

## A “forgotten” earthquake rediscovered: the 1948-1949 Monti Reatini (central Apennines) seismic sequence

F. BERNARDINI, V. CASTELLI, R. CAMASSI, C.H. CARACCILO AND E. ERCOLANI

*Istituto Nazionale di Geofisica e Vulcanologia, Sezione di Bologna, Italy*

(Received: April 4, 2013; accepted: May 28, 2013)

**ABSTRACT** Contemporary newspapers and seismological literature describe in detail an earthquake occurred on December 31, 1948 in the Monti Reatini area (central Apennines, Italy). The seismic sequence that had this event as its main shock started in December 1948, went on for most of 1949 and was recorded in full by an unpublished regional earthquake catalogue compiled in 1980. However, none of the Italian parametric earthquake catalogues printed from the 1980s onwards records either the December 31, 1948 earthquake or the earliest part of the 1948 - 1949 sequence. This paper describes how the “forgotten” event of December 31, 1948 was rediscovered and reinstated as one of the main quakes on record in the Monti Reatini area.

**Key words:** historical seismology, earthquake catalogue, local seismicity.

### 1. Introduction

It is a truth universally acknowledged that “past seismicity is one of the keys for predicting future seismicity; [...] the more reliable picture of the past we have, the more successful prediction of the future we expect to perform” (Stucchi *et al.*, 2004). For this reason, over the last thirty years, in Italy and other European countries, many large-scale historical investigations have been carried out with the aim of improving the picture of past seismicity embodied in the national parametric earthquake catalogues; for a list see the reference page of the recent AHEAD database (AHEAD Working Group, 2013).

As a general rule, historical investigations of past earthquakes start from information summed up in a catalogue record, and/or in a description provided by some earthquake descriptive compilation, and proceed to sift through vast amounts of assorted historical records in order to find out whether that information is correct or not and to increase/improve it as thoroughly as possible. While browsing historical records, it does often happen - as a sort of bonus - that one stumbles upon traces of other earthquakes (even significant, damaging ones) whose existence is unknown to historical seismology because no parametric earthquake catalogue or descriptive earthquake compilation has ever recorded them (Vogt, 1984). Impressed by the dimensions of this phenomenon, several researchers over the years did launch ad hoc searches for past earthquakes “unknown” to seismology (Alexandre, 1990; Albin and Rodriguez de la Torre, 1993; Camassi and Caracciolo, 1994; Mariotti *et al.*, 2000; Camassi and Castelli, 2004; Castelli and Camassi, 2005; Castelli and Bernardini, 2006; Mariotti and Guidoboni,

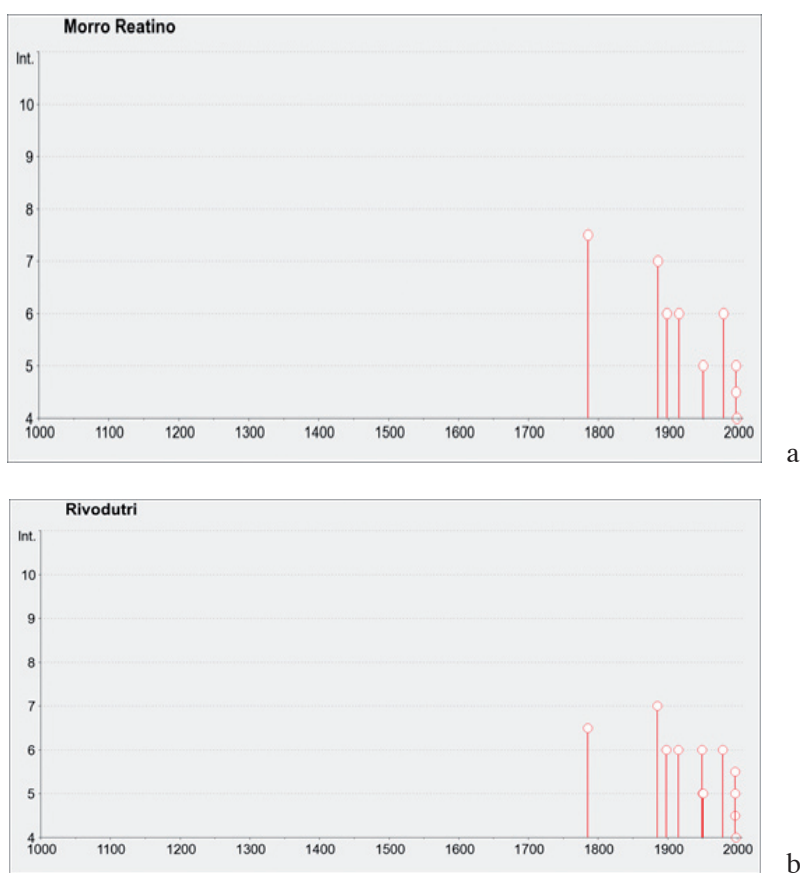


Fig. 1 - Seismic histories of Morro Reatino (a) and Rivodutri (b), two of the main sites of the area (Locati *et al.*, 2011).

2006; Guidoboni *et al.*, 2007; Tertulliani *et al.*, 2008). In Italy, the success of these studies was recently acknowledged by the inclusion in the latest Italian parametric earthquake catalogue (Rovida *et al.*, 2011) of 138 new records related to as many damaging earthquakes that had never previously figured in any parametric earthquake catalogue; 103 of these new records are derived from Guidoboni *et al.* (2007) and 35 from other studies.

The most recent large-scale Italian venture in this field of research is Camassi *et al.* (2011), a study that deals both with “forgotten” earthquakes and with “neglected” ones, i.e., earthquakes that had been included in the earliest Italian parametric earthquake catalogue (Postpischl, 1985) but were discarded by the catalogues compiled, for purposes of seismic hazard assessment, from the mid-1990s onwards, because at the time there was no evidence of any damage caused by them. Further research having retrieved the required evidence, a significant re-evaluation of the epicentral parameters of these earthquake is now possible and their reinstatement in the next issue of the Italian catalogue can be proposed.

This paper describes the case of a comparatively recent and regionally relevant seismic sequence, whose actual importance for the assessment of seismic hazard in some urban sites of a small area of central Italy has failed to be remarked so far because its main shock has not been recorded by any of the Italian catalogues in the public domain.

## 2. Geographical and seismological setting of the studied area

The earthquake described in this paper occurred in an area that takes its name from the Monti Reatini (Rieti Mountains), a minor branch of the central Apennines on the border between the Lazio and Umbria regions, about 100 km NE of Rome. This is a marginal and comparatively underpopulated area dotted with minor urban settlements (Labro, Colli sul Velino, Morro Reatino, Rivodutri, Poggio Bustone, Cantalice, Polino, Arrone and Piediluco), with a population that ranges from a few hundreds to a couple of thousands in each site and which dwells partly in the namesake towns and partly in the hamlets (or *frazioni*) scattered throughout the surrounding territories. Some of the mentioned towns have a historical seismic record (Fig. 1) that in most cases covers little more than a couple of centuries, with comparatively moderate intensities.

Local seismicity is moderate also with respect to the number and magnitudes of the recorded earthquakes (Table 1). The largest local earthquake on record (1885,  $M_w = 4.9$ ) reached maximum intensity VII MCS in Morro Reatino and Rivodutri (Locati *et al.*, 2011).

Table 1 - Seismic history of the studied area (Rovida *et al.*, 2011).

Date	Lat. (°N)	Lon. (°E)	I <sub>max</sub>	I <sub>0</sub>	M <sub>w</sub>	Epicentral area
1298 12 01	42.575	12.902	X	IX - X	6.2	Reatino
1785 10 09	42.536	12.788	VIII - IX	VIII - IX	5.7	Umbria meridionale
1885 06 17	42.521	12.844	VII	VII	4.9	Poggio Bustone
1949 06 03	42.517	12.850		V - VI	4.5	Poggio Bustone
1949 10 27	42.532	12.805	VI - VII	VI - VII	5.0	Labro

Owing to the proximity of the main seismogenic belt of the central Apennines, the highest macroseismic intensities on record in the area were caused by non-local earthquakes (Fig. 2). The 1298 Reatino earthquake ( $M_w = 6.2$ ), whose epicentre is currently located some kilometers north of the Monti Reatini area, reached  $I = IX-X$  MCS in Poggio Bustone, a few kilometers east of Rivodutri (Guidoboni *et al.*, 2007). The destructive Norcia - L'Aquila sequence of 1703 (two  $M_w = 6.7$  main shocks on January 14 and February 2) reached  $I = VII-VIII$  MCS in Apoleggia, Borgo San Pietro and Cantalice. Damage assessed as  $I = VI$  MCS was caused by the non-local 1915 (Marsica,  $M_w = 7.0$ ) and 1979 (Valnerina,  $M_w = 5.9$ ) earthquakes and by the June 27, 1898 earthquake ( $M_w = 5.5$ ), located close to the studied area in the surroundings of the provincial capital, Rieti.

Local seismicity seems to tend to arrange itself in seismic sequences of variable length and formed by mostly low-energy events. Two such sequences occurred in the Rivodutri area in 1924 and 1949, and have been studied by Molin *et al.* (2008). The 1924 sequence (main shock on September 15) affected a very circumscribed area around Rivodutri; its stronger shocks were barely felt in Poggio Bustone and Morro Reatino (only 3 km far from Rivodutri) and not felt at all in Labro, Cantalice and Piediluco, at a distance of 5 - 7 km. The 1949 sequence will be examined more closely in the next chapter.

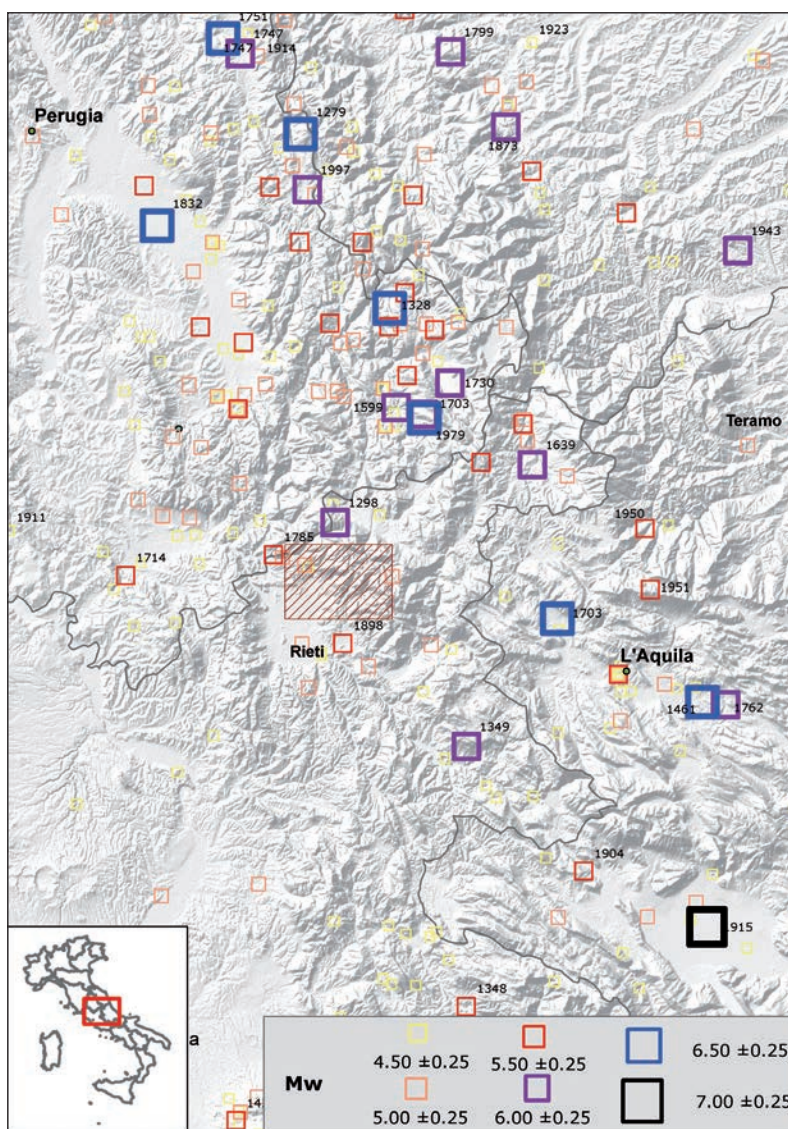


Fig. 2 - The studied area (red-shaded rectangle) in the context of the historical seismicity of the central Apennines (Rovida *et al.*, 2011).

### 3. Rediscovering the 1948 - 1949 sequence

Postpischl (1985) records about 70 low-intensity events located in the neighbourhood of Poggio Bustone from mid-February to mid-December 1949. All data are derived from an earlier unpublished regional catalogue (Dell’Olio e Molin, 1980) that does not indicate its own sources. The two most significant events, dated on June 3 (Poggio Bustone,  $I_0 = V-VI$  MCS) and October 27, 1949 (Labro,  $I_0 = VI-VII$  MCS) are recorded in the Rovida *et al.* (2011) catalogue. The epicentral location and intensity of the October 27 event are based on an intensity table provided by Dell’Olio and Molin (1980).

In the frame of a large-scale study of minor damaging Italian earthquakes (Molin *et al.*,

2008) a systematic examination of 20<sup>th</sup> century newspapers led to the discovery that the area affected in 1949 by the seismic sequence recorded in Postpischl (1985) had been subjected to earthquake shocks from as early as December 1948. The 1948 - 1949 sequence was studied in its entirety, for the first time ever, by Camassi *et al.* (2011), with special reference to a previously “unknown” damaging earthquake occurred on December 31, 1948. The earliest newspaper article describing this earthquake is dated on January 1, 1949 and sketches a picture of severe damage, with 50 buildings left uninhabitable in Rivodutri, and collapses and casualties elsewhere (L’Unità, 1949.01.01, 1949.01.02). Other newspapers picked up the story in the next few days, stressing the severity of earthquake effects in Rivodutri and its *frazioni* (Il Popolo, 1949.01.01; Il Tempo, 1949.01.01), as well as in the neighbouring province of Terni, Umbria (La Nazione Italiana, 1949.01.01, 1949.01.02). Additional information useful for calibrating macroseismic intensities at the sites is provided by a first-hand news report from the affected area that was published around mid-January 1949 [Il Giornale d’Italia, 1949.01.14 (Lazio issue)]. Besides pointing out that the buildings of Poggio Bustone were already in a state of disrepair before the earthquake on account of heavy war damage undergone in 1944, this report does also mention the poor architectural quality of the buildings in Rivodutri and other heavily affected localities.

“[Le abitazioni, ndr] sono costruite in maniera così poco solida che, anche se riparate, non possono essere più abitate con sicurezza e la cosa va anche a svantaggio della pubblica incolumità. Si rende quindi necessario costruire solide casette a valle, cioè nella pianura sottostante (...). Per le cosiddette riparazioni, del resto, la spesa è abbastanza elevata in quanto si rende necessaria la demolizione delle pareti o delle case sinistrate, per poi ricostruirle. Ed ora, se tutti hanno rilevato che i danni sono stati sensibili dove non esistono fondamenta, perché insistere per ricostruire sulle stesse?” [Il Giornale d’Italia, 1949.01.14 (Lazio issue)].

[trans. “(The residential buildings) are so poorly constructed that, even after being repaired, to dwell in them would be dangerous and detrimental to public safety. Instead sturdy new cottages should be built on more level ground, i.e., at the foot (of the hill on which Rivodutri is built). Moreover, the so-called repair work would be very expensive, because it would require pulling down and rebuilding anew the damaged walls or houses. Now, as everyone agrees that the worst damage affected just those buildings that had no foundations, why should we persist in rebuilding them as they were?”].

The historical investigation developed from this input pointed out that both the December 31, 1948 event and the aftershocks occurred in January - February 1949 were recorded by the monthly seismic bulletins of the Istituto Nazionale di Geofisica (ING, 1938 - 1984) and by dozens of “macroseismic cards” compiled by local correspondents of the Ufficio Centrale di Meteorologia ed Ecologia Agraria (UCMEA) of Rome. According to the ING bulletin for December 1948, the main shock (December 31, 1948 at 3:32 GMT) was recorded by all the main observatories then operating in Italy. The cards provide observations of macroseismic effects for about 30 sites, with intensity values ranging from III to VII MCS.

About another 70 macroseismic observations are included in the UCMEA unpublished Register of Macroscopic Cards (UCMEA, 1948 - 1975). From February 15, 1949 to the end of the same year many macroseismic cards were dispatched from Rivodutri to UCMEA with details on the occurrence of later aftershocks, most of them with  $I = IV$  MCS. The State Archives of Rieti hold some official files (Fig. 3 - left) recording damage caused by the

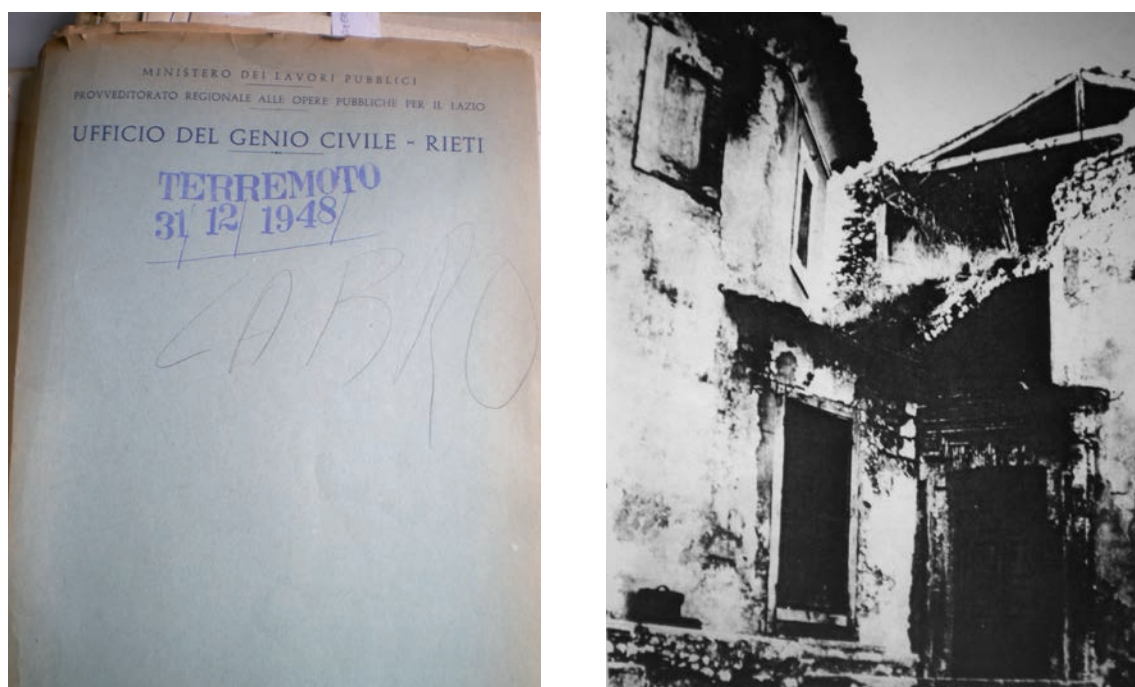


Fig. 3 - Left: One of the files on the December 31, 1948 earthquake preserved at the State Archives in Rieti (ASRI, 1948). Records in the files include: correspondence between owners of damaged buildings and public authorities, damage surveys and financial records of repair work. Right: Contemporary pictures of damaged buildings in Rivodutri (Vannozi, 1988).

earthquakes in the Labro municipality (ASRI, 1948); a few snapshots of earthquake-shattered buildings in Rivodutri (Fig. 3 - right) are also available (Vannozi, 1988).

#### 4. The December 31, 1948 earthquake in the context of the 1948 - 1949 sequence

The event of December 31, 1948 at 4.32 local time (03:32 GMT) was the main shock of the 1948 - 1949 sequence, as evidenced by the severity of its macroseismic effects and the extension of the area over which it was felt. The most severe effects occurred in a few municipalities at the northern end of the Rieti basin, some 12 km north of the provincial capital. The most heavily affected sites were Rivodutri and Apoleggia (a *frazione* of Rivodutri) where several collapses occurred and some people were hurt. Severe damage also occurred in Morro Reatino, Poggio Bustone and Piedicolle; in Rieti itself there was panic but little damage; the shock was felt in Rome, L'Aquila and in the eastern central Italy (Fig. 4 and Table 2).

As for Rivodutri, in particular, some press news report that: at least fifty houses were heavily damaged and left uninhabitable (L'Unità, 1949.01.02); a few of them suffered either partial or total collapses, including the main church, the municipal hall, the school and the "mill-building" (L'Avvenire d'Italia, 1949.01.06); "many buildings collapsed" (Il Tempo, 1949.01.06); around 70% of dwellings turned out to be "uninhabitable" [Il Giornale d'Italia, 1949.01.02: (Lazio issue)], and many of them "are going to be either shored up or partially demolished by the

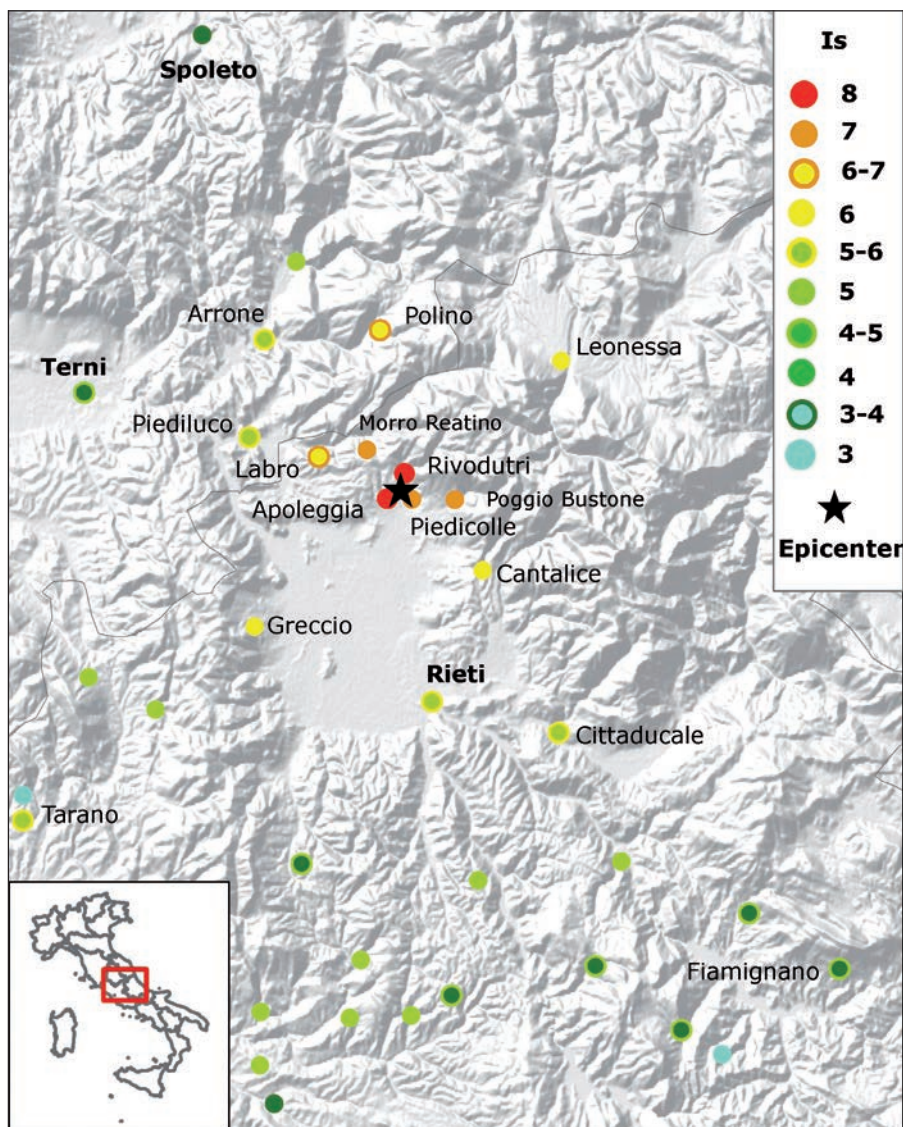


Fig. 4 - Macroseismic field of the December 31, 1948 earthquake. The black star corresponds to the macroseismic epicentre (see Table 3).

Engineers corps of the Public Works Office” (Il Popolo, 1949.01.01).

All these pieces of information bear convincing testimony to the high level of damage that the December 31, 1948 earthquake caused in Rivodutri and its *frazioni*. At the end of the 1940s Rivodutri was a mountain settlement composed of about a hundred of buildings of low architectural quality (vulnerability class A), as it appears from its panoramic views depicted in contemporary postcards (Vannozzi, 1988). Although no precise estimate of earthquake damage percentages is available, we believe, from the available information, that at least 50% of the buildings in Rivodutri and Apoleggia suffered damage level 3, of which around 20 - 25% suffered a higher damage level (4 and, in a few cases, even 5). Therefore a maximum intensity value as high as VIII MCS was assigned to Rivodutri and Apoleggia localities.

Table 2 - Macroseismic effects of the December 31, 1948 earthquake expressed according to the MCS macroseismic intensity scale (PR: province; Lat.: latitude; Lon: longitude; *I*: intensity, F = felt, NF = not felt).

Locality	PR	Lat. (°N)	Lon. (°E)	I (MCS)
Apoleggia	RI	42.503	12.844	VIII
Rivodutri	RI	42.515	12.856	VIII
Morro Reatino	RI	42.527	12.832	VII
Piedicolle	RI	42.502	12.860	VII
Poggio Bustone	RI	42.501	12.888	VII
Labro	RI	42.525	12.800	VI - VII
Polino	TR	42.585	12.844	VI - VII
Cantalice	RI	42.466	12.904	VI
Greccio	RI	42.444	12.753	VI
Leonessa	RI	42.566	12.962	VI
Arrone	TR	42.583	12.768	V - VI
Cittaducale	RI	42.386	12.949	V - VI
Piediluco	TR	42.536	12.755	V - VI
Rieti	RI	42.404	12.867	V - VI
Tarano	RI	42.355	12.596	V - VI
Belmonte in Sabina	RI	42.316	12.892	V
Borbona	RI	42.512	13.137	V
Casaprota	RI	42.252	12.804	V
Castelnuovo di Farfa	RI	42.231	12.744	V
Collevecchio	RI	42.334	12.553	V
Concerviano	RI	42.322	12.986	V
Configni	RI	42.423	12.643	V
Cottanello	RI	42.406	12.686	V
Ferentillo	TR	42.620	12.791	V
Forano	RI	42.297	12.595	V
Montenero Sabino	RI	42.280	12.813	V
Poggio San Lorenzo	RI	42.252	12.844	V
Salisano	RI	42.257	12.746	V
Stimigliano	RI	42.299	12.565	V
Turania	RI	42.137	13.009	V
Collalto Sabino	RI	42.135	13.048	IV - V
Fiamignano	RI	42.265	13.125	IV - V
Longone Sabino	RI	42.272	12.966	IV - V
Monte San Giovanni in Sabina	RI	42.328	12.777	IV - V
Narni	TR	42.517	12.521	IV - V
Nera Montoro	TR	42.499	12.474	IV - V
Nespolo	RI	42.155	13.071	IV - V
Petrella Salto	RI	42.294	13.068	IV - V
San Gemini	TR	42.613	12.547	IV - V
Terni	TR	42.561	12.648	IV - V
Torricella in Sabina	RI	42.261	12.871	IV - V
Varco Sabino	RI	42.239	13.020	IV - V
Vasanello	VT	42.416	12.346	IV - V
Accumoli	RI	42.694	13.248	IV
Amatrice	RI	42.628	13.290	IV
Capranica Prenestina	RM	41.862	12.952	IV



Table 2 - continued.

Cerreto Laziale	RM	41.944	12.982	IV
Orvinio	RI	42.131	12.939	IV
Pozzaglia Sabina	RI	42.158	12.964	IV
Spoletto	PG	42.732	12.736	IV
Toffia	RI	42.212	12.752	IV
Macerata	MC	43.299	13.452	III - IV
Matelica	MC	43.256	13.009	III - IV
Poggio Catino	RI	42.295	12.692	III - IV
Arsoli	RM	42.040	13.019	III
Bellegra	RM	41.884	13.027	III
Borgorose	RI	42.193	13.234	III
Castelnuovo di Porto	RM	42.128	12.497	III
Cave	RM	41.818	12.931	III
Foligno	PG	42.955	12.704	III
L'Aquila	AQ	42.356	13.396	III
Marcetelli	RI	42.226	13.046	III
Montebuono	RI	42.367	12.597	III
Perugia	PG	43.106	12.386	III
Roma	RM	41.895	12.482	III
Carpineto Romano	RM	41.605	13.084	II
Cerveteri	RM	41.997	12.099	II
Rocca di Papa	RM	41.760	12.710	II
Subiaco	RM	41.925	13.095	II
Fiano Romano	RM	42.170	12.590	F
Frascati	RM	41.808	12.681	F
Genzano di Roma	RM	41.707	12.688	F
Treia	MC	43.311	13.312	F
Agosta	RM	41.981	13.033	NF
Altino	CH	42.102	14.331	NF
Anzio	RM	41.451	12.628	NF
Ascrea	RI	42.196	12.996	NF
Atessa	CH	42.066	14.446	NF
Bomba	CH	42.035	14.366	NF
Camerata Nuova	RM	42.018	13.108	NF
Campodimele	LT	41.390	13.530	NF
Canosa Sannita	CH	42.294	14.304	NF
Carpineto Sinello	CH	42.009	14.504	NF
Casalanguida	CH	42.036	14.498	NF
Casalbordino	CH	42.150	14.584	NF
Casoli	CH	42.117	14.291	NF
Castelguidone	CH	41.823	14.524	NF
Chieti	CH	42.351	14.169	NF
Civitaluparella	CH	41.944	14.303	NF
Civitavecchia	RM	42.090	11.799	NF
Crecchio	CH	42.297	14.327	NF
Foggia	FG	41.460	15.553	NF
Todi	PG	42.781	12.407	NF
Torgiano	PG	43.025	12.436	NF
Valfabbrica	PG	43.158	12.602	NF

The event had  $M_w = 5.3$ , calculated with the Boxer 3.3 code (Gasparini *et al.*, 1999) on the basis of the macroseismic datapoints listed in Table 2; the macroseismic epicentre corresponds to the point of coordinates Lat. 42.507° N, Lon. 12.853° E (Table 3).

Table 3 - Epicentral parameters of the December 31, 1948 earthquake calculated with the Boxer 3.3 code (Gasparini *et al.*, 1999).

Date	Time (UTC)	Lat. (°N)	Lon. (°E)	$I_x$	$I_o$	$M_w$
1948 12 31	3:32	42.507	12.853	VIII	VIII	5.3

The event of December 31, 1948 was preceded, a couple of weeks earlier, by a lesser foreshock and followed by a great number of aftershocks up to December 1949. The strongest aftershocks occurred on January 4 and 14, 1949 (Tables 4 and 5). The earthquake of October 27, 1949 [already known and included in the Rovida *et al.* (2011) catalogue; see Table 1] too is likely to have been a late aftershock of the Rivodutri sequence, though shifted a handful of kilometers westwards, close to the border between the Rieti e Terni provinces.

Table 4 - Macroseismic effects of the January 4, 1949 aftershock expressed according to the MCS macroseismic intensity scale (PR: province; Lat.: latitude; Lon.: longitude;  $I$ : intensity).

Locality	PR	Lat. (°N)	Lon. (°E)	$I$ (MCS)
Piedicolle	RI	42.502	12.860	VI
Rivodutri	RI	42.515	12.856	VI
Apoleggia	RI	42.503	12.844	V - VI
Morro Reatino	RI	42.527	12.832	V - VI
Labro	RI	42.525	12.800	V
Poggio Bustone	RI	42.501	12.888	V
Rieti	RI	42.404	12.867	IV - V

Table 5 - Macroseismic effects of the January 14, 1949 aftershock expressed according to the MCS macroseismic intensity scale (PR: province; Lat.: latitude; Lon.: longitude;  $I$ : intensity).

Locality	PR	Lat. (°N)	Lon. (°E)	$I$ (MCS)
Morro Reatino	RI	42.527	12.832	VI
Rivodutri	RI	42.515	12.856	IV - V
Poggio Bustone	RI	42.501	12.888	IV - V

## 5. Why did the December 31, 1948 earthquake disappear?

Thank to the accidental discovery of some essential pieces of information it has been possible to identify the previously unknown main shock of a seismic sequence occurred in the Monti Reatini (central Apennines, Italy) in 1948 - 1949 and to piece together a full picture of the chronology and effects of the sequence (Fig. 5 and Table 6).

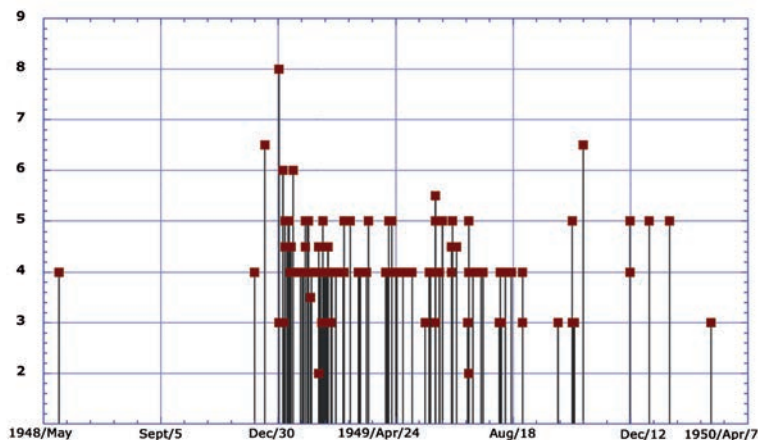


Fig. 5 - The 1948 - 1950 seismic sequence [from Dell’Olio and Molin (1980), updated after this study].

Table 6 - Chronology of the 1948-1950 seismic sequence. All records are from Dell’Olio and Molin (1980) catalogue, except the ones marked with a code number (see Ref. column), whose parameters were revised and modified by: (1) Molin *et al.* (2008); (2) this study; (3) CPTI11 catalogue (Rovida *et al.*, 2011). In bold the main shock.

Date	Time	Epicentral area	Lat (°N)	Lon (°E)	Is (MCS)	REF.
1948 05 28	11 45	Rivodutri	42.517	12.850	IV	
1948 12 07	20 23	Terni	42.567	12.650	IV	
1948 12 17	21 18	Ternano	42.585	12.844	VI - VII	(1)
<b>1948 12 31</b>	<b>03 32</b>	<b>Rivodutri</b>	<b>42.507</b>	<b>12.853</b>	<b>VIII</b>	<b>(2)</b>
1949 01 04	20 55	Rivodutri	42.517	12.816	VI	(2)
1949 01 06	00 50	Rivodutri	42.517	12.850	IV - V	
1949 01 06	04 35	Rivodutri	42.517	12.850	V	
1949 01 08	05 55	Rivodutri	42.517	12.850	IV - V	
1949 01 09	08 05	Rivodutri	42.517	12.850	V	
1949 01 10	02 25	Rivodutri	42.517	12.850	IV - V	
1949 01 10	22 50	Rivodutri	42.517	12.850	V	
1949 01 11	03 45	Rivodutri	42.517	12.850	IV - V	
1949 01 11	17 30	Rivodutri	42.517	12.850	IV	
1949 01 12	00 50	Rivodutri	42.517	12.850	IV - V	
1949 01 14	16 ??	Morro Reatino	42.527	12.832	VI	(2)
1949 01 14	18 21	Rivodutri	42.517	12.850	IV	
1949 01 14	19 45	Rivodutri	42.517	12.850	IV	
1949 01 21	20 18	Poggio Bustone	42.500	12.883	IV	
1949 01 23	07 ??	Rivodutri	42.517	12.850	IV	
1949 01 23	10 ??	Rivodutri	42.517	12.850	IV	
1949 01 24	03 ??	Rivodutri	42.517	12.850	IV	
1949 01 26	02 ??	Rivodutri	42.517	12.850	IV - V	
1949 01 26	16 59	Rivodutri	42.517	12.850	V	
1949 01 26	17 12	Rivodutri	42.517	12.850	IV	
1949 01 26	23 05	Rivodutri	42.517	12.850	IV	
1949 01 28	22 15	Rivodutri	42.517	12.850	V	
1949 01 29	01 30	Rivodutri	42.517	12.850	V	
1949 02 01	01 00	Rivodutri	42.517	12.850	IV	

Table 6 - continued.

1949 02 01	04 00	Rivodutri	42.517	12.850	IV	
1949 02 08	11 ??	Rivodutri	42.517	12.850	IV - V	
1949 02 08	11 10	Rivodutri	42.517	12.850	II	
1949 02 08	18 ??	Rivodutri	42.517	12.850	IV	
1949 02 09	03 ??	Rivodutri	42.517	12.850	IV	
1949 02 09	06 45	Rivodutri	42.517	12.850	IV	
1949 02 10	08 47	Rivodutri	42.517	12.850	IV	
1949 02 10	09 ??	Rivodutri	42.517	12.850	IV	
1949 02 10	15 ??	Rivodutri	42.517	12.850	IV	
1949 02 11	03 30	Rivodutri	42.517	12.850	III	
1949 02 12	04 50	Rivodutri	42.517	12.850	IV	
1949 02 12	04 55	Rivodutri	42.517	12.850	V	
1949 02 13	20 12	Rivodutri	42.517	12.850	IV	
1949 02 14	01 ??	Rivodutri	42.517	12.850	IV	
1949 02 14	02 ??	Rivodutri	42.517	12.850	IV	
1949 02 14	03 30	Rivodutri	42.517	12.850	IV	
1949 02 14	06 ??	Rivodutri	42.517	12.850	IV	
1949 02 15	04 25	Rivodutri	42.517	12.850	IV	
1949 02 15	06 40	Rivodutri	42.517	12.850	IV	
1949 02 15	22 15	Rivodutri	42.517	12.850	IV	
1949 02 16	05 15	Rivodutri	42.517	12.850	IV	
1949 02 17	01 50	Rivodutri	42.517	12.850	IV - V	
1949 02 17	02 ??	Rivodutri	42.517	12.850	IV - V	
1949 02 17	08 55	Rivodutri	42.517	12.850	IV	
1949 02 17	09 ??	Rivodutri	42.517	12.850	III	
1949 02 17	12 20	Rivodutri	42.517	12.850	III	
1949 02 20	19 40	Rivodutri	42.517	12.850	IV	
1949 02 20	19 45	Rivodutri	42.517	12.850	III	
1949 02 21	10 25	Rivodutri	42.517	12.850	IV	
1949 02 25	14 30	Rivodutri	42.517	12.850	IV	
1949 03 04	13 45	Rivodutri	42.517	12.850	IV	
1949 03 04	16 45	Rivodutri	42.517	12.850	IV	
1949 03 04	17 10	Rivodutri	42.517	12.850	IV	
1949 03 05	10 ??	Rivodutri	42.517	12.850	IV	
1949 03 05	16 ??	Rivodutri	42.517	12.850	V	
1949 03 11	05 05	Rivodutri	42.517	12.850	V	
1949 03 19	05 20	Rivodutri	42.517	12.850	IV	
1949 03 19	17 27	Rivodutri	42.517	12.850	IV	
1949 03 20	04 ??	Rivodutri	42.517	12.850	IV	
1949 03 20	19 21	Rivodutri	42.517	12.850	IV	
1949 03 21	10 20	Rivodutri	42.517	12.850	IV	
1949 03 27	11 45	Rivodutri	42.517	12.850	IV	
1949 03 29	21 45	Rivodutri	42.517	12.850	V	
1949 04 15	09 15	Rivodutri	42.517	12.850	IV	
1949 04 16	13 36	Rivodutri	42.517	12.850	IV	
1949 04 17	11 36	Rivodutri	42.517	12.850	IV	

Table 6 - continued.

1949 04 17	20 30	Rivodutri	42.517	12.850	IV	
1949 04 18	00 32	Rivodutri	42.517	12.850	V	
1949 04 21	00 24	Rivodutri	42.517	12.850	V	
1949 04 25	05 ??	Rivodutri	42.517	12.850	IV	
1949 04 26	10 24	Rivodutri	42.517	12.850	IV	
1949 05 02	18 20	Rivodutri	42.517	12.850	IV	
1949 05 11	06 45	Rivodutri	42.517	12.850	IV	
1949 05 24	21 27	Rivodutri	42.517	12.850	III	
1949 05 28	11 45	Rivodutri	42.517	12.850	IV	
1949 05 29	05 07	Rivodutri	42.517	12.850	IV	
1949 06 03	07 11	Rivodutri	42.517	12.850	III	
1949 06 03	08 08	Rivodutri	42.515	12.856	V	(1)
1949 06 03	08 26	Rivodutri	42.517	12.850	IV	
1949 06 03	16 16	Rivodutri	42.517	12.850	V	
1949 06 03	20 27	Rivodutri	42.517	12.850	IV	
1949 06 07	03 05	Rivodutri	42.517	12.850	IV	
1949 06 10	14 12	Rivodutri	42.517	12.850	V	
1949 06 19	14 23	Rivodutri	42.517	12.850	IV - V	
1949 06 19	20 05	Rivodutri	42.517	12.850	IV	
1949 06 20	00 27	Rivodutri	42.517	12.850	V	
1949 06 20	19 40	Rivodutri	42.517	12.850	IV - V	
1949 06 24	21 45	Rivodutri	42.517	12.850	IV - V	
1949 07 05	22 07	Rivodutri	42.517	12.850	III	
1949 07 06	00 21	Rivodutri	42.517	12.850	II	
1949 07 06	17 45	Rivodutri	42.517	12.850	IV	
1949 07 06	17 57	Rivodutri	42.517	12.850	V	
1949 07 06	21 23	Rivodutri	42.517	12.850	IV	
1949 07 10	02 54	Rivodutri	42.517	12.850	IV	
1949 07 18	02 21	Rivodutri	42.517	12.850	IV	
1949 07 18	16 32	Rivodutri	42.517	12.850	IV	
1949 07 20	15 50	Rivodutri	42.517	12.850	IV	
1949 08 05	23 55	Rivodutri	42.517	12.850	III	
1949 08 06	00 08	Rivodutri	42.517	12.850	IV	
1949 08 07	14 02	Rivodutri	42.517	12.850	III	
1949 08 11	05 53	Rivodutri	42.517	12.850	IV	
1949 08 17	02 28	Rivodutri	42.517	12.850	IV	
1949 08 28	02 15	Rivodutri	42.517	12.850	IV	
1949 08 28	03 49	Rivodutri	42.517	12.850	III	
1949 10 02	18 12	Rivodutri	42.517	12.850	III	
1949 10 16	05 43	Rivodutri	42.517	12.850	III	
1949 10 16	15 00	Rivodutri	42.517	12.850	V	
1949 10 17	00 13	Rivodutri	42.517	12.850	III	
1949 10 18	15 45	Rivodutri	42.517	12.850	III	
1949 10 27	19 08	Labro	42.532	12.805	VI - VII	(3)
1949 12 12	02 ??	Morro Reatino	42.533	12.833	V	
1949 12 12	07 04	Rivodutri	42.517	12.850	IV	

The main shock and earliest portion of the 1948 - 1949 sequence are not recorded by any of the Italian parametric earthquake catalogues in the public domain, from the earliest (Postpischl, 1985) to the latest one (Rovida *et al.*, 2011). Postpischl (1985) records only the later portion of the sequence, quoting as its source an unpublished regional catalogue (Dell'Olio and Molin, 1980). A comparison between the two show that a block of 53 records included in Dell'Olio and Molin (1980) are missing from Postpischl (1985). The missing records represent the first two months of the Rivodutri sequence, from late December 1948 to mid-February 1949, including both the main shock and the strong aftershock of January 4, 1949. It seems likely that these records must have been discarded by mistake in the course of an automatic transfer of data from the unpublished regional catalogue (Dell'Olio and Molin, 1980) to the first Italian catalogue in the public domain (Postpischl, 1985).

This commonplace error led to the lapse from consciousness of a significant local earthquake that was responsible for the most severe damage recorded so far in Rivodutri and Morro Reatino (Locati *et al.*, 2011: Fig. 1). The December 31, 1948 earthquake is very important for the purposes of hazard assessment at the sites of Rivodutri and Morro Reatino and as such needs to be reinstated in the catalogue. Besides allowing an undoubted improvement of knowledge on seismicity at a regional level, this episode of historical seismological research does also remind us that even the most recent time-window of historical earthquake catalogues can be less complete than they are ordinarily thought to be.

**Acknowledgements.** The authors acknowledge, once again, the pioneering work of their friend and colleague Diego Molin, whom they all regard as a teacher. Moreover, we also wish to thank Ina Cecic and Andrea Tertulliani for their constructive reviews and suggestions which have significantly contributed to improve our presentation of this material. A preliminary version of this paper was the object of an oral presentation at the 27th yearly meeting of the Gruppo Nazionale di Geofisica della Terra Solida (Trieste, Italy, October 2008).

## REFERENCES

### a) Primary sources

#### a.1) Bulletins and macroseismic cards

ING; 1938 - 1984: *Bollettino sismico*. Istituto Nazionale di Geofisica, Roma, Italy.

UCMEA; 1948 - 1975: *Protocollo delle Cartoline Sismiche*. Ufficio Centrale di Meteorologia ed Ecologia Agraria, Roma, Italy.

#### a.2) Newspapers<sup>1</sup>

Il Giornale d'Italia, 1949.01.02 (Lazio issue).

Il Giornale d'Italia, 1949.01.05 (National issue).

Il Giornale d'Italia, 1949.01.06 (Abruzzo-Molise issue).

---

<sup>1</sup> References include all newspapers consulted during the study and found to report information on the 1948-1949 seismic sequence, either cited or not cited in the text.

Il Giornale d'Italia, 1949.01.06 (Lazio issue).  
Il Giornale d'Italia, 1949.01.07 (National issue).  
Il Giornale d'Italia, 1949.01.07 (Lazio issue).  
Il Giornale d'Italia, 1949.01.07 (Umbria issue).  
Il Giornale d'Italia, 1949.01.09 (National issue).  
Il Giornale d'Italia, 1949.01.09 (Lazio issue).  
Il Giornale d'Italia, 1949.01.11 (National issue).  
Il Giornale d'Italia, 1949.01.13 (National issue).  
Il Giornale d'Italia, 1949.01.14 (Lazio issue).  
Il Giornale d'Italia, 1949.01.14 (Umbria issue).  
Il Popolo, 1949.01.01.  
Il Popolo, 1949.01.06.  
Il Tempo, 1949.01.01.  
Il Tempo, 1949.01.02.  
Il Tempo, 1949.01.06.  
Il Tempo, 1949.01.11.  
Il Tempo, 1949.01.13.  
L'Avvenire d'Italia, 1949.01.01.  
L'Avvenire d'Italia, 1949.01.06.  
La Nazione Italiana, 1949.01.01.  
La Nazione Italiana, 1949.01.02.  
La Nazione Italiana, 1949.01.03.  
La Nazione Italiana, 1949.01.06.  
La Nazione Italiana, 1949.01.09.  
L'Unità, 1949.01.01.  
L'Unità, 1949.01.02.  
Voce Adriatica, 1949.01.02.  
Voce Adriatica, 1949.01.09.

### a.3) Official archive records

ASRI; 1948: *Genio Civile, busta 18*. Archivio di Stato, Rieti, Italy.

### b) Studies

AHEAD Working Group; 2013: *AHEAD, the European, distributed Archive of Historical Earthquake Data*. Doi:10.6092/INGV.IT-AHEAD, <http://www.emidius.eu/AHEAD>.

Albini P. and Rodriguez de la Torre F.; 1993: *Known and unknown earthquakes through some European periodicals of the eighteenth century*. Terra Nova, **5**, 481-487.

Alexandre P.; 1990: *Les séismes en Europe occidentale de 394 à 1259. Nouveau catalogue critique*. Observatoire Royal de Belgique, Bruxelles, Belgium, 267 pp., [http://seismologie.be/dir1600/pdf/Les\\_Seismes\\_en\\_Europe\\_occidentale\\_de\\_394\\_a\\_1259.pdf](http://seismologie.be/dir1600/pdf/Les_Seismes_en_Europe_occidentale_de_394_a_1259.pdf).

Camassi R. and Caracciolo C.; 1994: *The gazette "Bologna": an observer of European natural events in the early 18th century*. In: Albini P. and Moroni A. (eds), Materials of the CEC project "Review of Historical Seismicity in Europe", Milano, Italy, vol. 2, pp. 153-162, [http://emidius.mi.ingv.it/RHISE/ii\\_12cam/ii\\_12cam.html](http://emidius.mi.ingv.it/RHISE/ii_12cam/ii_12cam.html).

Camassi R. and Castelli V.; 2004: *Looking for "new" earthquake data in the 17<sup>th</sup> - 18<sup>th</sup> century European "newssellers" network*. J. Earthquake Eng., **8**, 335-359.

- Camassi R., Castelli V., Molin D., Bernardini F., Caracciolo C.H., Ercolani E. and Postpischl L.; 2011: *Materiali per un catalogo dei terremoti italiani: eventi sconosciuti, rivalutati o riscoperti*. Quaderni di Geofisica, **96**, 1-53, <http://istituto.ingv.it/lingv/produzione-scientifica/quaderni-di-geofisica/archivio>.
- Castelli V. and Bernardini F.; 2006: *Unearthing earthquakes in the Sienese Crete: how we improved the seismic catalogue of a low seismicity area*. In: Proc. 1<sup>st</sup> Eur. Conf. Earthquake Eng. and Seismol., Geneva, Switzerland, Paper No. 837, pp. 1-9.
- Castelli V. and Camassi R.; 2005: *The shadow-zone of large Italian earthquakes. Early journalistic sources and their perception of 17<sup>th</sup>-18<sup>th</sup> centuries seismicity*. J. Earthquake Eng., **9**, 333-348.
- Dell'Olio A. and Molin D.; 1980: *Catalogo macrosismico del Lazio dall'anno 1000 al 1975*. ENEA, Roma, Italy, Rapporto interno, 143 pp.
- Gasperini P., Bernardini F., Valensise G. and Boschi E.; 1999: *Defining seismogenic sources from historical earthquake felt reports*. Bull. Seismol. Soc. Am., **89**, 94-110.
- Guidoboni E., Ferrari G., Mariotti D., Comastri A., Tarabusi G. and Valensise G.; 2007: *CFTI4Med, catalogue of strong earthquakes in Italy (461 B.C. - 1997) and Mediterranean area (760 B.C. - 1500)*. INGV - SGA, <http://storing.ingv.it/cfti4med/>.
- Locati M., Camassi R. and Stucchi M. (eds); 2011: *DBMI11, the 2011 version of the Italian Macroseismic Database*. Milano - Bologna, Italy, doi:10.6092/INGV.IT-DBMI11 <http://emidius.mi.ingv.it/DBMI11>.
- Mariotti D. and Guidoboni E.; 2006: *Seven missing damaging earthquakes in Upper Valtiberina (central Italy) in 16<sup>th</sup> - 18<sup>th</sup> century: research strategies and historical sources*. Ann. Geof., **49**, 1139-1155, <http://www.annalsofgeophysics.eu/index.php/annals/article/view/3096/3141>.
- Mariotti D., Comastri A. and Guidoboni E.; 2000: *«Unknown» earthquakes: a growing contribution to the Catalogue of Strong Italian Earthquakes*. Ann. Geof., **43**, 787-795, <http://www.annalsofgeophysics.eu/index.php/annals/article/view/3667/3726>.
- Molin D., Bernardini F., Camassi R., Caracciolo C.H., Castelli V., Ercolani E. and Postpischl L.; 2008: *Materiali per un catalogo dei terremoti italiani: revisione della sismicità minore del territorio nazionale*. Quaderni di Geofisica, **57**, pp. 75 + CD-ROM, <http://istituto.ingv.it/l-ingv/produzione-scientifica/quaderni-di-geofisica/archivio>.
- Postpischl D.; 1985: *Progetto Finalizzato Geodinamica. Catalogo dei terremoti italiani dall'anno 1000 al 1980*. Quaderni de «La Ricerca Scientifica», **114**, 1-239.
- Rovida A., Camassi R., Gasperini P. and Stucchi M. (eds); 2011: *CPTI11, the 2011 version of the Parametric Catalogue of Italian Earthquakes*. Milano - Bologna, Italy, doi:10.6092/INGV.IT-CPTI11, <http://emidius.mi.ingv.it/CPTI>.
- Stucchi M., Albinì P., Mirto C. and Rebez A.; 2004: *Assessing the completeness of Italian historical earthquake data*. Ann. Geophys., **47**, 659-673, <http://www.annalsofgeophysics.eu/index.php/annals/article/download/3330/3376>.
- Tertulliani A., Rossi A., Castelli V., Vecchi M. and Gottardi F.; 2008: *Terremoti "dispersi" al confine tra Marche, Umbria e Lazio nel 1941 - 1943*. Quaderni di Geofisica, **58**, 6-23.
- Vannozi L. (ed); 1988: *Materiale storico del comune di Rivodutri*, vol. 4 (*Le amministrazioni comunali dall'unità d'Italia ad oggi*). Cooperativa culturale Arcadia, Rivodutri, Rieti, Italy, 190 pp.
- Vogt J.; 1984: *Problèmes de sismicité historique: exemples de faux séismes, de séismes méconnus et de séismes réinterprétés dans l'ensemble Allemagne / Belgique / Nord-Ouest de la France / Sud de la Grande-Bretagne*. In: Melchior P. (ed), *Seismic activity in western Europe*, Reidel D., NATO/ASI series, Series C, t. 144, pp. 205-214.

*Corresponding author:* Filippo Bernardini  
Istituto Nazionale di Geofisica e Vulcanologia, Sezione di Bologna  
Via Donato Creti 12, 40128 Bologna (Italy)  
Phone: +39 051 4151430; fax: +39 051 4151498; e-mail: [filippo.bernardini@bo.ingv.it](mailto:filippo.bernardini@bo.ingv.it)