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Seismic microzoning from synthetic ground motion earthquake scenarios parameters: The case study of the city of Catania (Italy)

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ABSTRACT

The city of Catania (Italy) in the South-Eastern Sicily has been affected in past times by several destroying earthquakes with high values of estimated magnitude. The seismogenic area to the south of Volcano Etna, known as Iblean Area, is placed between the African and the Euro-Asiatic plates on the west of the Ibleo-Maltese escarpment, to the south of the Graben of the Sicilian channel and on the east of the overlapping front of Gela. Basing on the seismic history of Catania, the following earthquake scenarios have been considered: the *"Val di Noto"* earthquake of January 11, 1693 (with intensity X-XI on MCS scale, magnitude $M_W = 7.41$ and epicentral distance of about 13 km); the *"Etna"* earthquake of February 20, 1818 (with intensity IX on MCS scale, magnitude $M_W = 6.23$ and epicentral distance of about 10 km). The soil response analysis at the surface, in terms of time history and response spectra, has been obtained by 1-D equivalent linear models for about 1200 borings location available in the data-bank of the central area of Catania of about 50 km^2, using deterministic design scenario earthquakes as input at the conventional bedrock.

Seismic microzoning maps of the city of Catania have been obtained in terms of different peak ground acceleration at the surface and in terms of amplification ratios for given values of frequency.

1. Introduction

Earthquake hazard zonation in urban areas is the first and most important step towards a seismic risk analysis in densely populated regions. The aim achieved in seismic hazard microzonation studies throughout 10 years performed at the city of Catania was to quantify the spatial variability of the site response on some typical historical scenario earthquakes that would be expected in the area. In order to quantify the expected ground motion, the manner in which the seismic signal is propagating through the subsurface was defined. Propagation was particularly affected by the local geology and by the geotechnical dynamic ground conditions of the city of Catania. Large amplification of the seismic signals generally occurs in areas where layers of low seismic shear wave velocity overlie material with high seismic wave velocity, i.e. where soft sediments cover bedrock or more stiff soils. Therefore, essential here is to obtain a good understanding of the local subsurface conditions.

For the city of Catania there is a great availability of borehole data, geophysical surveys and laboratory tests. Subsequently, the seismic microzonation has been carried out by dividing the given area in rather small sub-areas where the geological model and ground conditions are considered to be homogeneous. For each sub-area, the seismic response has been evaluated and assumed to be representative for this entire area.

2. Historical seismicity of South-Eastern Sicily

Eastern Sicily is characterised by NNE-SSW normal faults, mostly located offshore, from Messina to the eastern part of the Etna Volcano. In the south-eastern Sicily there are two major seismic areas: the first along the Ionian coast (earthquakes of magnitude $M > 7.0$) and the second in the hinterland area (earthquakes of magnitude lower than 5.5). These normal faults were in the past sources of earthquakes with Mw up to 7.4 such as the 1169, 1693, 1818 and 1908 events. Some of these events generated also destructive tsunamis along the Sicilian Ionian coast [1].

There are evidences from the late Quaternary period that the Malta Escarpment fault system is the most probable source for the

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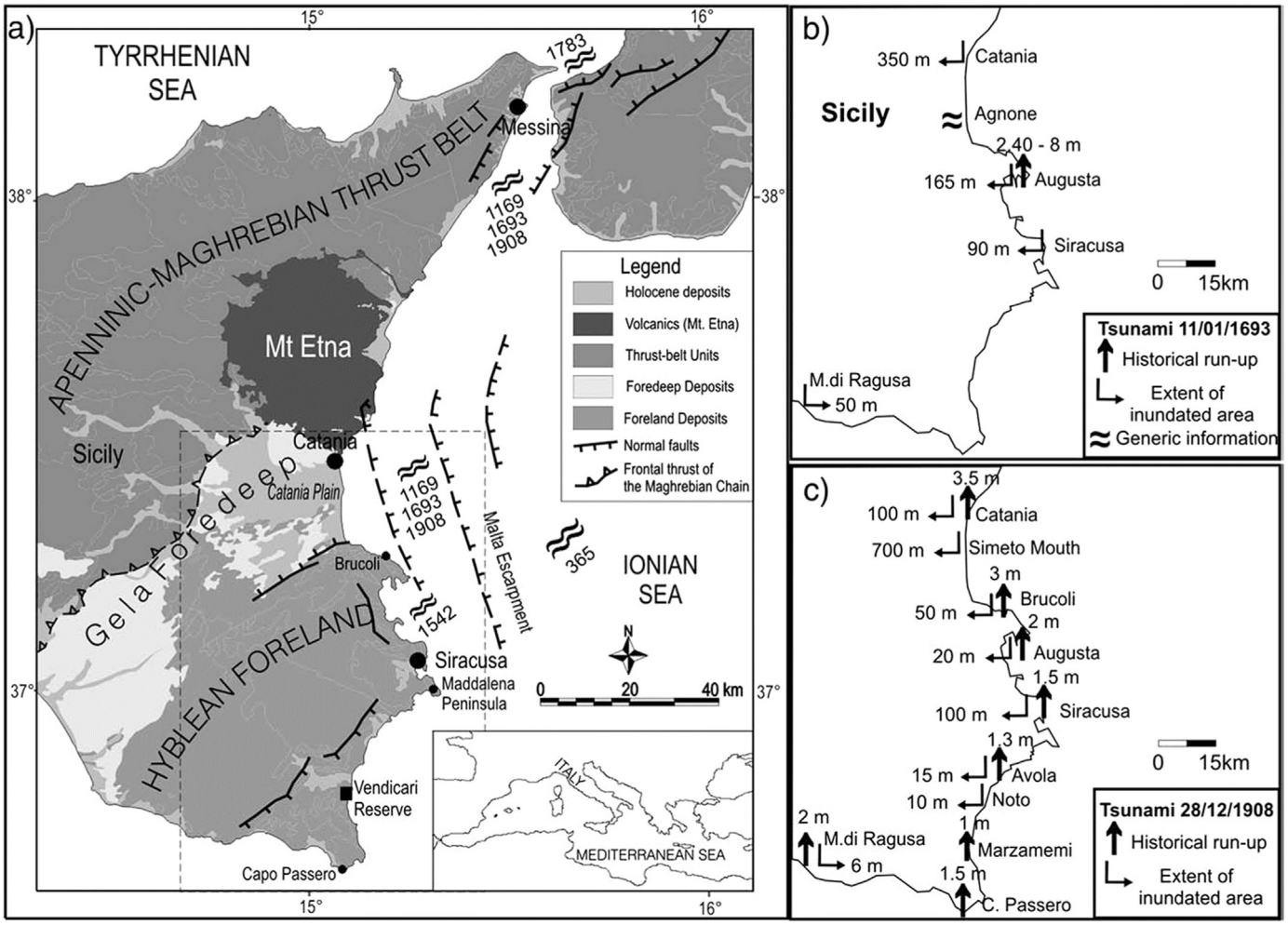

Fig. 1. Map of seismotectonic features of South-Eastern Sicily, with indication of 1693 and 1908 historical tsunamis, after [1].

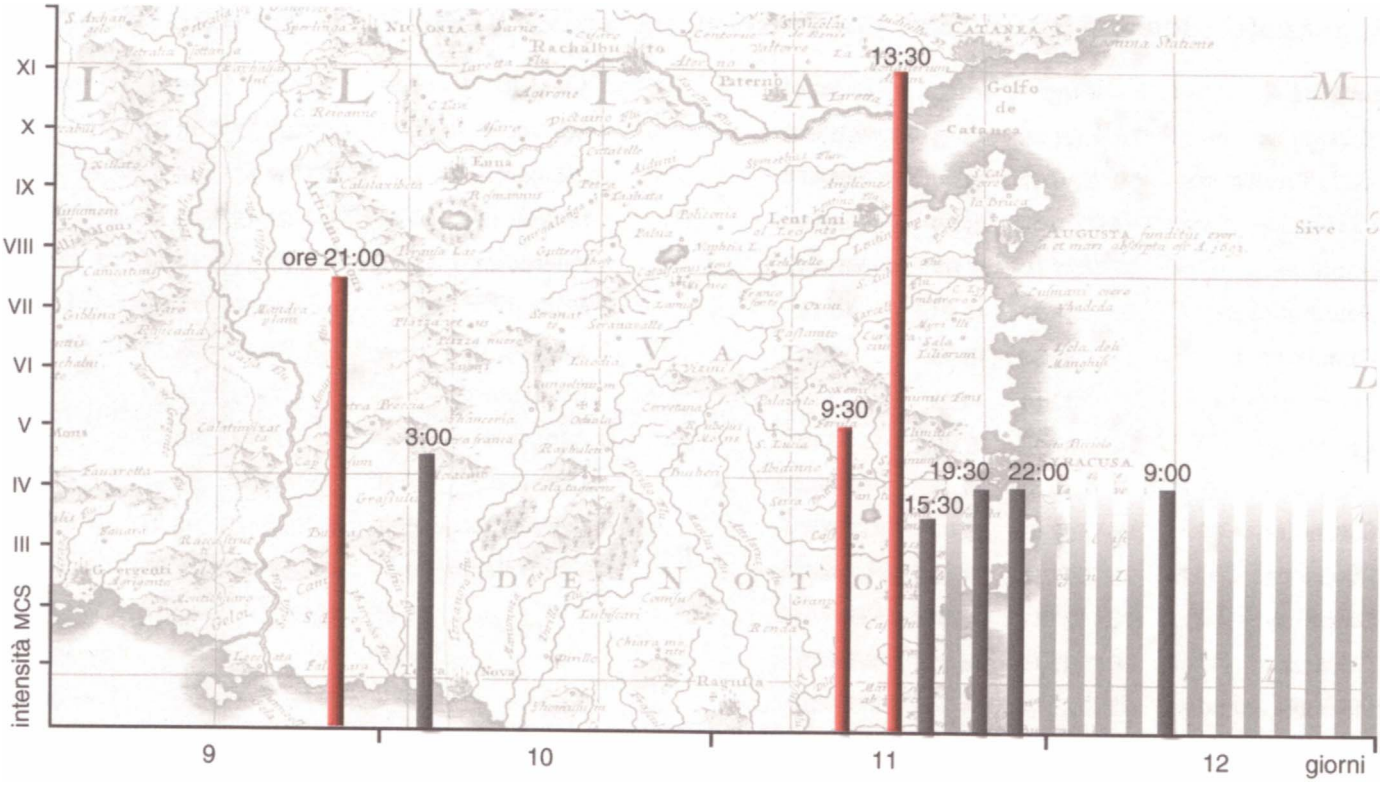

Fig. 2. Seismic activity in various localities of South-Eastern Sicily and Malta from January 9 to January 12, 1693, after [6].