

Evidence of tsunami deposits in East Tunisia coastline contemporaneous of the AD 365 Crete earthquake: Field data and modeling

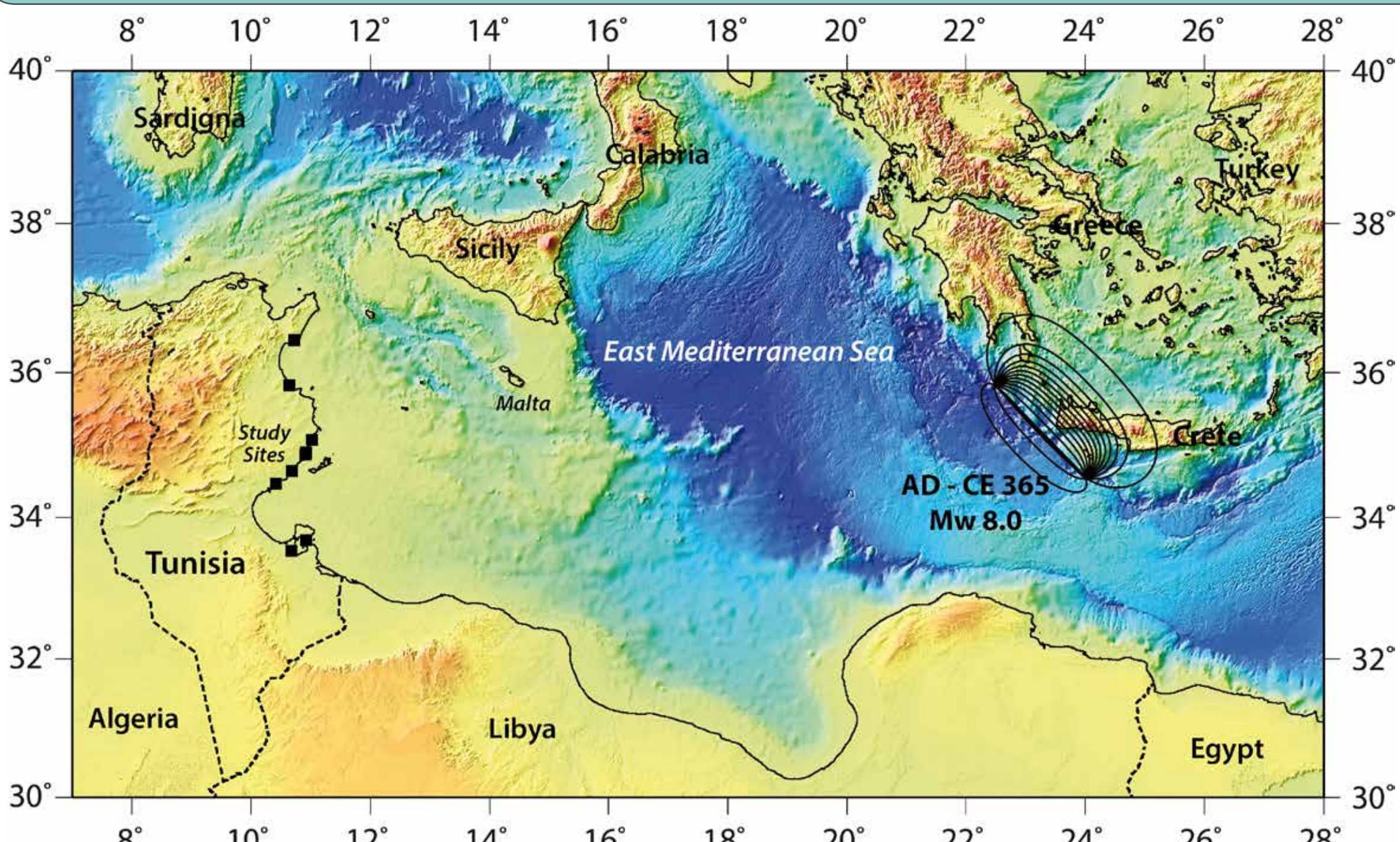
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Summary

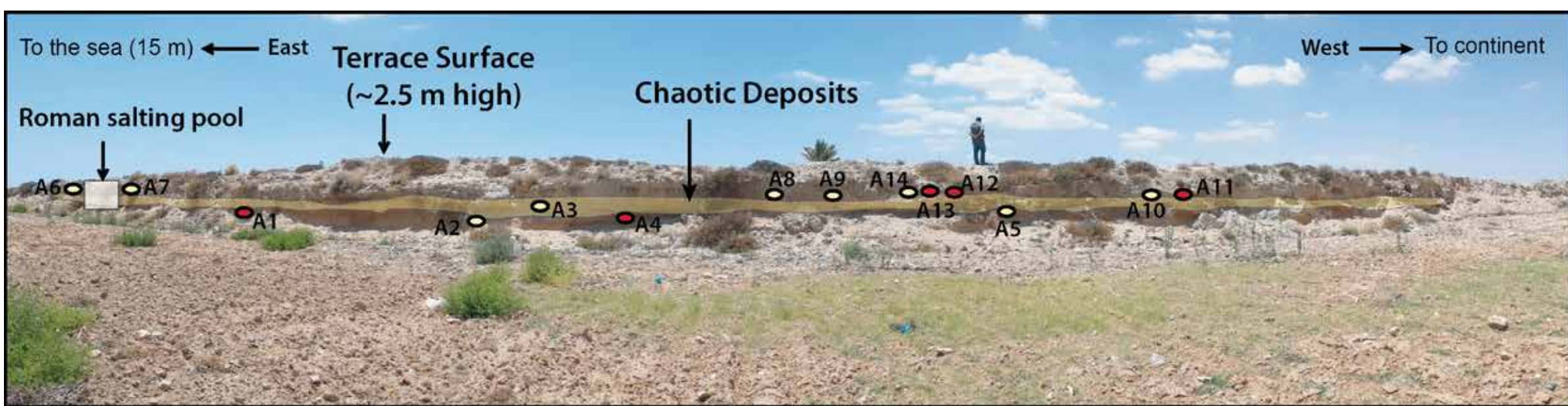
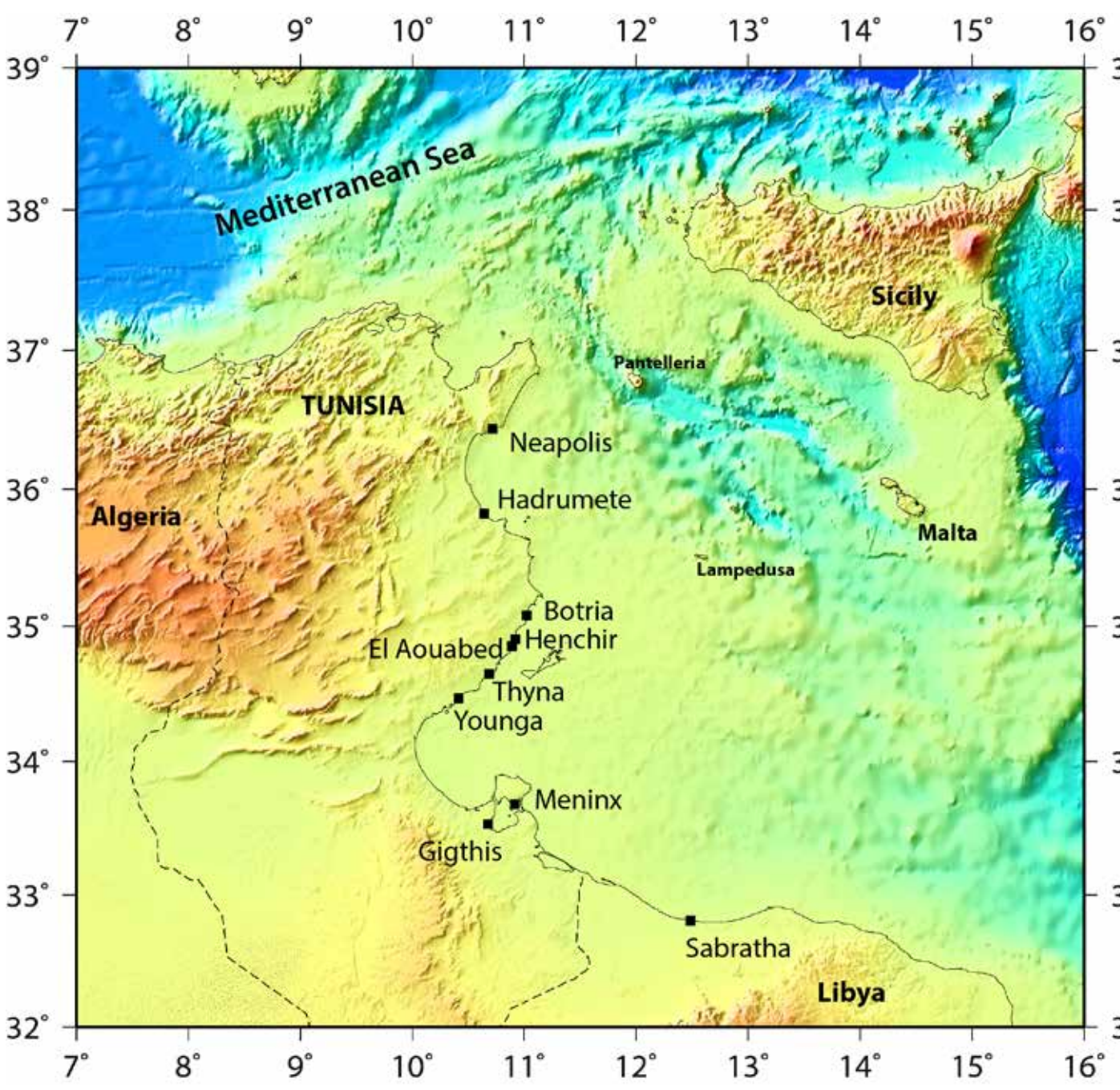
New field investigations along the East Tunisian near Sfax coastline reveal sedimentary deposits that may account for a catastrophic event. The sedimentary unit is made of sand coarse gravels, limestone beach-rock, mixed with broken shells of marine gastropods and lamellibranch mollusks, bones and organic matter. Near Thyna, at Henchir site located north of Sfax city, 2.4 m to 3.6 m high late Quaternary coastal terraces are spread over the coastline [1]; they contain a catastrophic deposit that often cover archeological sites of the Roman period. The stratigraphic units show a succession of sandy-silty paleosol truncated by 40 to 70-cm-thick catastrophic unit which is covered in some sites by fire remains overlain by a relatively thin (~10 cm) sandy-silty aeolian unit. The sedimentary succession ends with about 1-m-thick of alluvial deposits and paleosol units. Charcoal samples collected at 10 cm below and 4 cm above the catastrophic units provide radiocarbon dating 236 – 385 cal AD and 249 – 541 cal AD (2 σ), respectively. Radiocarbon ages bracket the catastrophic unit that may refer to the major tsunamigenic earthquake of 21 July 365 (Mw ~ 8) in west Crete (Greece) reported to have inundated coastlines of Sabratha in Libya and Alexandria in Egypt. The maximum tsunami wave heights distribution calculated along the Tunisia coast peak in both cases at about 3 meters. The run-up caused by these sources, also considering that we have used uniform slip on the causative fault, can be significantly higher. This proves that the tsunami waves may have reached Tunisia where several coastal cities were severely damaged and reported to have stopped their economic activity. With the identification of the 365 tsunami deposits in eastern coast of Tunisia, the tsunami hazard and risk associated with a major earthquake from the western Hellenic subduction zone cannot be ruled out.

The 10 July 365 Crete Earthquake



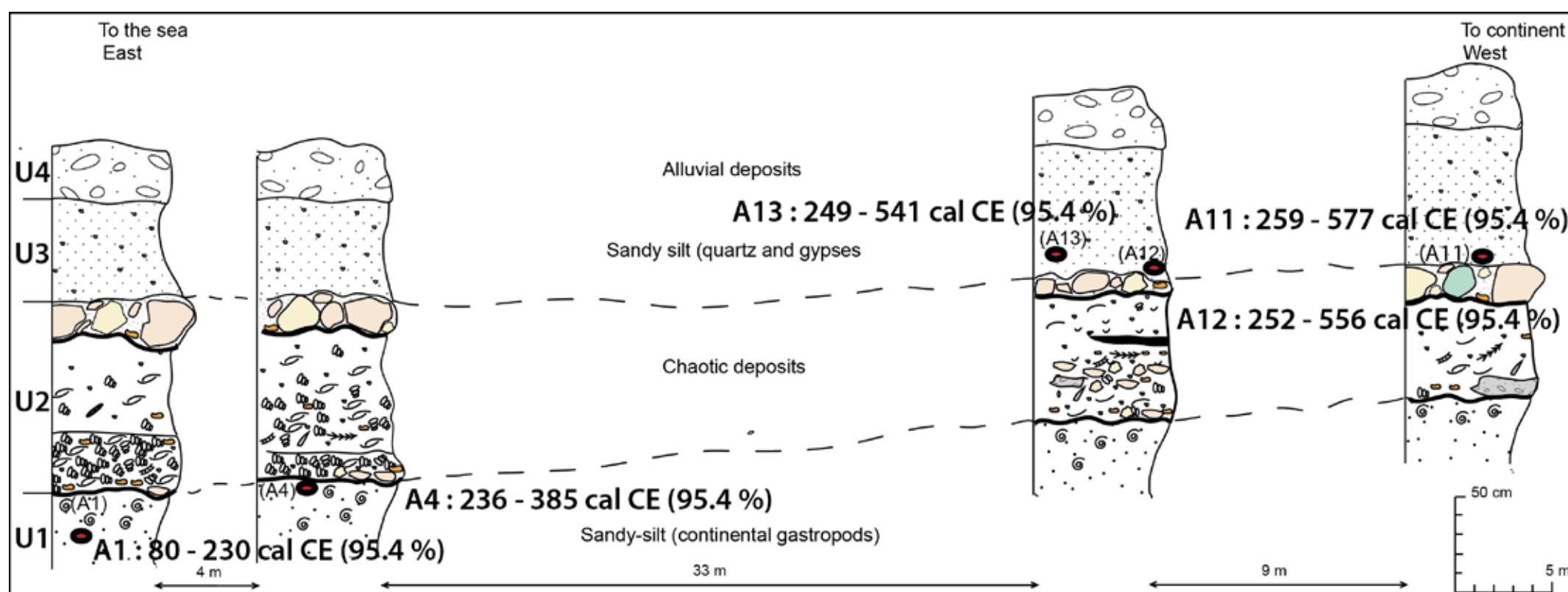
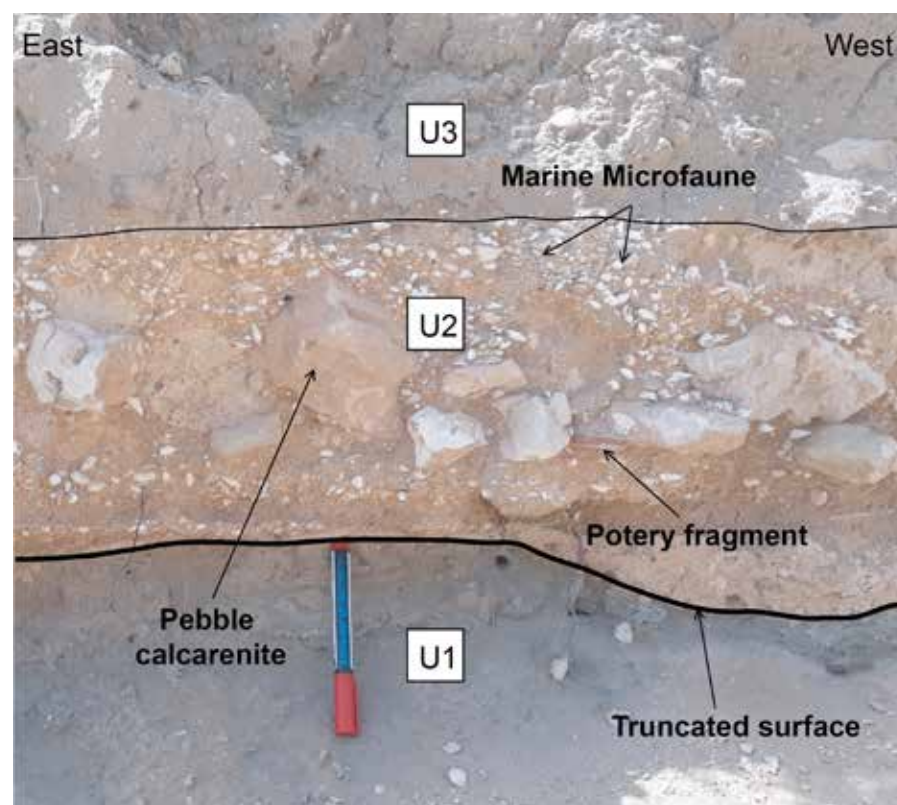
The historical earthquake generated ~9 m uplift in east Crete Island (Greece) [5]. The model correspond to a Mw ~8.0 earthquake with seismic slip distribution at surface using Okada dislocation approach [4]. The study sites in coastal Tunisia face the Crete seismic source with no significant obstacle (except Malta Island) to the tsunami wave propagation.

Tsunami Sites

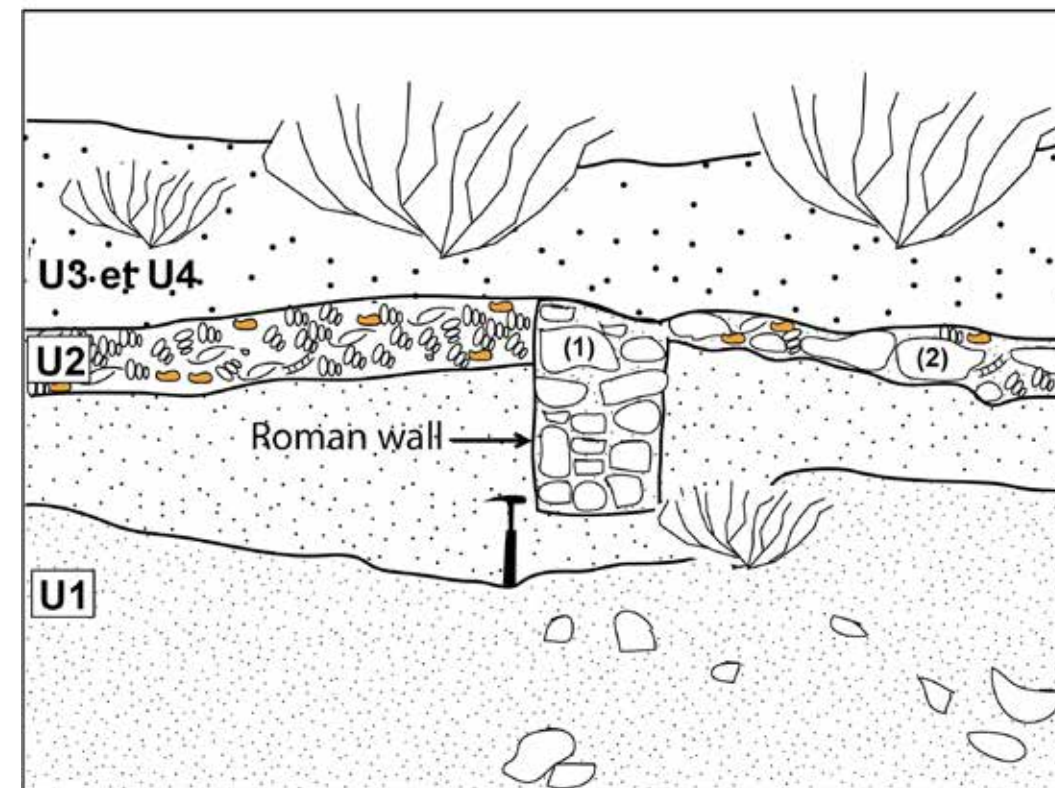
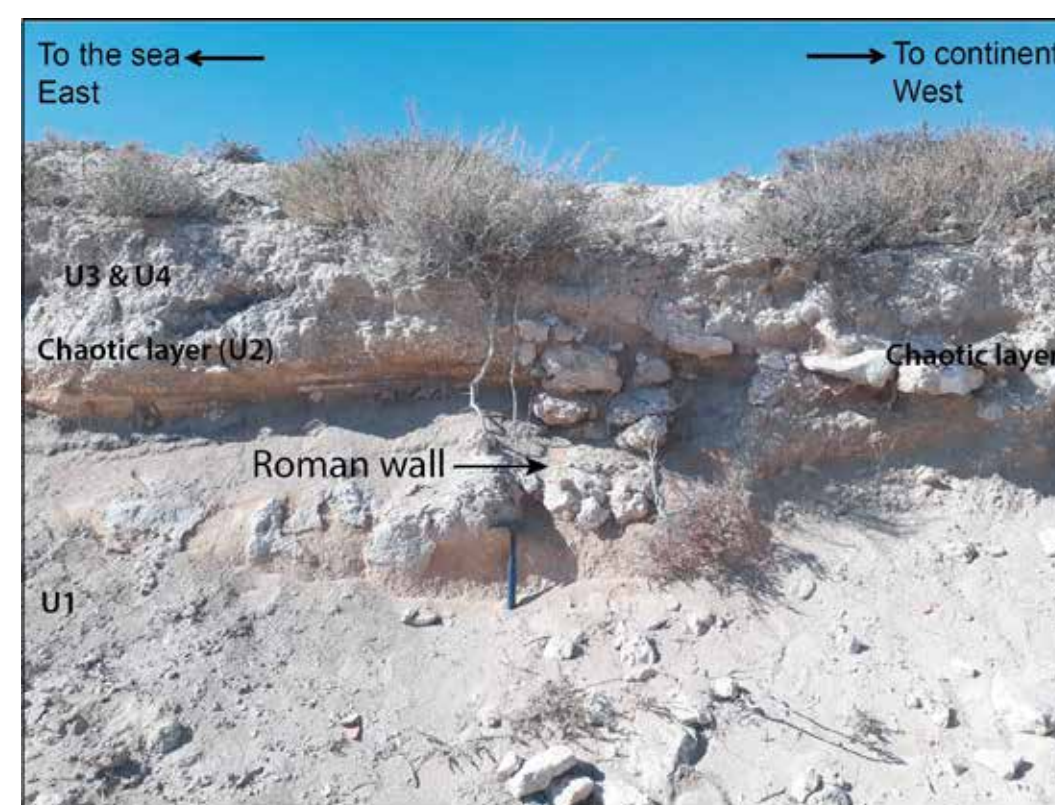
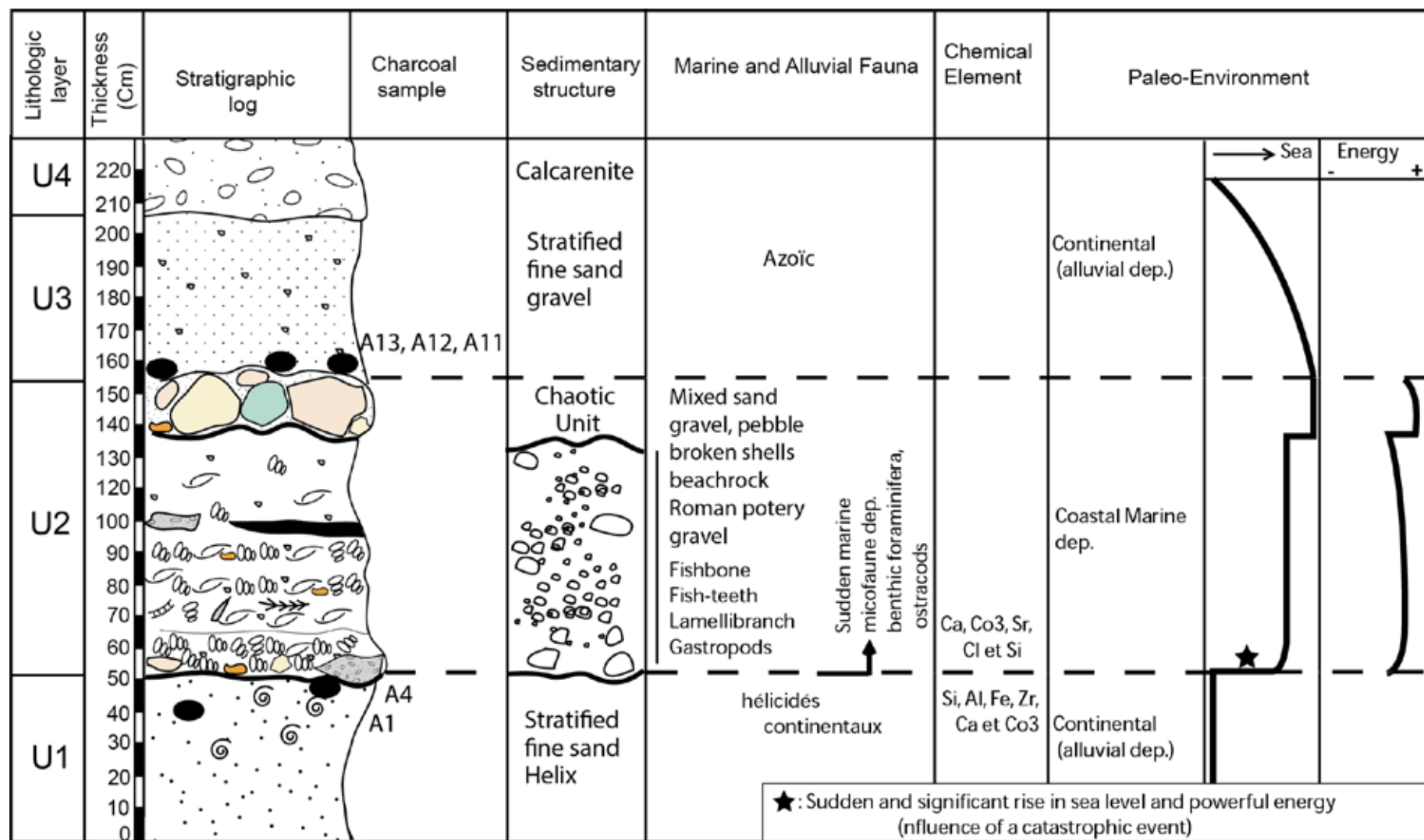
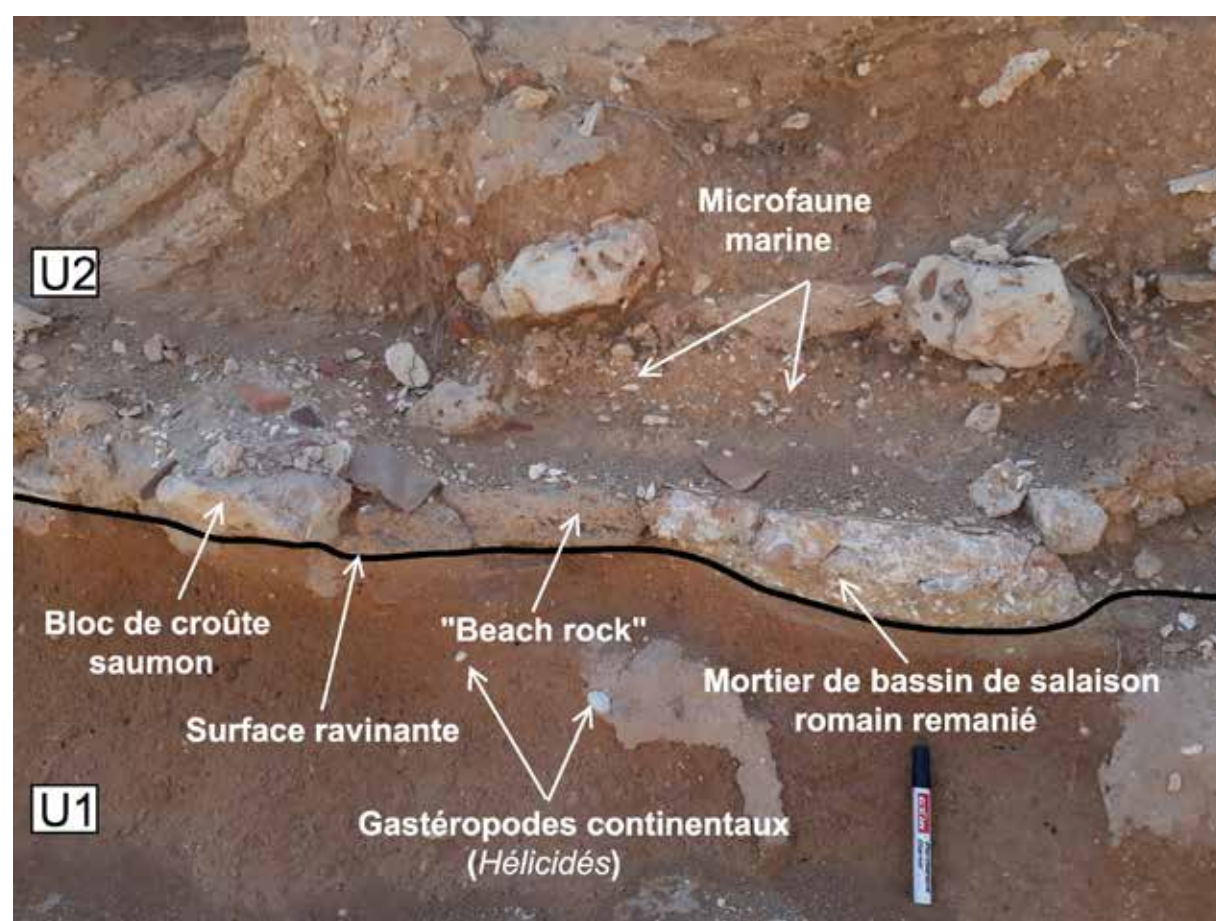


Left: Main archeological sites in coastal Tunisia with damaged and abandoned Roman cities in the IVth century (CE). Neapolis (now Nabeul) in Tunisia and Sabratha in Libya show visible tsunami damage.
Up: The site at Henchir (photo) shows a catastrophic layer with mixed beachrock, Roman pottery, Roman masonry stones with mortar, gravel and fine sand with broken shells. A1 ... A14 are collected samples for dating (only red samples have been dated).

Tsunami Deposits

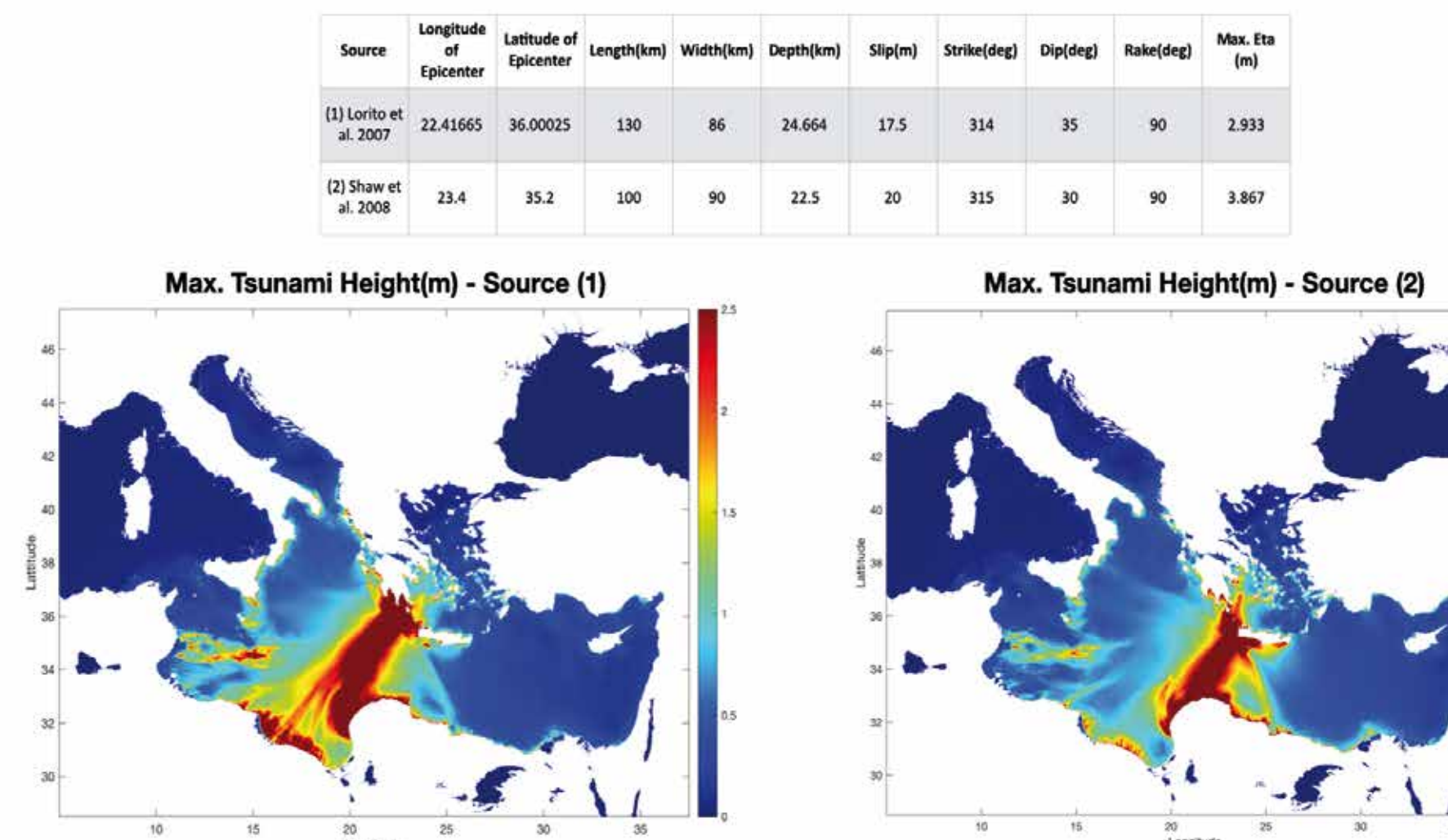


Stratigraphic log of four sections of outcrops from the mixed marine and alluvial terrace at Henchir (see location in the above landscape photograph). A 40 cm to 100 cm-thick chaotic layer is characterized by an erosion basal limit and mixed content of broken shells, pebbles, Roman masonry stones and beachrock. C14 dating of 5 charcoal samples that bracket the chaotic - catastrophic layer.



Tsunami Modeling

The nonlinear shallow water Tsunami-HySEA code is used to perform numerical modelling using 2 different seismic sources [2, 5] comparable to that of the AD 365 Crete earthquake. They feature 2 principal mechanisms that accommodate the Nubia-Aegean convergence along the Hellenic Arc, namely a shallowly dipping thrust-faulting on the subduction interface, as well as a steeper splay faulting in the overriding material.



Distribution of Max. Tsunami Wave Height for 2 different sources.

Conclusion

The study of marine and alluvial terrace at Henchir site along the shoreline in southern Tunisia (north of Sfax city) shows evidence of a chaotic catastrophic layer that may be correlated with a past tsunami event. We observe:

- A layer made of broken shells, beachrock, fine marine sand mixed with alluvial sandy-gravel, Roman pottery, Roman masonry stone with mortar.
- The chaotic layer has an erosion base limit that truncates the fine sand with Helix below.
- Fine sand with gravel deposits cover the chaotic layer
- Radiocarbon dating of 5 charcoal samples collected immediately below and above the chaotic layer provide an age bracket between 236 and 541 Current Era (2 σ , 95.4 %), which correlates with the 365 CE large earthquake tsunami of western Crete.
- The numerical modelling of tsunami wave propagation using 2 different seismic sources shows ~3-m-high height at the coastal region of Tunisia.
- The tsunami wave propagation may generate turbidite-homogenite in between Malta and Tunisia [3].
- Our results imply the development of a new strategy for tsunami hazard assessment in coastal Tunisia.

References

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