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HISTORY OF ISCHIAN EARTHQUAKES

BIBLIOPOLIS

ISBN 978-88-7088-652-8

Napoli, Via Arangio Ruiz 83
http://www.bibliopolis.it – e-mail: info@bibliopolis.it

include an earthquake felt in the Island on 13th July 1875 at 1:30 a.m. The two authors related to the contents of a letter of P. T. Bertelli (1875) who described the experience of some people who testified that it had taken place in the Island. According to their experience the rumble of earthquake was heard in Casamicciola. The shock was felt at short distance from Mt. Epomeo but frightful foreigners visitors left the Island.

Another earthquake was indicated in the year 1879, 24th July, by D'Ambra (1981) but also in this case, as for 1853 earthquake, reliable fonts are missing.

On 24th July 1880 the seismometer of the University of Naples in the historic centre of the town recorded some slight shocks, whose epicentres were located at short distance. But these events were not recorded at the seismic station of Observatory at Mt. Vesuvius (Interview of Palmieri to a newspaper of Naples – Palmieri 1880; Palmieri, 1880 a; De Rossi, 1880; Palmieri and Oglialoro, 1884). The following day a shock was felt in Naples and it was recorded at the seismic stations above mentioned. Referring to this seismic activity the major of Forio, in the island of Ischia, wrote on 25th July a short message to Palmieri, Director of Mt. Vesuvius Observatory: «Yesterday and today many earthquakes were felt in the Island, one of them was very strong. The people are afraid of shocks and ask advice about what they should do». In addition, on 28th July the Major sent to Palmieri more detailed informations on the seismicity felt in the period 24th-28th July and on the phenomena as the thermal state of the fumaroles and the variations of the sea level, recorded in the Island since the beginning of the month. The epicentre of the largest earthquake, felt in the Island of Ischia on 25th July at 04:35 a.m., was localized in the Ponzian Islands where the church in Ventotene was seriously damaged (De Rossi, 1880; Mercalli 1881, 1884, 1893).

On 4th March 1881 at 1:05 p.m., a destructive earthquake occurred in the island of Ischia. It was studied by Henry James Johnston-Lavis (1885) who spent about three weeks in the Island for measuring in 55 sites the directions of fissures in buildings and recording the peculiar sensations of people during the soil shaking. From these observations he obtained the paths of the seismic waves generated at the hypocenter. Making use of this data Johnston-Lavis, following Mallet's method (Mallet, 1862), found that the epicentre of the earthquake was located at Casamennella in Casamicciola and the foci depth was evaluated of 618 m (Fig. 3). From the field data on the damages and sensations of people Johnston-Lavis delimited three

areas with different level of damages as: area of complete and total destruction; area of partial destruction; area of damaged buildings. In addition he modelled the seismic source with a NNW – SSE fracture which passes through Casamicciola town (Johnston Lavis, 1881, 1885). This earthquake was studied also by L. Palmieri (1881), E. Semmola (1881), M.S. de Rossi (1881 a,b,c,d), G. Mercalli (1881); three days after the earthquake Palmieri visited the Island and carried out seismic measurements with his portable seismometer and described the results of his survey at the Accademia in Naples during the session of 2nd April 1881. He observed a total destruction in the upper part of Casamicciola, where fractures in the soil and landslides occurred. The area of damages spread towards Lacco Ameno; on the contrary, along the sea shore the earthquake was felt without evidences of damage. Moreover some fellows of Accademia Pontaniana (E. Semmola, F. Schiavone, S. Zinno, G. Guiscardi) had the report on their survey in the island of Ischia after the 4th March 1881 earthquake, during the session of the Accademy on 21st August 1881 (Semmola et al., 1881). They observed the largest damages proceeding towards the interior of Casamicciola along an E-W belt, from Piccola Sentinella to Fango (Fig. 4), around which an area with lower damages develops. Less detailed informations on the effects of the earthquake in the Island are available for Forio, in the western sector of the Island, and Serrara-Fontana, Barano and Moropano in the southern part. The authors reveal that the earthquake was felt in the islet of Vivara (Procida island), at a short distance from Ischia, in the Phlegrean Fields and in the Ponza Islands. Aftershocks were felt in Ischia on 6, 7, 15 and 17 March; on the contrary the instruments installed during the survey in the Island did not record any shock.

Seven years before the occurrence of the 4th March 1881 earthquake M.S. de Rossi had begun to make a catalogue of earthquakes of Italian Peninsula published in the Italian review "Bullettino del Vulcanismo Italiano". The result of this experience was the seismic source model that De Rossi introduced which declares that the seismic waves are generated by the vibrations of the lips of tectonic fractures during their propagation. De Rossi studied the 1881 earthquake of Casamicciola also with the target to verify if the seismic source was a radial fracture of Mt. Epomeo, because it was considered the central crater of the Island where the fractures have radial trend (De Rossi, 1881 a,b,c). But the distribution of damages was not only along a radial strike through Mt. Epomeo; infact they were also concentrated in an E-W belt in the town of Casamicciola at the northern edge of the massif of Mt. Epomeo (Fig. 5). To explain this scenario De Rossi

modified his model introducing the contribution of a hidden structure, covered by the tuffs of Mt. Epomeo, to the vibrations of the ground; this area was at the cross between the radial fracture and the hidden structure.

The 1881 Casamicciola earthquake gave rise to Mercalli's (1881) interest for the seismology and its relation to volcanism. Infact Mercalli published his first paper on earthquakes studying the 1881 earthquake away from the Island, utilizing data from newspaper reports. According to the distribution of damages Mercalli localized the epicenter in Casamicciola at the base of Mt. Epomeo and he classified it as a volcanic earthquake because its genesis was associated to the volcanic activity of Mt. Epomeo, considered by Mercalli an active volcano. Some years later Mercalli (1884) set the boundaries of the epicentral area of this earthquake and established that the seismic source was a N-S fracture in the northern sector of the Island crossing Casamicciola (see Fig. 10).

D'Ascia (1884) described the catastrophe of 1881 with a detailed and quantitative analysis of damages to the buildings of Casamicciola and Lacco Ameno in occasion of a conference he gave in the hall of Municipality of Forio on 4th April 1881. He localized the epicentral area at the hill side of Casamicciola which is the same of the earthquakes occurred in 1796 and 1828.

A significant improvement of the knowledge of the seismicity of the island of Ischia takes place since seventies of the last century, when in Italy started researches on the mitigation of seismic and volcanic risk, with the sponsorship of National Researches Centre (CNR) of Italy. Object of this revision was also the 1881 earthquake which produced diffuse collapses and more then one hundred victims in the town of Casamicciola; it was considered one of the most strong seismic events occurred in the historical time in the Island.

The intensities of this event were evaluated for the first time by MCS Scale and the isoseismal lines of VII and VIII degrees were inferred (Luongo 1977; Cubellis, 1985; Luongo et al., 1987). The maximum intensity was estimated of IX MCS by Cubellis (1985) and Cubellis and Luongo (1998); on the other hand the epicentral intensity was evaluated of VIII MCS by Postpischl (1985) and Molin et al. (2003); finally Alessio et al. (1996) outline the isoseismal lines of IX, VIII and VII MCS.

Cubellis and Luongo (1998) analyzed critically the data from the contemporary literature on the 4th March 1881 Casamicciola earthquake to obtain the focal parameters of the destructive shock. On the basis of the distribution of damages and of the limit of the felt area they defined the

zone where the largest part of buildings collapsed which extends in an east-west belt at the northern edge of Mt. Epomeo including part of Casamicciola and Lacco Ameno. The intensity in this area was evaluated of VIII MCS degree with peaks of IX MCS. Using these data the authors deduced a magnitude between 4.4. and 4.7, while a lower value M=4.0, was obtained by the extension of the felt area. According to CPTI11 (Rovida et al., 2011) and DBMI11 (Locati et al., 2011) the epicentral and maximum intensities had the same value of IX MCS. For this earthquake intensity values are available for 17 localities; 11 of them are localized in the Island with intensity from IX to IV MCS; the felt area extends to Ponza at west and to Campi Flegrei at east of the Island. In addition in the quoted-catalogues the value of magnitude Mw of 1881 earthquake was estimated of 5.4.

The authors of this monograph increased in recent times the knowledge on 1881 earthquake by a deeper analysis of fonts; consequently the number of sites with their intensity increases from 17 of DBMI11 (Locati et al., 2011) to 40. In this investigation it was highlighted the analysis on the epicentral area, where the sites increased from 3 to 20. This notable improvement on the previous data allowed to draw a new map of intensities (Fig. 6). In particular the extension of the epicentral area of VIII MCS degree is enlarged respective to a precedent analysis (Cubellis, 1985) and some peaks of IX degree come out from the VIII background intensity. The poor number of sites with the highest values of intensities do not permit to define the isosist of IX degree accurately. Moreover the local amplification has not to be neglected for the interpretation of the intensities of IX degree according to Carlino et al. (2010).

The terrific experience of 1881 and the warnings of seismologists will not be a deterrent to rebuild Casamicciola which suffered a more complete disaster on July 28th 1883, when occurred the most destructive earthquake which has been recorded in Ischia. In fact the town of Casamicciola was almost razed to the ground (See records from Francesco Genala Museum, Soresina, Italy at the end of the text); severe damages affected Lacco Ameno and Forio, relatively less intense at Serrara Fontana and Barano. The lowest effects were observed at Ischia town. The death toll, according to different sources, was between 2313 and 2333, of whom at least 600 were guests on the Island, while 726 were injured (Cubellis and Luongo, 1998; Delizia, 1998; Luongo et al., 2012 b).

This earthquake was studied by numerous contemporaneous scientists, among them some of those who had investigated the 1881 earth-

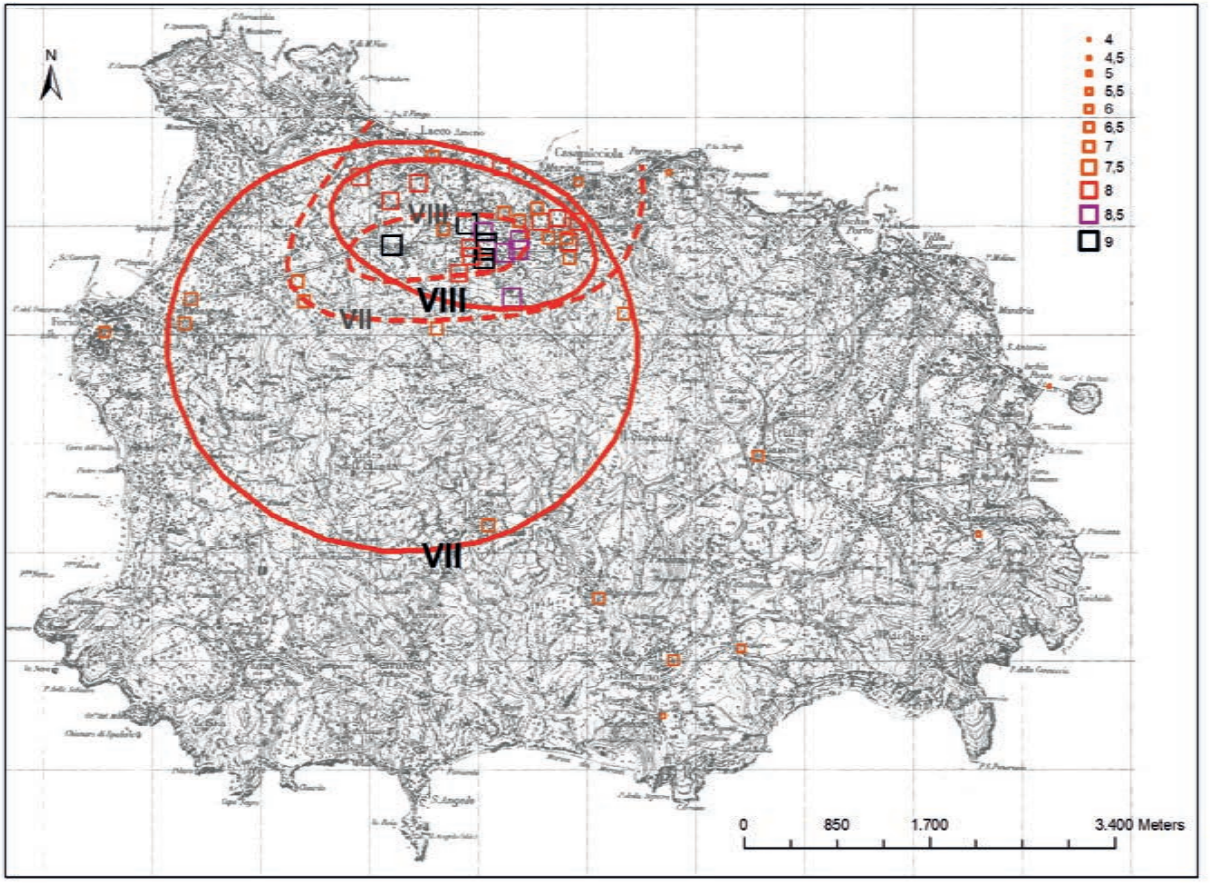

Fig. 6 – 4 March 1881 Casamicciola earthquake. The broken lines represent the isoseismals of the previous papers by Cubellis (1985) and Luongo et al. (1987). The solid lines are the isoseismals obtained by the analysis of the data described in this paper. The new data show larger areas for VIII degree and VII degree (MCS) than the previous papers.

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