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On the origin of multiple tsunami inundation of the archaeological site of Ognina (Sicily): Numerical models and field geological data

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South-eastern Sicily is among the most seismically active areas of the central Mediterranean. As such, it is marked by a high level of crustal seismicity producing major earthquakes (up to Mw 7), and consequent several earthquake-generated tsunami, which have affected the Ionian coast of South-eastern Sicily in historical times. These tsunami events left geomorphic imprints such as large boulders or high-energy deposits along the Sicily coasts. In Ognina, a small town located 20 km south of Siracusa, high-energy deposits were correlated with three tsunami events that struck this coast on 21 July 365 Common Era (CE), 4 February 1169 CE, and 11 January 1693 CE. The deposits are detected in the inner part of a narrow channel, that is thought to have funnelled the tsunami flow energy. In this work, numerical models have been performed to simulate the tsunami impacts, considering the most probable tsunamogenic sources described in literature and integrating them with the past sea-level positions. To this end, we used Delft Dashboard, Delft 3d-FLOW and XBeach. A reconstruction of the past topography of Ognina coast was performed through geological and historical information, in order to model the tsunami wave propagation in the ancient landscape. Geological evidence with model results, under different scenarios, allow us to benchmark fault location and displacement scenarios. Modelling results indicate that the 1693 tsunami event was stronger than others impacting the Ognina area, determining significant inland flooding in the narrow channel. Moreover, simulations show that the most probable tsunamogenic sources of 1693 and 1169 tsunami events could be attributed to Western Fault dislocations occurred off-shore of Ognina area, rather than the other tsunamogenic sources described in literature, located off-shore of Catania and Siracusa. Modelling of 365 AD event shows a long period for the tsunami wave that determined the sedimentation on the lower units in the outcrop. For each of the three tsunami events, models of high-energy deposition match with position and thickness of high-energy layers detected in the field. The results of this study show how a combined approach between geological evidence and tsunami modelling could be a suitable tool for the attribution of tsunami deposits connected to specific tsunamogenic sources.

Keyword: tsunami; earthquake; faults; flooding; sea-level