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THE MESSINA 1908 EARTHQUAKE AND THE EFFECT OF IRREGULAR SEAFLOOR TOPOGRAPHY ON THE SUBSEQUENT TSUNAMI GENERATION: A 2-D NUMERICAL EXPERIMENT

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The generation mechanism of earthquake-induced tsunamis is generally assumed to be related to the sudden displacement of the seafloor induced by the seismic shock. More precisely, the basic hypothesis is that the initial sea surface perturbation exactly reproduces the vertical coseismic movement due to faulting. The availability of a reliable model for the computation of the ocean bottom's deformation should then be considered a basic demand in tsunami research. In the most commonly adopted approach, the Earth's crust is modelled as a homogeneous and isotropic elastic half-space bounded by a flat-free surface (FFS), for which the displacement field induced by arbitrary point sources as well as by rectangular faults can be computed analytically (e.g. Okada, 1992). As to its application to the tsunami generation problem, this model is completely unable to account for the real seafloor topography. Hence, incorrect results may be predicted especially when the seismic sources are very close to, or even intersect, the coastlines and when relevant topographic structures like escarpments or grabens are involved, which is the typical scenario for the tsunami source regions in the Mediterranean sea. So far, the effect of non-flat bathymetries has been modelled through approximate algorithms (Tanioka and Satake, 1996; Tinti and Armigliato, 1998), taking into account the coseismic horizontal movement of the sea bottom and the correction it adds to the vertical displacement. Only rough estimates of the effect of an irregular bathymetry can be obtained through these methods, since they don't allow for the computation of the displacements exactly on the points belonging to the bathymetric relief. This goal can be accomplished by means of a hybrid approach we

developed recently, which solves the equilibrium equations of linear elasticity in two dimensions through both the analytical FFS solutions and a finite element code. The approach is here applied to compute the coseismic displacements along selected 2-D cross sections intersecting the Messina Straits (southern Italy), where one of the most catastrophic tsunamis hitting the Italian coasts was generated by the December 28, 1908, M=7.2 earthquake. After selecting some of the most reliable fault models proposed in the literature for this earthquake, we compare the results accounting for the seafloor topography with those obtained through the FFS analytical formulas and the approximate algorithms cited above, and we discuss the consequences for the tsunami generation process.