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Active faulting and seismicity along the Siculo–Calabrian Rift Zone (Southern Italy)

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Abstract

Southern Italy is dominated by extensional tectonics that in the Calabrian arc and Eastern Sicily produced the development of the Siculo–Calabrian Rift Zone (SCRZ). This zone is represented by a ≈370 km-long fault belt consisting of 10 to 50 km long distinct fault segments which extend both offshore and on land being also responsible of the crustal seismicity of this region. The geological and morphological observations indicate that the active normal faults of the SCRZ are characterized by throw-rates ranging from 0.7 to 3.1 mm/a. They accommodate an almost uniform horizontal extension-rate of about 3.0 mm/a along a WNW–ESE regional extension direction. Based on our field observations and following empirical relationships between magnitude and surface rupture length connections between large crustal earthquakes and distinct fault segments of the SCRZ have been also tentatively tested. Our data indicate moreover that the magnitudes (M) of the historical and instrumental earthquakes are consistent with the estimated values and that the geometry and kinematics of the fault segments and the related different crustal features of the SCRZ control the different seismic behaviours of adjacent portions of the active rift zone.

Keywords: Seismotectonics; Quaternary; Normal faulting; Seismicity; Calabrian arc; Eastern Sicily; Southern Italy

1. Introduction

The Calabrian arc and Eastern Sicily are the most seismically active regions of Southern Italy, displaying the effects of an intense Quaternary tectonics mainly represented by a huge regional uplift and by normal faulting consistent with a regional WNW–ESE oriented extension. The regional tectonic uplift started since about 0.6 Ma (Westaway, 1993; Tortorici et al., 1995) and produced the emergence of the entire orogenic belt, including the Lower–Middle Pleistocene syncollisional sedimentary basins of the Tyrrhenian side of the arc (Mesima, Gioia Tauro, Reggio Calabria and Barcellona Basins), and of the south-eastern Sicily foredeep. Tectonic uplift was accompanied by marine terracing along the basin margins and, on land, by deep entrenchment of rivers with the consequent deposition of alluvial and/or transitional coarse grained sediments along the major depressions on top of Lower–Middle Pleistocene pelagic sequences. Normal faulting affects the Tyrrhenian side of Calabria and, through the Strait of Messina, the Ionian coast of Sicily forming the Siculo–Calabrian Rift Zone (SCRZ) (Monaco et al., 1997; Monaco and Tortorici, 2000) that develops both offshore and on land with 10 to 50 km-long distinct fault segments (Fig. 1). Relations between the large crustal earthquakes occurring in this region (Postpischl, 1985; Boschi et al., 1995) and tectonic structures have been suggested for the major fault segments of the SCRZ that consequently represent the major seismogenic sources of Southern Italy (Ghisetti, 1992; Valensise and Pantosti, 1992; Westaway, 1993; Tortorici et al., 1995; Monaco and Tortorici, 2000; Jacques et al., 2001; Amoruso et al., 2002; Galli and Bosi, 2002; Tinti et al., 2004). In this paper we try to estimate the Late Quaternary deformation rates of the most active portion of the SCRZ combining the available information with new data to yield new constraints on the significance and role of the SCRZ in the frame of kinematics and seismotectonic picture of Southern Italy. In order to evaaluate the recent activity of the SCRZ and to estimate long-term slip-rates and relation with the major seismotectonic parameters, a detailed study of the major fault scarps has been carried out by combining morphological and structural information based on

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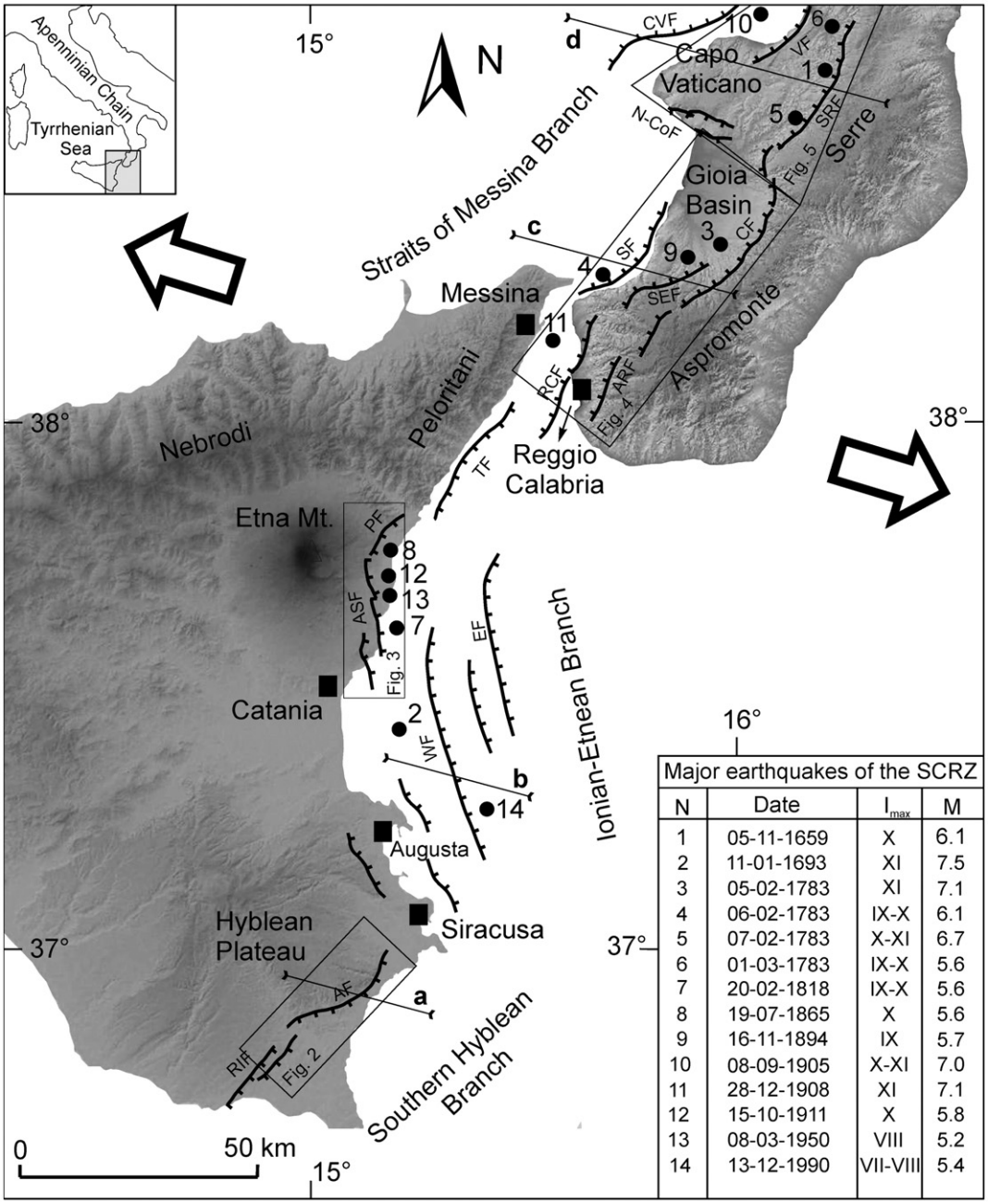

Major earthquakes of the SCRZ

N	Date	I_{max}	M
1	05-11-1659	X	6.1
2	11-01-1693	XI	7.5
3	05-02-1783	XI	7.1
4	06-02-1783	IX-X	6.1
5	07-02-1783	X-XI	6.7
6	01-03-1783	IX-X	5.6
7	20-02-1818	IX-X	5.6
8	19-07-1865	X	5.6
9	16-11-1894	IX	5.7
10	08-09-1905	X-XI	7.0
11	28-12-1908	XI	7.1
12	15-10-1911	X	5.8
13	08-03-1950	VIII	5.2
14	13-12-1990	VII-VIII	5.4

Fig. 1. Seismotectonic map of the Siculo–Calabrian Rift Zone (SCRZ). Faults are mainly normal with barbs on downthrown block. Black dots and numbers indicate the major historical and instrumental crustal earthquakes occurred in the last six centuries as reported in the inset (data from Postpischl 1985; Boschi et al., 1995, 1997). Large arrows indicate the regional extension direction (data from Monaco and Tortorici, 2000). Boxes indicate the locations of Figs. 2–5. RIF: Rosolini–Ispica faults; AF: Avola fault; WF: Western Ionian fault; EF: Eastern Ionian fault; ASF: Acireale–S. Alfio faults; PF: Piedimonte fault; TF: Taormina fault; RCF: Reggio Calabria fault; AR: Armo fault; SF: Scilla fault; SEF: S. Eufemia fault; CF: Cittanova fault; SRF: Serre fault; VF: Vibo fault; CVF: Capo Vaticano fault; N-CoF: Nicotera–Coccorino faults.

the analysis of satellite imageries, aerial photographs, topographic maps, field observations and, for the segments extending offshore, by interpreting available seismic profiles. Time constraints for evaluating the fault activity have been obtained by analysing the lateral and vertical distribution of Quaternary stratigraphic markers. In particular new data regard the distribution and the age determination of distinct levels of marine terraces and a detailed analysis of the major fault escarpments. The occurrence of the well dated 0.9–0.6 Ma old marine sequences uplifted at an elevation up to 1200 m (Aspromonte massif), together with younger flights of marine terraces developed since the Oxygen Isotopic Timescale (OIT) stage 15 (580 ka) are crucial to estimate the Quaternary deformation with the time-resolution of the OIT stages. Particularly, taking into account that around the major active normal fault segments marine terraces are severely deformed according to the flexural cantilever model (King et al., 1988; Kusznir et al., 1991), they represent very useful tools to