

New insights in the seismic history of Monti della Laga area

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Abstract

The earthquake of August 24, 2016 hit an Apenninic "border" area, now at the crossroads of four regions, but for many past centuries on the edge of two independent Italian states. The geographic, cultural and historical marginality of this area did certainly affect the level of knowledge available on its historical seismicity. However, the recent publication of the new Italian Macroseismic Database and Parametric Catalogue produces a significant improvement of knowledge, based on the analysis of new sources on two major seismic clusters that characterize the seismic history of the area. Further improvements are possible, but these new data define what are the key issues that research is now facing.

I. INTRODUCTION

The latest version of the Parametric Catalogue of Italian Earthquakes CPTI15 [Rovida et al., 2016] includes in its 1000-2014 time-window some hundreds of earthquakes that did not figure either in the previous version CPTI11 [Rovida et al., 2011] or in the earlier Italian parametric catalogues. Most of these events had not been registered by the centuries-old tradition of Italian earthquake studies that culminated in the big descriptive compilation *I terremoti d'Italia* [Baratta, 1901] and their discovery has been possible only thanks to the extensive and systematic investigations of historical records carried out in the last decades by studies such as Molin et al. [2008], Tertulliani et al. [2008], Camassi et al. [2011], Guidoboni and Ciuccarelli [2011], Az-zaro and Castelli [2015], Castelli et al. [2016]. These new entries significantly improved many of the local seismic histories provided in the Italian Macroseismic Database DBMI15 [Locati et al., 2016] and - in some cases - they

even turn out to be the key earthquakes at a local or regional level.

The improvement of knowledge provided by CPTI15 is particularly striking in the case of the Central Apennines area affected by major effects in the August 2016 sequence (Fig. 1) Until a few years ago the level of knowledge on the seismicity of the area between Arquata del Tronto and Montereale was very low. The CPTI11 catalogue, based on the studies published up to 2006, lists ten events located in the Monti della Laga area, only two of which (1639 and 1916) are supported by studies providing a high number of Macroseismic data Points (henceforth MdP, Tab. 1). This situation has been significantly improved by some of the studies carried out after 2006 and taken into account by the CPTI15 catalogue. None of these studies was specifically dedicated to the Monti della Laga area, but they highlighted some interesting features of local seismicity and a few problems still open. To solve them, a new dedicated study has just been undertaken.

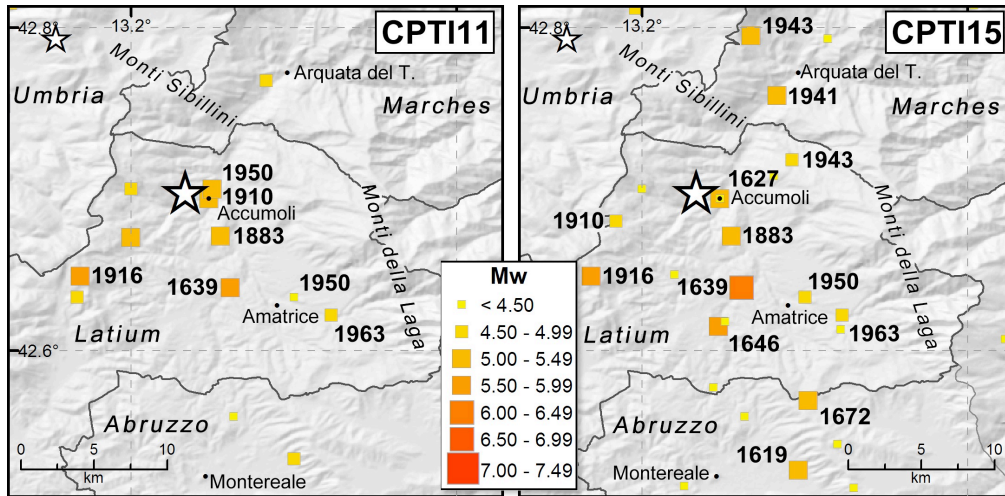


Figure 1: Main seismicity of the Central Apennines according to (a) CPTI11 and (b) CPTI15. Stars indicate the sequence’s main shocks (August 24, 2016, Mw 6.0 and 5.4)

II. AN OVERVIEW OF LOCAL SEISMICITY

Tab. 1 lists the Mw≥4.5 earthquakes located in the area by CPTI15. Apart from two cases (1883, Mw 5.1; 1963, Mw 4.7), for which only a set of MdP is available, each of these events is provided with a more or less recent study including a set of original historical descriptions of effects. The latest published studies date back to 2011 but historical investigation went on in the following years. Its results will be

published soon, in the frame of an ongoing systematic revision of the whole set of events. The most interesting feature shown by local historical seismicity is the existence of two potential “earthquake clusters”, respectively occurring in the 1600s (five events located in the area of Accumoli-Amatrice-Montereale) and the 1940s (three events located in the area of Arquata del Tronto-Accumoli).

Table 1: Comparison of the background of the CPTI11 and CPTI15 catalogues.

Date Time	CPTI11				CPTI15				Notes
	Study	MdP	Ix	Mw	Study	MdP	Ix	Mw	
1619.07.07 22	-	-	-	-	Camassi et al., 2011	5	7-8	5.3	New study
1627.07	Arch. Macro. GNDT, 1995	1	7-8	5.3	Arch. Macro. GNDT, 1995	1	7-8	5.3	
1639.10.07	Castelli, 2003a	39	10	5.9	Castelli, 2003a	39	10	6.2	
1646.04.28 07	Arch. Macro. GNDT, 1995	1	5-6	4.5	Camassi et al., 2011	10	9	5.9	Updated study
1672.06.08 17:30	Monachesi and Castelli, 1992	1	5-6	4.5	Camassi et al., 2011	10	HD	5.3	Updated study
1883.11.07 03	Dell’Olio and Molin, 1980	4	7	5.1	Dell’Olio and Molin, 1980	4	7	5.1	
1910.12.22 12:34	-	-	-	-	Molin et al., 2008	19	5-6	4.3	New study
1910.12.22 17:18	-	-	-	-	Molin et al., 2008	3	5-6	3.9	New study
1910.12.26 16:30	-	-	-	-	Molin et al., 2008	50	6	4.6	New study
1916.11.16 06:35	SGA, 2002	40	8	5.5	SGA, 2002	40	8	5.5	
1941.12.19	-	-	-	-	Tertulliani et al., 2008	30	7	5.0	New study
1943.01.16	-	-	-	-	Tertulliani et al., 2008	22	D	5.0	New study
1943.01.29	-	-	-	-	Tertulliani et al., 2008	50	7	4.9	New study
1950.03.07 04:05	(Only instrumental parameters)	-	-	4.4	(Only instrumental parameters)	-	-	4.7	
1950.03.12 18:15	-	-	-	-	Molin et al., 2008	1	5	4.1	New study
1951.08.02 12:50	(Only instrumental parameters)	-	-	4.6	(Only instrumental parameters)	-	-	4.4	
1960.03.16 01:52	(Only instrumental parameters)	-	-	4.6	Molin et al., 2008	81	5	4.4	New study
1963.07.21 11:09	Dell’Olio and Molin, 1980	11	7	4.9	Dell’Olio and Molin, 1980	11	7	4.7	

Their existence had never been perceived before, for several reasons: the occurrence of

some of the involved earthquakes was unknown; others had been located elsewhere; a

couple had been listed in the earliest Italian parametric catalogues [Carrozzo et al., 1973; Postpischl, 1985] but not included in the most recent ones. Fortunately, the relevant information was retrieved and put in its correct context by recent historico-seismological studies. Here follows a short summary of currently available information.

III. THE 17th CENTURY EARTHQUAKE CLUSTER

1619 July 7 (Aquilano)

Unknown to catalogues earlier than CPTI15. Contemporary accounts from Aquila and Rome describe a sequence that started with a couple of foreshocks felt in Aquila on July 7 (afternoon). The main event (July 7, 22:00 local time) caused buildings to collapse in Mascioni and Montereale, the fall of chimneypots in Aquila and was felt in Rome (about 130 km W) and Urbania (about 200 km N). Smaller shocks went on being felt in Aquila for some days, inducing many of the townsfolk to sleep outdoors [Camassi et al., 2011].

1627 July (?) (Monti della Laga)

The current parameters derive from a macro seismic data set assembled by a preliminary study [Archivio Macrosismico GNDT, 1995], now under revision. This earthquake damaged several buildings of Accumoli (three churches, the municipal house, some private houses). As much is known because on November 4, 1627, the town council of Accumoli was discussing how to pay for the necessary restoration [Cappello, 1829]. The exact date of the earthquake was not put on record and is still unclear. Cappello [1829] attributed the damage to the Capitanata earthquake of July 30, 1627 (Mw 6.6), but this highly unlikely suggestion was already dismissed by Baratta [1901].

1639 October 7 (Monti della Laga)

The current parameters were assessed from a macroseismic data set [Castelli, 2003a] whose main fault is that all descriptions of damage come from a single, contemporary and well-informed but not firsthand source [Castelli,

2003b]. This earthquake is believed to be the strongest on record for Amatrice and its surroundings but, considering that most intensities had to be assessed from the briefest of descriptions (often, actually, from no more than a single adjective apiece) a modicum of overestimation could not have been avoided. Fortunately, the now ongoing revision will benefit from the information to be derived from some more recently discovered contemporary sources.

1646 April 28 (Monti della Laga)

Catalogues earlier than CPTI11 located this earthquake in Aquila (the only known affected locality according to an extremely poor data set) with Mw 4.5 and I 5-6 MCS. A better assortment of contemporary sources collected by Camassi et al. [2011] allowed to relocate it near Amatrice. It is reported to have “*destroyed*” a couple of villages (Scai and Torrita) and severely damaged Amatrice itself and Accumoli. The shock was felt in Spoleto, Ascoli Piceno and Aquila [Petrucci, 1646; Secinara, 1652; Antinori, 18th century]. That this could have been the main event of a sequence is suggested by the fact that minor shocks went on being felt in Aquila and Spoleto for some months after April 28.

1672 June 8 (Monti della Laga)

Catalogues earlier than CPTI11 located this earthquake generically in the Montereale area (Mw 4.5) but the only known affected locality was Aquila (I 5-6 MCS). Contemporary sources collected by Camassi et al. [2011] mention the destruction (“*spianto*” i.e. eradication) of a few unidentified villages in the Amatrice- Montereale area, severe damage in Amatrice, Campotosto and Montereale and, to a lesser extent, in Aquila. The shock was strongly felt in Ascoli Piceno, Roma and possibly Frascati. A few “*very feeble*” aftershocks were felt in the next few days.

IV. A WW2 EARTHQUAKE CLUSTER

1941 December 19 (Monti Sibillini)

This earthquake does not figure in any parametric catalogue, but is recorded by earthquake bulletins and macroseismic postcards [AMINGV, 1941; UCMEA, 1941]. Tertulliani et al. [2008] collected ample archival evidence of slight to moderate damage in the municipalities of Accumoli and Arquata del Tronto (particularly in Pescara del Tronto, Camartina and Grisciano, where some buildings did partially collapse and several others had to be demolished). Slighter damage occurred in Arquata itself and possibly in the vicinity of Norcia. The shock was widely felt in the area between Ascoli Piceno, Norcia and Rieti. Restoration work started as early as 1942 but was discontinued in 1943-1945, when the area became a theater of active military conflict.

1943 January 29 (Monti Sibillini)

Already listed in the PFG catalogue [Postpischl, 1985] with Io 6 MCS, these events were not included in the most recent catalogues. Archive records collected by Tertulliani et al. [2008] give a cumulative picture of the damage they caused in the municipalities of Accumoli, Acquasanta Terme and Roccafluvione. The worst affected locality was Poggio Casoli (a *frazione* of Accumoli), where the parish church and 12 out of a total of 20 buildings undergone severe damage (partial collapses and large fissures in the weight-bearing walls). Slightly less severe damage is reported in Accumoli, Amatrice, Arquata del Tronto and several of their frazioni. Minor damage occurred in Ascoli Piceno, Cascia, Norcia and Visso, too.

V. DISCUSSION AND CONCLUSIONS

In the last decades extensive historical seismology researches were performed for updating the Italian catalogue and macroseismic database. They provide a substantial improvement of knowledge on the seismicity of the area affected by the August 24, 2016 earthquake, as far as both the site seismic histories (Fig.2) and the earthquake parameters (Fig. 1 and 3) are concerned.

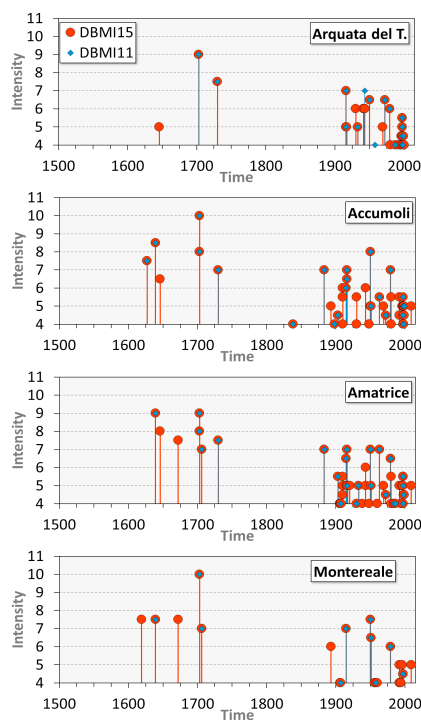


Figure 2: Comparison between seismic histories of Arquata del Tronto, Accumoli, Amatrice, and Montereale from DBMI11 [Locati et al., 2011], and the improved ones in DBMI15.

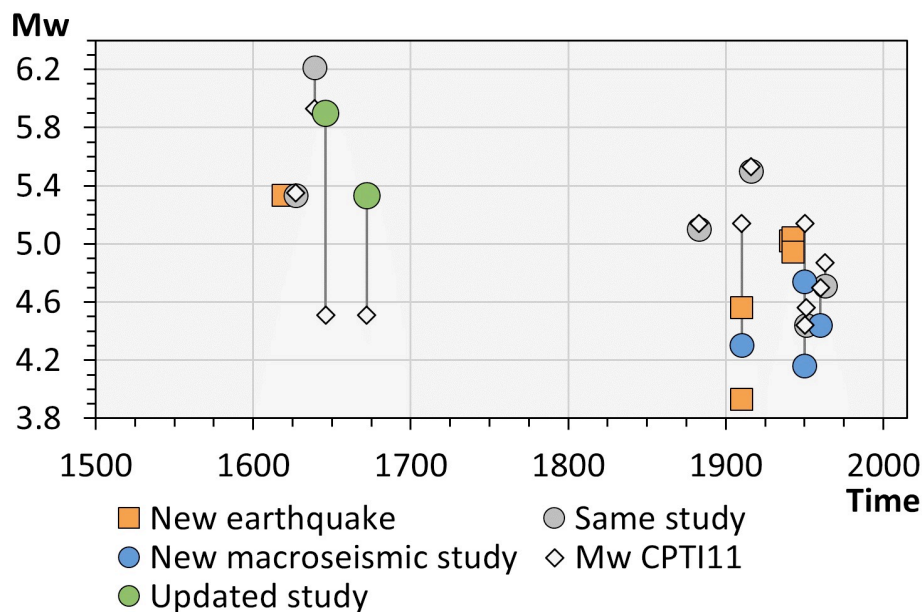


Figure 3: Magnitude variations from CPTI11 to CPTI15 deriving from the improved knowledge.

Such an improvement was not gained by the implementation of an ad hoc research plan but it was mainly a by-product of the systematic revision of the minor seismicity of the national territory [Molin et al., 2008] and of studies aimed at identifying unknown or forgotten earthquakes [Tertulliani et al., 2008; Camassi et al., 2011]. In addition, such studies significantly improved the knowledge of the seismicity of the 20th century, which is usually, and mistakenly, considered fully represented through instrumental recordings.

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The most interesting feature shown by local historical seismicity is the presence of two potential “earthquake clusters”, one in the 17th century - when no less than five damaging earthquakes occurred in the area of Accumoli-Amatrice-Monteverde - and another in the first half of 20th century, when three damaging earthquakes occurred in the area of Arquata del Tronto-Accumoli. The first of these potential “clusters” includes the strongest and most damaging earthquakes on record in this area before the August 24, 2016 event and responsible for comparable damage levels.

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