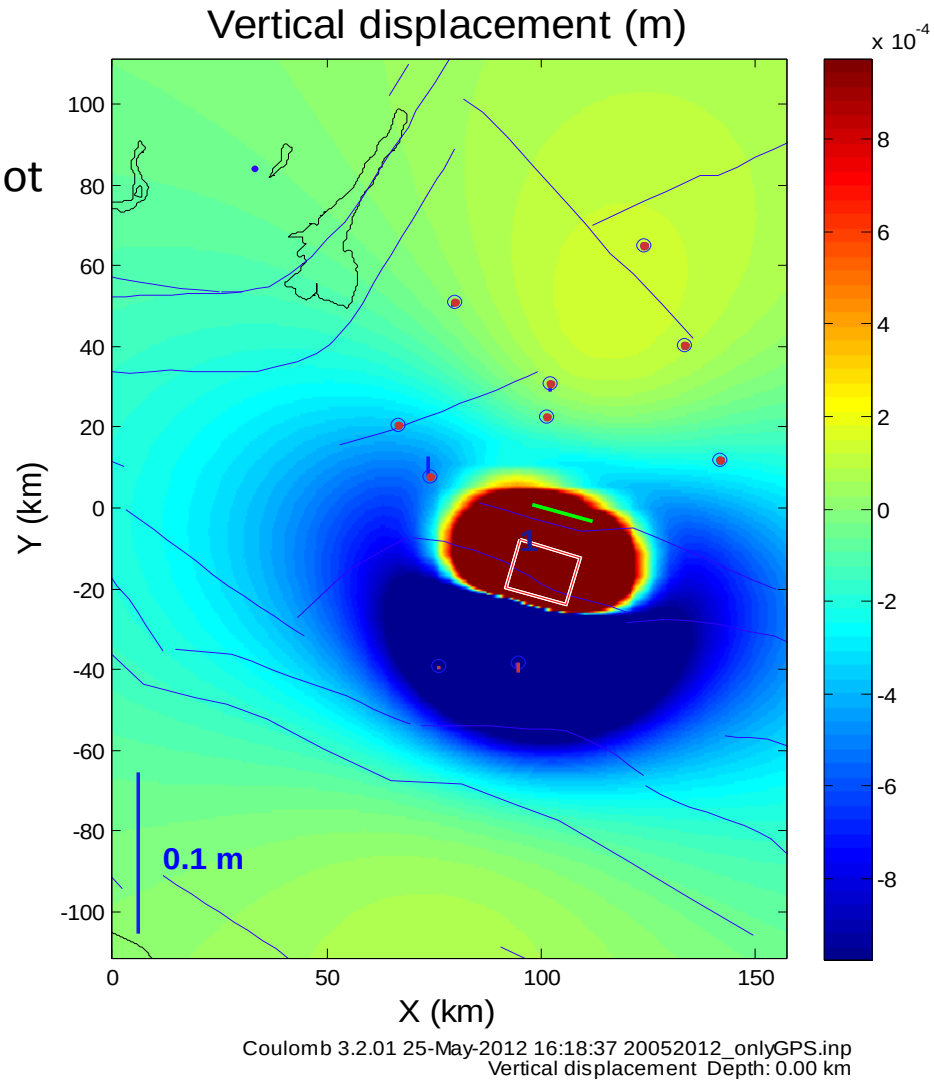


Apriori model from seismology (left); improved model with GPS data (center); difference (right): how to make seismology and GPS working together – 20.05.2012 event



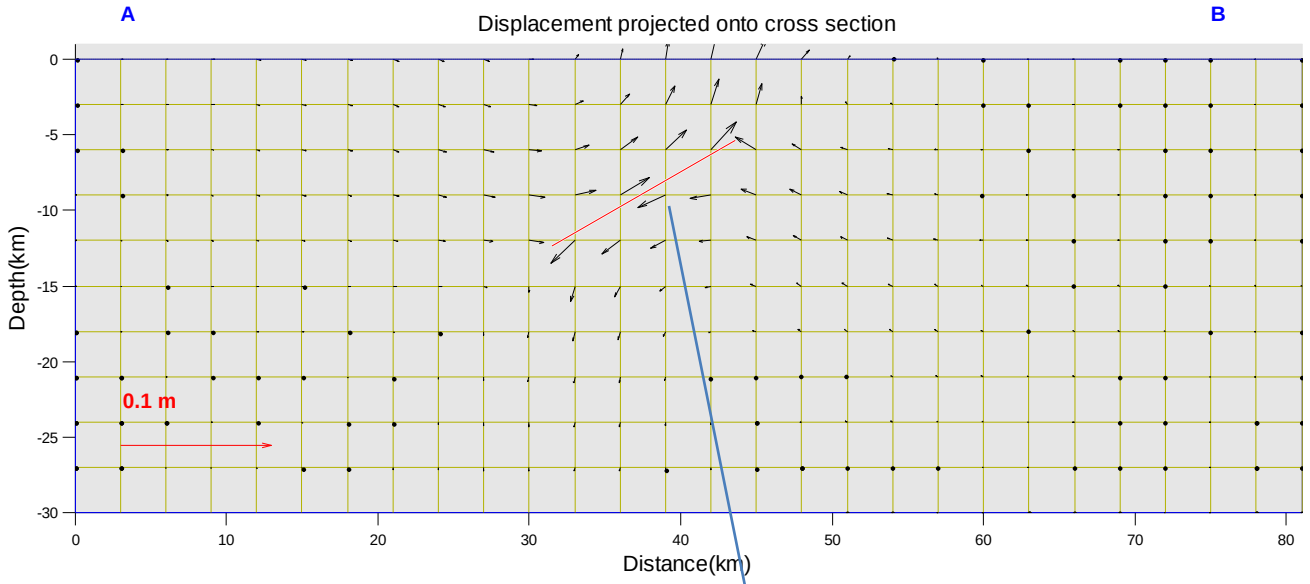
Expected vertical model (to be validated with DInSAR data)

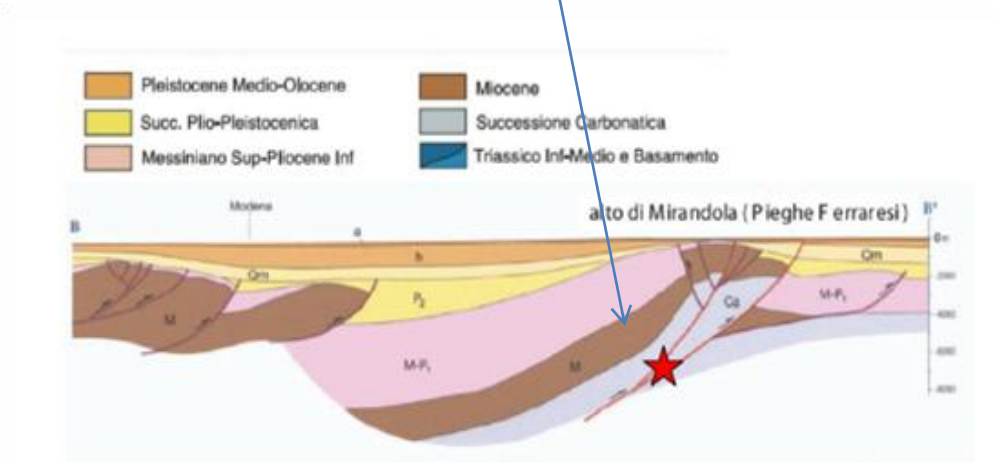
mm uplift expected: not large because fault is probably at low dip angle (30 deg)



In conclusion: what happened at depth?

Displacement of ca. 35 cm updip, along a 30 deg south dipping plane LxW 12 x7 km, 11 km depth of the center. On the 29.05 the fault and displacement were very similar.

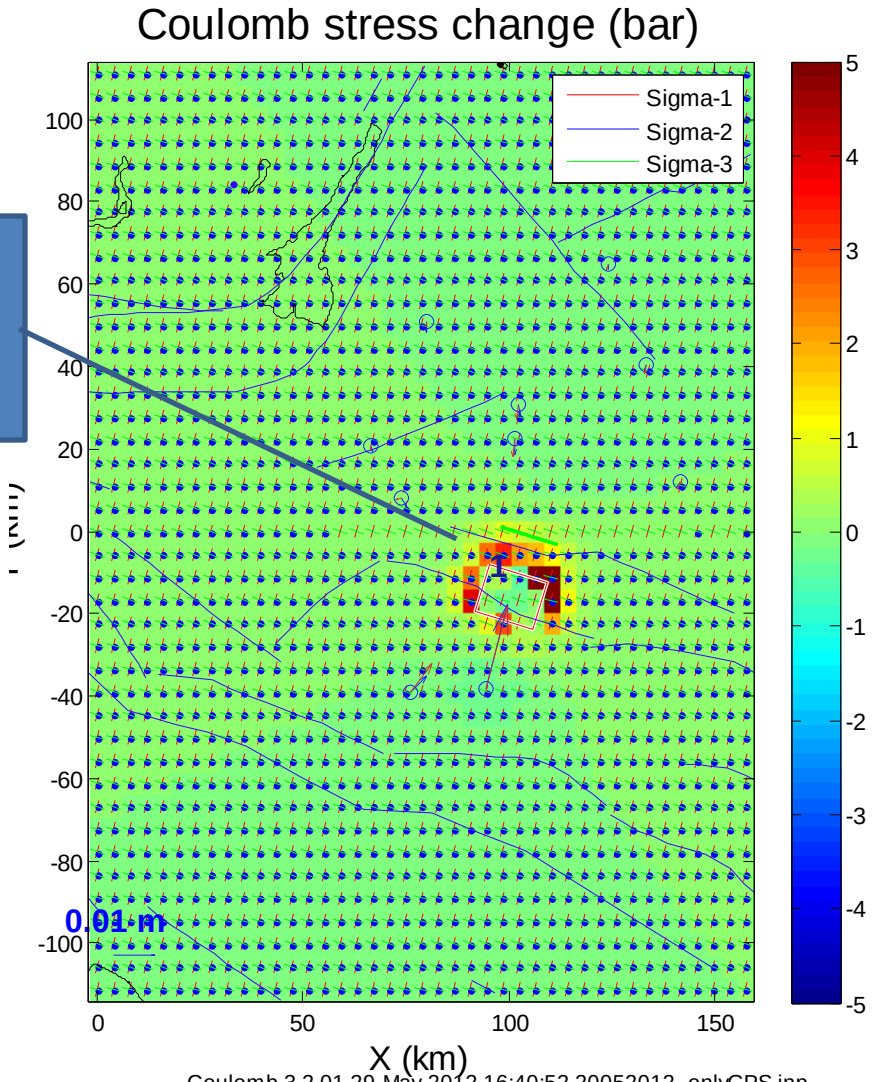




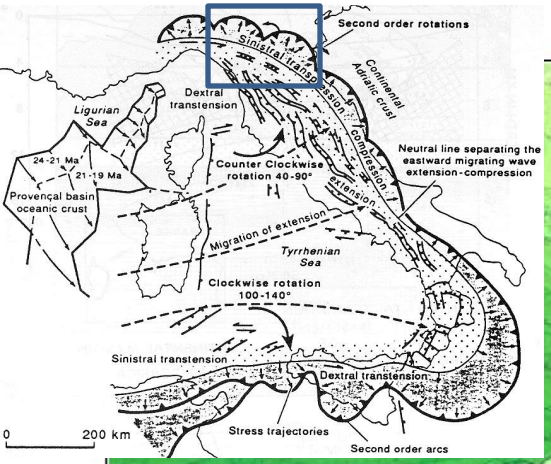
How much stress was transferred to nearby faults?

- Depends an assumed friction coefficient (0.4)
- Could be of the order of a few bar (or few 100 kPa) within few tens of km
- Sufficient to trigger the May 29 Mw=5.9 event?
- Could the events of the 20 and 29 jointly transfer to nearby faults sufficient stress to trigger additional events?
- Should we concentrate on reverse faults or consider also sinistral strike slip faults, which do exist in the area?
- Were the faults to the East of the May 20 fault 'unloaded'?

Load added at the fault of the May 29 5.8 event?



Westwards drift of the seismicity



Summary

- Event in a seismic region, among the highest intensity if not the most intense; large replica 9 days later: ‘receiver’ fault activated by Coulomb stress transfer?
- GPS stations give crucial data within few hours (processing on Sunday!): fault plane solution can be better constrained with GPS data than with seismological data alone.
- Daily updates using IGS rapid orbits. Georeferencing coherent with Datum from Class A EPN stations
- No discontinuity observed in EPN stations. MEDI unreliable.
- Uplift model ready for DInSAR data: validation very important
- Good practice for readiness in case of future events