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Analysis of large boulders along the coast of south-eastern Sicily to discriminate between storm and tsunami deposits.

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We present a study to discriminate the kind of anomalous waves, storms or tsunamis, that were responsible for the large boulder accumulation in the Vendicari Reserve along the south-eastern Sicilian coast. These depositional and erosional indicators of the large wave impact have been already observed in some rocky coasts of the Mediterranean basin and associated to strong waves of tsunamigenic or meteorological origin. Distinguishing boulders deposited by tsunamis from that deposited by storms and determining the age of their deposition can help to evaluate the magnitude and frequency of tsunamis and the hazard along the coast also regarding extraordinarily violent storms.

The Sicilian Ionian coast has been affected in historical time by large destructive earthquake-related tsunamis (e.g. the 1169, 1693 and 1908) and it is exposed to an intense wave motion coming from a NNE- SSE span direction .

In the rocky coastal area of Vendicari Reserve, three different GPS surveys (from September 2006 until April 2009) have been performed with the aim to observe the distance of each boulders with respect to the shoreline and if storms removed boulders or deposited new ones. A morphological analysis aiming to identify boulder shapes, measuring their volumes, elongation axis azimuth, pre-transport setting and the probable transport mechanism on the platform, was also carried out. The calcarenitic boulders (specific weight about 2,3 g/cm^3), reaching about 20 tons and a distance up to 60m from the shoreline, are generally carved out from the supratidal or mid-sublittoral zone, showing widespread biogenic encrustations sometimes so fresh that suggest a recent deposition. The GPS surveys allowed us to observed that, after a strong storm during January 2009, several boulders were removed while new have been deposited on the platform by the storm waves.

Hydrodynamic equations jointly to statistical analysis of sea storms have been used to determine the extreme event, geological or meteorological, responsible for this singular accumulation. We computed the minimum wave height, of storm and tsunami, required to start the movement of each boulder from its initial position. Moreover, we calculated the maximum penetration of the waves for the two major storm waves estimated at Vendicari and for the 1693 and 1908 tsunami waves. Finally we compared the computed values with the boulder distribution.

The results show that the strongest storms were probably responsible for the current distribution of many boulders but about the 30% of them need of stronger waves, likely tsunami waves, than the maximum assumed storms to be moved and transported in their final place.

Radiocarbon dating, performed on three probably tsunami boulders, having weight of about 15 t and sited at a distance $>$40 m from the shoreline, suggests that two of them were probably deposited by the 1693 tsunami, and one by a tsunami occurred after 650-930 AD that could be an unknown event or one of the historical tsunamis occurred in the Ionian coast of Sicily. Absolute age dating, such as optical stimulated luminescence, should be necessary to gather a correct imprint of the paleotsunami event.