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New developments in paleotsunami research: inland and offshore multiple records from the Augusta Bay (eastern Sicily, ITALY)

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Eastern Sicily (Italy) was repeatedly hit by tsunami waves related to large local historical earthquakes (e.g. 1908, 1693, 1169) as well as to far-field sources (e.g. AD 365 Crete earthquake). Along the eastern Sicily coasts, we selected the Augusta Bay, a natural gulf about 15 km wide and with a 25 km-long shoreline, as the key area of this study because it is one of the locations where both information available from historical written reports on tsunami effects (hit localities, inundated areas and run-up distribution) and local geomorphology suggest it is very favorable for the research of the geological signature of past tsunamis. Lowlands and lagoons characterize the coastal area, while a relatively wide continental shelf with a thick late-Holocene record has been investigated offshore through the acquisition of a tight grid of CHIRP-sonar profiles. Well-targeted sediment samples have been collected both offshore and inland. The integrated interpretation of the geophysical and geological data has been carried out in order to recognize, date and correlate key-layers in the sediment column that may be directly or indirectly related to tsunami events.
A total of 22 cores were collected inland in two different sites at a maximum distance of 530 m from the present coastline. The dominant fine to very fine stratigraphy is intercalated by at least 6 high-energy depositional layers, repeatedly found in several cores. These thin single massive and structureless beds with abrupt erosional lower contact are made of coarse to fine sand and present a bioclastic component of marine provenance. Chronological constraints on the age of these deposits are based on 8 AMS radiocarbon datings and on the attribution of a tephra layer to the 122 BC Etna eruption. On the basis of the combination of all the data collected, the inland sequence spans the last 4100 yrs and three among six tsunami deposits found along the Augusta Bay coastline may be associated to historical tsunamis.
The offshore record was derived from a 6.7 m-long piston-core sampled 2 km offshore the Augusta harbor at 72 m depth. The work involved the study of original geophysical data and sediment samples, including X-ray imaging, isotopic dating, tephrochronology, grain-size and micropaleontology. The homogeneous sequence of dark gray mud is interrupted at -3 m by the same Etna tephra deposit found inland. Through the analysis of tephrostratigraphy, radiocarbon datings and radioactive tracers, the entire core sequence has been dated back to the last 4500 yrs. Moreover, the quantitative micropaleontological (on the benthic foraminifera assemblage) and sedimentological analyses highlighted 12 anomalous layers marked by high concentration of displaced epiphytic foraminifera (species growing in vegetated substrates like the Posidonia oceanica) and subtle grain size changes.
These anomalous layers could have been caused by high-energy events, with tsunamis (back-wash wave) as best candidates. This hypothesis is also supported by observation that the ages of 5 of these peculiar layers coincide with that of historical tsunamis.
The Augusta Bay represents a unique case study because it allows a comparison between geological (both inland and offshore) and historical records. For the 365 AD Crete tsunami and the Late Minoan Santorini event, our findings may represent the first inland-offshore evidence in the central-western Mediterranean area. On the basis of these results we can propose an inland and offshore geologic average tsunami recurrence interval of about 600-700 and 330-370 years, respectively, for the past 4 ka in the Augusta Bay.