TEST OF SOURCE-PARAMETRES INVERSION OF THE 11 JANUARY 1693 CATANIA EARTHQUAKE IN A NEW CONTEST

F. Pettenati, D. Sandron
Istituto Nazionale di Oceanografia e di Geofisica Sperimentale OGS, Trieste, Italy

Introduction. The preliminary results of the 11 January 1693 Catania earthquake, after the the new inversions of macroseismic intensity data, using the KF technique, are shown. The inversions are constrained on four source hypotheses, formulated by other studies, including those related to the inversions of some of the four sources indicated. The choice of constrained inversions is also due to the large extension of the area investigated (between teh hinterland of south-eastern Sicily and the Ionian Sea). Four source hypotheses have been taken, including a new one, compared to those already investigated.

At first, a macroseismic dataset from the CFTI (Boschi *et al.*, 1997) catalog was selected within a squared area with a side of 200 km, and centre the macroseismic epicentre. Subsequently a reduced dataset was used, keeping only the data of the January 11 event outside the zone of damage (intensity greater than V) of the previous shock of January 9 in the same area. The results always confirm the ground hypothesis compatible with the Scicli-Ragusa-Monte Lauro structure.

Modelling. The Mw 7.3 (CPTI15) earthquake in south-eastern Sicily of 11 January 1693, historically has been associated to the large offshore structure Ibleo Maltese. Sirovich and Pettenati (1999, 2001), led to the formulation of a hypothesis in the Catania hinterland, denying the source at sea. The method used is the macroseismic data inversion of the KF kinematic function (Pettenati and Sirovich, 2007), driven by genetic algorithms. The question of the great tsunami, that accompanied the earthquake, remains and this makes the ground source hypothesis falsifiable. We must also bear in mind the event of January 9th, an earthquake of Mw 6.5 occurred 40 hours before. Although the macroseismic catalogs distinguish the two earthquakes, for the hazard estimates, it is possible that the effects of this shock have in part influenced the damage estimates of the following event. Furthermore, we need consider five sites along the coast (Brucoli, Augusta, Belvedere, Siracusa and ancient Avola, Fig. 1), with an intensity decidedly lower than the XI estimates immediately placed in the hinterland.

Starting from the work of 2001 (Sirovich and Pettenati, 2001), to have a comparison, we started from the CFTI database (Boschi *et al.*, 1997), taking the data inside a window of side of 200 km, with centre the macroseismic epicentre. The three hypotheses considered in the 2001 work, were then tested: Scarpata Ibleo Maltese (IBLMAL); the Graben Scordia Lentini (SCOLEN) and the Scicli-Ragusa-Monte Lauro structure (SCICLI) (Fig. 1). A new hypothesis at sea was tested, identified in a portion to the north of the tear fault recognized in the western Jonio (Del Ben *et al.*, 2008), also

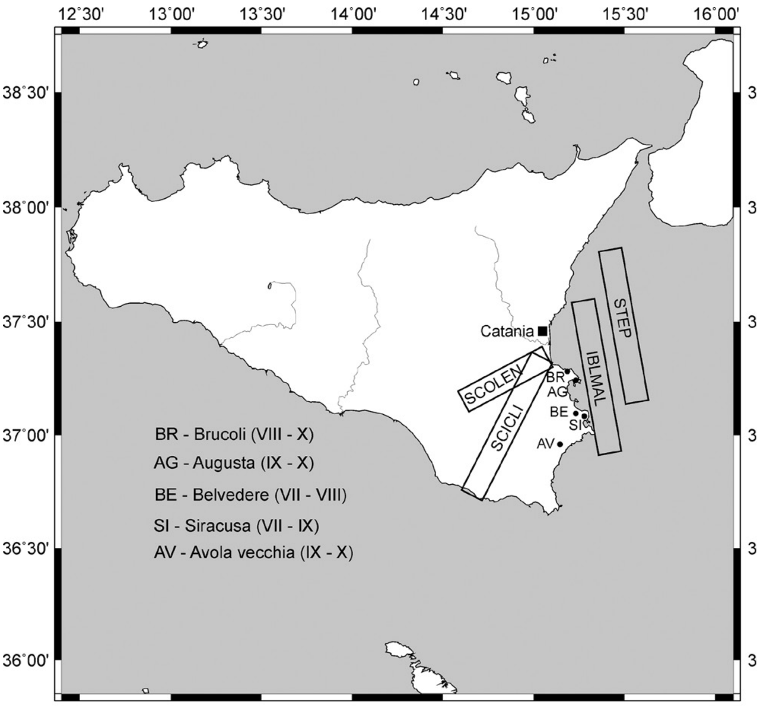

Fig. 1 - Area of the study. In legend the name of the five sites interested of a fall of intensities respect the hinterland. The two intensities reported in the brackets are refferd to 9 – 11 January event.

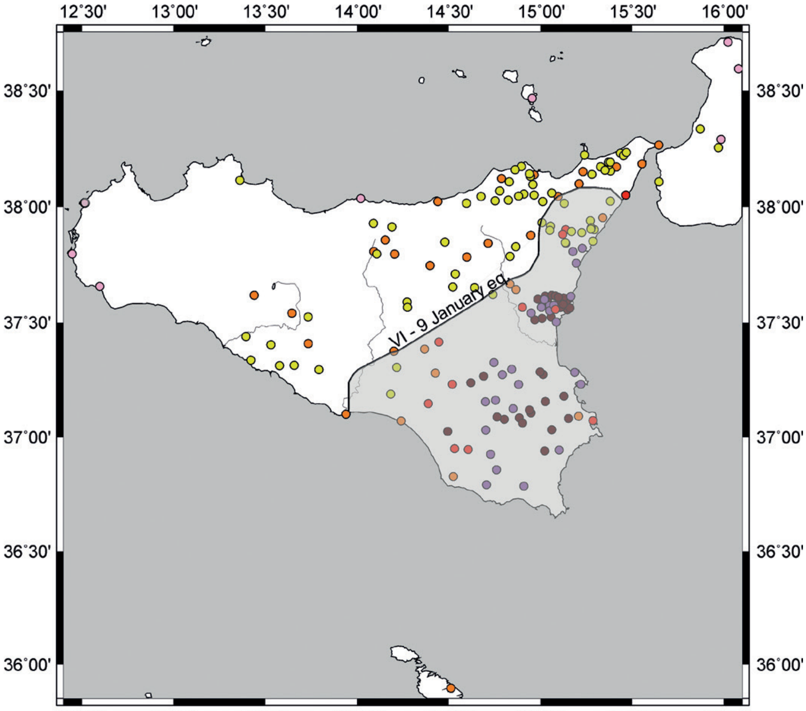

Fig. 2 - Distribution of intensities of CFTI (Boschi *et al.*, 1995) of the Mw 7.3 earthquake in south-eastern Sicily of 11 January 1693. The gray shaded area is the zone of damage (intensity greater than V) of the earthquake of January 9. The data inside this area were not taken into account in the second phase of inversions.

defined as STEP sensu Govern and Wortel (2005).

In this work the grid-search inversion technique was used, constrained on the four hypotheses. Furthermore, constraints have been placed on the five sites mentioned, with a tolerance of ± one degree of intensity. Then we switched the CFTI dataset with intensities outside the damage zone (intensities greater than V) of the shock of 9 January (Fig. 2), avoiding any doubt about the possible influence on the macroseismic estimates of the 11 January event.

Results. The results using the complete data set of 11 January are shown in Table 1. The lowest fit is always obtained for the hinterland solution relative to the Scicli-Ragusa-Monte Lauro fault system (SCICLI).

In general the results are comparable with the study of Sirovich and Pettenati (2001). Table 2 shows the results obtained using the reduced dataset, considering the influence of the earthquake of 9 January as a foreschock. The SCICLI model is always the best solution and the The STEP hypothesis is better than IBLMAL. But, by this reduced dataset if we don't put the constrains for the five sites, the best solution became the IBLMAL model. However, in the forward modelling, for IBLMAL we achieve intensity XI for all the five sites, that for the 11 January earthquake don't justify the best solution.

Table 1 - Dataset CFTI full, with constrain of the five sites on the shore (178 site data).

Parametres	IBLMAL	SCOLEN	SCICLI	STEP
Longitude E	15.3	15.09	14.88	15.5
Latitude N	37.3	37.34	37.19	37.25
FPL, s, d, r [°] **	350, 76, 310 &	242, 58, 300 &	27, 82, 224 &	349, 82, 310 &
Depth [km]	7	6	5	14
Length [km] #	+36, -40	+36, -40	+29, -32	+34, -30
Mach numb $	+0.56, -0.59	+0.7, -0.58	+0.51, -0.50	+0.52, -0.66
Vs [km/s]	3.61	3.64	3.6	3.82
S mom [N m] 10^{20}	4.65	4.76	4.67	8.89
FIT	348	150	127	300

** Fault Plane Solution: strike, dip, rake. & By intensities KF inversion cannot distinguish the polarity. We assume normal faults by tectonic informations.

The length are + in the strike verse; - in antistrike verse.

$ The mach number are + in the strike verse; - in antistrike verse.

Table 2 - Dataset CFTI reduced, with constrain of the five sites on the shore (80 site data).

Parametres	IBLMAL	SCOLEN	SCICLI	STEP
Longitude E	15.31	15.06	14.88	15.48
Latitude N	37.29	37.33	37.03	37.27
FPL, s, d, r [°] **	352, 75, 303 &	242, 58, 301 &	29, 81, 219 &	351, 79, 304 &
Depth [km]	7	5	3	10
Length + [km] #	+31, -38	+47, -39	+43, -23	+39, -22
Mach numb $	+0.55, -0.70	+0.60, -0.56	+0.51, -0.50	+0.51, -0.64
Vs [km/s]	3.5	3.52	3.5	3.73
S mom [N m] 10^{20}	4.89	4.74	4.7	8.92
FIT	43	51	37	39

References

Boschi E., Guidoboni E.,. Ferrari G, Valensise G., and Gasperini P.; 1997: *Catalogo dei forti terremoti in Italia dal 461 a. C. al 1990, no. 2*, Istituto Nazionale di Geofisica, Storia Geofisica Ambientale (SGA), Rome, Italy, CD and paper versions (in Italian).

CPTI15 Group: *Catalogo Parametrico dei Terremoti Italiani. Release v1.5,* https://emidius.mi.ingv.it/CPTI15-DBMI15/description_CPTI15.htm

Del Ben A., Barnaba C., Taboga A.; 2008: *Strike-slip systems as the main tectonic features in the Plio-Quaternary kinematics of the Calabrian Arc*. Mar Geophys Res (2008) **29**,1–12, doi 10.1007/s11001-007-9041-6.

Govers R., Wortel M. J. R.; 2005: *Lithosphere tearing at STEP faults: Response to edges of subduction zones*. Earth Planet. Sci. Lett., **236**, 505–523, doi:10.1016/j.epsl.2005.03.022.

Pettenati F., Sirovich L.; 2007: V*alidation of the Intensity-Based Source Inversions of Three Destructive California Earthquakes*. Bull. Seism. Soc. Am., **97**, 5, 1587-1606, doi: 10.1785/0120060169.

Sirovich, L. &. Pettenati F; 1999: *Seismotectonic outline of South-Eastern Sicily: an evaluation of available options for the scenario earthquake fault rupture*. Journal of Seismology, **3**, 213-233.

Sirovich, L. & Pettenati F;. 2001. *Test of Source-Parameter Inversion of the Intensities of a 54,000-Deaths Shock of the Seventeeth Century in Southeast Sicily*. Bull. Seism. Soc. Am., **91**, 4, 792-811.