



# Full characterization of the $M_L$ 5.4 2019/11/11 Le Teil earthquake in France based on a multi- technology approach

DE LA RECHERCHE À L'INDUSTRIE

**EGU 2020** – EARTHQUAKES AND ACTIVE TECTONICS IN REGIONS OF SLOW LITHOSPHERIC DEFORMATION

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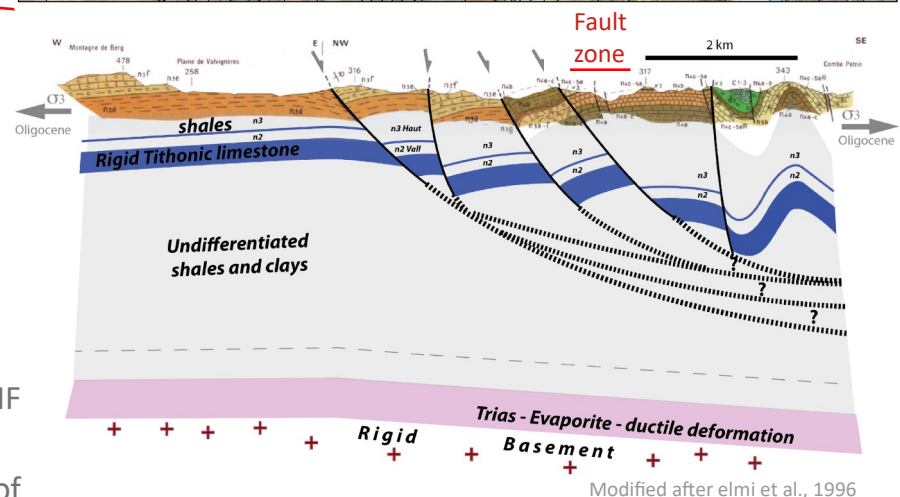
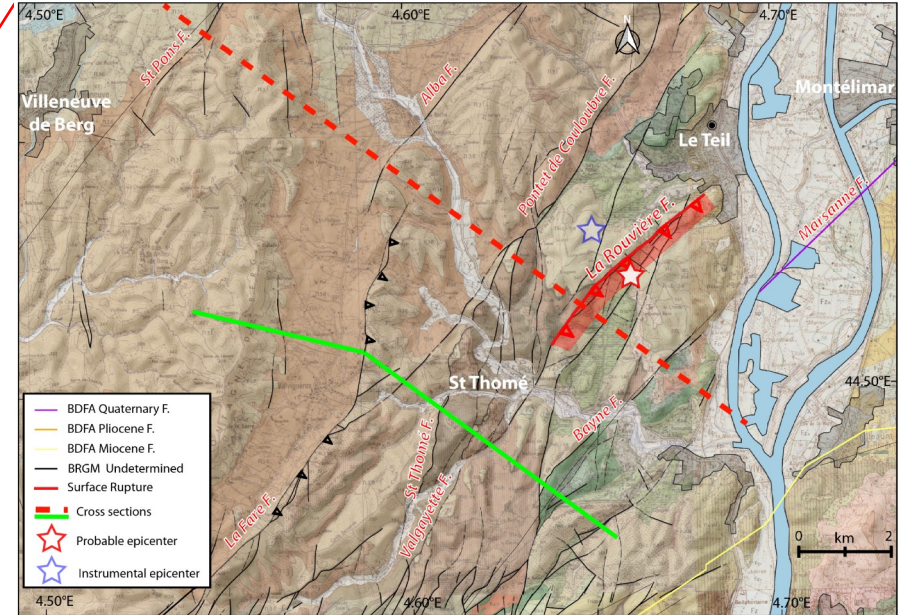


▲ LDG short-period network  
 ▲ RESIF broad-band network  
 ▲ RAP accelerometric network  
 ★ Le Teil earthquake epicenter

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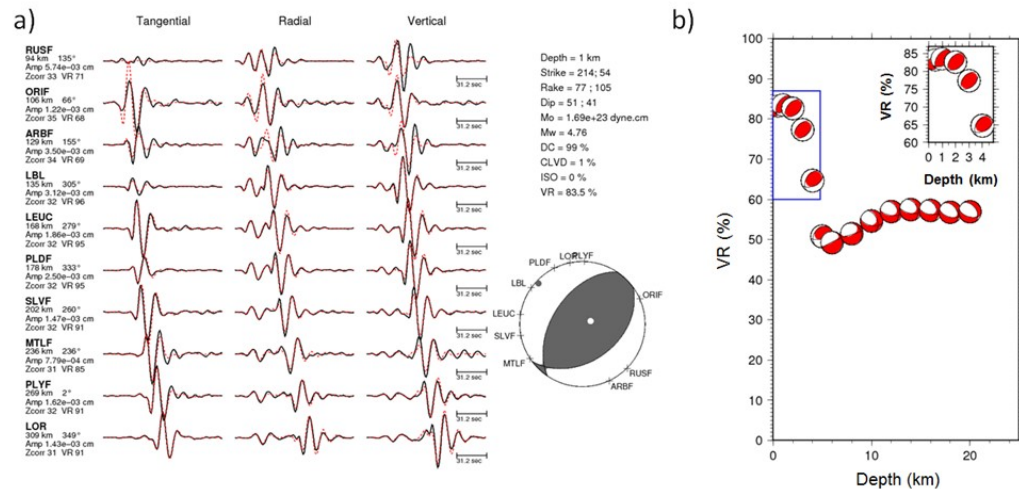
○ Stations used for MT inversion

- Epicentre located using 173 stations (mainly CEA and RESIF networks). Local magnitude  $M_L$  5.4
- The earthquake occurred on La Rouvière fault which is part of the Cévennes fault system. These faults used to be normal faults and accommodated extension during Oligocene.



Modified after elmi et al., 1996

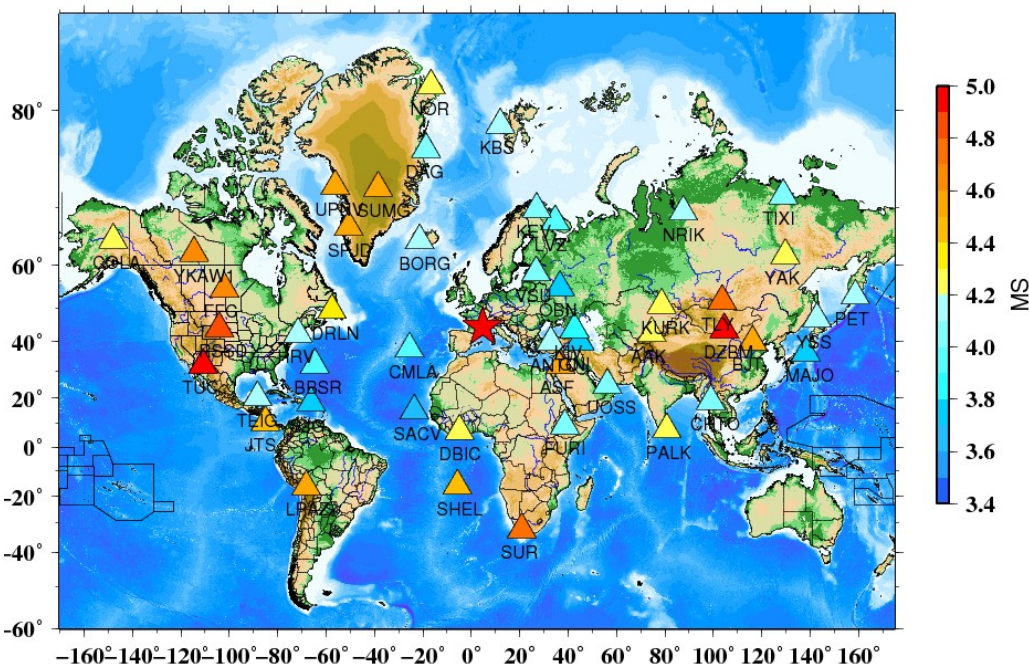




### Full waveform inversion performed on 10 broadband CEA and RESIF stations

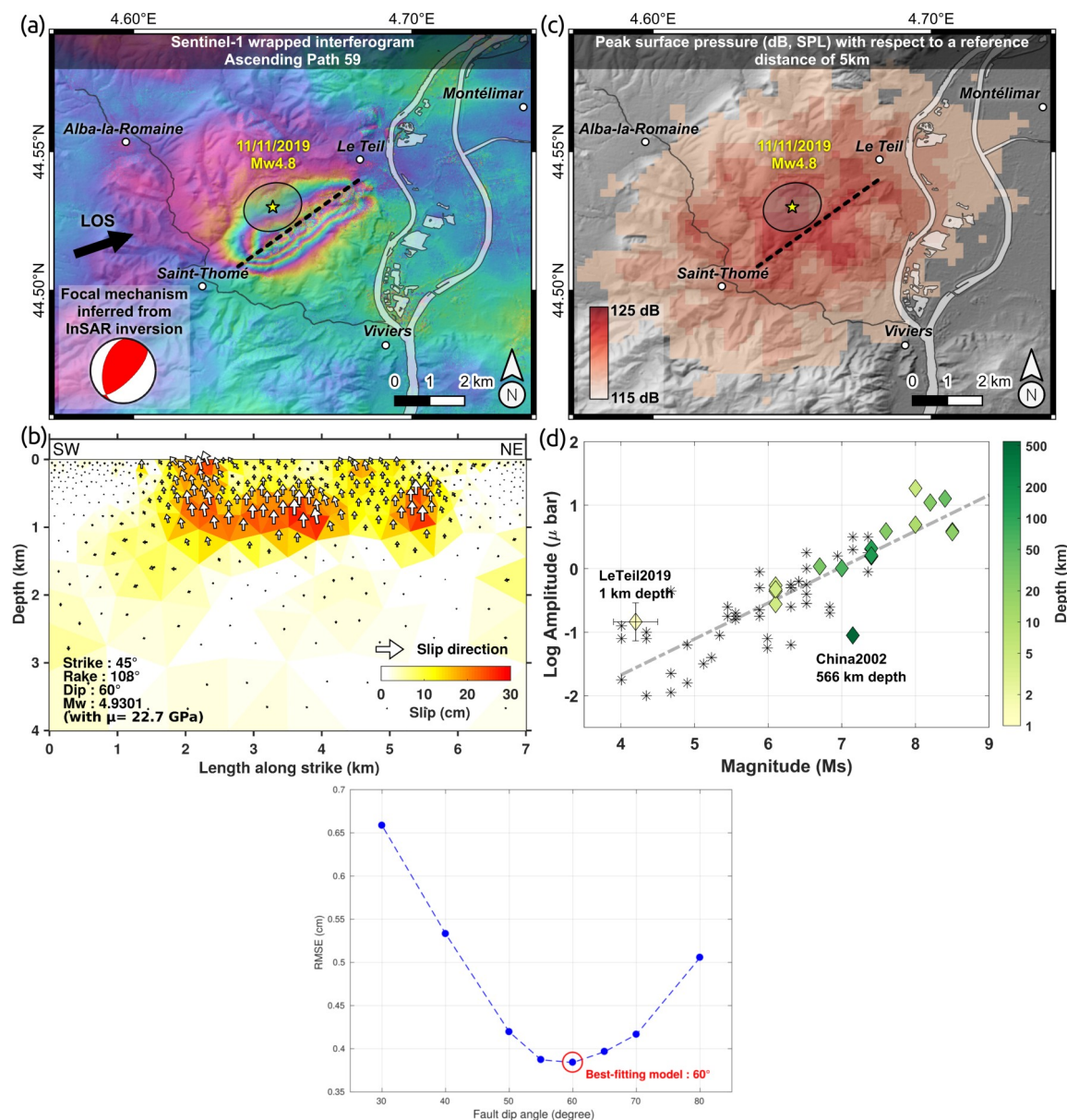
- Maximum variance reduction: 1 km depth
- Focal mechanism mainly reverse with a small strike-slip component
- Strike ( $N54^\circ$ ) in agreement with La Rouvière fault local azimuth ( $N46^\circ$ )
- Best dip:  $41^\circ$
- Moment magnitude  $M_w = 4.77$

→  $M_s : 4.03 \pm 0.17$  (Scordilis et al., 2006)



### Surface-wave magnitude is commonly used for French seismic hazard assessment

- Vanek et al., (1962) formula,
- 20-s period filtered waveforms recorded by 48 stations distributed between  $20^\circ$  and  $90^\circ$  around the epicentre
- $M_s = 4.2 \pm 0.3$



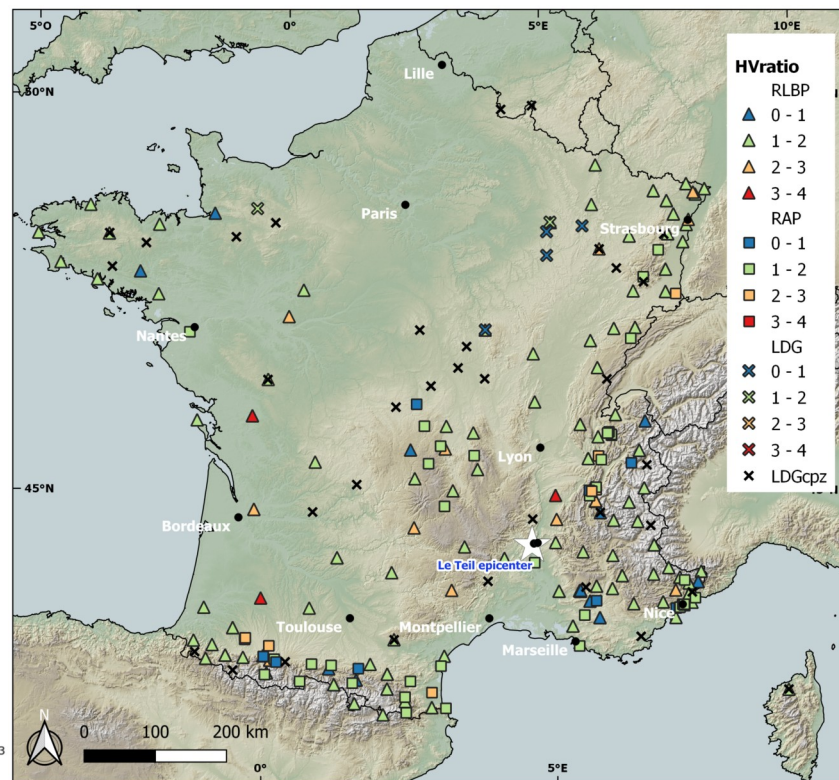
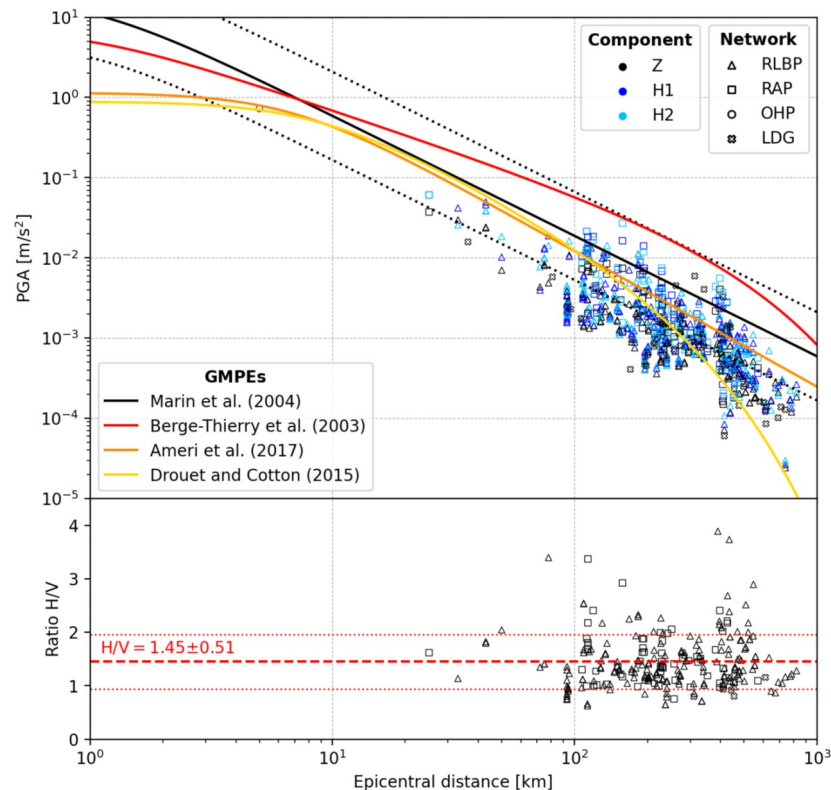
### SAR data

- Four Sentinel-1 tracks are used (2x ascending and 2x descending)
- Phase discontinuity suggests surface rupture
- Inversion for fault's dip and displacement with fixed strike
  - ◆ Best dip: 60°
  - ◆ Maximum displacement ~30 cm at 1 km depth
  - ◆ 10 cm of displacement up to the surface
  - ◆ Inverted focal mechanism in agreement with seismological inversion
- Moment magnitude  $M_w = 4.93$   
 →  $M_s : 4.27 \pm 0.17$  (Scordilis et al., 2006)

### Infrasound data

- 0.035 Pa infrasound peak pressure measured 107 km away from the epicentre at the Haute-Provence Observatory (OHP)
- Ground-to-air coupling and peak surface pressure (PSP) regions coincide with surface deformation measured by InSAR
- Infrasound back-projection from OHP gives a pressure value of  $120 \pm 5$  dB at a reference distance of 5 km from the epicentre
- Infrasound amplitude, corrected for propagation effects, is primarily driven by seismic magnitude and focal depth





PGA measured on 802 records from 290 stations, located between 0 to 1000 km from the epicentre:

- French permanent strong motion network (RESIF-RAP) – 3 components accelerometers
- French permanent broadband network (RESIF-RLBP) – 3 components velocimeters (converted to acceleration)
- CEA-LDG network – 1 and 3 components velocimeters (converted to acceleration)
- Infrasound back projection:  $120 \pm 5$  dB at 5 km distance  $\rightarrow 0.4$ - $1.1 \text{ m.s}^{-2}$

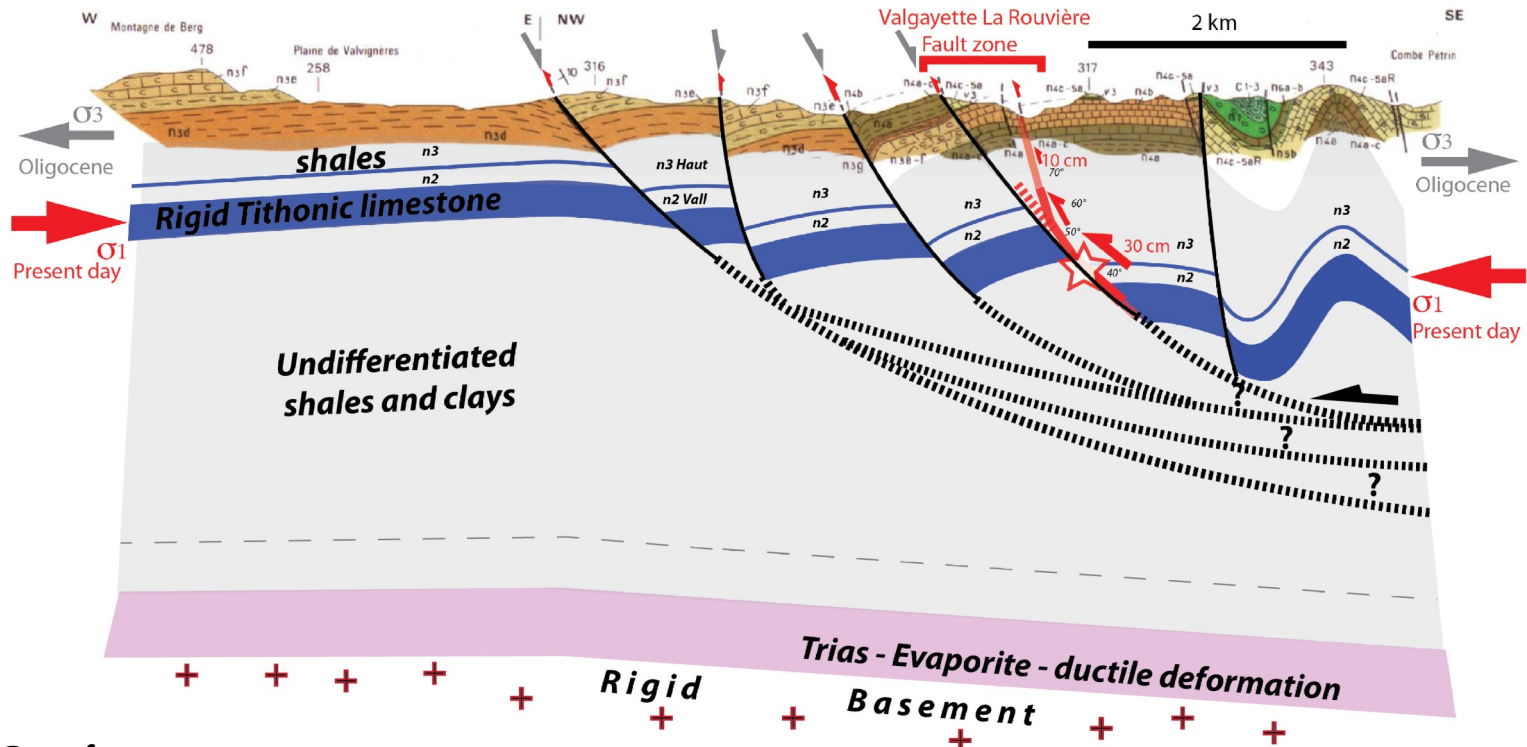
H/V ratios calculated for all 3-component stations

- Mean  $H/V = 1.49 \pm 0.54$

## LE TEIL EARTHQUAKE – TAKE HOME MESSAGES

- The 11/11/19 Le Teil earthquake is very shallow and it ruptured the surface despite its rather small magnitude
- Seismic, geodetic and infrasound data helped characterizing the event. Magnitude differences probably reflect the processes at work ( $M_L=5.4$ ,  $M_W^{seismo}=4.8$ ,  $M_W^{geodesy}=4.9$ ,  $M_S=4.2$ )
- All the technologies agree on the the origin of the earthquake: La Rouvière fault. The earthquake was reverse but took place on older, pre-existing, normal structures

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