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Modelling the 365 AD Crete Earthquake and its Tsunami

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A major earthquake with an estimated magnitude of M_W=8.5 rocked the whole Eastern Mediterranean in the year 365 AD. This earthquake destructed many cities on Crete and generated a tsunami which travelled as far as Egypt to the East and Sicily to the West. Preserved uplifted (up to 9 m) and dated shorelines in western Crete and Antikythera were used to invert for the most likely rupture plane of this event. This inversion is done by comparing calculated uplifts in a viscous-elastic layered half-space with the observed data. The resulting rupture plane coincides with the actual plate interface between the subducting African plate and the overriding Aegean plate. It has a minimal length of approximately 145 km, a width of 130 km, a strike of 297°, a dip of 13° and a uniform slip of 42 m. The magnitude of this earthquake would be M_W=8.5 and the resulting co-seismic uplift reached values of over 15 m off-shore Crete and the long-term uplift fits very well the observed deformation field.

The calculated uplift of the seafloor is the base for modelling the resulting tsunami which generates maximal wave heights of approximately 2–3 m off-shore Alexandria and Sicily (without taking into account any coastal run-up) and more than 10 m off-shore Libya. Whether this event was one 'universal' earthquake or different smaller earthquakes is still a matter of debate, but the results show that an earthquake of magnitude M_W=8.5 in the Hellenic subduction zone off-shore Crete can explain the confirmed historic and modern data.

Additional 3D models (finite-element method) analyse the effect of curvature of the subduction zone and the influence of the dipping slab. Different modelling scenarios of after-slip, distributed creep, and (re-)activation of juxtaposed faults give new insights into the complex and highly dynamic processes of the Hellenic subduction zone.