

Pre-1500s earthquakes in Ferrara (NE Italy) and an overrated source: first results of a critical revision

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ABSTRACT In the frame of the PRIN 2020 NASA4SHA project, a revision of the seismic record of the Ferrara (NE Italy) area was started for the period prior to A.D. 1500. Eleven earthquakes dated from 1234 to 1495 A.D. were considered. Nine of them are listed by the latest Italian parametric catalogue, CPTI15 v. 4.0, with epicentral parameters mostly derived from decade-old reference studies. Other two earthquakes are listed only by the oldest Italian parametric catalogue and had never been studied at all. The evidence available was critically analysed and placed in its proper historical context, special care being paid to a single source that, alone, provides evidence on several earthquakes. Some earthquakes result to have been overestimated, others appear to be non-existent and should be deleted from the catalogue.

Key words: Ferrara, historical seismology, historical source criticism, seismic history, false earthquakes.

1. Introduction

A critical revision of part of the historical seismic record of the Ferrara area of NE Italy (Fig. 1) was undertaken in the frame of the PRIN 2020 NASA4SHA project, “Fault segmentation and seismotectonics of active thrust systems: the Northern Apennines and Southern Alps laboratories for new Seismic Hazard Assessments in northern Italy” (directed by Riccardo Caputo of the Ferrara University).

The aim of the revision was to update and improve the knowledge on local earthquakes listed in the CPTI15 v. 4.0 parametric earthquake catalogue (Rovida *et al.*, 2022). The first step considered the revision of the data provided by CPTI15 v. 4.0 reference studies on the earthquakes which occurred before A.D. 1500.

Most of these studies (ENEL, 1985) date back to the early 1980s. This, in itself, would be reason enough for revising them and updating them with the progress of historical research of the last decades. Another reason making such a revision advisable is the context in which the ENEL (1985) studies were carried out, i.e. the feasibility studies undertaken in the early 1980s for the identification of sites for the installation of nuclear power plants in Italy. In this context, it was necessary to adopt a highly precautionary approach in the selection of data: researchers would comb through masses of written historical records (chronicles, annals, archive records, etc.) and collect as many reports of earthquake effects as possible, taking care not to discard even those reports appearing to be less informative or not entirely reliable, in order to minimise the risk of losing any potentially useful information. The need to process large amounts of data within tight deadlines imposed another common trait of historical seismology research in those

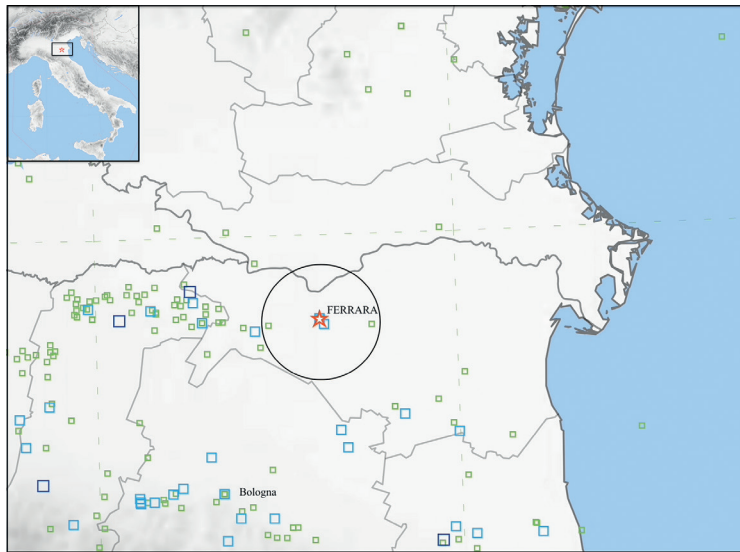


Fig. 1 -The studied area and NE Italy seismicity [from the CPTI15 v. 4.0 catalogue, Rovida *et al.* (2022)].

times: descriptions of earthquake effects would be taken at face value without considering their historical and cultural context and be turned, without further ado, into macroseismic intensity degrees, from which the earthquake epicentral parameters would, then, be assessed.

Now, however, with forty years of experience behind us, and no other requirements to meet, apart from the deepening of knowledge and the improvement of the Italian earthquake catalogue, it must be acknowledged that assessing macroseismic intensities from data extrapolated from their proper context and background, can mean relying on information whose actual value for this purpose cannot be adequately weighed. Indeed, any information removed from its context, while useful in itself, remains impoverished, just like archaeological findings whose site, location, and circumstances of discovery are unknown.

For these reasons, we undertook an admittedly ambitious task: to return to the original descriptions of earthquake effects observed in/around Ferrara from the 1200s to 1400s, and to examine them in their textual surroundings and within their historical and cultural framework. In other words, we aimed at checking the intrinsic value and ‘authoritativeness’ of the original reports that had been used to assess macroseismic intensities for Ferrara and surroundings in the 1200-1400 period, and, if possible, improving the quality of general knowledge on the early section of Ferrara seismic history.

2. The studied earthquakes

Fig. 2 shows the seismic history of Ferrara from A.D 1000 to 2020, as can be derived from the Italian Macroseismic Data Base, DBMI15 v. 4.0 (Locati *et al.*, 2022). Referring to the introduction of Locati *et al.* (2022) for a detailed description of the structure and compilation criteria of the DBMI15 database, here suffice it to say that a seismic history can be defined as a summary list of macroseismic effects observed at a given site in a given time frame. These effects are summarised as macroseismic intensities obtained by comparing the available descriptions of effects with the standard scenarios proposed by a macroseismic intensity scale – in this case

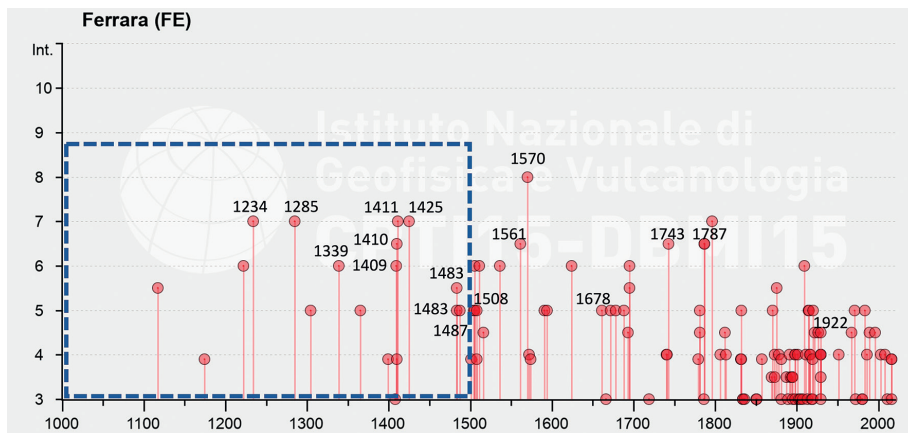


Fig. 2 - Seismic history of Ferrara from 1000 to 2020 [from the DBMI15 v. 4.0 database, Locati *et al.* (2022), modified]. Intensity degrees assessed according to the Mercalli-Cancani-Sieberg scale (MCS, 1930). Dates are indicated only for local earthquakes (i.e. those with epicentral location in a radius of 25 km from Ferrara). The dashed frame indicates the time window considered in this study.

the Mercalli-Cancani-Sieberg scale (MCS, 1930) – and translating each set of evidence into an intensity degree or macroseismic data point. The seismic history of Ferrara currently includes 131 macroseismic observations, only part of which are related to local earthquakes (those for which dates are provided in Fig. 2).

Table 1 shows the epicentral parameters of the 11 local earthquakes studied in this paper. In 9 cases the parameters are derived from the CPTI15 v. 4.0 catalogue (Rovida *et al.*, 2022). The epicentral parameters of the 1379 and 1495 earthquakes are derived from the earliest Italian

Table 1 - Epicentral parameters of the studied earthquakes derived from CPTI15 v. 4.0 (Rovida *et al.*, 2022) or – for the 1379 and 1495 earthquakes – from the earlier Progetto Finalizzato Geodinamica (PFG – Geodynamics Finalised Project) catalogue (Postpischl, 1985). Epicentral intensities assessed according to the Mercalli-Cancani-Sieberg scale (MCS, 1930). The parameters of the 1346 earthquake are included (in italics, in square brackets) merely as a chronological reminder: this earthquake, considered false by Camassi and Castelli (2013), was removed from the CPTI15 catalogue. Legend – BA901: Baratta, 1901; POS985: Postpischl, 1985; ENEL985: ENEL, 1985; CFTI4Med: Guidoboni *et al.*, 2007; MOLAL008: Molin *et al.*, 2008; CPTI11: Rovida *et al.*, 2011; CPTI15: Rovida *et al.*, 2022; MDP: Macroseismic Data Points.

Year	Mo	Da	Ho	Min	Epicentral area	Reference	Catalogue	Latitude	Longitude	I_0	M_w	MDP
1234	3	20	-	-	Ferrara	ENEL985	CPTI15	44,835	11,62	7	5,1	1
1285	12	13	-	-	Ferrara	ENEL985	CPTI15	44,835	11,62	7	5,1	2
1339	11	16	14	10	Ferrara	CFTI4med	CPTI15	44,835	11,62	6	4,63	1
[1346	02	22	11	-	<i>Ferrara</i>	<i>CFTI4Med</i>	<i>CPTI11</i>	<i>44.836</i>	<i>11.618</i>	<i>6-7</i>	<i>4.93</i>	<i>3]</i>
1379	2	10	5	-	Ferrara, South	BA901	POS985	44.50	11.40	6	4.1	-
1409	8	17	0	35	Ferrara	CFTI4med	CPTI15	44,835	11,62	6	4,63	1
1410	5	9	22	30	Ferrara	ENEL985	CPTI15	44,835	11,62	6-7	4,86	1
1411	1	9	2	-	Ferrara	CFTI4med	CPTI15	44,835	11,62	7	5,1	1
1425	8	10	-	-	Ferrarese	MOLAL008	CPTI15	44,835	11,62	6	4,63	2
1483	3	3	22	-	Ferrara	ENEL985	CPTI15	44,835	11,62	5-6	4,4	1
1487	1	11	15	40	Ferrara	CFTI4med	CPTI15	44,835	11,62	4	3,7	2
1495	12	13	19	-	Crespino	BA901	POS985	45.000	11.50	7	4.7	-

parametric catalogue (Postpischl, 1985); these earthquakes do not appear in Fig. 2, as they are not included in the CPTI15 v. 4.0 catalogue and related DBMI15 v. 4.0 database. For the sake of completeness and merely as a chronological reminder, Table 1 also includes (in italics, in square brackets) the epicentral parameters of the 1346 Ferrara earthquake. This earthquake was listed in the CPTI11 catalogue (Rovida *et al.*, 2011), but was removed from the CPTI15 catalogue as a non-existent or ‘false’ earthquake, according to a study by Camassi and Castelli (2013).

As shown in Table 1, the CPTI15 v. 4.0 catalogue (Rovida *et al.*, 2022) lists nine earthquakes located in the Ferrara area before 1500. Several of them were already mentioned in Mario Baratta’s treatise, “*I terremoti d’Italia*” (Baratta, 1901), which is both the most important descriptive compilation of pre-1900 Italian earthquakes and the main source of information on them for all Italian parametric earthquake catalogues, from the earliest (Postpischl, 1985) to the latest to date (Rovida *et al.*, 2022).

The treatise “*I terremoti d’Italia*” (Baratta, 1901), is divided into two parts. In the first, Mario Baratta sketches a “documented history” (“*cronistoria documentata*”) of earthquakes “above the damage threshold” occurring in Italy from A.D. 0 to 1898: among them there are eight of the 11 Ferrarese earthquakes considered in this paper. The second part of the book (“*Saggio di geografia sismica*”) describes the topographical distribution of Italian earthquakes, in which the Ferrarese area figures but little, with mentions of two main local earthquakes (1570, Ferrarese; 1624, Argenta), and several non-local earthquakes that were merely felt in Ferrara.

To write his monumental work, Mario Baratta relied on previously published earthquake compilations, on research he had carried out himself, and on the contributions he received by numerous Italian librarians and scholars, in response to a circular call sent out, on Baratta’s behalf (in October 1894), by the Italian Central Office of Meteorology and Geodynamics. These volunteers collected data on historical earthquakes at several locations, copied them and mailed them to Rome, for Baratta to peruse (Baranello *et al.*, 2024). Among the few surviving files, currently kept at the library of the Ufficio Centrale di Ecologia Agraria (Central Office of Agricultural Ecology), one is dedicated to Ferrara (Bongiovanni, 1895). Its author, Giuseppe Bongiovanni (1851-1918), was the director of the Meteorological Observatory of the Ferrara University. Another collection of earthquake data was compiled at the same time by Demetrio Bandi (1895), the director of the Meteorological Observatory of Argenta, a minor town of the Ferrarese area. A copy of it is preserved in the Argenta municipal archives.

The short monographies provided by Baratta (1901) for the Ferrarese earthquakes prior to 1500 are mostly based on medieval chronicles from Ferrara (Chronicon Estense, 14th-15th centuries; Diarium Ferrariense, 15th-16th centuries) and other areas of NE Italy (della Gazzata, 14th-15th centuries; Historia Miscella Bononiensis, 14th-15th centuries; Malipiero, 15th century), supplemented by late historical and seismological compilations (Buoni, 1571; Ghilini, 1666; Dalla Fabra, 1749; Mezzotti 1838-1840; Mercalli, 1883; Dondi, 1896).

The earthquakes of 1234, 1285, 1410, and 1483, after being included in the PFG catalogue, became the object of ENEL (1985) studies, carried out by the same agency that would later be entrusted with the creation and upkeep of the “*Catalogo dei Forti Terremoti in Italia*” [Catalogue of Strong Earthquakes in Italy (CFTI)] database. Those same ENEL (1985) studies are still quoted as reference for the earthquakes in question by the CPTI15 catalogue (Rovida *et al.*, 2022). However, none of these earthquakes are currently included in the CFTI5Med catalogue (Guidoboni *et al.*, 2018).

The earthquake of 1425, known to Baratta (1901) and listed in the PFG catalogue, was included in the CPTI15 catalogue on the basis of a reference study by Molin *et al.* (2008).

The earthquakes of 1339, 1409, 1411, and 1487 – unknown to Baratta (1901) and to the PFG

Table 2 - Dates of the 1200-1400 Ferrara earthquakes and relevant historical references cited by Baratta (1901) and by the following historical seismology studies: 1) ENEL (1985); 2) Guidoboni and Comastri (2005); 3) Guidoboni *et al.* (2007); 4) Molin *et al.* (2008); 5) Guidoboni *et al.* (2018).

N.B. *Diarium Ferrariense* (15th-16th c.) and *Diario Ferrarese* (15th-16th c.) are different editions of the same text.

Baratta (1901)	Studies (1985-2018)	Baratta (1901): references	Studies (1985-2018): references
25 December 1234	20 March 1234 (1)	Dalla Fabra (1749)	G. da Marano (16 th c.)
13 December 1285	13 December 1285 (1)	Chronicon Estense (14 th -15 th c.)	Chronicon Estense (14 th -15 th c.) G. da Marano (16 th c.) Later 16 th –18 th c. works
-	16 November 1339 (2)	-	G. da Marano (16 th c.) Later 16 th c. works
22 February 1346 (northern Italy, no mention of Ferrara)	22 February 1346 (2, 3, 5)	della Gazzata (14 th -15 th c.) Ghilini (1666), Mezzotti (1838-1840), Mercalli (1883), Dondi (1896)	della Gazzata (14 th -15 th c.) G. da Marano (16 th c.) Ghilini (1666), Mezzotti (1838-1840), Mercalli (1883), Dondi (1896)
4 March 1365	-	Chronicon Estense (14 th -15 th c.) Historia miscella ... (14 th -15 th c.)	-
10 February 1379	-	Chronicon Estense (14 th -15 th c.)	-
-	17 August 1409 (2, 3)	-	Diario Ferrarese (15 th -16 th c.) Frammenti (15 th c.) G. da Marano (16 th c.)
-	9 May 1410 (1)	-	Rodi (1616)
-	9 January 1411 (2, 3, 5)	-	G. da Marano (16 th c.) Another 16 th c. source
10 August 1425	10 August 1425 (4)	Diarium Ferrariense (15 th -16 th c.) Buoni (1571)	Diarium Ferrariense (15 th -16 th c.) Buoni (1571) Cronica di Ferrara (15 th -17 th c.)
11 March 1483	11 March 1483 (1)	Diarium Ferrariense (15 th -16 th c.) Buoni (1571)	Diario Ferrarese (15 th -16 th c.) Zambotti (15 th -16 th c.) Cronica imperfetta (16 th c.) Later 16 th -17 th c. works
-	11 January 1487 (3)	-	Ferrarini (15 th c.) Zambotti (15 th -16 th c.)
13 December 1495	-	Diarium Ferrariense (15 th -16 th c.) Malipiero (15 th c.) Buoni (1571)	-

catalogue – are listed in the CPTI15 catalogue on the basis of reference studies by Guidoboni *et al.* (2007), derived from Guidoboni and Comastri (2005).

This study also considers the earthquakes of 1379 and 1495, known to Baratta (1901) and to the PFG catalogue, but not included in the CPTI15 catalogue.

Ultimately, mention should be made of the controversial earthquake of 22 February 1346. This earthquake was once believed to be one of the strongest Ferrara earthquakes ever (CFTI4Med, Guidoboni *et al.*, 2007) and, as such, it was included in the CPTI11 catalogue (Rovida *et al.*, 2011). A study by Camassi and Castelli (2013) cast doubts on this interpretation, leading to the exclusion of the 1346 earthquake from the CPTI15 catalogue. The current versions of the CFTI database and catalogue (CFTI5Med, Guidoboni *et al.*, 2018) maintain it as a real earthquake, though with a downsized epicentral intensity.

3. A few words on Ferrara's history and historical sources

A quick sketch of Ferrara's history and sources will be useful to appreciate the complexities of this investigation. Ferrara lies in the midst of a wide plain, not far from the Po River delta, some 50 km NE of Bologna and 80 km SW of Venice. Today, Ferrara is only the principal town of one of Italy's administrative provinces, but from the 1200s to 1597 it was the capital of one of Italy's regional states under the family of the Estensi, first *Signori*, then Marquises and finally Dukes of Ferrara. The earliest records of Ferrara's existence date back to the 8th century A.D., when it was a tiny settlement close to a ford of the Po River, amid swamps and wild scrublands. In time, Ferrara grew important enough for its overlordship to be disputed between the papacy and the German Empire. In the 1100s, Ferrara set up as a self-ruling free commune, with a territory of its own. Infighting for control over the town government, then, broke out between the main local families, and lasted until 1208, when power was seized by Azzo d'Este, whose descendants ruled Ferrara, as vassals of the Pope, until the late 1500s. An extensive programme of land reclamation, military conquest and urban planning, led the Estensi to build up a domain that extended from the Adriatic coast to the Apennines, to establish throughout the lower Po Plain a dense network of drainage dykes, farms and villas connected by navigable channels and roads (Fig. 3a), and to turn Ferrara into a rationally planned 'ideal city' in the Renaissance style (Fig. 3b). The main Estensi line ended with Duke Alfonso II, whose death brought Ferrara under the direct control of the Holy See until 1859, when the town and its countryside were annexed to the newly-established Kingdom of Italy.

Ferrara was one of the earliest Italian towns to turn from a free commune into a *signoria*, under a ruling dynasty. This could have influenced the output of local chroniclers, an analysis of whose works (starting with the published ones) suggests that the desire to remain in the Estensi good books may have been one of the main goals of Ferrarese history-tellers.

For the 11th-13th centuries, the only surviving Ferrarese chronicle is the "*Chronica parva Ferrariensis*" (Riccobaldo da Ferrara, 13th-14th centuries), written by a notary, who was born around 1245 and died sometime after 1318, i.e. shortly after the ending date of the chronicle (Giansante, 2017). The *Chronica parva* does not mention any earthquake in Ferrara or elsewhere. Several chronicles are available from the late 14th century to the first decades of the 16th century, some even in print, such as the anonymous, multi-authored "*Chronicon Estense cum additamentis usque ad annum 1478*", which critics consider a "non-negligible point of reference within the [...] late medieval historiographical tradition" (Zanella, 1991); the "*Storia della città di Ferrara*" by notary Ugo Caleffini (15th century_a, 15th century_b); and two private diaries, both known as "*Diario Ferrarese*", one by an anonymous author (Diario Ferrarese, 15th-16th centuries), the other by Bernardino Zambotti (Zambotti, 15th-16th centuries), which critics consider "very reliable and of particular importance" (Zanella, 1991).

These narratives generally begin by recounting legends on the origins of Ferrara or historical events copied from non-local chronicles (mostly Venetian), and start to deal with real episodes that occurred in Ferrara mostly from the 13th century onwards. Earthquakes are rarely mentioned in these texts, possibly because considered less important than battles, politics, and the Estensi family affairs. Even when earthquakes are mentioned, narrators seem more interested in using them as rhetoric tropes (e.g. as symbols of divine chastisement against sinners) than in accurately describing their effects. The most enthusiastic and detailed chronicler of Ferrara earthquakes is Giacomo da Marano, whose text is the sole or main source of information for 8 out of 11 earthquakes considered in this paper. As such, an in-depth examination of this text is advisable.



Fig. 3 - A) The Duchy of Ferrara (Magini, 1620); David Rumsey Map Collection, David Rumsey Map Center, Stanford Libraries; B) a bird's-eye view of the town of Ferrara (Scoto, 1665); Google Books.

4. A new scrutiny of an apparently well-known source

The work called "*Il Principio et origine de la città di Ferrara et da chi fu edificata et de la illustrissima casa da Este*" [Of the beginning and origins of Ferrara, of its founder and of the most illustrious House of Este] is a chronicle written in the vernacular by a certain Giacomo da Marano. So far, this text was never published in its entirety, though some excerpts were

inaccurately printed, in 1929-1931, by a local periodical called “*Bollettino statistico del Comune di Ferrara*” (Giacomo da Marano, 16th century_c). A critical edition by Beatrice Saletti (Ferrara University) is now in the offing.

Very little is known about Giacomo da Marano apart from his name, and the fact that his work was very popular among the Ferrarese 16th-19th century erudites and history buffs, as testified by the number of handwritten copies that were made of it from the 1500s to the early 1800s. Most medieval Ferrara chronicles survived in a single handwritten codex or at most two, but the public libraries of Ferrara and Modena preserve at least 10 manuscript (MS) copies of Giacomo da Marano’s work, some under the title chosen by the author – “*Principio et origine de la città di Ferrara*” [Beginning and origin of the city of Ferrara] – some under different titles. For instance, the Biblioteca Comunale Ariostea di Ferrara (BCAFe) Nuove accessioni 42 MS (Giacomo da Marano, 16th century_l), deletes the first words of the original title replacing them with *Storia veridica* (although the following text begins with the original title). After the 1500s, the Giacomo da Marano chronicle was copied several times. The Ferrara library owns a copy made in 1779 (which discards all legendary parts of the original text, preserving only the historically ascertained events). The Biblioteca Estense Universitaria in Modena (BEUMo) owns a later 16th century copy, three 17th century copies, and an early 19th century one (Giacomo da Marano, 16th century_b), that is perhaps the most interesting of all, as it shows the enduring appreciation of cultured people for the work of Giacomo da Marano (Table 3).

The earliest of these MSs, preserved in the BCAFfe, shelf mark ‘Class I, 534’, is Giacomo da Marano (16th century_g). This is a presentation copy meant to be offered to the Duke of Ferrara, Ercole II d’Este, as indicated by the accuracy of the script, and also by a small pen portrait of the duke himself, inserted in the initial letter of the frontispiece text (Fig. 4).

This MS is very important because it is the final version of the work, it bears the original title chosen by the author and, finally, because it summarises all we know about its author, expressed in his own words. In the dedication preface to the text, Giacomo da Marano himself explains that



Fig. 4 - Frontispiece (A) of MS classe I, 534 of the BCAFfe (Giacomo da Marano, 16th century_g) (reproduced by kind permission of the BCAFfe); detail of the capital letter Q (B) from the above: inserted portrait representing Ercole II d’Este, duke of Ferrara, as indicated by a comparison with a 1559 coin (C) bearing the duke’s effigy (private collection).

Table 3 - Handwritten copies of Giacomo da Marano's history of Ferrara available in public libraries (arranged in chronological order of production). Legend: BCAFe: Biblioteca Comunale Ariostea of Ferrara (Italy); BEUMo: Biblioteca Estense Universitaria of Modena (Italy).

Library and shelf mark	Title	Written	Reference
BCAFe, Classe I, 534	<i>Principio et origine de la città di Ferrara</i>	≥1534	G. da Marano (16 th century_g)
BCAFe, Nuove accessioni, 42	<i>Storia veridica ...</i> [Truthful history ...].	1500s ?	G. da Marano (16 th century_j)
BEUMo, MSS italiani, 168	<i>Cronica di Ferrara sino al 1412</i> [Chronicle of Ferrara up to 1412].	1500s	G. da Marano (16 th century_e)
BEUMo, MSS italiani, 447	<i>Cronica di Ferrara sino al 1362</i> [Chronicle of Ferrara up to 1362].	1600s	G. da Marano (16 th century_d)
BEUMo, MSS italiani, 473	<i>Cronica di Ferrara</i> [Chronicle of Ferrara].	1600s	G. da Marano (16 th century_f)
BEUMo, MSS italiani, 558	<i>Principio et origine della città di Ferrara et dell'Illustrissima Casa d'Este</i> [Beginning and origin of the city of Ferrara and the most illustrious House of Este]	1600s	G. da Marano (16 th century_h)
BCAFe, Nuove accessioni, 68	<i>Annali della città di Ferrara di Giacomo da Marano ferrarese in parte qui ridotti a fragmenti.</i> [Annals of the city of Ferrara by Giacomo da Marano of Ferrara, here partly reduced to fragments].	1700s	G. da Marano (16 th century_a)
BCAFe, Coll. Antonelli, 249	<i>Principio et origine della Cittade de Ferrara, e da chi la fu edificata et della ill.ma Casa da Este et come la eschusatione che io Iacopo da Marano faccio verso li candidissimi lectori che legerano questa presente opera</i> [Beginning and origin of the city of Ferrara, with information on its founder and the most illustrious House of Este, with an apology which I, Iacopo da Marano, tender to the most ingenuous readers of this work]. [Cataloguer's note: Copied in 1779 by Ippolito Prampolini from another copy owned by Count Achille Crispi. Chronicle extends to 1412 and is dedicated to Ercole II, Duke of Ferrara (1534-1559).]	1779	G. da Marano (16 th century_i)
BEUMo (Raccolta Molza-Viti b. 6, n. 74)	<i>Annali Ferraresi</i> [Annals of Ferrara].	1800s	G. da Marano (16 th century_b)

he set out to recount the history of Ferrara from its origins up to his own days, i.e. to the reign of Duke Ercole II (1534-1559). Wishing to compose an exhaustive narrative of Ferrara's history, he reorganised and summarised extant vernacular sources (not Latin ones, since he did not know the language), and compiled a narrative that takes up no less than 18 books, though it only arrives at the year 1412, namely more than a century earlier than the time of composition. The text is divided into short chapters, set in chronological order, preceded by a title and date, each dedicated to a single episode of the city's history: a simple scheme that facilitates consultation and could be one of the reasons for the popularity garnered by this work.

5. Earthquakes included in the 16th-century chronicle by Giacomo da Marano and in earlier chronicles

Despite its popularity, a few historians and critics took a less than optimistic view of Giacomo da Marano's chronicle, describing it as "an arsenal of truths and lies" (Frizzi, 1793) of "very modest value" (Zanella, 1991). However, not even the most severe critics doubted that Giacomo da Marano was a contemporary of the events described in the latter part of his chronicle. Zanella

(1991) suggests that his life-span roughly stretched from 1344 to 1412, and the same belief was shared by the historical seismologists that dealt with the Ferrara earthquakes, including two authors of this paper (Guidoboni and Comastri, 2005; Guidoboni *et al.*, 2007; Camassi and Castelli, 2013; Castelli and Camassi, 2015; Guidoboni *et al.*, 2018).

The belief that Giacomo da Marano lived at least up to 1412, or little after, was based on a single fact: the chronicle ends its narration in 1412. Nonetheless, a careful analysis of the earliest extant copy of this work shows that its author was a contemporary of Duke Ercole II, who was born in 1508, ascended to the throne in 1534, and died in 1559. In other words, the chronicle must have been written in the first half of the 1500s, perhaps earlier than 1534 (when Ercole became duke), certainly not later than 1559 (when Ercole died), and at least a century after the last earthquakes mentioned in it.

Giacomo da Marano's chronicle takes the lion's share in shaping the seismic 'memory' of Ferrara, as it reports no less than 15 descriptions of earthquakes, dated between 1104 and 1411 (see original texts in the Electronic Supplement) and invariably defined as 'very large' and damaging. In Table 4, a comparison is attempted between Giacomo da Marano's descriptions of the earthquakes considered in this paper and those made by earlier Ferrara chronicles. From the comparison it appears that a) in earlier chronicles there is no trace of some of the earthquakes mentioned by Giacomo da Marano (1234, 1339, 1346, and 1411), though in some cases other phenomena are reported (1234: harsh winter; 1339: flood); b) when the earthquakes mentioned by Giacomo da Marano are also reported by earlier chronicles (1285, 1379, 1409, and 1410) the descriptions provided by earlier chronicles tend to be less dramatic than those by Giacomo da Marano.

6. Final observations

An examination of the Giacomo da Marano chronicle in its entirety, provided significant and innovative insights that could not have been derived from the partial and not very accurate transcriptions previously available.

First of all, Giacomo da Marano lived in the first half of the 16th century, rather than between the second half of the 14th century and the first decades of the 15th century, as was once and simplistically deduced from the fact that his chronicle ends in 1412.

Furthermore, it emerged that Giacomo da Marano was not very learned for the standards of the time (he did not know Latin). This implies that he could have made a less than accurate use of his sources, whatever they were. A comparison with earlier surviving Ferrarese chronicles shows that, though Giacomo da Marano reports several earthquakes as invariably and severely damaging, these earthquakes are either not mentioned in earlier local chronicles or, if mentioned, they are said or implied to be non-damaging ones.

It also appears that Giacomo da Marano's aim was to produce a historiographical work worthy of his dedicatee, the duke. Given his limited learning, he contented himself with stringing together a sequence of episodes without commenting or providing a solid interpretative structure for them. However, he shared the contemporary notion that historiography should only deal with grandiose and relevant topics. This could have led him, in the case of events that were either not quite relevant or poorly documented, to systematically adopt the rhetorical procedure of amplification, emphasising both the content and form of the narration. This is clear in the case of the earthquakes he reports, all of which are described with equal emphasis and in the same manner (see Electronic Supplement). Indeed, if one were to set out all the passages concerning

Table 4 - A comparison between earthquake descriptions: Giacomo da Marano's 16th-century chronicle vs. 13th-15th-century chronicles.

Date	13th-15th-century chronicles	Giacomo da Marano (16th century)	Comments
20 March 1234	No earthquakes mentioned by Riccobaldo da Ferrara (13 th -14 th centuries). Chronicon Estense (14 th -15 th centuries) report a very harsh winter in 1234, no earthquakes.	"Big earthquake in many places of Italy, but above all in Ferrara (...), caused great damage, in the town and the countryside, caused chimneys to fall, ruined many houses and other buildings (...)".	<i>False earthquake</i>
13 December 1285	No earthquakes mentioned by Riccobaldo da Ferrara (13 th -14 th centuries). Chronicon Estense (14 th -15 th centuries) and Caleffini (15 th century_b) report a 'great earthquake' in Ferrara, at time of death of a local personality.	"Terrible earthquake in Ferrara, lasted half an hour, caused great damage, many chimneys to fall and many houses too in the town and in the countryside (...)".	<i>Non-damaging earthquake</i>
16 November 1339	Chronicon Estense, (14 th -15 th centuries) reports a major flood in 1339. No earthquakes mentioned.	"Big earthquake in Ferrara (...) it lasted an hour (...) and only caused a few chimneys to fall. It was felt in many places in Italy (...)".	<i>False earthquake</i>
22 February 1346	No mention of this earthquake anywhere.	"There was a big earthquake in Ferrara (...) and all over the world (...) many houses, buildings and towers fell in Ferrara and in the countryside, houses, barns and other buildings fell, and so for the whole of Italy".	<i>False earthquake</i>
10 February 1379	Chronicon Estense, (14 th -15 th centuries) reports a ' <i>magnus</i> ' (big) earthquake lasting a third of an hour, before sunrise of 10 February 1379.	"On 4 December there was a big earthquake in Ferrara, terrible and frightening (...), it lasted less than an hour and brought down many chimneys and some houses in the city, but in the countryside it was much worse".	<i>Non-damaging earthquake. (Wrong date?)</i>
17 August 1409	Diario Ferrarese (15 th -16 th centuries) reports an earthquake felt in Ferrara, at night on 17 August 1409.	"On 17 August, a big and terrible earthquake struck Ferrara (...), many chimneys fell in the city".	<i>Non-damaging event</i>
9 May 1410	Diario Ferrarese (15 th -16 th centuries) reports an earthquake on June 1410, no further details.	"On 9 May there was a big earthquake in Ferrara, Bologna and Romagna (...) it brought down many houses and an infinite number of chimneys".	<i>Non-damaging earthquake. (Wrong date?)</i>
9 January 1411	No mention of this earthquake in Diario Ferrarese (15 th -16 th centuries).	"On 9 January (...) there was a very big earthquake that lasted just under an hour (...) it destroyed a great many chimneys (...) it also caused damage in the area around Ferrara, where it ruined an infinite number of houses and barns".	<i>False earthquake</i>

earthquakes in a table, highlighting their place, characteristics, consequences, and duration, each event would be interchangeable with the others.

From these considerations, it may be deduced that Giacomo da Marano's earthquake descriptions cannot be taken literally, but only with the utmost caution. In fact, if Giacomo da Marano presents all the earthquakes as being equal, the suspicion arises that he could not/did not distinguish between them, even in the sources he used, and, therefore, could not/did not know how to prevent possible duplications of events or simply wrong dates, possibly even doubling them himself, without realising it.

It is no coincidence that, while much of Giacomo da Marano's information is found in other sources not dependent on him, the same Giacomo da Marano is the only one to hand down a large number of earthquakes that are not mentioned by any other source. This singular circumstance, which can only be clarified when we have a critical edition of the text and a thorough examination of its sources, strongly discourages, for the time being, from using Giacomo da Marano's chronicle for the purpose of defining epicentral earthquake parameters.

Therefore, for the time being, our advice to the compilers of the next release of the CPTI15 catalogue will be to consider as false or non-existent all the earthquakes for which Giacomo da Marano's chronicle provided the original information to date (Table 4).

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Additional electronic material: Giacomo da Marano earthquake reports from Biblioteca Comunale Ariostea, Ferrara, MS Classe I, 534 are available at the BGO webpage.

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