Department of Geology, Aristotle University of Thessaloniki

Earthquake Geology Research Team
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Hellenic Disaster Risk Reduction Forum
HDRRF

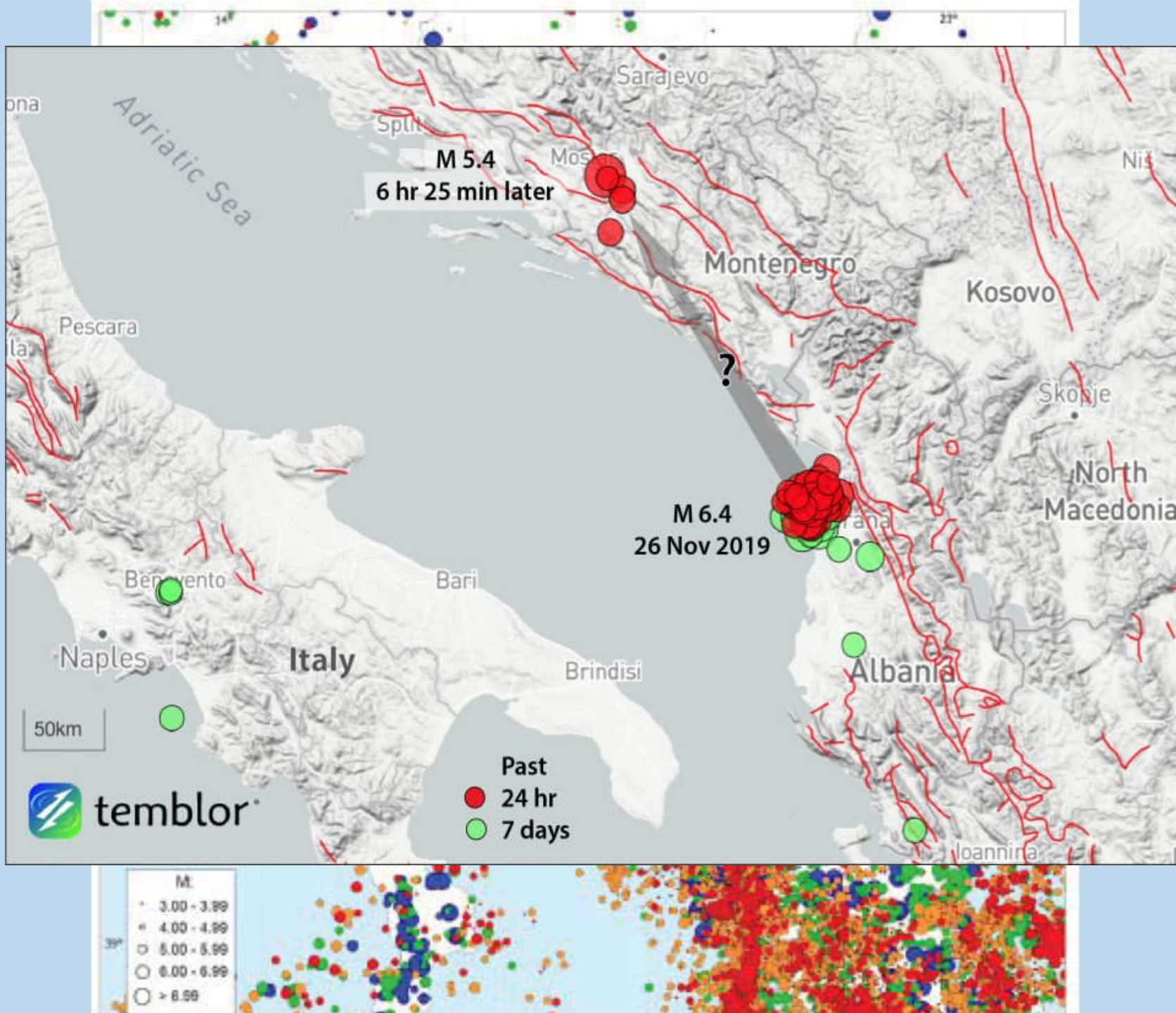
Preliminary report on the Geotectonic regime of Central Albania and ground effects of the November 26, 2019, Albania earthquake

Spyros Pavlides, Alex Chatzipetros, Ylber Mukeku

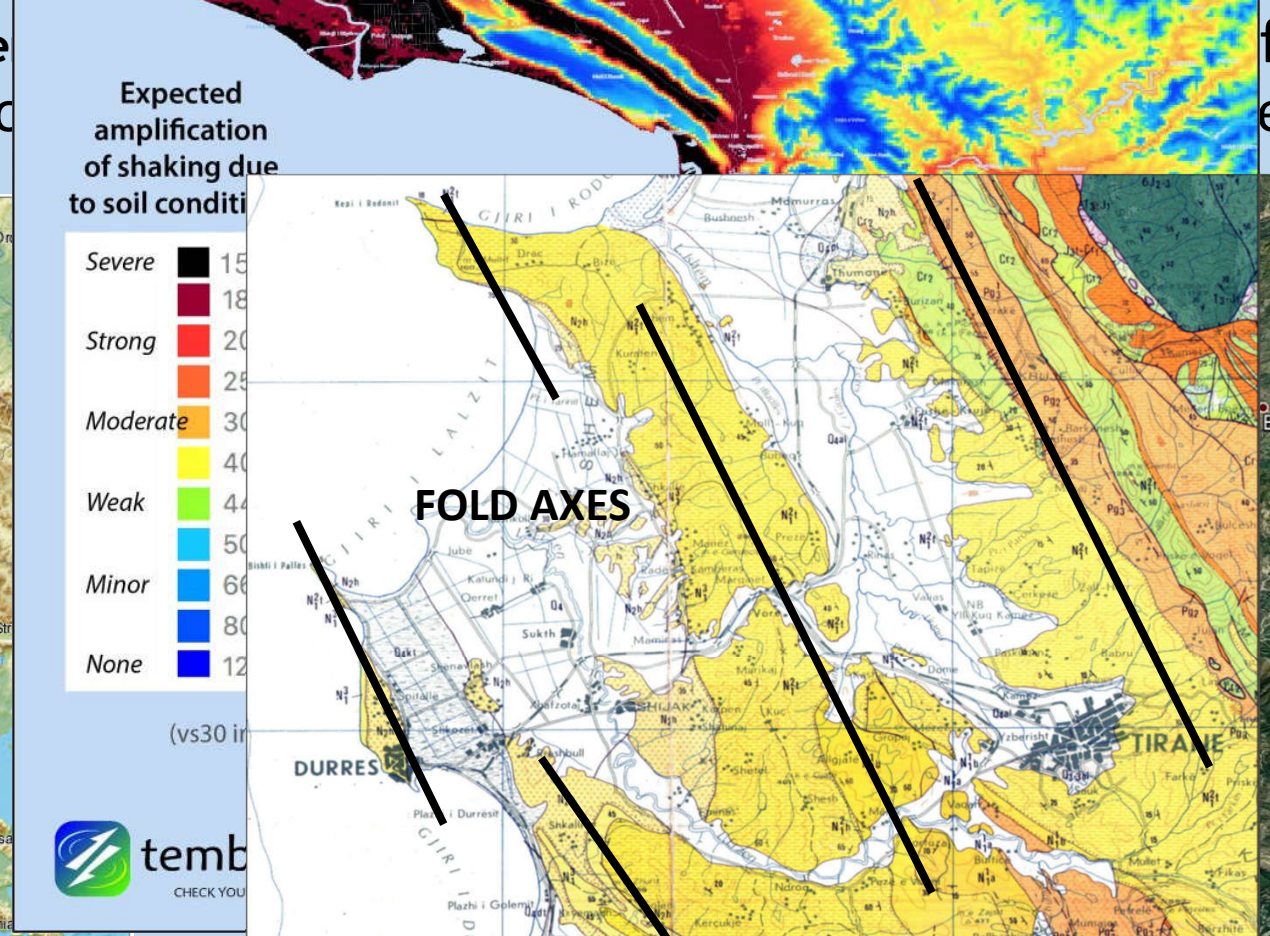
Department of Geology AUTh	Polytechnic University of Tirana
Spyros Pavlides, Prof. Emeritus Alexandros Chatzipetros, Assoc. Prof. George Georgiadis, MSc, PhD student Ilias Lazos, MSc, PhD Student	Arjan Beqiraj, Prof. (UPT) Ylber Muceku, Assoc. Prof. (IGEWE) Hamza Reçi, Assoc. Prof. (UPT)

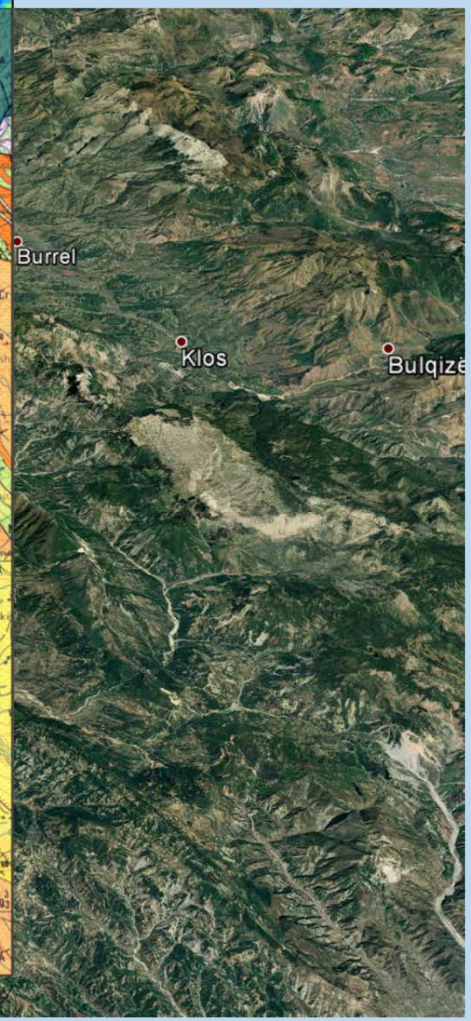
ALBANIA

an earthquake of magnitude Ms=4.9 has a recurrence interval of 3 years, and that an earthquake of Ms=5.5 features a recurrence interval of 10 years, an earthquake of Ms =6.0 has a recurrence interval of 30 years and an earthquake of Ms=6.5 could recur every 95 years while an earthquake of Ms =7.0 could be repeated every 500 years. (Sh. Aliaj, E. Sulstarova 2010)

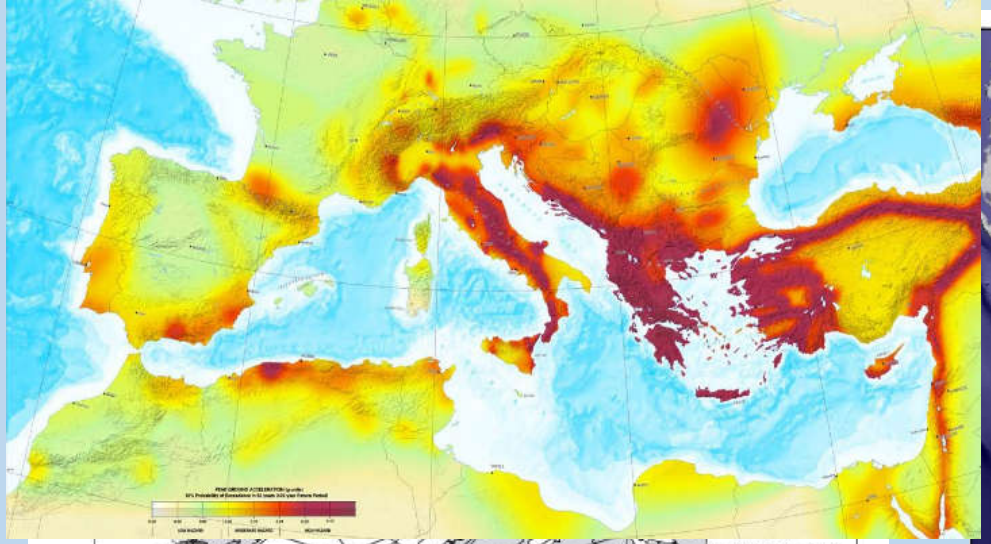


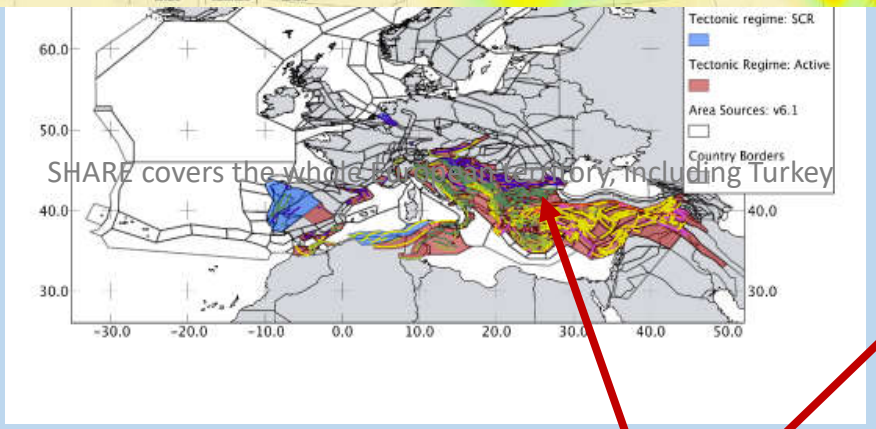
The earthquake of **Nove** fferent
magnitudes and sc es



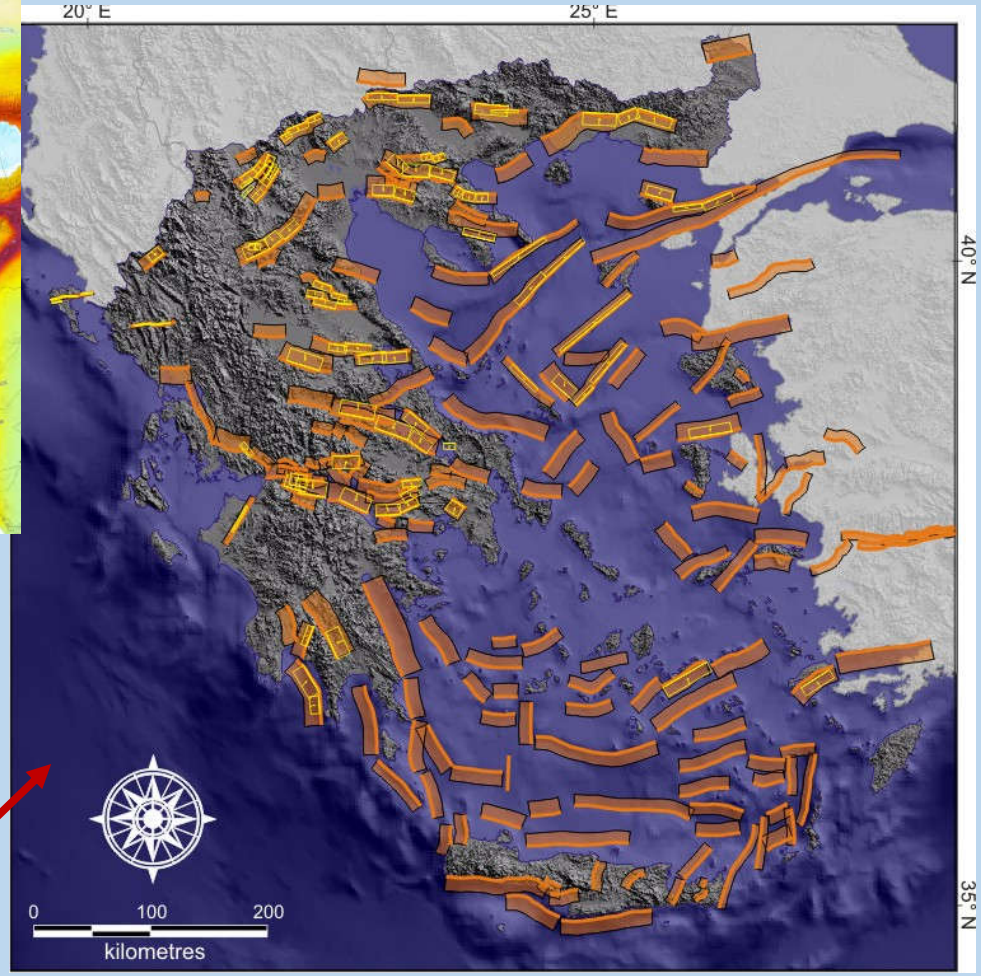


Temblor's STAMP high resolution (200 m) model of site amplification reveals that in Thumanë, Durres, and Lezhe, the shaking could have been severely amplified, contributing to the damage of weak buildings. Areas in black likely shook four times higher than those in yellow. The black areas are water-saturated coastal estuaries and plains that might also liquify when shaken violently, which can cause buildings to sink and tilt, rendering them a total loss. The fault on which the Mag. 6.4 quake struck is probably concealed by a growing fold





SHARE covers the whole Euro-Mediterranean region, including Turkey



SHARE

Τα ρήγματα

SEVENTH FRAMEWORK PROGRAMME

Seismic Hazard Harmonization in Europe 2013-15
http://www.share-eu.org/ Eurocode 8 (EC8) application

ΓΕΩΛΟΓΙΚΗ ΠΛΗΡΟΦΟΡΙΑ
ΣΕΙΣΜΙΚΑ ΡΗΓΜΑΤΑ ΣΕ ΜΕΓΑΛΑ ΤΕΧΝΙΚΑ ΕΡΓΑ

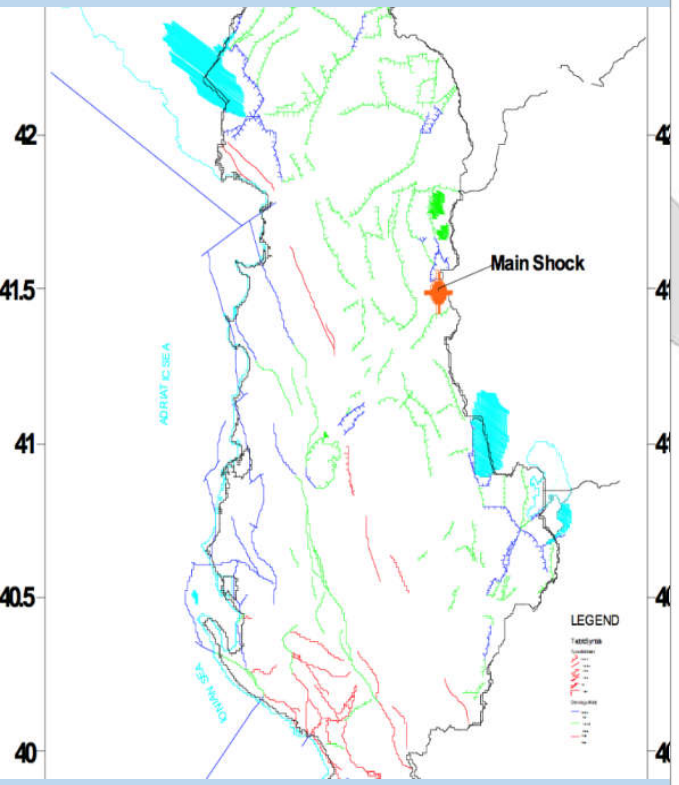
TAP route
the investigated region along the pipeline.

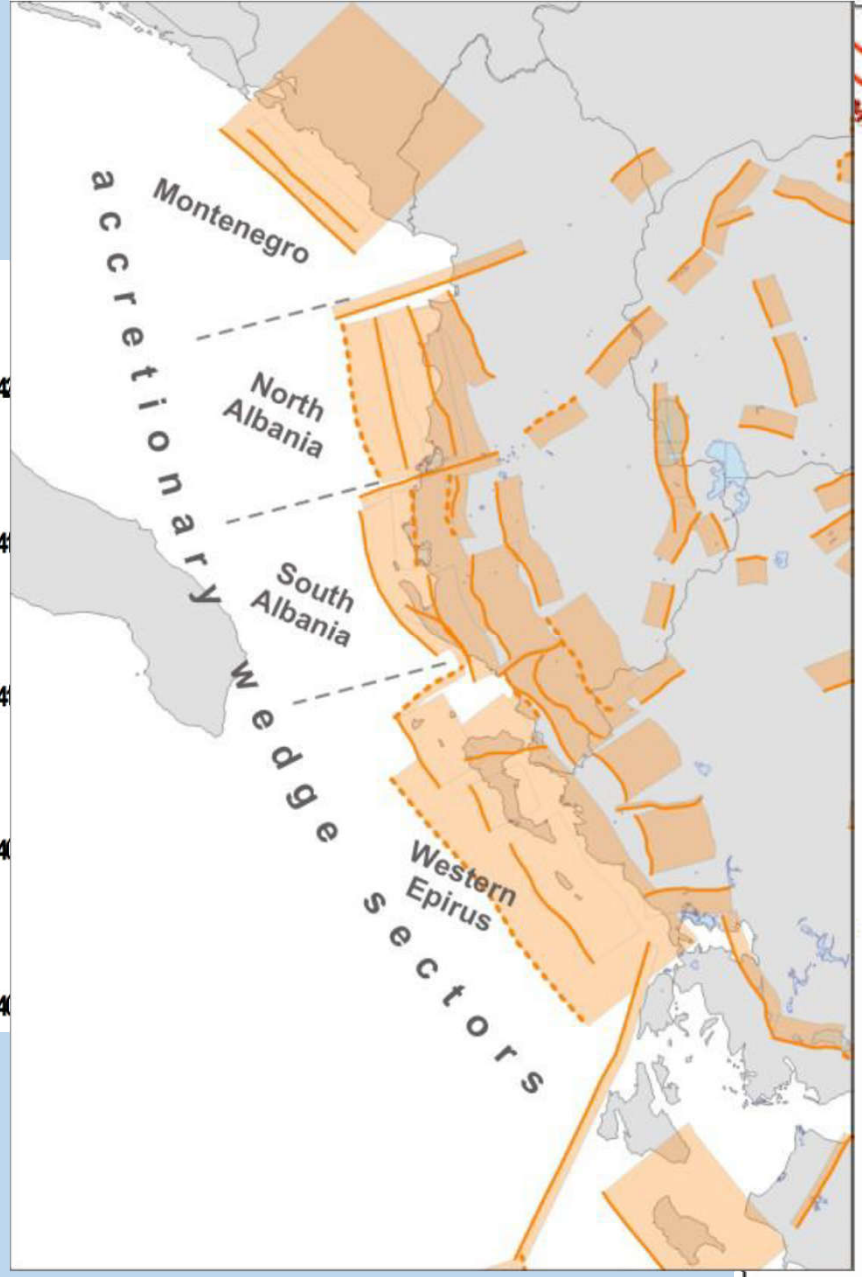
Rubble from the Fukushima Daiichi Nuclear Power Plant caused by the 2011 earthquake and tsunami. Photo by Gill Tudor for IAEA

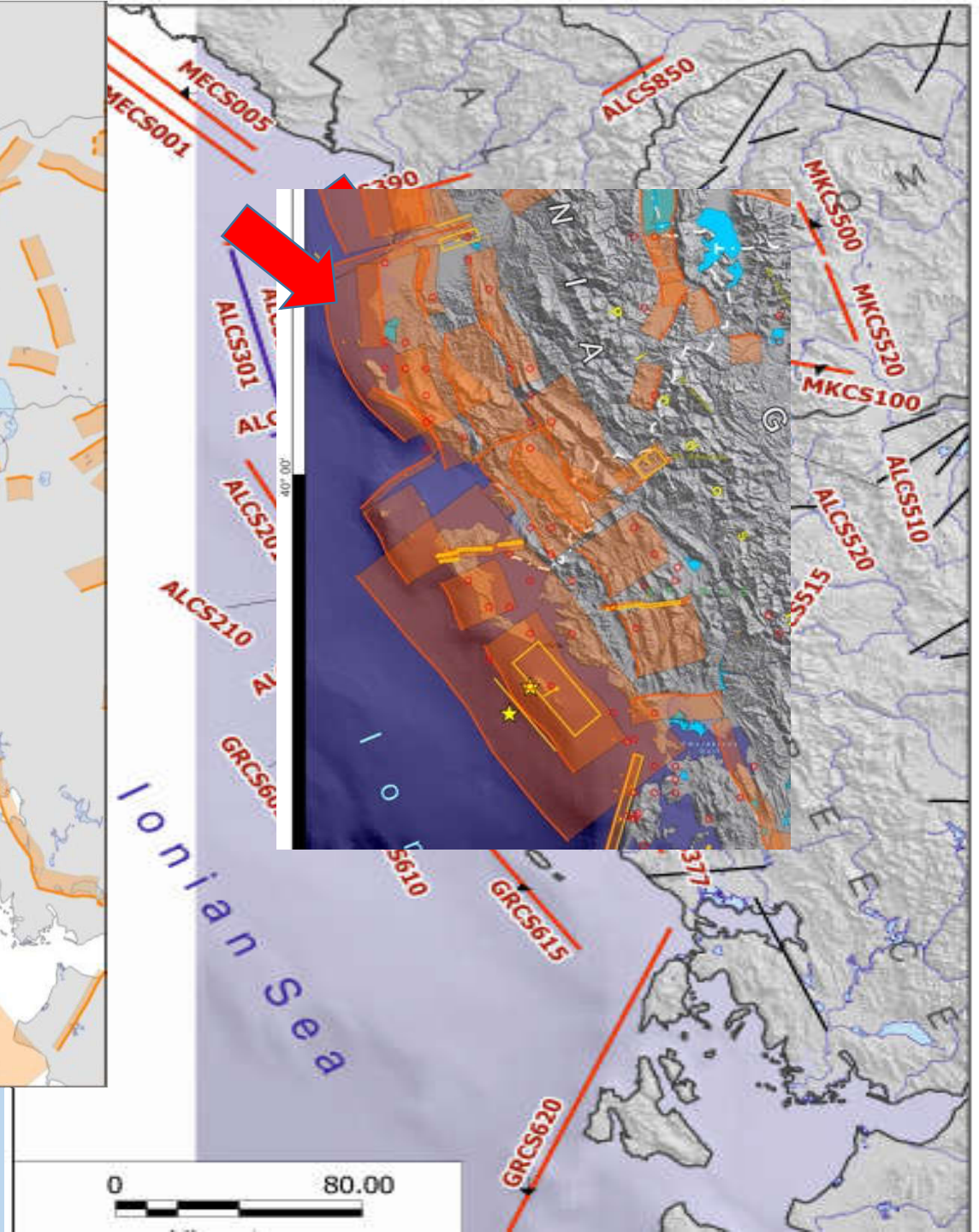
Seismogenic sources in Albania

Neotectonic Map of Albania

(Alija 2002)

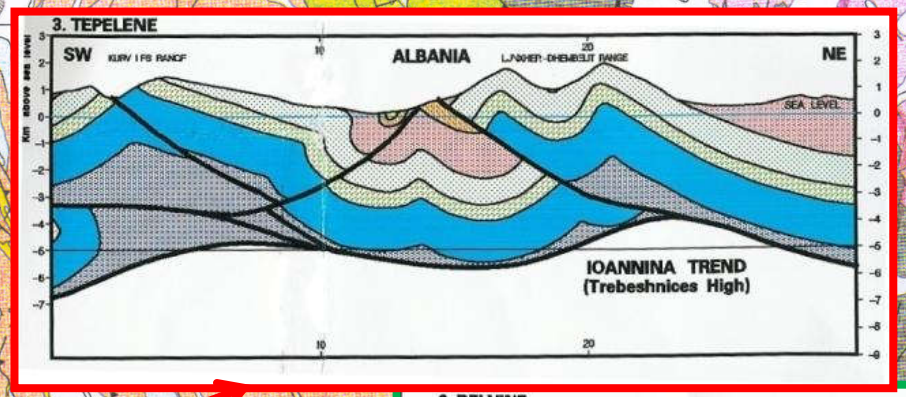


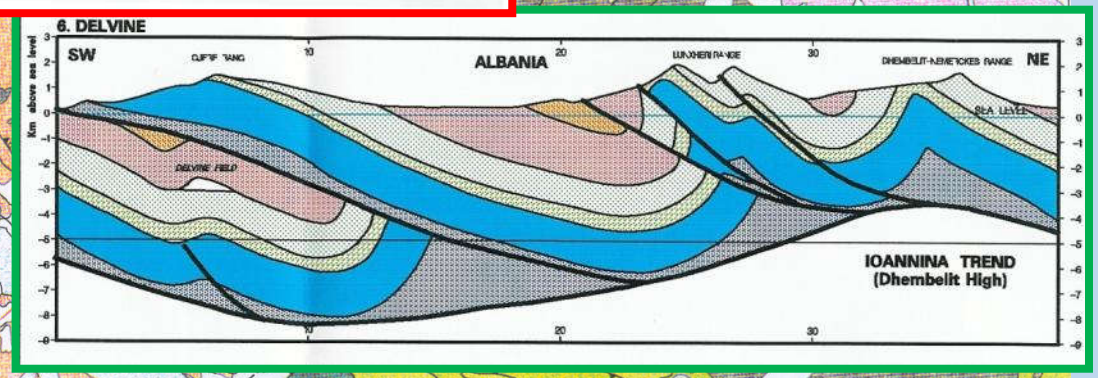




GreDaSS & TAP 2014-15

Cross sections in Albania





Ionian Sea

OTHONI

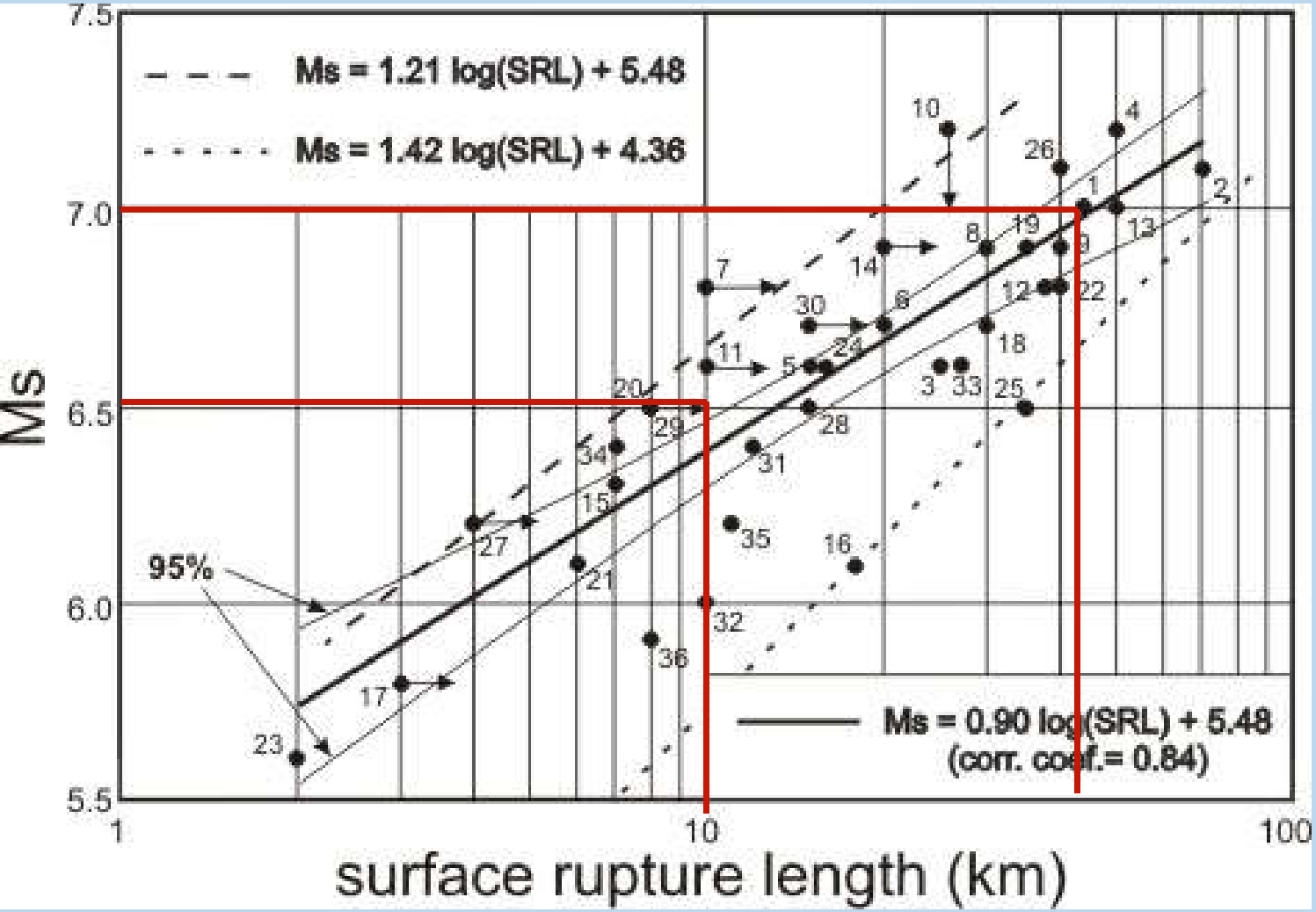
ERIKOUSSA

MATHRAKION

CORFU (KERKIRA)

Kerkira Channel

Empirical relationships of Ms – L for the Aegean region



M max 7.2
M av 6.7
M min 6.4

Σεισμός Σχεδιασμού (για τεχνικά έργα) μέγεθος μέχρι 6.7 για το κύριο ρήγμα και 6.5 για τα δευτερεύοντα, ανεξαρτήτως χρόνου

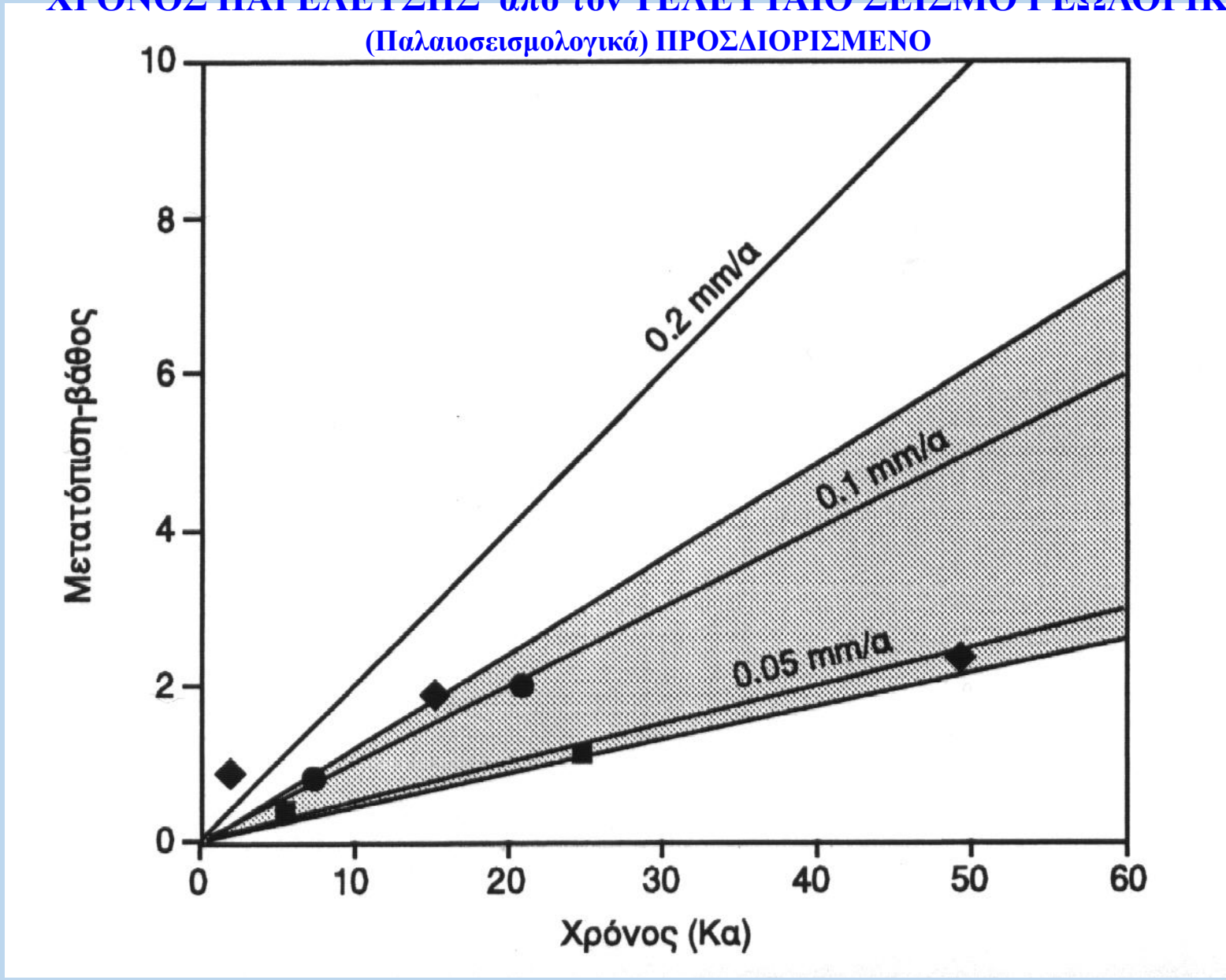
Pavlides & Caputo 2004 for Normal Faults - Wells and Coppersmith (1994) magnitude-scaling relationship for Reverse and strike-slip faults is used ..

ΡΥΘΜΟΣ ΟΛΙΣΘΗΣΗΣ SLIP RATE

και

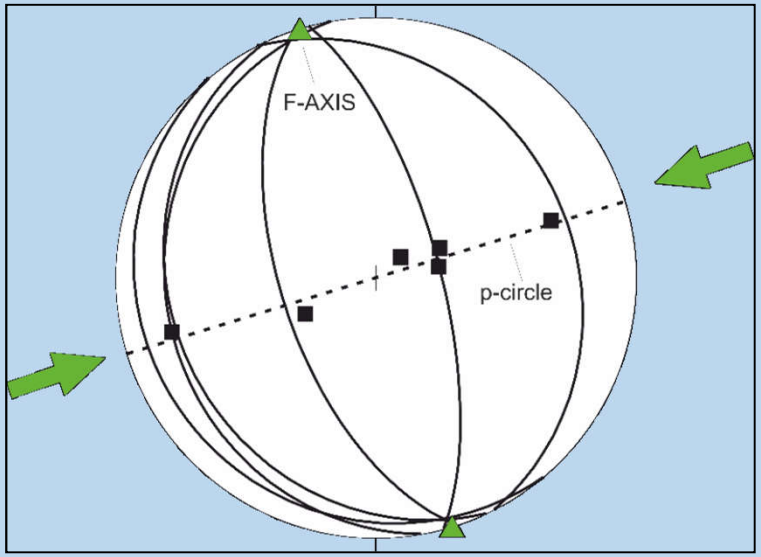
ΧΡΟΝΟΣ ΠΑΡΕΛΕΥΣΗΣ από τον ΤΕΛΕΥΤΑΙΟ ΣΕΙΣΜΟ ΓΕΩΛΟΓΙΚΑ

(Παλαιοσεισμολογικά) ΠΡΟΣΔΙΟΡΙΣΜΕΝΟ



Crush zone

Crush zone comprised by heavily deformed limestone and a zone of tectonic breccia. This outcrop is interpreted as the base of the thrust zone.

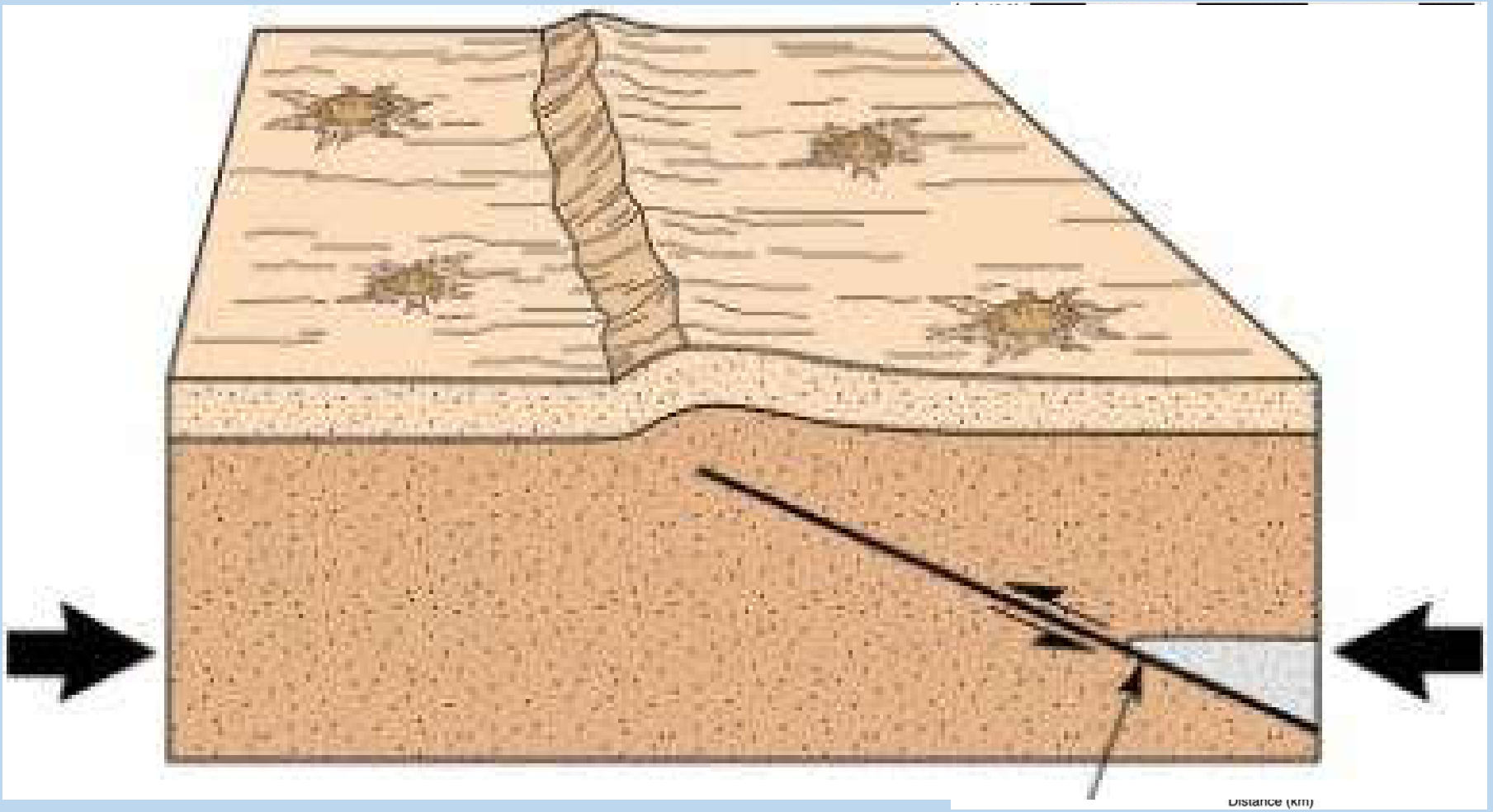


Bedding planes of limestone and flysch in the area of the fault and the inferred compressional stress direction, using the bedding planes as indicators of folding. This stress direction coincides with the active one, hence this fault is characterized as possibly active

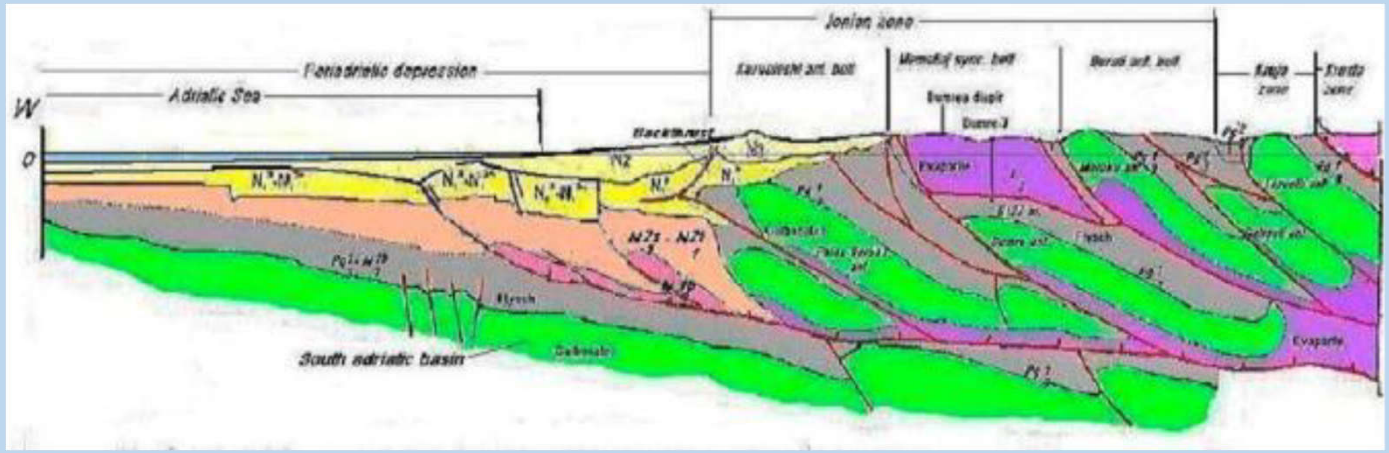
Bedding of Paleocene-Eocene limestone.

Folded Upper Oligocene flysch.

Thrust blind faults

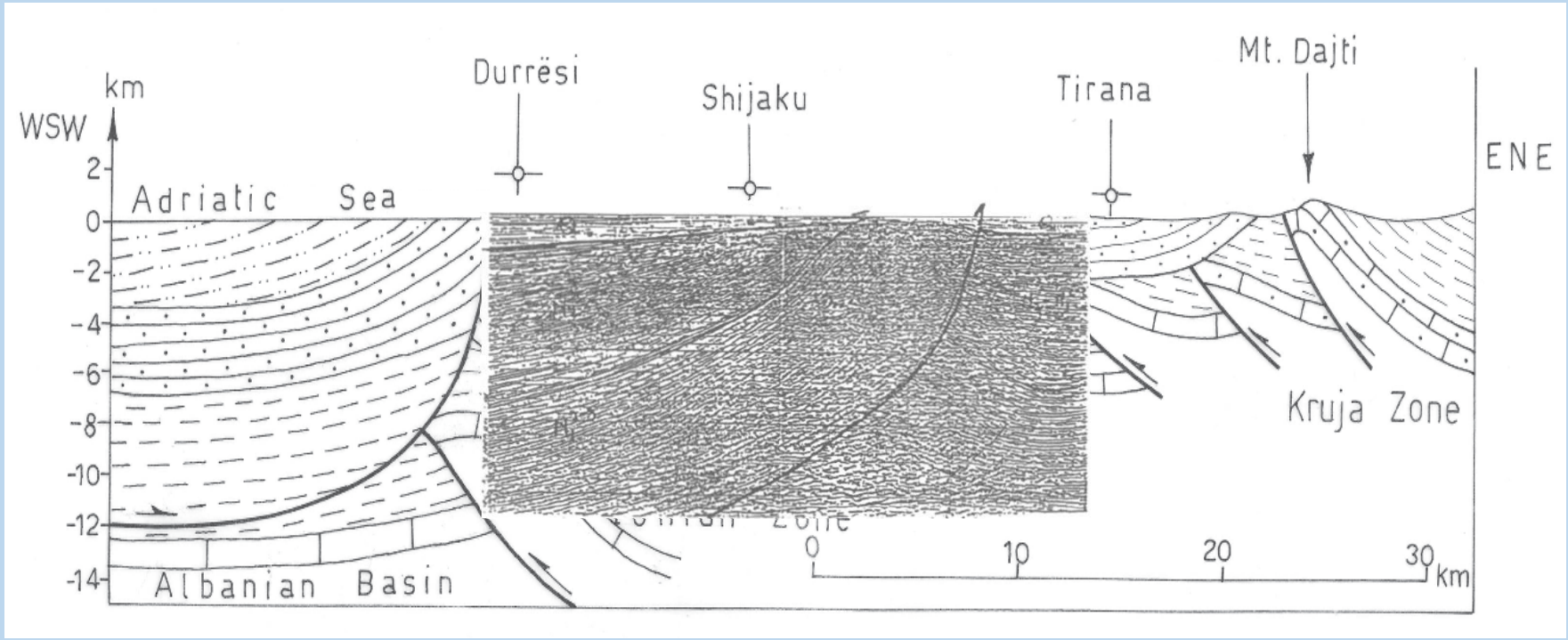


Stress axis orientations derived from Louvari et al., 2001 and Serpetsidaki et al., 2011 BSSA and Louvari & Kiratzi 2003)



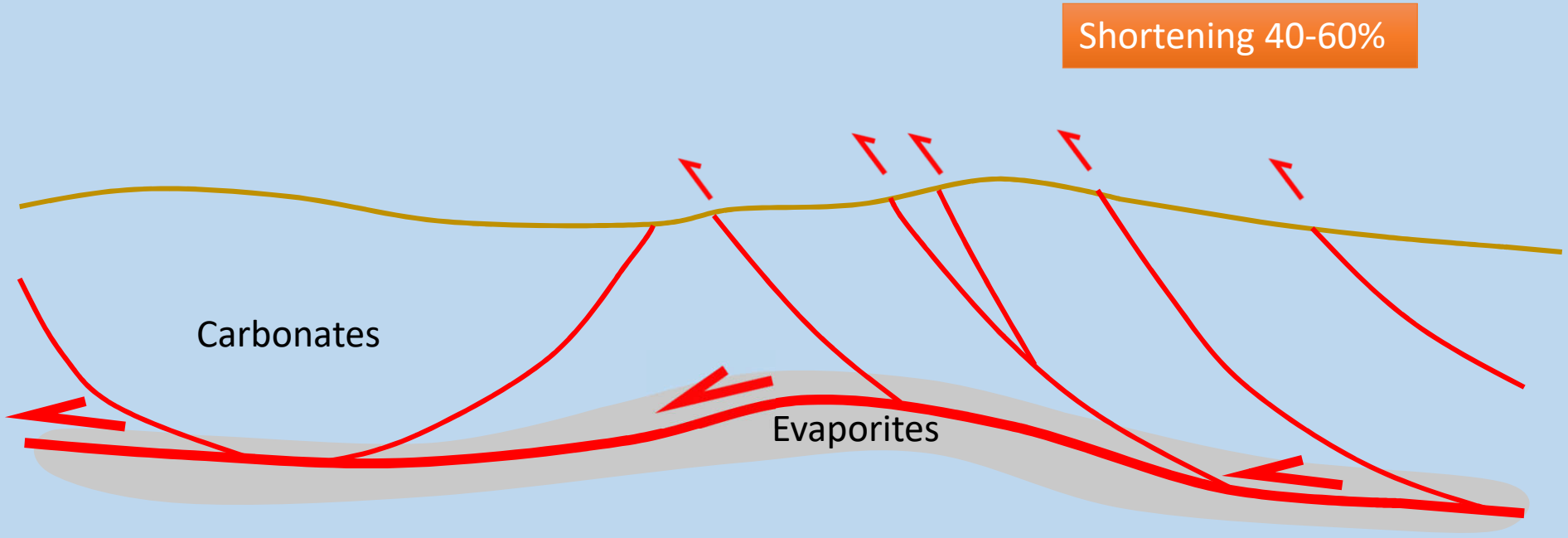
Interpreted seismic profile across the external Albanides (after Velaj, 2011).

The red dotted line represents the simplified geometry of the *Durressi Offshore Thrust-ALCS315*.



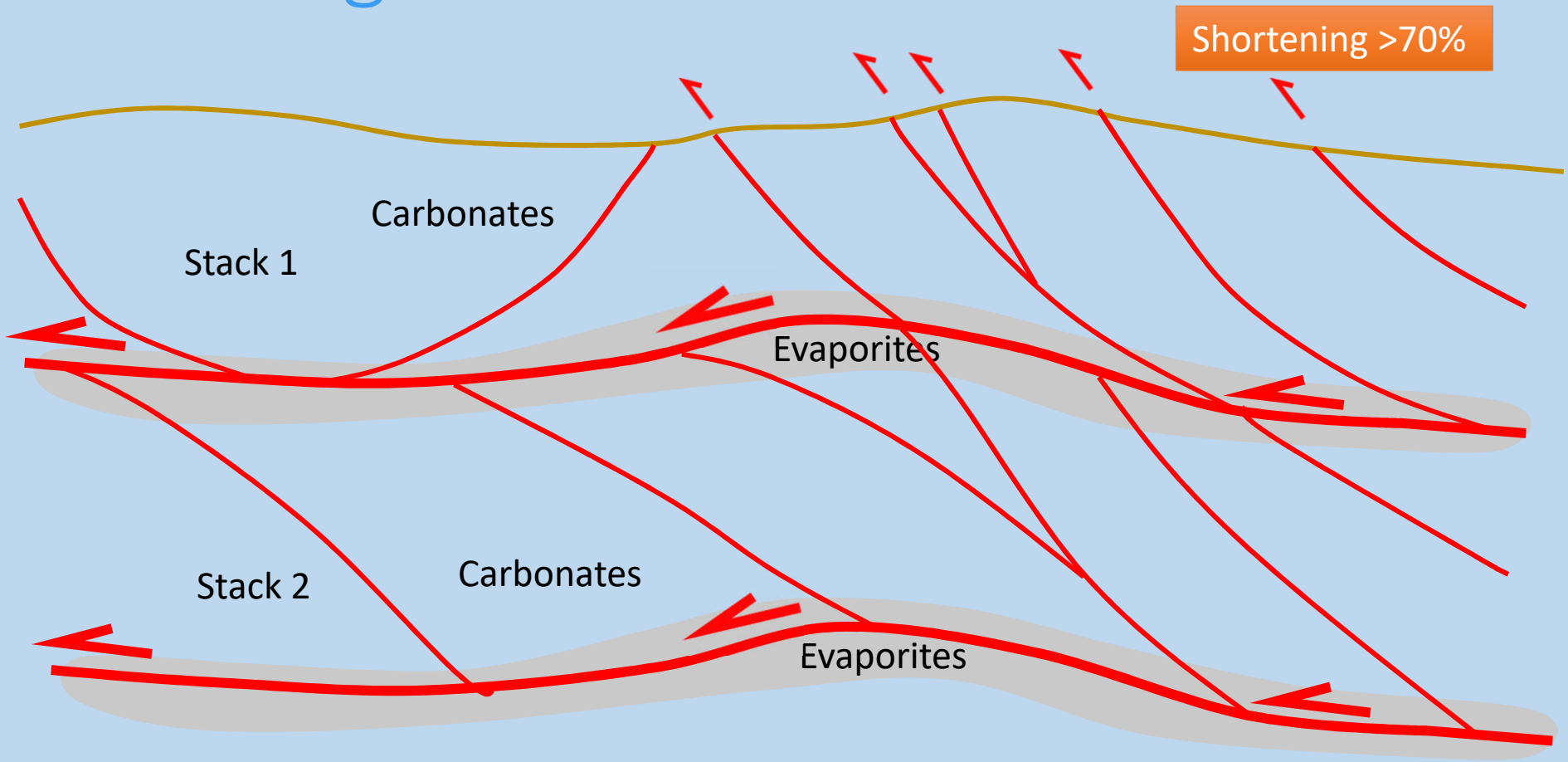
- The Durresi Backthrust (ALCS325)

Deformation model 1: Thin-skinned tectonics



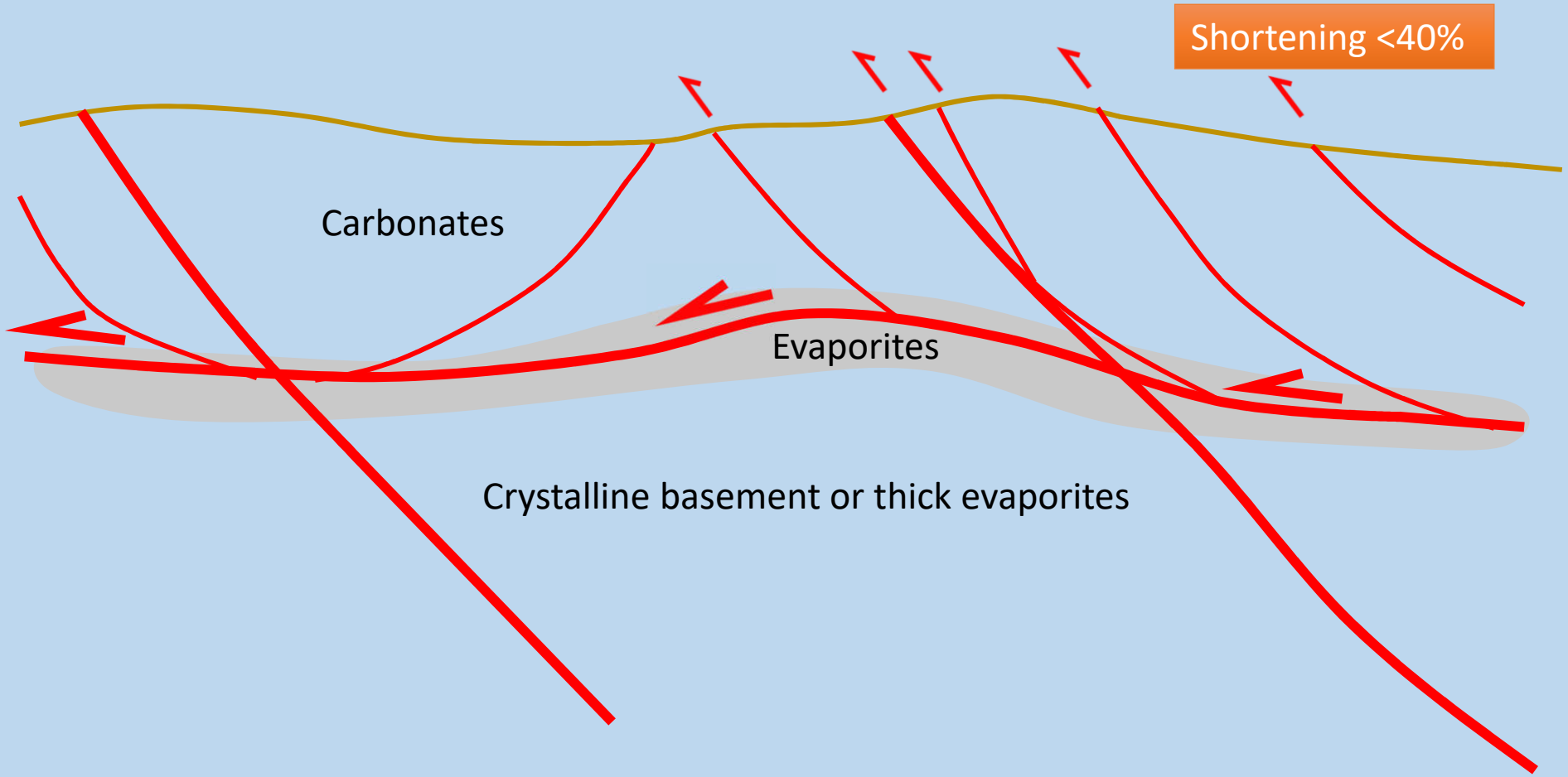
Evaporites: weakness zone

Deformation model 2: Thin-skinned tectonics with stacking



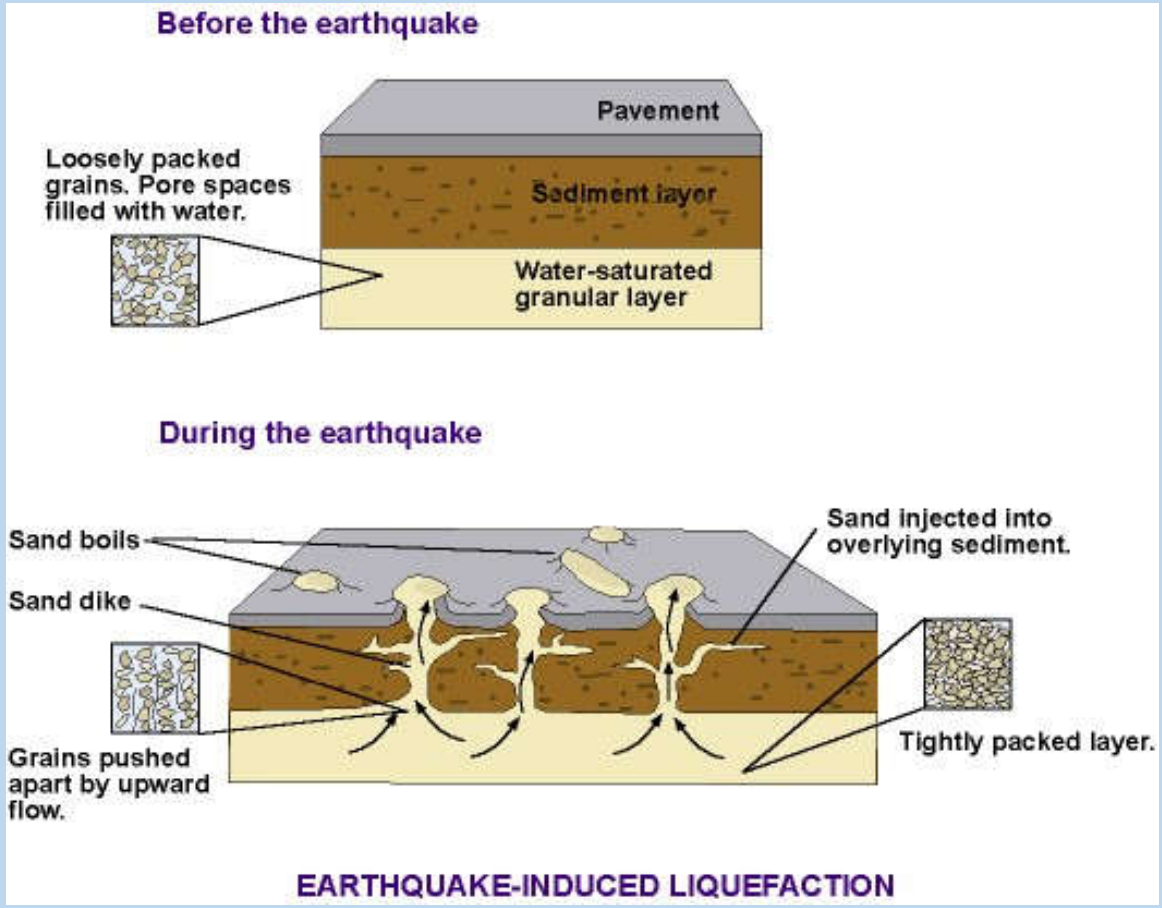
Evaporites: weakness zone which seals the underlying rocks

Deformation model 3: Thick-skinned tectonics



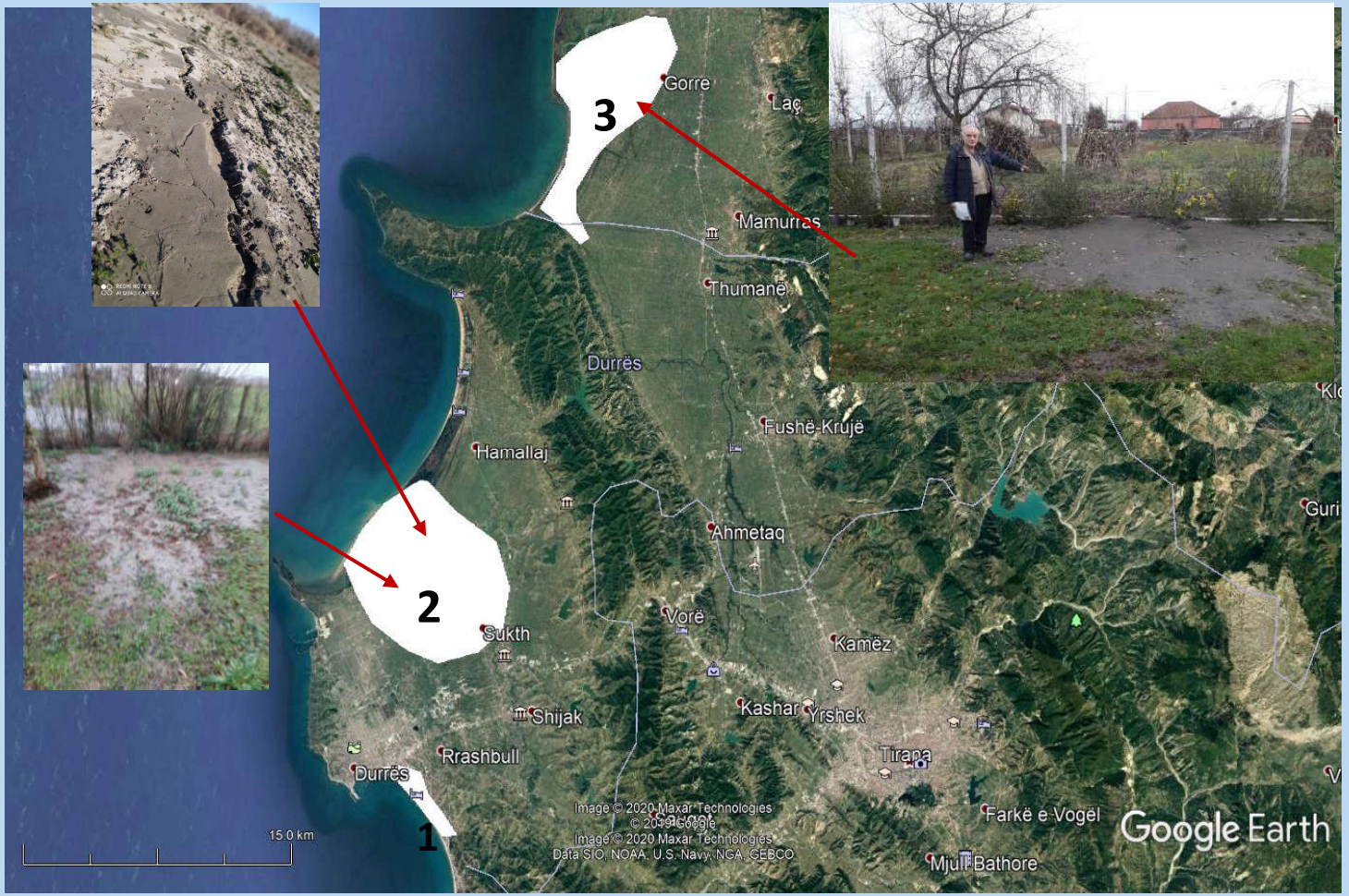
Thrusts are surface manifestations of deeper, crustal scale deformation.

Soil liquefaction is the transformation of saturated, unconsolidated granular material from a solid state to a liquid state as a consequence of increased pore pressures that reduce the effective strength of the material. The liquefaction of a subsoil layer may have induced ground failures such as ground settlements, sand boils and lateral spreading and lead to structural damage of buildings, pipelines, and bridges. The generation of liquefaction manifestations is influenced by many factors such as the parameters of the earthquake, the depositional environment of the geological unit, the depth of the water table, and the density of the soil layer. These parameters can be evaluated based on seismic hazard analysis.



The effects are mainly distributed in three areas of particularly poor geotechnical propertie

- Area 1: Durrës Beach.
- Area 2: Rrushkull area.
- Area 3: Fushë Kuqe area.

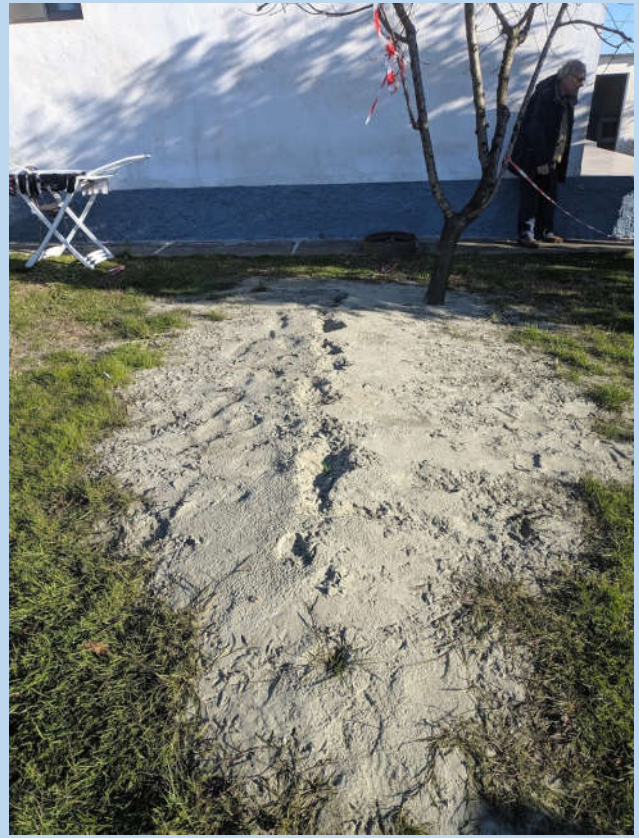


Generalized location map of the areas in which liquefaction was observed: 1. Durrës Beach, 2: Rrushkull area, 3: Fushë Kuqe area.

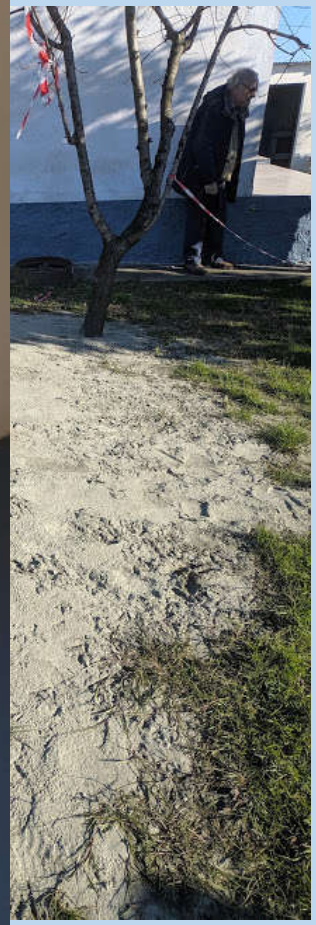
Gravitational cracks and landslides - Durres

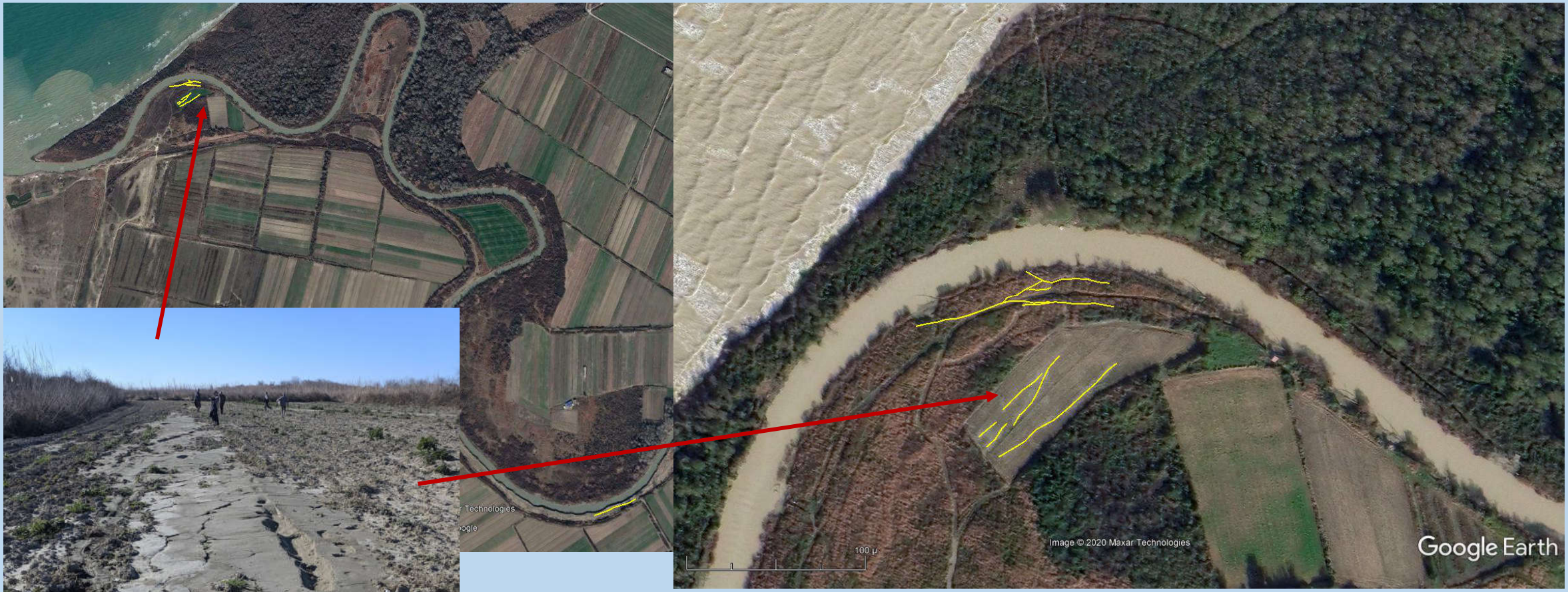
2. Brushkull area

eraction of the meandering river and the coast. Satellite images show a
st development. The flat morphology has led to the deposition of loose
these sediments widespread liquefaction was observed, together with



Compaction due to liquefaction -results





Mapped lateral spreading near the river eastuary in area 2. Liquefaction was widespread along the southern branches.

Of particular importance in this area are the lateral spreading effects that were observed along the riverbanks. They are mostly parallel to the riverbanks and are attributed to local failures due to the shaking during the earthquake.

Lateral spreading phenomena and sand volcanoes (boil),

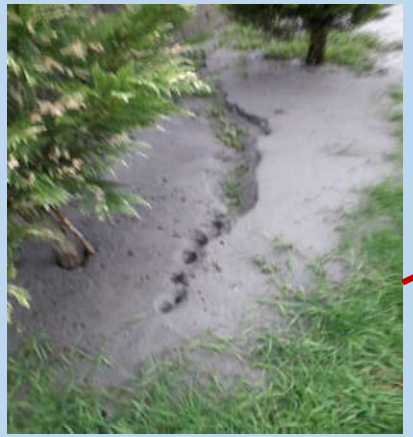
Of particular importance in this area are the lateral spreading effects that were observed along the riverbanks. They are mostly parallel to the riverbanks and are attributed to local failures due to the shaking during the earthquake.

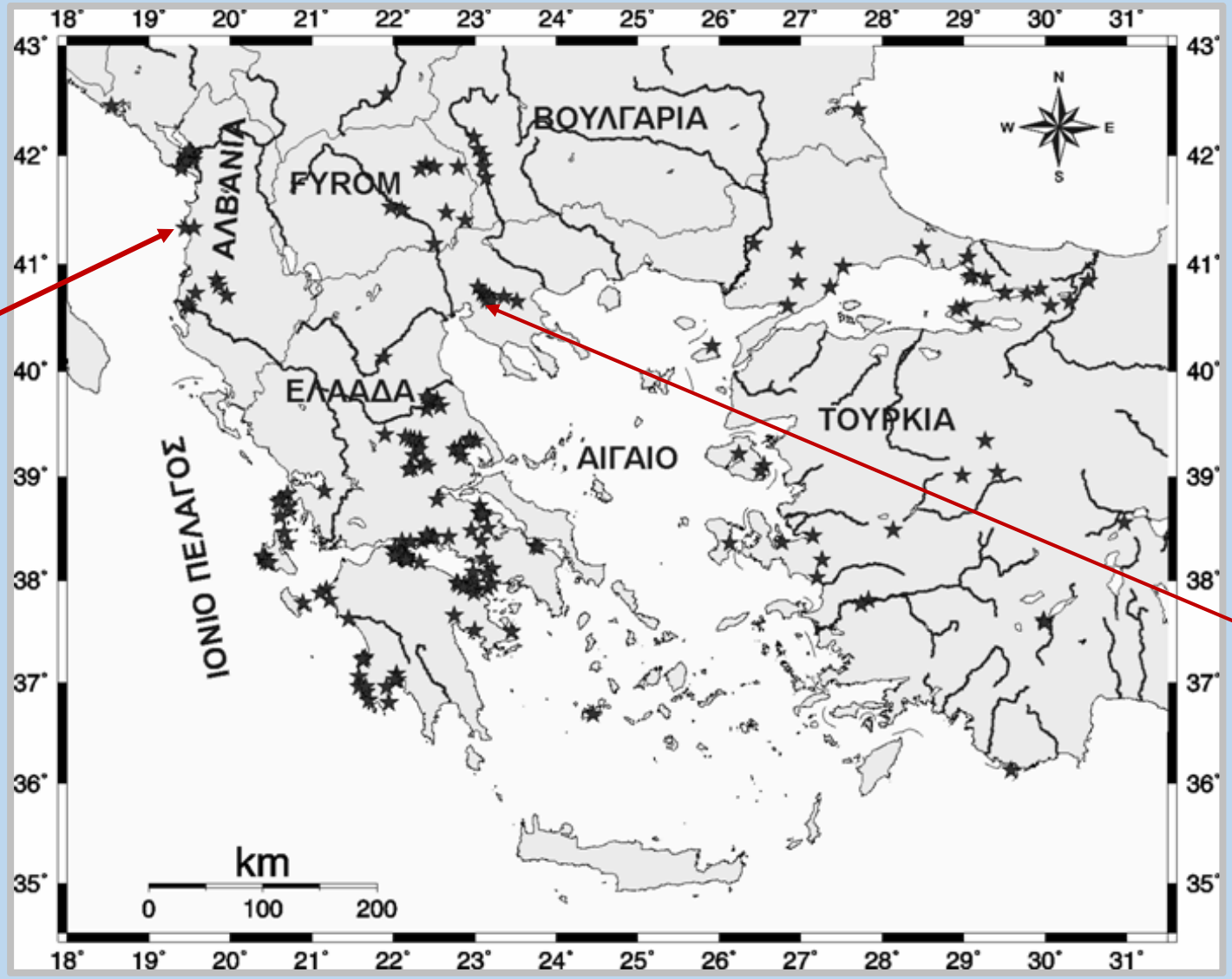
Vertical displacement of up to 15 cm was evident in certain places along the crack.

3. Fushë Kuqe area

This area has many common geological-geotechnical characteristics with the Rrushkull one. A shallow water table is developed in alluvial deposits, with the main difference being the existence of gravels that can be seen in a gravel pit next to the river north of Gurëz village. In this area, liquefaction was observed in the fields, as well as in the area of boreholes (Figures). In one case, which the only site where this was observed, liquefaction caused the ejection of not only sand, but gravel as well (Figure). A sample from this site is currently under analysis.

DALO Spatial distribution of liquefaction sites upplementary Data





Map of historical liquefaction occurrences (Papathanassiou et al. 2005)

http://users.auth.gr/gpapatha/Dalo.htm

G. Papathanassiou

Evaluating the susceptibility to liquefaction

Empirical relationships of Magnitude Ms versus maximum epicentral distance Re

- **53 earthquakes**

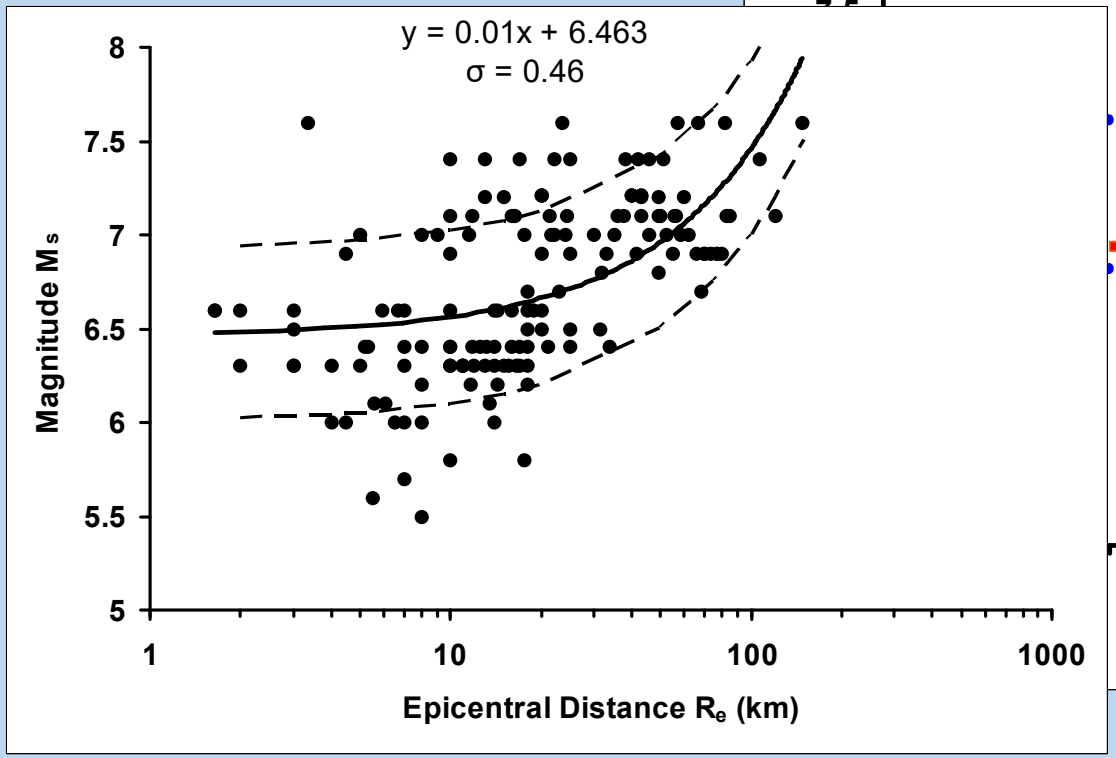
$Ms=4.742+4.655*10^{-3}Remax+0,8907\log(Remax)$ **Remax**

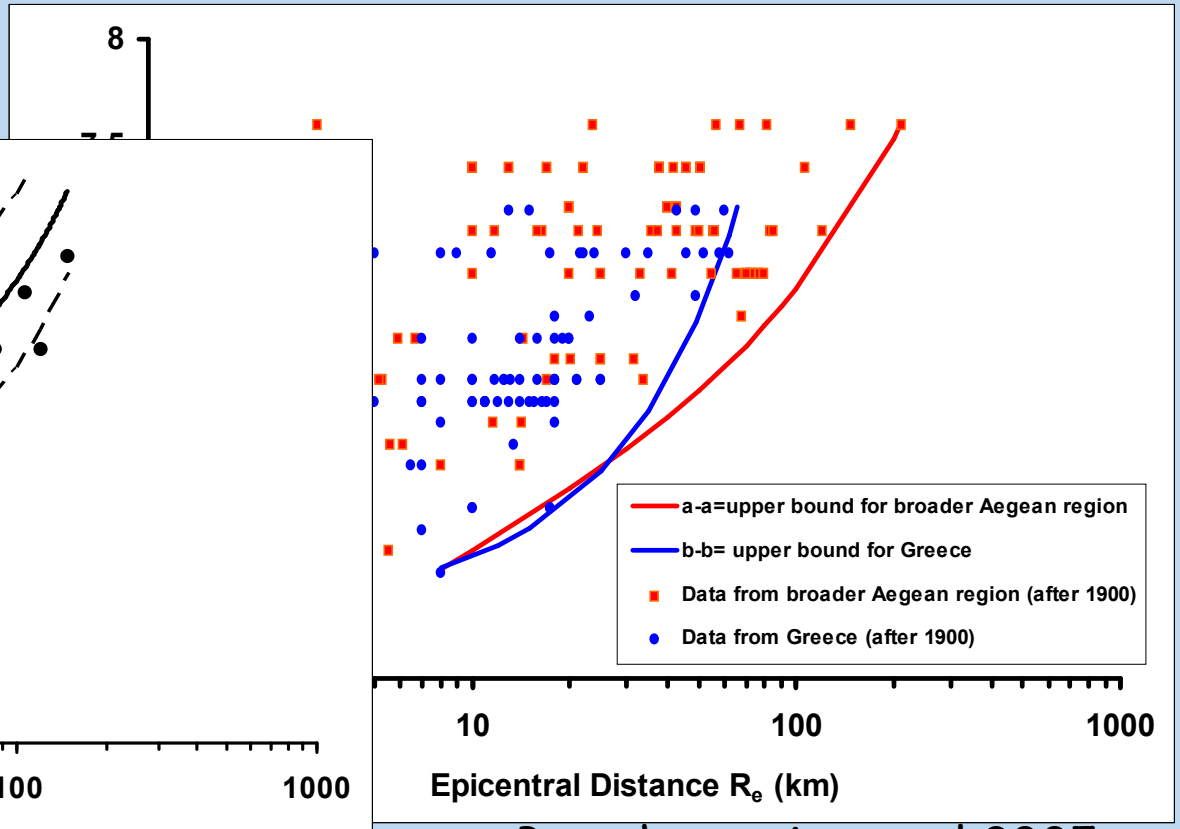
in cm

- **33 'Greek' earthquakes**

$Ms=5.3225e^{0.0046Remax}$

In our study, the susceptibility to liquefaction at these sites has been further investigated by performing back-analysis. In particular, two criteria of susceptibility were taken into account; the epicentral distance of the liquefied sites and the gradiation of the ejected material.





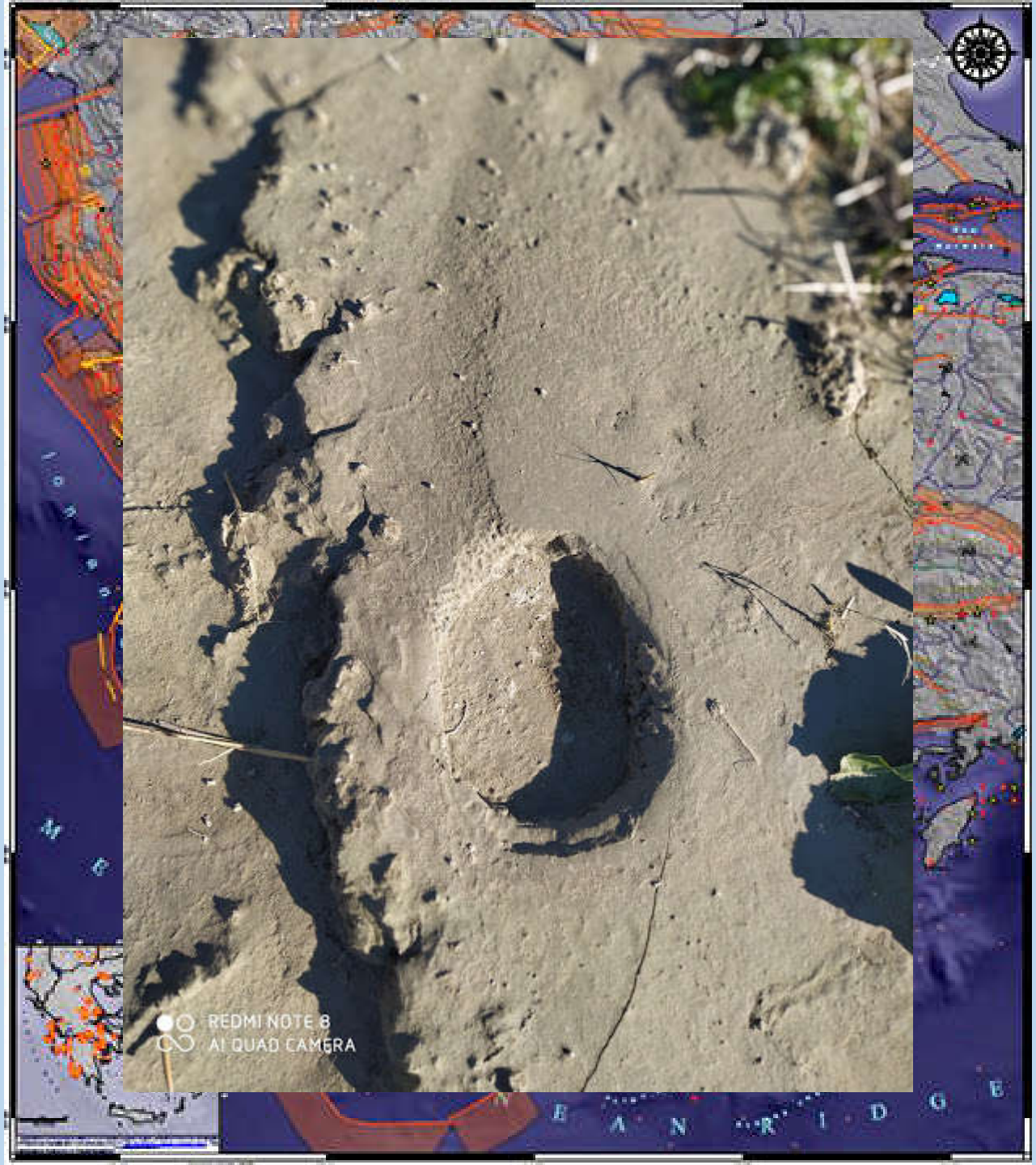
Papathanassiou et al 2005

Conclusions

- The general Geotectonic regime of Central Albania has been summarised
- The goal of the ground deformation study was to document the secondary effects at the Central Albania region and to describe in a qualitative way the liquefaction induced failures triggered by the 26th November 2019 earthquake, by providing information regarding their characteristics. In addition, samples of ejected material were collected and analyzed by the Albanian colleagues in their laboratory in order to define their grain size characteristics.

The main types of observed liquefaction phenomena are:

- Lateral spreading and ground settlements
- Sand boils (sand volcanoes) and ground fissures
- Failure of riverbanks.



EARTHQUAKE GEOLOGY TEAM
of the Geological Depart. Aristotle University of Thessaloniki

http://eqgeogr.weebly.com/

GreDaSS 2004 -2015

http://gredass.unife.it/

http://users.auth.gr/gpapatha/Dalo.htm

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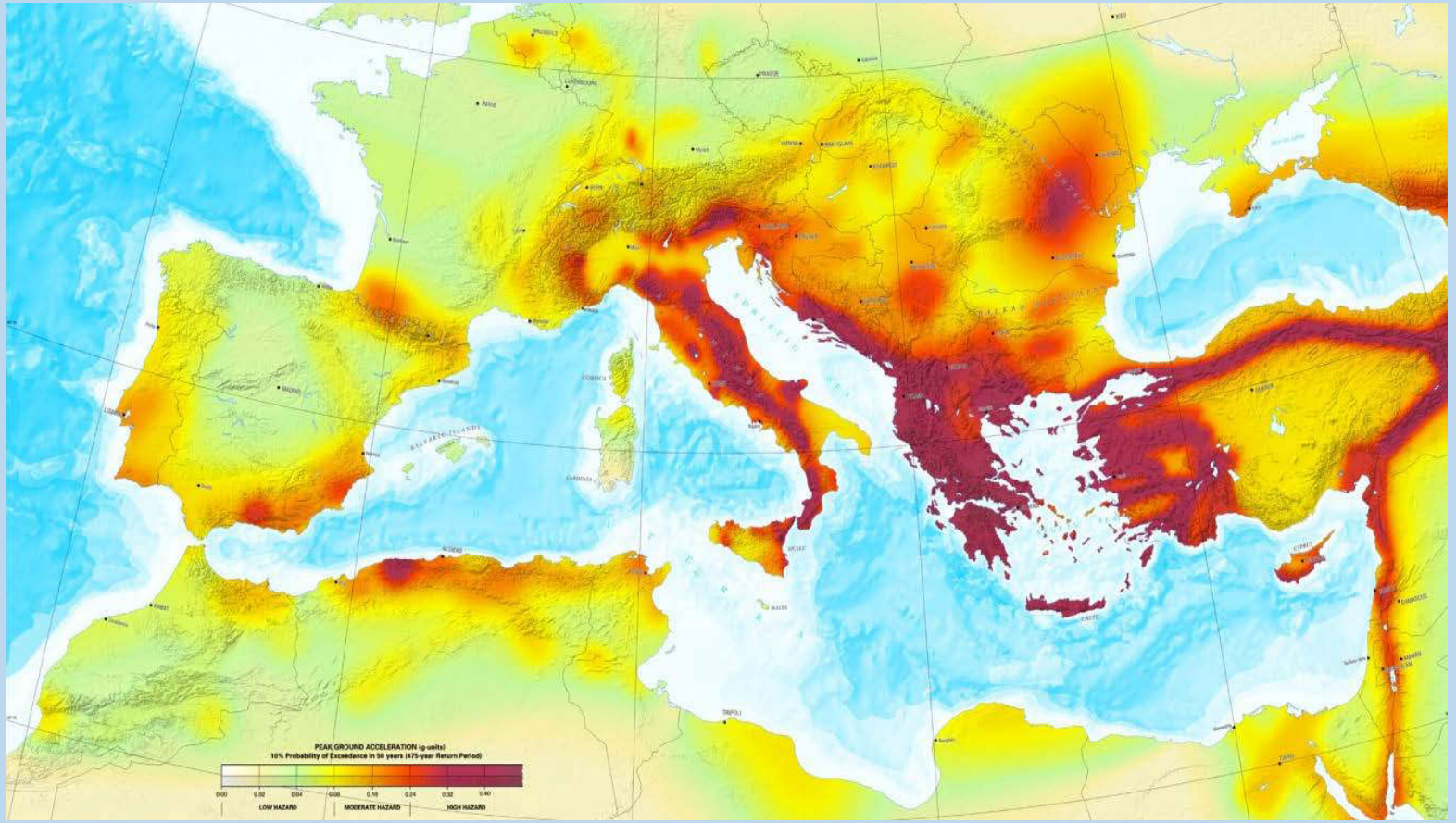

(European Seismological Commission 2003/2015)

Seismic Hazard Harmonization in Europe

SHARE produced more than sixty time-independent European Seismic Hazard Maps (ESHMs)