

ATLANTE DELLE MAPPE DELLE ISOSISME DEI TERREMOTI ITALIANI

edizioni
Consiglio Nazionale delle Ricerche

Consiglio Nazionale delle ricerche
Dipartimento Scienze del sistema Terra e tecnologie per l'ambiente
Istituto di geologia ambientale e geoingegneria

ISBN (ed. digitale) 978 88 8080 736 0
DOI https://doi.org/10.32053/atlanteisosismeterremotiitaliani-2025

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Pubblicato da:
© CNR Edizioni, 2025
Piazzale Aldo Moro, 7- 00185 Roma
www.edizioni.cnr.it
bookshop@cnr.it

La presente pubblicazione è una riedizione, in versione digitale, dell'"Atlas of isoseismal maps of the italian earthquakes, Bologna, 1985. CNR, Progetto finalizzato geodinamica, Sottoprogetto Rischio sismico e ingegneria sismica (Quaderni de la ricerca scientifica n. 114, vol.2A)

In copertina: Chiesa del Purgatorio, Santa Margherita di Belìce (Libero consorzio comunale di Agrigento). Dipartimento della protezione civile; Istituto centrale per il catalogo e la documentazione.

Copertina e impaginazione a cura di:
Laura Attisani, CNR-Istituto di scienze del patrimonio culturale/Unità Editoria

Digitalizzazione del volume a cura di:
Sara Santorsa e Luca Tiberi, CNR-Biblioteca Centrale "Guglielmo Marconi"

Prefazione

Sono trascorsi ormai quarant'anni dalla pubblicazione, nel 1985, dell'Atlante delle carte delle isosisme dei terremoti italiani (intensità epicentrale non inferiore al IX della scala MCS), stampato su tavole 35x47 e pubblicato in lingua inglese (*Atlas of isoseismal maps of the Italian earthquakes,* Bologna 1985).

L'Atlante fu concepito come complemento al "Catalogo dei Terremoti Italiani dall'anno 1000 al 1980" (Catalogo PFG) realizzato ad opera di un gruppo di oltre 50 ricercatori, coordinati dal compianto Daniele Postpischl, nell'ambito del Progetto finalizzato Geodinamica (PFG), Sottoprogetto rischio sismico e ingegneria sismica promosso e finanziato dal Consiglio nazionale delle ricerche dal 1976 al 1981.

Per carenza di tempo e risorse, non fu allora possibile realizzarne una versione esaustiva dell'Atlante, almeno per gli eventi con intensità epicentrale pari o superiore al grado IX della scala MCS, come inizialmente auspicato dagli Autori. Si optò dunque per la pubblicazione delle mappe dei soli terremoti per i quali si riteneva di aver raggiunto un buon livello di conoscenza e completezza dei dati di intensità.

Le isosisme (o isosiste) — curve che collegano punti a pari intensità macrosismica — sono state a lungo uno strumento privilegiato per rappresentare in forma areale la distribuzione degli effetti sismici. Il loro uso si è affermato tra la fine dell'Ottocento e l'inizio del Novecento, grazie al lavoro pionieristico di studiosi come Mercalli, e ancor più di Baratta, Cavasino, Oddone, Rizzò, Riccò e molti altri. Questa pratica è rimasta prevalente fino all'ultimo quarto del secolo scorso, quando ha iniziato a farsi strada l'impiego di rappresentazioni alternative, come i piani quotati o le mappe interpolative basate su algoritmi matematici.

Eppure, forse anche per quel margine di soggettività inevitabile nel disegno e chiusura delle singole isolinee, le mappe delle isosisme conservano intatto il loro fascino, unito a una straordinaria immediatezza comunicativa.

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CONSIGLIO NAZIONALE DELLE RICERCHE
PROGETTO FINALIZZATO
GEODINAMICA

ATLAS OF ISOSEISMAL MAPS OF ITALIAN EARTHQUAKES



Cover: Terremoto in Calabria, 1894. Bagnara, *La popolazione attendata sulle vie.*
Drawn by: «Illustrazione popolare»; Giornale per le famiglie, volume XXXII - N. 2 pag. 1, Dec 9, 1894
Fratelli *Treves Editori - Milano*

CONSIGLIO NAZIONALE DELLE RICERCHE
PROGETTO FINALIZZATO GEODINAMICA
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Sottoprogetto Rischio sismico e ingegneria sismica
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ATLAS OF ISOSEISMAL MAPS OF ITALIAN EARTHQUAKES

Editor: D. Postpischl

Bologna 1985

Editorial staff CNR: Franco Barberi, Giuseppe Bigi, Maurizio Parotto, Livio Vezzani
General coordination by: Giuseppe Bigi
Editing and graphic paging by: Pina Testoni
Mapping and drawing by: Bruno Rossi

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Base line, graph and final preparation of the tables by: GTM Roma
Printing by: Graficoop Bologna, 1985.

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(Group Catalogue of Earthquakes)

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Presentazione

Nel contesto delle attività di ricerca promosse dal Progetto Finalizzato Geodinamica (PFG) è emersa la necessità di un Gruppo di lavoro, Gruppo Catalogo dei Terremoti (GCT), per verificare le informazioni sui terremoti storici italiani contenute nei cataloghi disponibili.

Nel 1977 il Gruppo ha acquisito il Catalogo dei terremoti italiani dell'ENEL, un file che elenca oltre 20.000 eventi che hanno avuto luogo sul territorio nazionale dall'anno 1000 al 1975.

Dopo una serie di riunioni a carattere generale e organizzativo, l'attività del GCT ha assunto una struttura precisa: si sono costituite dodici Unità Operative (UO) con diverse competenze territoriali, coordinate per conseguire i seguenti obiettivi:

1) la revisione del «Catalogo dei Terremoti italiani dall'anno 1000 al 1975» fornito dall'ENEL e l'aggiornamento dello stesso fino al 1980;
2) la realizzazione di un atlante delle isosiste dei terremoti italiani di intensità non inferiore al grado IX MCS.

Questi obiettivi, benché superiori alle possibilità reali del GCT, rispetto sia ai finanziamenti sia alle forze impegnate, hanno permesso di raddoppiare quasi il numero dei terremoti del Catalogo e di affrontare i problemi metodologici delle ricerche di sismicità storica.

Per rispondere alle esigenze del «Gruppo di lavoro Scuotibilità», il cui obiettivo consisteva nella realizzazione di una carta di pericolosità sismica del territorio nazionale, si è provveduto al controllo dei dati riportati nel Catalogo ENEL: ciò ha comportato il confronto fra dati di diversi cataloghi e l'acquisizione di nuovi dati desunti dalla successiva letteratura sismologica, includendo anche i risultati progressivamente resi disponibili dalle ricerche in corso. È stato anche aggiornato il Catalogo fino a tutto il 1980 utilizzando i dati forniti dalla rete sismica nazionale e dalle reti locali.

Questo compito è stato affidato ad una sola Unità Operativa di coordinamento, che aveva fra l'altro anche l'incarico di raccogliere e sintetizzare nel Catalogo le informazioni di sismicità storica fornite dalle altre undici UO. Il prodotto finale è costituito dal «Catalogue of Italian earthquakes from O up to 1980», pubblicato nella serie dei lavori editi dal Progetto Finalizzato Geodinamica e dal presente Atlante delle isosiste.

L'obiettivo iniziale del GCT era quello di studiare i terremoti che nel catalogo figuravano con una intensità epicentrale non inferiore al grado IX MCS; si trattava di oltre 200 eventi. L'obiettivo era quello di verificare i dati riportati nel catalogo attraverso la lettura critica di documentazione e testimonianze contemporanee agli eventi.

Le forze a disposizione hanno poi permesso la realizzazione di solo 64 carte delle isosiste e la revisione di altri 21 eventi allegati in appendice.

Una particolare attenzione è stata dedicata al problema dell'interpretazione macrosismica dei dati storici.

Nel «Seminario sui metodi di interpretazione dei dati sismici storici» (pubblicazione n. 238, 1979 del PFG-CNR) si evidenziarono i problemi connessi all'uso delle scale macrosismiche e si aprì un dibattito sul reperimento di quelle fonti di informazioni, che permettessero di delineare i quadri descrittivi previsti dalle scale macrosismiche.

Fu da subito chiaro che occorreva allargare il concetto riduttivo di catalogo come registrazione di pochi parametri dati dalla localizzazione spazio-temporale dell'evento e dall'intensità massima, per descrivere i vari eventi sismici.

Si osservò che con il progressivo affermarsi della sismologia strumentale era praticamente cessata la raccolta dei dati descrittivi sugli effetti dei terremoti, interrompendo la ricca tradizione italiana di osservazioni e di studi di sismicità, che è stata fra le più antiche del mondo.

Si constatò che i dati forniti dai cataloghi sono insufficienti a descrivere i terremoti, in quanto rilevano solo alcune caratteristiche di sorgente e non forniscono le indicazioni necessarie sul processo di interazione tra il terremoto e il territorio. Occorre infatti individuare, oltre ai parametri fisici, anche l'aspetto sociale e culturale del fenomeno per delineare l'immagine complessiva degli effetti su un'area più vasta possibile. Soltanto valutando per un elevato numero di località gli effetti dei terremoti si possono acquisire dati importanti per la conoscenza della vulnerabilità del territorio. L'attività di ricerca programmata fu drammaticamente interrotta dal terremoto Irpino del 23 novembre 1980.

Il PFG decise di organizzare il rilievo macrosismico delle aree investite dagli effetti del terremoto. Furono pertanto organizzati gruppi operativi multidisciplinari composti da sismologi, geologi e ingegneri, che rilevarono e valutarono gli effetti di danneggiamento in circa 300 località. Nelle aree in cui si ebbero effetti di solo risentimento del terremoto, fu distribuito attraverso la rete delle scuole un questionario appositamente predisposto. Questo lavoro dei gruppi permise di raccogliere complessivamente informazioni per quasi 1300 località del territorio nazionale. I risultati, che compaiono sintetizzati nel presente volume, evidenziarono l'importanza della raccolta dei dati descrittivi per la conoscenza della vulnerabilità del territorio.

Quando ripresero i lavori sui grandi terremoti del passato, era più radicata nel GCT la convinzione che occorreva impostare un più critico e consapevole metodo di ricerca per ottenere nuove conoscenze sulla sismicità storica nazionale. Alcune unità operative aprirono una fase di collaborazione con ricercatori di discipline storiche: al convegno annuale del PFG-CNR (Udine, maggio 1981) furono presentati i primi approcci su un versante multidisciplinare.

Si andava intanto verso il termine del periodo di 5 anni di attività, previsto per il Progetto: nel seminario di bilancio dei lavori «I terremoti distruttivi della storia sismica italiana» (Bologna, settembre 1982), emersero le nuove possibilità che aprivano le ricerche storiche: l'immagine complessiva di un terremoto, dovuta spesso a conoscenze approssimative degli effetti cumulativi, poteva essere sostituita con la sequenza cronologica delle varie scosse e dei relativi effetti. Questa analisi ha permesso più volte di modificare le conoscenze precedenti e di compiere un ulteriore avvicinamento verso una valutazione realistica degli effetti dei terremoti del passato.

È emersa l'importanza dei problemi connessi alla esatta cronologia e alla localizzazione degli eventi sismici; si è avvertita la necessità di conoscere il contesto sociale e culturale in cui si collocano storicamente i terremoti; di avere dati sulla densità abitativa, la rete degli insediamenti, e sulla rete viaria.

Irrinunciabile è parso poi un quadro di conoscenze relative alla mentalità e alla sensibilità di un periodo storico per quanto riguarda i fenomeni naturali nel loro complesso.

Questa esperienza di lavoro si è conclusa con la positiva convinzione che una stabile collaborazione fra ricerca sismologica e ricerca storica sia realizzabile.

Per quanto riguarda i risultati delle ricerche delle singole unità operative, benché sia stato fatto uno sforzo per definire criteri operativi comuni, è rimasta una certa disomogeneità nei metodi e nei criteri di lavoro evidente anche formalmente nelle bibliografie allegate.

Risultano esclusi da questo volume grandi terremoti storici, quali quelli del 1117 e del 1222 per il medioevo e, per il periodo moderno e contemporaneo, gli eventi del 1783 della Calabria e del 1908 di Messina. Per questi terremoti non è stato infatti possibile, nei tempi disponibili per la ricerca, raggiungere significativi avanzamenti rispetto alle precedenti conoscenze.

I lavori ospitati nel presente volume possono essere ricondotti a due categorie: la prima include tutti gli studi ritenuti dagli autori definitivi o molto avanzati; la seconda raccoglie quegli studi per i quali gli autori hanno ritenuto di avere raggiunto un avanzamento apprezzabile rispetto alle conoscenze precedenti, in particolare per quanto riguarda i dati di localizzazione e di intensità epicentrale. Brevi commenti sui terremoti di questa ultima categoria sono raccolti nella appendice: i risultati sono sintetizzati nelle correzioni apportate al catalogo.

Ai testi relativi ai vari terremoti seguono gli elenchi delle località a cui è stato possibile assegnare un valore di intensità. I casi di attribuzione incerta sono indicati con i simboli $\geqslant \leqslant$, oppure sono inseriti tra parentesi.

La scala di intensità utilizzata è la scala Mercalli-Cancani-Sieberg (MCS), che è stata ritenuta la più adeguata per valutare la documentazione relativa ai terremoti storici.

Concordemente si è deciso di usare i gradi della scala come valori interi di intensità; le classificazioni intermedie assumono perciò il significato di valore incerto tra le due diverse categorie.

Per quanto riguarda l'intensità epicentrale si è attribuito a questo parametro il valore della isolinea di massimo grado che è stata possibile tracciare. Nel caso di fenomeni di amplificazione locale l'intensità massima osservata può superare il valore attribuito all'intensità epicentrale; viceversa per tutti i terremoti con epicentro in mare è possibile attribuire solo il valore della intensità massima osservata.

Spesso, in passato, l'uso di relazioni empiriche tra intensità e magnitudo è stato causa di grossolani errori, per esempio quando valori uguali di magnitudo sono attribuiti ad eventi che dal punto di vista della energia liberata sono del tutto diversi.

È spesso infatti possibile rilevare che piccoli terremoti superficiali possono produrre effetti locali molto severi, per cui l'applicazione rigida di formule empiriche per il calcolo della magnitudo può risultare inadeguata e scorretta.

Per la stima di ciò che può essere definito l'equivalente macrosismico della magnitudo si ritiene opportuno l'utilizzo di relazioni empiriche tra la magnitudo e l'ampiezza dell'area delle isosiste. In particolare, la relazione di Galanopoulos del 1962 sembra applicabile alla situazione italiana nei casi in cui è possibile valutare l'area di IV grado MCS.

Il tracciamento delle isosiste è stato effettuato collegando i punti intermedi tra due valori contigui della scala di intensità. Le isolinee risultano tratteggiate quando si attraversano zone con informazioni scarse o di bassa attendibilità.

I numeri arabi indicano i valori di intensità locale: oltre il nono grado sono stati usati il simbolo X per indicare il decimo grado e il simbolo ✱ per l'undicesimo. Il simbolo ⊡ è stato utilizzato per indicare le località di non risentimento. I numeri romani indicano la stima dell'intensità assunta come Valore normale per tutta l'area.

Soltanto in due casi (per il terremoto del 1703 e per il terremoto del 23/11/1980) si è ricorsi a simboli particolari ritenuti dagli autori più idonei per la rappresentazione dei valori della intensità locale.

Le carte sono state realizzate in maggioranza alla scala 1:500.000, utilizzando la base topografica adottata per tutti gli elaborati del Progetto Finalizzato Geodinamica. Solo in alcuni casi il livello di dettaglio delle informazioni reperite o l'ampiezza delle aree coinvolte hanno richiesto di ricorrere a carte di scala diversa.

I lavori raccolti nell'atlante sono stati consegnati nel mese di gennaio del 1983.

Daniele Postpischl

Introduction

Within the framework of the research promoted by the «Progetto Finalizzato Geodinamica», (PFG) a working group called «Gruppo Catalogo dei Terremoti» (GCT), was created and encharged of checking and updating the information included in the catalogues on Italian earthquakes.
In 1977 the Group acquired the ENEL Catalogue of Italian earthquakes, a file listing over 20.000 events in Italy from 1000 to 1975.
After numerous general and organizational meetings, twelve Operative Units (UO) were created having different territorial competence and aimed at reaching the following goals:

1. a revision of the ENEL «Catalogue of Italian earthquakes from 1000 to 1975» and its updating to 1980 included;
2. the production of a atlas of the isoseisms of Italian earthquakes with an intensity higher than IX degree MCS.

These goals, even though higher than the real possibilities of the GCT, with respect to both the financing and the people involved, have allowed almost to double the number of the earthquakes of the Catalogue and have also allowed to face methodological problems related to the researches of the historical seismicity.
In order to meet the requirements of the «Gruppo di Lavoro Scuotibilità», whose aim was the production of a map indicating seismic hazards, the data of the ENEL Catalogue have been checked, by comparison with data contained in other catalogues, or in the literature relative to individual earthquakes and incorporating the results progressively obtained during the preparation of the isoseismal mapes atls.
Moreover, by using the data supplied by the national seismologic network and by local networks, the Catalogue has been updated up to 1980.
The above task has been entrusted to a single Operative Unit, having among other duties, the assignment to gather and summarize in the Catalogue all the information of historical seismicity supplied by the other eleven Operative Units.
The final-product is represented by the «Catalogue of Italian earthquakes from 0 up to 1980» published separately, by the «Progetto Finalizzato Geodinamica», and by the present Atlas of isoseismal maps.
The initial objective of the GCT was to review and list isoseisms of earthquakes included in the Catalogue having an intensity at the epicentre not inferior to IX degree MCS: these amounted to more than 200 events. The goal was to verify the listing of those events appearing in the catalogue, if possible through the critical reading of original documents contemporary with the event itself, by means of a specific historical researches. The resources available have allowed the fulfilment of only 61 maps of the isoseisms and the review of other 21 events that have been included in the appendix.
A particular attention was given to the problem of the macroseismic interpretation of the historical data.
This problem was particularly discussed during an ad hoc Seminar in 1979 (see PFG publication n. 238) when the questions related to the use of the macroseismic scales were also raised. Also discussed was the problem of finding the sources of information which could assist in understanding the descriptive pictures provided by the macroseismic scales.
It was immediately clear that the limiting concept of the Catalogue, as a register of a few parameters describing the different seismic events given by the space-time location of the event and by the maximum intensity should be broaden.
As a matter of fact, the development of instrumental seismology has almost put an end to the process of gathering data describing the effects of earthquakes was interrupting a long tradition of observation and study of historical seismicity, that in Italy had been one of the most ancient in the world.
As a consequence of this change, the data supplied by the catalogues are completely insufficient, as they indicate only some characteristics of the seismic source and not the whole interaction process between the earthquakes and the territory. It was clear, therefore that, in addition to the physical parameters, the social and cultural aspect of the phenomenon had to be taken into consideration, in order to obtain a more general picture of the earthquake. Important data relative to the vulnerability of the territory could be derived only from a thorough study of the effects of the earthquake on a large number of localities.
The planned research program has however been dramatically interrupted by the Irpinia earthquake of November 23, 1980.
The PFG decided to carry out the macroseismic survey in the areas hit by the earthquake.
Multirole groups formed by seismologists, geologists and engineers were therefore organized with the task of surveying and estimating the damage in about 300 localities. In those areas where the earthquake showed only minor effects, a questionnaire to be filled out had been distributed through the school network.
The work carried out by the groups allowed the gathering of information for about 1300 localities on the national territory.
The results which have been summarized in this volume, show the importance of the descriptive data to understand the vulnerability of the territory.
When the studies on the large earthquakes of the past resumed, the GCT was even more convinced that a more critical and wide research method was necessary in order to obtain new information on the national historical seismicity.
Some Operative Units started to cooperate with the researchers of historical disciplines on the occasion of the annual meeting of the PFG-CNR (Udine, May 1981), the earliest approach having a multirole character have been introduced.
The 5-year activity of the Project was approaching its end. On the occasion of the seminar on «I terremoti distruttivi della storia sismica italiana» (Distructive earthquakes in the seismic history of Italy - Bologna - September 1982), the new opportunities provided by the historic research arose. The picture of an earthquake obtained by often approximative information of the global effects, could be replaced by the chronological succession of the different shocks and their effects.
In several cases such an analysis allowed to modify the previous information and to provide a more realistic estimate of the effects of the past earthquakes. The importance of the problems related to both the exact chronology and the location of the seismic effects was pointed out; the need arose to know the largest possible context in which the earthquakes could be historically located; of obtaining data on the density of population, on the network of the build-up areas, and on roads network.
Moreover, it was deemed very useful to have information concerning both the mentality and the sensitiveness on natural phenomena of the people living in any particular historical period.
As a whole, this working experience brought to the conclusion that a stable cooperation between seismological and historical research was possible and positive.
As to the results of the research carried out by the single Operative Units, although a remarkable effort has been made to determine common operative criteria, a certain difference arises in the enclosed bibliography too, both in the methods and working criteria.
This volume does not include the great medival historical earthquakes such as those of Northern Italy dated 1117, 1222 and, as to the modern and contemporary times, the events of Calabria dated 1783 and Messina dated 1908. As to those earthquakes, it has not been possible, within the time available for the study to get more data with respect to what had been already published.
Contributions introduced included in this volume can be divided into two categories:
The first includes all those studies that have been considered final by the authors or at least to have reached a good degree of knowledge, the second gathers those studies for which the authors thought to have reached an improvement compared to previous information, in particular as to the data concerning both the location of and the intensity at the epicentre.
Brief comments on these earthquakes have been assembled in the appendix and the results have been incorporated in to the emended catalogue. The text commenting upon the earthquake has been integrated by the list of those localities to which an intensity value could be assigned.
Cases of uncertainty in the intensity values are indicated by symbols like $\geqslant \leqslant > <$ or in bracktes.
The intensity scale that has been used in this study is the Mercalli-Cancani-Sieber scale (MCS) considered to be the most suitable for the documentation on past earthquakes. It has been decided to use the degree of the scale only as entire values of intensity; intermediate classifications were used only in case of uncertainty between two different degrees.
The value of the highest possible isoseismal line, has been used for the intensity at the epicentre. It can therefore happen that in case of local amplification phenomena the maximum intensity observed can be higher than the intensity values assigned at the epicentre. On the contrary, if the earthquake epicentre is on sea, it has been possible to assign only the value of the max. intensity observed.
In the past, the use of empirical connections between intensity and magnitude has often caused gross mistakes, as to give the same magnitude value to events that were completely different in terms of released energy.
In fact, small shallow earthquakes can cause locally very severe damage, and the rigid use of empirical formulae to estimate the magnitude can turn out to be inadeguate and incorrect.
In order to estimate the macroseismic equivalent of the magnitude, the use of empirical connections between the magnitude and the area of the isoseisms is necessary.
In particular, the Galanopoulos formula of 1962 seems to apply to the Italian situation in those cases where the area of IV degree MCS can be estimated.
The drawing of the isoseisms has been carried out by connecting the intermediate points between two values of intensity. The isoseismal lines have been dashed when they encompass an area of insufficient or not entirely reliable information.
Arab numbers indicate the values of local intensity: beyond the intensity IX MCS, the symbol X indicates the intensity X MCS and the symbol * the intensity XI MCS. The symbol ⊡ has been used to indicate not-felt localities. The Roman numbers give the estimate of the intensity regarded as normal values of the whole area.
In two cases only (earthquake of 1703 and earthquake of 23/11/1980) the authors have deemed it more suitable to use special symbols to indicate the values of local intensity.
The majority of the maps have been drawn to a scale of 1:500.000, on the same base used for the publication of the final results of the «Progetto Finalizzato Geodinamica».
Only in few cases the level of detail of the information found or the size of the areas involved required maps having a different scale.
The papers gathered in the atlas have been received in January 1983.

Daniele Postpischl

The Campania earthquake of 990.

D. Molin

The intensity and the epicentre as well as the date of this earthquake are uncertain; yet, this earthquake has to be considered among the strongest that has occurred in this region, since the Irpinia, the Beneventano, the Casertano, and probably both Potenza and Salerno provincies were affected by destructive intensities.

It has been reported by several writers that this event was strongly felt both in Apulia and Abruzzi regions.

A large amount of literature on this earthquake refers to the chronicle by Romualdo Salernitano (31), who was a later writer.

The date of the event is uncertain; the writers report it between 981 and 994; the most likely year seems to be 990 as reported by Romualdo Salernitano and other writers.

No information on the seismic sequence is available.

The intensities in the epicentral area, evaluated on the basis of poor information, range between the IX and X degree of the MCS scale. For larger distances the intensities are undetermined.

The most severe damages seem to have occurred close to Conza della Campania «where the village of Rosa (or Ronsa) has been totally destroyed». This locality no longer exists.

On the basis of the scarce information, the epicentre can be located close to Conza della Campania (40°49' lat. N, 15°21' long. E).

In the figure the isoseismal lines (dashed line) are shown. Since information is poor, they are only indicative of the most affected area.

List of shocked localities:

Locality	Latit.	Long.	I (MCS)
Ariano Irpino	41°09'	15°05'	IX
Avellino	40°33'	14°28'	IX
Benevento	41°08'	14°46'	IX
Capua	41°07'	14°13'	IX
Conza della Campania	40°52'	15°20'	X
Frigento	41°01'	15°06'	IX
Matera	40°40'	16°36'	?
Oria	40°30'	17°39'	?
Rosa or Ronsa	?	?	X
Salerno	40°41'	14°45'	?
San Liberatore a Maiella	42°14'	14°07'	?
Sassinoro	41°22'	14°40'	VIII-IX
Sorrento	40°38'	14°22'	?
Taranto	40°29'	17°14'	?

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ISERNIA

CAMPOBASSO

BENEVENTO

CASERTA

AVELLINO

NAPOLI

SALERNO?

POTENZA

Volturno

Ofanto

Ufita

Calore

Sele

9

IX

X

Conza della Campania

MARE TIRRENO

0 10 20 30 km

SCALA 1 : 500 000

14° Est Greenwich

30'

15°

30'

41°

40'

20'

47°
46°
45°
44°
43°
42°
41°
40°
39°
38°
37°
36°

8°
10°
12°
14°
16°
18°

THE CAMPANIA EARTHQUAKE OF 990

Compiled by

D. Molin

The drainage network of this map – scale 1:500.000 – is the same as the "Structural Model of Italy."

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The Catania earthquake of February 4, 1169.

G. Lombardo

The 1169 Sicilian earthquake is one of the oldest shocks of great magnitude, for which it was possible to gather some reliable information. It took place in the southeastern part of the island, whose seismicity is characterized by strong energy releases occurring after long quiet periods. The study of this earthquake can add useful information to the knowledge of the seismicity of this important area.

Further investigations for data concerning older shocks encounter enormous difficulties due to lack of original descriptions because of missing documents or destruction of original texts.

The study of the 4.2.1169 earthquake, presents great difficulties as well. The majority of contemporary authors did not give detailed descriptions of villages and respective damages due to the shock with scientific purposes. Rather, they were impressed by the extent of the phenomenon which was considered due wrath of God because of human evil. In some cases the information found comes from letters written by local notables to squires and nobles, in which they talk of the phenomenon together with other news and personal considerations. Another problem that occurred often in this study was the difficulty of locating villages indicated by various authors. In many cases this problem was solved with further research in order to determine the present name of the place otherwise, a rough location of the area has been used.

Bibliographic research was done in libreries and archives of Catania and Siracusa, collecting descriptions of both contemporary and subsequent authors.

This earthquake seems to have struck all eastern Sicily and part of southern Calabria with considerable damage. The limits of the area in which it was felt cannot be obtained from the poor descriptions available, but it seems comparable to those of 1693 earthquake (19). There is a lack of information regarding foreshocks and aftershocks, and contradictory information about the time the shock took place. It seems very likely that the earthquake occurred after sunset as mentioned by (1) and (3), which is in accordance with the fact that the majority of people killed in Catania were inside the cathedral.

All the most important villages and cities of Val di Noto, Piana di Catania, and Val Demone were heavily damaged. Catania and Lentini were completely destroyed, as was Modica. Serious damage occurred to a number of castles and villages between Catania and Piazza Armerina and to some castles close to Caltagirone. Messina suffered from a tzunami and a tzunami wave went up the Simeto river destroying the village of Casal Simeto, which, since then, has ceased to exist. Several springs dried out and many new ones appeared, but no details about their locations are given; only for Fonte Aretusa and Tavi (close to Siracusa and Assoro, respectively), are there good descriptions. An eruption took place on Etna on the same date of the shock and there are descriptions of collapse of a great part of the top of the volcano (3) (20), but no useful details are given in order to distinguish if this event is linked to eruptive activity or to an effect of the earthquake. Slight damage also occurred in Reggio Calabria, but descriptions are very poor.

A detailed report of descriptions of damage with indications of places where original texts can be found is presented separately.

Considering the quality of data collected, it is extremely difficult to interpret them in terms of intensity in order to obtain observation points for drawing isoseismals. In Tab. 1, a list of localities with a summary description of damage is reported.

It seems more suitable, considering the poor quality of data obtained, to asses relative degrees of seriousness of effects according to the following empirical scale:

A = Total destruction.
B = Damage to villages, permanent phenomena on ground and effects on undergound water.
C = Felt with slight damage.

In order to deal with more familiar values, a rough estimation of described effects in terms of intensity by M.S.K. scale will be attempted. This attempt must be considered only as indicative. Thus, the degrees XI, X and VIII can be very roughly compared with class A, B and C respectively.

The tentavive isoseismal map obtained is shown.

The difficulties above described did not allow the drawing of a good isoseismal map from which reliable conclusions can be obtained regarding the main source characteristics of the shock. Nevertheless, from the map obtained, some considerations can be drawn:

the 1169 earthquake, similar to 1693 one, has an epicentral area which seems to be located in the sea, close to the coast line between Catania and Siracusa, as the effects of tzunami widely described seem to confirm.

The maximum intensity attained a value at least comparable with that of 1693 shock (I – XI M.S.K.).

Both earthquakes seem to take origin in the same tectonic structures located in the hyblean foreland and they are evidence of the high seismicity of this area, which undergoes a remarkably high risk, considering its great industrialization and urbanization.

Tab. 1

LOCALITY	*DESCRIPTION OF EFFECTS*	*CLASS*	*I*
Aci Castello	Total destruction. In the river Aci, water became red.	A	XI
Catania	Total destruction, with 15.000 or 20.000 people killed. In the country around the town, new springs appeared and some others dried up.	A	XI
Cosenza	Suffered heavier damage than Reggio Calabria.	B?	
Lentini	Total destruction. Dislocations in the ground.	A	XI
Messina	Oscillations of the sea and tzunami wave which went inside the town. No description of any damage.	C	VIII
Modica	Damage similar to that suffered by Lentini.	A	XI
Reggio Cal.	Felt as strong shock with slight damage and some collapse.	C	VIII
Simeto	Tzunami wave which went up the river. The village of Casal Simeto, close to the mouth of the river, is destroyed.	A	XI
Siracusa	The castle almost collapsed. Spring Aretusa dried up and then started again with red water.	B	X
Val Demone	Castles destroyed.	B	X
Val di Noto	Castles destroyed.	B	X
Area between Catania and Piazza Arm. and close to Caltagirone	Eleven villages, castles, and little towns were heavily damaged.	A-B	X

List of shocked localities:

Locality	Latit.	Long.	I (MCS)
Aci Castello	37°33'	15°09'	XI
Catania	37°31'	15°05'	XI
Catania (Area between and Piazza Armerina)	37°26'	14°34'	X
Caltagirone (Area of)	37°14'	14°30'	X
Cosenza	39°18'	16°15'	?
Lentini	37°18'	15°00'	XI
Messina	38°11'	15°33'	VIII
Modica	36°52'	14°45'	XI
Reggio Cal.	38°06'	15°39'	VIII
F. Simeto	37°25'	15°04'	XI
Siracusa	37°04'	15°18'	X
Tavi (close to Assoro)	37°37'	14°27'	X
Val Demone	30°00'	15°00'	X
Val di Noto	37°00'	15°00'	X

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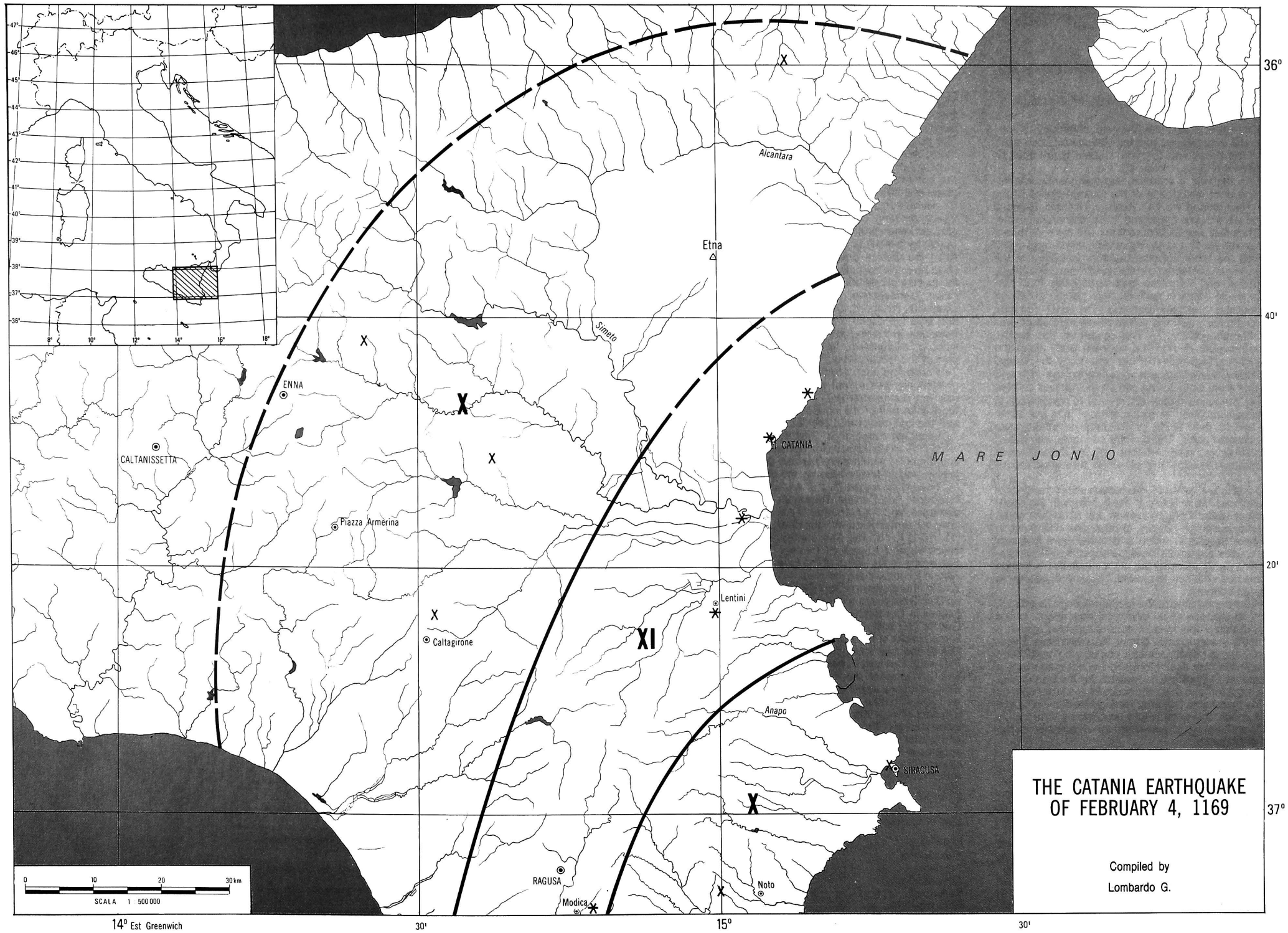

THE CATANIA EARTHQUAKE OF FEBRUARY 4, 1169

Compiled by

Lombardo G.

The drainage network of this map – scale 1:500.000 – is the same as the "Structural Model of Italy."

G.T.M - Via Marco Marulo 47a - 00143 ROMA

The Villach earthquake of January 25, 1348.

F. Gentile, G. Renner, A.M. Riggio, D. Slejko, M. Zacchigna

On January 25, 1348 during the Vespers ceremony, a very strong earthquake occured: the town of Villach was completely destroyed and the shock was felt from Napoli (1) to Lubek (2) and from Alessandria (3) to Krakow (2).

Before analyzing the text of the historical documents, it is important to give a brief description of the characteristics of the settlements in Friuli during the 14th century. Cividale, Gemona and Pordenone were towns belonging to the patriarchal ecclesiastic state. They had a political autonomy and were important commercial centres (4, 5). Udine, expecially, with about 6,000 inhabitants, was the most important economic centre in the region (6). Big villages protected by walls and moats, like Nimis, Tarcento, Venzone, and Tricesimo were remarkable road junctions and places of country markets; here people practiced commercial activities and handcraft too. The most common form of rural settlement was the «villa» where agriculture was the principal human activity (7). The castles of this region, placed on the morainic hills of the northern plain along the northern part of the Tagliamento River and along the valleys northward of Udine, were built principally during the 11th and 12th century and were both strong military points and centres of reference for the jurisdictional activity (8). In conclusion, in this period, people grouped in settlements of different sizes: every village had its own fields, and natural resources were utilized as a common good. The country economy was based on a peculiar structure, called «manso» (7, 9). The valleys of Carnia concentrated the economic activity of their small mountain villages.

It is difficult to find in the literature information about the system of erecting buildings. The majority of the buildings in the country, were made of wood. Only clergymen and noblemen could build big mansory buildings (castles, abbeys, and churches). In the towns, where houses in wood and straw were still very frequent, the houses made of stones belonged to the middle-class people. The earthquake hit the most expensive buildings that would have been difficult to rebuild. There-fore, economic activities suffered seriously.

To understand the importance of the earthquake and its effects, it is necessary to dispose of an analitycal description of the damages: unfortunately this kind of data is reported only in a general form in the contemporany chronicles, while more specific information (notarial deeds, account books, etc.) are difficult to find. Although the historical information is not numerous, a rather large amount of literature is available for the earthquake of Villach. The most famous original document is a letter sent by some Florentine merchants (10) after having heard in Udine about the terrible shock: this letter is fully reported by Villani in his «Cronaca» (11) and it gives a quite thorough description of the effects of the earthquake.

The earthquake occured in the early afternoon on Friday January 25, 1348, anniversary of the day of the conversion of St. Paul. 25, 1348, anniversary of the day of the conversion of St. Paul. The first shock was slight, the second very strong, and the third terrible (12). According to almost all the historical sources, the earthquake occured at «XXIII hora», meaning 23 after the previous sunset: the shock, therefore, happened at about 15 GMT. The Florentine merchants, describing the destructions caused by the quake, quote some of the principal centres in the region: Sacile, Udine, Venzone, Gemona, Tolmezzo; some castles located on the morainc hills: San Daniele, Ragogna, and many places in Carinthia, where the town of Villach was completely destroyed (11). All along the valley of the Gail River the shock strongly modified the aspect of the territory: landslides completely destroyed some villages. Some hamlets and many castles, overwhelmed by the landslides, were never rebuilt. The most important landslide occured in the area of Mt. Dobratsch along a length of 5 km from Notsch to Schutt (1) and it destroyed 17 hamlets, 3 castles and 9 churches (2); the flow of the Gail River was obstructed and a new lake appeared submerging 10 villages upstream of Notsch. The water of the river overflowed the barrier a few months after the earthquake causing a catastrophic flood in the valley of Villach (1, 13, 14). The Goritsch stream also changed its course due to rockfalls and the castles of Kirschentern, Stenberg and Wasseleonberg slumped into the lake of Ossiach (1).

The economic activity of this zone, based on the transit commerce through Villach, was dramatically reduced. In Villach, the most important centre in Carinthia at that time, all the houses, the convents, and the walls of the town ruined causing the death of 5,000 people (2), 300 of them during the collapse of the St. Jacopo church. Cracks in the ground of the main square of Villach emitting colored water are reported., About one year after its reconstruction in wooden buildings, Villach was destroyed by a fire (11). In the Gail valley, in the Drau valley, and in Krain the castles devoted to the safety of the roads and to guarantee the political order of the area, were strongly stricken: the castles of Lienburg, Federaun and Goritsch, near Villach, fell down; Gerlachstein, Zobelsberg and Neuhaus were ruined; Osterwitz, Ratsperg, Oedenfest and Feiersperg were damaged and also the castle of Schneeg, near Treffen, suffered heavy damages. In the epicentral area many hamlets were ruined: Hollenburg, Wildenstein, Arnolstein (1, 2, 11, 13). In the northern part of the Isonzo River, Tolmino (15) and Tirno (1) collapsed. Two convents near Villach were damaged: the new monastery of Wenberg was ruined while the old one of Ossiach suffered only few damages (16).

More than half of the houses of Gemona were destroyed (11) and the bell-tower and part of the castle were damaged; the 7-meter high statue of St. Cristoforo was sheared off below the waist (11). In Venzone many houses where razed to the ground and the bell-tower suffered severe damage; in Udine part of the castle, part of the bell-tower, the patriarchal palace and many factories were ruined (3, 11). All the castles in Friuli (Tolmezzo, Flagogna, San Daniele, Ragogna) collapsed or suffered heavy damages, and the cathedral of Aquileia and almost all the churches in Carnia ruined with the death of more than 1,000 persons (11, 15, 17, 18, 19). The earthquake also destroyed houses, churches and towers in Treviso, Pordenone and Belluno; at Sacile one of the doors of the town fell down (3, 11, 12, 20, 21). Also in Venezia many houses, 4 bell-towers and part of the St. Basilio church were ruined (22, 23) while the Canal Grande dried up (24); ten houses and the tower of Bolzano (25, 26, 27), many houses in Trento (28, 29), 7 in Verona (23, 30, 31), some also in Gorizia (32) and in Bologna ruined and in Vicenza there were some cracks in the buildings (11, 33).

The earthquake shaked strongly also Ferrara, Rovigo, Modena, Piacenza, Cremona, Lodi, Milano (3), Passau (34) and Wien (13). The total reported number of dead people is 40,000: half during the earthquake and the others due to floods and rockfalls (2) but we must also take into account the fires, the severe plague that diffused all over the Alps at the end of the year and rockfalls, landslides and floods assisted by an execeptionally wet autumn and winter (1, 35). All the numbers of victims seem to be exaggerated in the authors' opinion because it is difficult that the epicentral zone could be so populated.

Aftershocks were felt in the epicentral area for about 40 days (36).

List of shocked localities:

Locality	Latit.	Long.	I (MCS)
Alessandria	44°55'	08°37'	IV-V
Aquileia	45°46'	13°22'	VII-VIII
Arnoldstein	46°33'	13°44'	VIII-IX
Belluno	46°09'	12°13'	VIII
Bologna	44°30'	11°20'	VIII
Bolzano	46°30'	11°21'	VIII
Camporosso	46°31'	13°32'	VIII-IX
Cracovia	50°04'	19°54'	IV-V
Cremona	45°08'	10°01'	VI
Destrafitto	?	?	VIII-IX
Fagagna	46°06'	13°06'	VIII
Federaun	?	?	VIII-IX
Feiesperg	?	?	VIII-IX
Ferrara	44°50'	11°37'	VI-VII
Flagogna	46°12'	12°58'	VIII-IX
Fobelsberg	?	?	VIII-IX
Freising	48°23'	11°46'	IV-VII
Gemona	46°17'	13°08'	IX
Gerlachstein	?	?	VIII-IX
Goritschach	?	?	VIII-IX
Hochosterwitz	46°45'	14°27'	VII-VIII
Hollemburg	?	?	IX-X
Lienburg	?	?	VIII-IX
Lodi	45°19'	09°30'	VI
Lubiana	46°03'	14°30'	VII-VIII
Milano	45°28'	09°11'	VI
Modena	44°39'	10°56'	V-VI
Monaco	48°10'	11°32'	IV-V
Neuhaus	?	?	VIII-IX
Niederalteich	48°44'	13°09'	IV-VII
Oedenburg	?	?	VIII-IX
Ortenburg	?	?	XI
Ossiach	46°40'	13°59'	VII
Osterwitz	?	?	VIII
Passau	48°34'	13°26'	VII
Perugia	43°06'	12°23'	VI-VII
Piacenza	45°03'	09°42'	V-VI
Pordenone	45°58'	12°40'	VIII
Ragogna	46°11'	12°59'	VIII
Ratsperg	?	?	VIII
Ravenna	44°25'	12°12'	VIII
Rovigo	45°04'	11°47'	VI
Sacile	45°57'	12°30'	VIII
San Daniele	46°09'	13°01'	VIII-IX
Scheeg	?	?	VIII-IX
Strasburgo	48°35'	07°48'	IV-V
Straubing	48°53'	12°34'	IV-VII
Tarvisio	46°30'	13°35'	X
Tirno	?	?	VIII-IX
Tolmezzo	46°24'	13°01'	VIII-IX
Tolmino	46°11'	13°44'	VIII-IX
Trento	46°04'	11°07'	VII-VIII
Treviso	45°40'	12°15'	VIII
Udine	46°04'	13°14'	VIII
Venezia	45°26'	12°20'	VIII
Venzone	46°20'	13°08'	VIII
Verona	45°26'	11°00'	VII-VIII
Vicenza	45°33'	11°33'	VII-VIII
Vienna	48°13'	16°20'	VII-VIII
Villach	46°36'	13°50'	XI
Wernberg	49°32'	12°11'	VIII
Wildenstein	?	?	IX-X
Zobelsberg	?	?	VIII-IX

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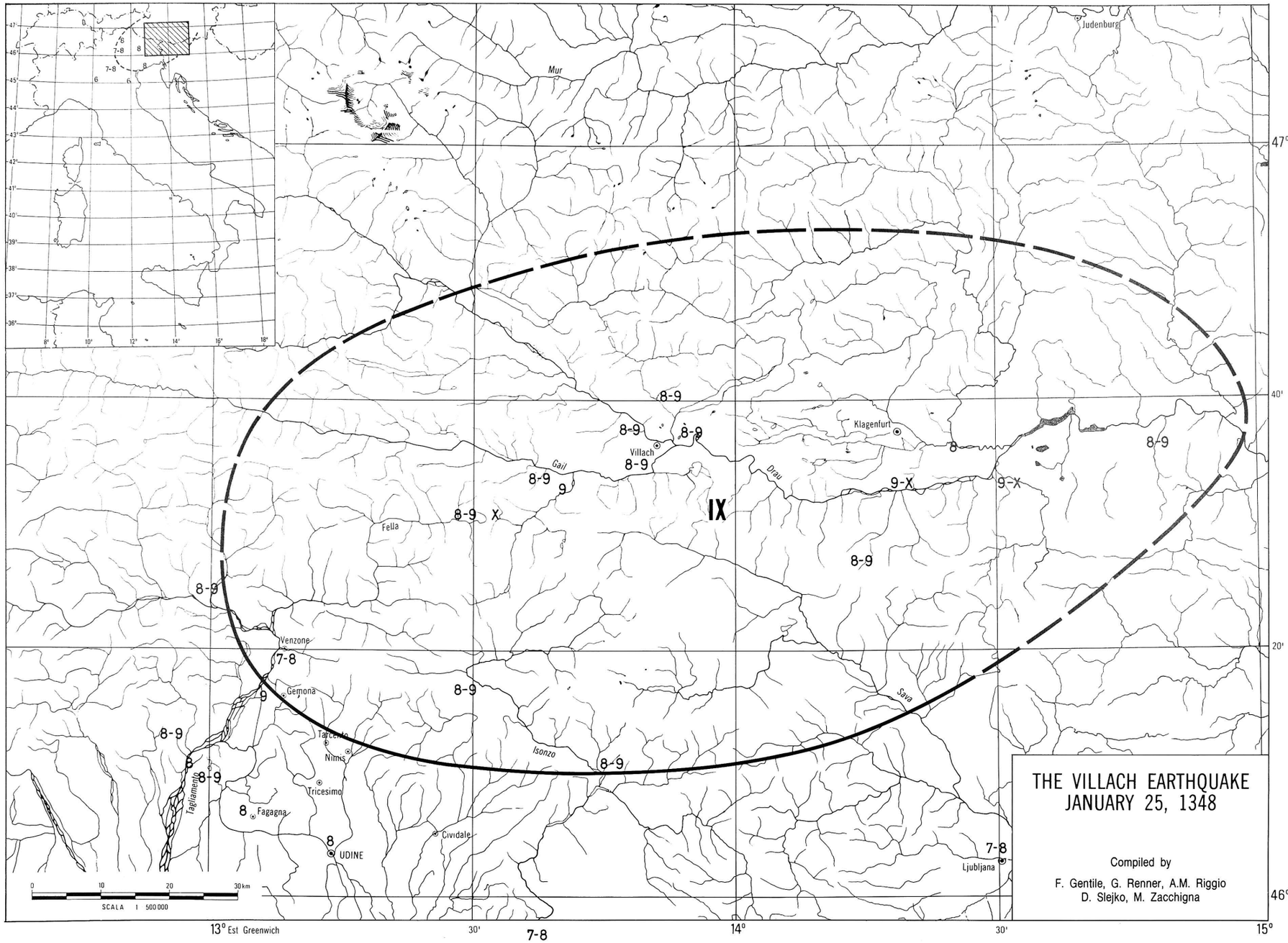

THE VILLACH EARTHQUAKE JANUARY 25, 1348

Compiled by

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D. Slejko, M. Zacchigna

The drainage network of this map – scale 1:500.000 – is the same as the "Structural Model of Italy."

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The earthquakes of January 22 and September 9, 1349.

M.C. Spadea, M. Vecchi, P. Gardellini, S. Del Mese

The seismic period began abruptly with the main shock.
Definite aftershocks lasted until September (4) and probably even afterwards, which became confused with those of the seismic period of Cassino of the same year.
There is much disagreement in the available data: some authors refer to 1345, others to 1348 or 1349, others again to 1350. However, the majority refer to 1349.
In this year reference is made to a great earthquake affecting mainly the Abruzzi and the Sannio area.
According to the description given by Baratta and many other authors, it was a single event. However, a detailed analysis of the data collected seems to indicate that there were at least two main seismic events, differing both in date (January and September) and in area (Abruzzi, Aquila area; Sannio, Cassino area). However, the information given by the individual chroniclers probably overlaps and thus becomes confusing.
We thus deemed it useful to present the intensities calculated from the macroseismic data analysed for each site on a single map, merely delimiting the two epicentral zones identified without attempting any further isoseismal breakdown.
Some of the sites indicated were certainly affected by both events, each of which was characterized by a prolonged seismic period. In some cases data from sites distant from the epicentre (e.g. Otranto, which Baratta includes in his general description) can probably more realistically be attributed to another epicentre and another date (probably the year 1350, in Puglia, with epicentre near Nardò).
Our interpretation is supported by two Cronacas, one by Ciarlanti (4) based on a Memorandum taken from Isernia Cathedral: «Anno Domini 1349, de mense Ianuarii in nocte S. Vincentii post cenam, fuit unus Terraemotus multum Magnum, et ab illa fere continue fuerunt quasi omni mense Terraemotus parvi usque ad Festum Nativitatis Gloriosae Virginis Die vero nona mensis Septembris anni praedicti seguenti post Festum dictae Gloriosae Nativitatis Sanctissimae Mariae in hora mediae tertiae fuit Terraemotus tam magnum, et tam ingentissimae potentiae, quod nemo recordatur similem Terraemotum a tempore Creationis. Diruit, et subvertit Ecclesiam Iserniensem, domus Domini Alferii, et generaliter omnia aedificia Civitatis Iserniae a minori usque ad majus; Itaque nullum omnino remansit, vel quod non esset totaliter destructum, vel pro majori parte dirutum...»: and another by MSS Bibl. Angelic. Rom. Papencorn DT:
«In the same year 1349, unusual and astonishing earthquakes occurred, which began in Italy on day 10 of the month of September, and lasted for several days in many parts of the world».
Rome was severely damaged. Petrarch says that the city had not suffered a similar disaster for two thousand years. Many relics from ancient times collapsed completely, such as the tower and one-third of the roof of San Paolo «fuori le mura»; the Lateran and S. Maria Maggiore were damaged; also the upper level of the Torre dei Conti fell. Everyone was afraid, and it was seen as a portent of great upheavals. Petrarch quoted the passage from Pliny, that «Rome was never shaken unless some mighty event was to follow...».
The January earthquake was thus felt very strongly as far as Isernia. Obviously the epicenter was fairly distant probably in the direction of Aquila, since the information about Aquila from surrounding areas is definitely of an epicentral nature.
The January earthquake was followed by a long seismic period lasting practically without interruption until September (4). All chronicles concur that the disaster hit the Sannio region during the religious festivities to celebrate the birth of the Virgin Mary.

Sannio area

Apparently the main shock was preceded by a foreshock, since Mambrino Roseo's (7) account of the event states that «in the town of Aversa, since all the leaders of the Hungarian and German army were meeting in the Great Church, whence fear had hardly driven them out without anything being concluded, that the Church collapsed without harming anyone».
Also on this occasion there was a seismic period with numerous aftershocks, which was also the case with the Aquila earthquake.
The duration of the seismic period is not specified; it must be remembered that this was another year of continual pestilence.
The bibliographic references (4) speak of chasms opening, water turbidity and springs drying up.

List of shocked localities:

Earthquake of January 22, 1349 - Abruzzi

Locality	Latit.	Long.	I (MCS)
Assisi	43°04'	12°37'	VII
Bologna	44°30'	11°20'	VIII (?)
L'Aquila	42°21'	13°24'	X
Contado dell'Aquila	42°21'	13°24'	X
Modena	44°39'	10°56'	III (?)
Orvieto	42°43'	12°07'	VIII-IX
Parma	44°48'	10°20'	?
Perugia	43°06'	12°46'	VIII
Pisa	43°43'	10°24'	VIII (?)
Roma	41°54'	12°29'	VIII
San Sepolcro	43°34'	12°08'	VII-VIII
Spello	42°59'	12°40'	VII
Spoleto	42°44'	12°44'	VII-VIII
Terni	42°34'	12°39'	?
Viterbo	42°25'	12°07'	VIII-IX

Earthquake of September 9, 1349 - Sannio

Alvito	41°41'	13°45'	VIII-IX
Ascoli Satriano	41°12'	15°34'	VIII
Atina	41°37'	13°48'	VIII-IX
Aversa	40°58'	14°12'	VII-VIII
Balsorano	41°48'	13°34'	VIII-IX
Campobasso	41°33'	14°40'	VIII
Fratte (ora Ausonia)	41°21'	13°45'	VIII
Isernia	41°36'	14°14'	IX
Monte Cassino	41°23'	13°49'	IX-X
Napoli	40°51'	14°16'	VIII
Otranto	40°09'	18°29'	?
S. Germano (ora Cassino)	41°29'	13°50'	IX-X
San Vittore	41°28'	13°56'	VIII (?)
Sant'Agata di Puglia	41°09'	15°23'	VIII
S. Elia Fiume Rapido e Terre dell'Abbadia di Montecassino	41°32'	13°52'	X
Sora	41°43'	13°37'	VII-VIII
Venafro	41°29'	14°22'	IX-X

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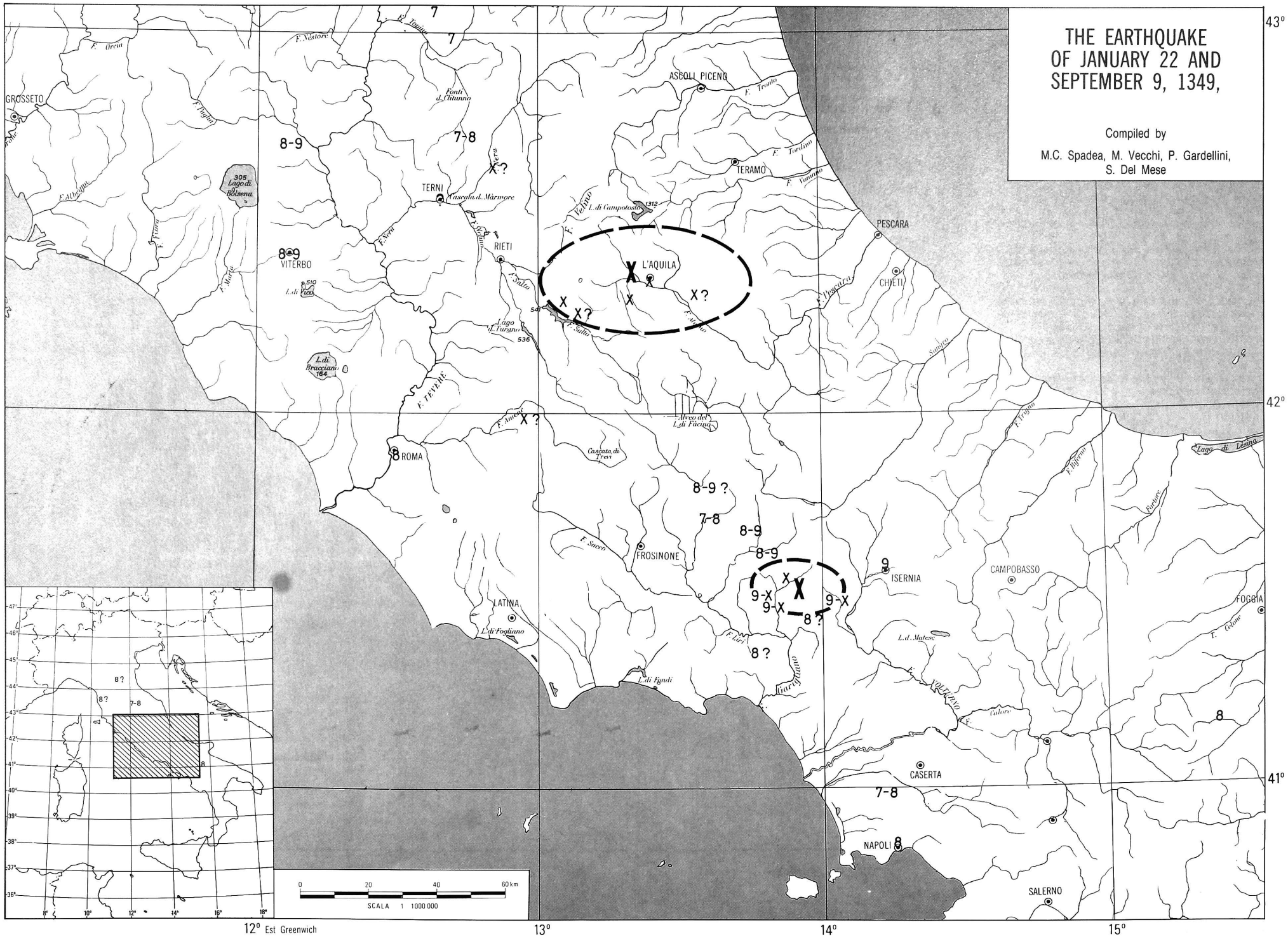
THE EARTHQUAKE OF JANUARY 22 AND SEPTEMBER 9, 1349,

Compiled by

M.C. Spadea, M. Vecchi, P. Gardellini,
S. Del Mese



The drainage network of this map - scale 1:1.000.000 - is taken from the official production of the IGMI - Firenze.

G.T.M - Via Marco Marulo 47a - 00143 ROMA

The Ascoli Satriano earthquake of July 7, 1361.

D. Molin

For this event the literature, and consequently the data, are scarce and uncertain. Villani M. (26) was the only contemporary writer found in the examined literature; later writers refer to his chronicle.
According to him the town of Ascoli Satriano was completely destroyed, causing the death of 4,000 people. This fact is confirmed by the «beginning of the rebuilding of the town at the end of the XIV century close to the ruines caused by the earthquake» (26).
The earthquake occurred at sunset, although is not reported.
Very scarce information is reported on the seismic sequence. According to Villani M. many aftershocks occurred.
Since the town suffered 4,000 casualties and considering that the population of this town, in those years, would have been much larger, it can easily be argued that the macroseismic intensity was close to the X degree of the MCS scale.
The evaluation of the intensity for other localities is uncertain.
The epicentre is likely to have been located close to Ascoli Satriano (41°12' lat. N, 15°36' long. E).
In the figure, the isoseismal lines have to be considered indicative only of the most affected area.

List of shocked localities:

Locality	Latit.	Long.	I (MCS)
Ascoli Satriano	41°12'	15°34'	X
Bovino	41°15'	15°21'	IX
Canosa di Puglia	41°13'	16°04'	IX
Rionero in Vulture	40°56'	15°41'	VII-VIII
Sant'Agata di Puglia	41°09'	15°23'	VIII-IX

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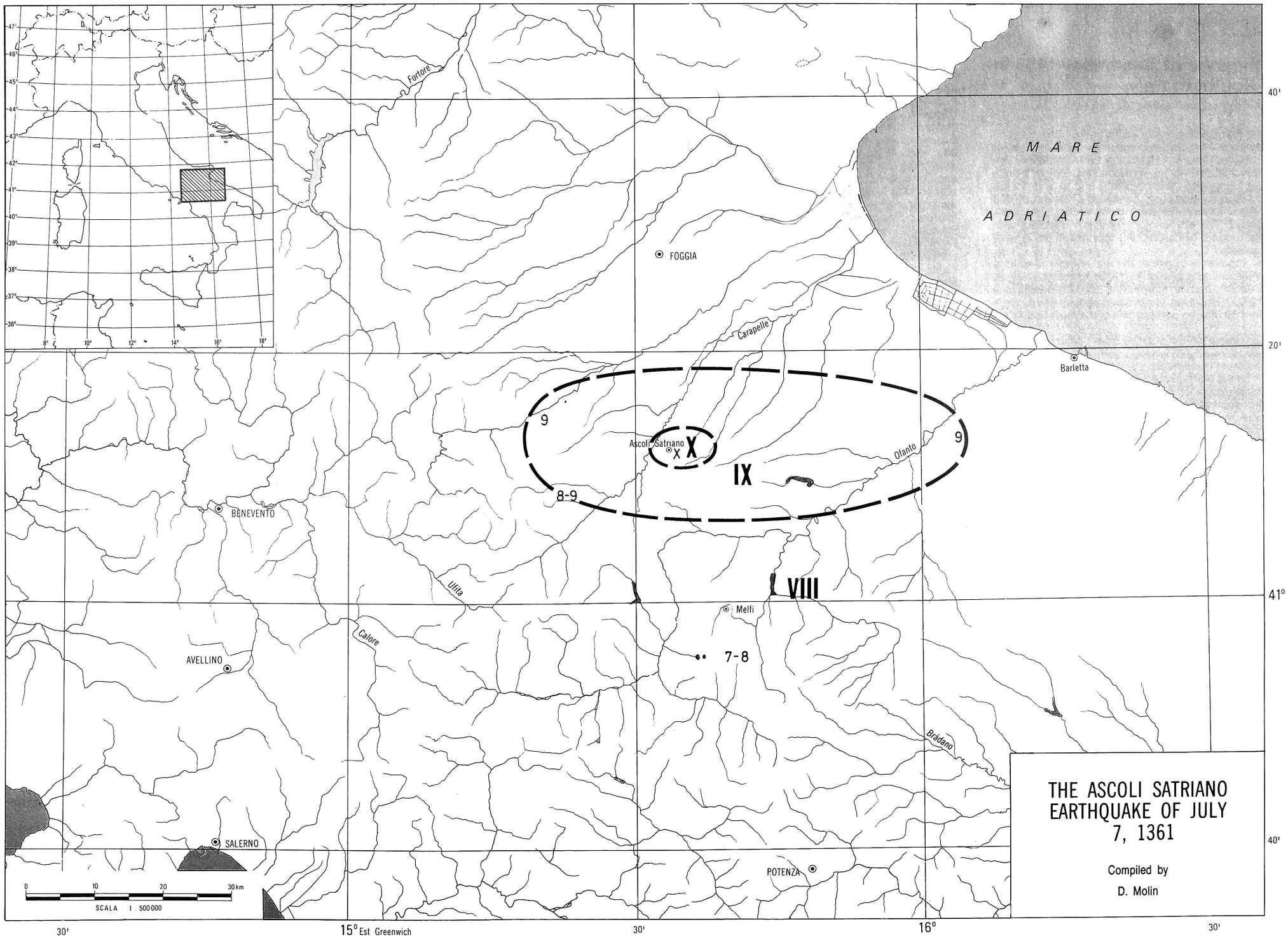

THE ASCOLI SATRIANO EARTHQUAKE OF JULY 7, 1361

Compiled by

D. Molin

The drainage network of this map – scale 1:500.000 – is the same as the "Structural Model of Italy."

G.T.M - Via Marco Marulo 47a - 00143 ROMA

The earthquake of December 1456 in Central-Southern Italy.

G. Magri, D. Molin

The earthquake that struck part of Central and Southern Italy in December, 1456 is to be considered one of the most destructive events in the seismic history of Italy. It caused very severe destruction and innumerable victims in the whole of Molise, Irpinia, the province of Benevento, and parts of Abruzzo and Apulia. The area that suffered destruction, consisted of almost 20,000 square kilometres. Several hundred towns and villages were severely damaged. The environment was also affected, with fractures in the ground, landslides and changes in the flow of underground waters.

It is practically impossible to gather the real number of victims from the information that is available. The contemporary writers give numbers varying from a maximum of 100,000 people to a minimum of 12,000. However, the majority of the writers give a number of about 30,000, so perhaps this is the most likely estimate.

There are innumerable written sources from contemporary authors; they consist mostly of letters, short accounts by historians and chroniclers, inscriptions, memorial stones, and also a specific report on the earthquake written by Giannozzo Manetti (210), a Florentine man of letters and a humanist who was living in Naples at the court of King Alfonso of Aragon.

This is by far the most important work dealing with the subject. It consists of a Latin manuscript of 132 pages divided into three parts: the first gives a catalogue of earthquakes; the second gives various opinions and theories about earthquakes; and the third lists the damage and effects of the 1456 earthquake in over 150 towns and villages in the Kingdom of Naples.

There are even more sources written by authors after the even. These are much less helpful since they are concerned with generic evidence.

It has been relatively easy to fix the date and time of the two major earthquakes, which occurred in December 1456, owing to the substantial agreement of most of the writers.

On the other hand, the information available on the seismic sequence is rather scarce. It seems to have begun directly with, the main shock soon after 4 a.m. local time, on 5 December 1456. There is no information about when the seismic sequence ended; it is known only that the aftershocks were still felt in Molise in March, 1457. Among the very few other events noted, that of 30 December 1456 at about 9 a.m. local time is very important, as it caused further severe destruction.

The highest intensity was equal to the XI degree of the MCS scale. This intensity has been assigned only to some small villages, characterized by the death of all the inhabitants, or by the more or less total collapse of the buildings. It must be remembered that there are many uncertainties about the evaluation of the intensity because of the frequent briefness of the information, and sometimes the disagreement of sources apart from their evident exaggeration as to damage and numbers of victims.

The location of the epicentre has proved to be rather problematic, because of the particular zonal distribution of the intensities. In fact, at least five main areas may be noted on the isoseismal map, with an intensity of the X degree and above, which presupposes a convergence of effects due to several shocks with different epicentres. However, since only two destructive events were recorded, there is a tendency to think that the very long duration of the first one (about six minutes) was due to the rapid succession of several shocks with different epicentres (multiple-shock event). It is thought that the most representative epicentre of the earthquake may be fixed some kilometres north-east of Boiano (41°31' Lat. N, 14°31' Long. E). This point is, in fact, the barycentre of the central area of the X degree, and also of the IX degree; this includes all the areas of the X degree.

Because of their many uncertainties, the isoseismal lines, found during the evaluation of the intensity, are not certain and are limited to the lines of the VIII-IX degree. It has not been possible to determine, even very roughly, the affected area, which was most probably very extensive.

Although uncertain, the isoseismal map immediately gives an idea of the importance of the event, with its very vast area of the IX degree, and particularly with its various areas of the X degree. It indicates areas that have been sources of destructive earthquakes in the seismic history of Italy. In fact, in the area between Benevento and Ariano Irpino, there have been earthquakes in 369, 1125, 1702, 1732 and 1962; an earthquake in 1688 in the area of Cerreto Sannita; one in 1805 in the area between Isernia and Campobasso; and also in 1706 and 1933 in the area to the north of Isernia and south-east of Chieti. It is noticeable that the upper part of the area that suffered the intensity of the 9th degree during this earthquake was also shaken by destructive intensity during the 1349 earthquake.

From the above, it is evident that the 1456 earthquake is characterized by a notable complexity, especially owing to the particular distribution of the intensities. Furthermore, it must be emphasized that the very wide area of the IX degree includes a great number of important seismic centres involved in many destructive events at different periods.

Areas related to different degree of intensity:

I	Area km²	Localization
XI	20	21 km N of Isernia
XI	20	13 km NW of Isernia
X	418	28 km SW of Chieti
X	932	20 km N of Isernia
X	35	... Isernia
X	642	13 km W of Campobasso
X	35	8 km E of Campobasso
X	35	8 km N of Caserta
X	237	18 km NW of Benevento
X	461	18 km E of Benevento
X	35	47 km E of Benevento
IX	19.569	—
IX	137	Lower Ofanto River

List of shocked localities:

Locality	Latit.	Long.	I (MCS)
Accadia	41°10'	15°20'	XI-X
Acerra	40°57'	14°22'	VIII
Acquaviva d'Isernia	41°40'	14°09'	X
Adiocrence	?	?	X
Albe	42°05'	13°25'	VII-VIII
Alberona	41°26'	15°08'	VIII
Alessano	39°53'	18°20'	VIII
Alife	41°20'	14°20'	IX
Alteville	?	?	X
Alvignano	41°15'	14°20'	IX
Alvito	41°41'	13°45'	IX
Andria	41°14'	16°17'	VII
Apice	41°07'	14°56'	X-XI
Aquilonia	40°59'	15°29'	IX-X
Ariano Irpino	41°09'	15°01'	X
Arienzo	41°02'	14°30'	?
Arpaia	41°02'	14°33'	IX
Arpino	41°39'	13°37'	IX
Ascoli Satriano	41°12'	15°34'	IX
Atella	40°52'	15°39'	IX
Avellino	40°55'	14°47'	VIII
Aversa	40°58'	14°12'	VIII-IX
Baia	40°49'	14°04'	VII
Baranello	41°32'	14°33'	X
Bari	41°07'	16°52'	VII
Barletta	41°19'	16°17'	VII
Benevento	41°08'	14°46'	IX-X
Betavio	?	?	IX
Biccari	41°24'	15°12'	VIII
Bitonto	41°06'	16°41'	VII
Boiano	41°29'	14°28'	X-XI
Bonito Irpino	41°06'	15°01'	X
Bovino	41°15'	15°21'	VIII-IX
Brindisi	40°38'	17°57'	VIII
Burutum	?	?	?
Busso	41°33'	14°34'	X
Calvi Vecchia	41°12'	14°09'	VIII
Campobasso	41°33'	14°39'	IX
Campochiaro	41°27'	14°30'	X
Canagrii	?	?	IX-X
Canne	41°18'	16°09'	IX-X
Canosa di Puglia	41°13'	16°04'	IX
Cantalupo	?	?	IX-X
Cantalupo nel Sannio	41°31'	14°23'	IX
Capua	41°07'	14°13'	VIII
Carpinone	41°36'	14°19'	X
Casacalenda	41°44'	14°51'	IX-X
Casalciprano	41°35'	14°32'	?
Casale di Certanda	?	?	X
Casalina	?	?	X
Casaltino	?	?	X
Casserum	?	?	?
Cassino	41°29	13°50	VIII
Cassione	?	?	?
Castel di Sangro	41°47'	14°07	X
Castellaccio	?	?	IX
Castelli	?	?	?
Castellino	?	?	?
Castellino del Bif.	41°42'	14°44'	IX
Castelliucci	?	?	IX
Castellone al Volturno	41°30'	14°28'	X
Castel San Donato	?	?	IX-X
Castel Sangiunio	?	?	IX
Castelluccio dei Sauri	41°18'	15°29'	VIII-IX
Castelmauro	41°50'	14°42'	IX
Castelnuovo	42°18'	13°38'	IX
Castel Petroso	41°33'	14°21'	IX
Castel Pizzuto	41°31'	14°17'	VIII
Castel San Vincenzo	41°39'	14°04'	XI
Castel Volturno	41°02'	13°57'	VII
Castiglione da Casauria	42°14'	13°54'	X
Castime	?	?	?
Castrignano del Capo	39°50'	18°21'	VIII-IX
Castrileonio	?	?	X
Castropignano	41°37'	14°34'	IX
Cava dei Terreni	40°42'	14°42'	VII
Cercemaggiore	41°27'	14°43'	?
Cerce Piccola	41°27'	14°40'	X
Cerreto Sannita	41°17'	14°33'	X
Cerro al Volturno	41°39'	14°06'	XI
Chercum	?	?	IX-X
Cheruta	?	?	X
Chune	?	?	?
Chieti	42°21'	14°10'	VII
Cichala	?	?	?
Civitanova del Sannio	41°40'	14°24'	IX
Civitella	?	?	IX-X
Conza della Campania	40°52'	15°20'	?
Cornara	?	?	X
Corsano	41°11'	15°00'	IX
Cornicasio	?	?	X
Cretendio	?	?	X
Cronno	?	?	IX
Crustensio	?	?	IX
Cuma	40°51'	14°03'	VII
Desivi	?	?	X
Dugenta	41°08'	14°27'	IX
Durazzano	41°04'	14°27'	IX
Ercolano	40°48'	14°21'	VII
Ferrazzano	41°32'	14°40'	IX-X
Foggia	41°28'	15°33'	VII
Fondi	41°22'	13°26'	VIII
Forlì del Sannio	41°42'	14°11'	X
Formia	41°16'	13°36'	VII
Fornelli	41°37'	14°08'	IX
Fossacesia	42°14'	14°29'	VIII
Fossalto	41°40'	14°33'	IX
Fragneto l'Abate	41°16'	14°47'	IX
Francolise	41°11'	14°03'	VIII
Franieto	?	?	X
Fravelle	?	?	IX
Frosolone	41°36'	14°27'	X
Gaeta	41°13'	13°35'	VII
Ghotto	?	?	?
Gichai	?	?	?
Gravina di Puglia	40°49'	16°25'	VIII
Guardiagrele	42°11'	14°13'	?
Guardiaregia	41°26'	14°33'	X
Guardia Sanframondi	41°15'	14°36'	X
Guglionesi	41°55'	14°55'	VIII-IX
Isernia	41°35'	14°14'	X
Labatina	?	?	?
Lacedonia	41°03'	15°26'	IX
Lanciano	42°14'	14°23'	VII
L'Aquila	42°21'	13°23'	VII
Larino	41°18'	14°55'	VIII
La Tosara	?	?	?
Lecce	40°21'	18°11'	VIII
Leverano	40°18'	18°00'	VIII
Limatola	41°08'	14°23'	X
Limosano	41°40'	14°37'	X
Liniceto	?	?	?
Lucera	41°30'	15°20'	IX
Lucito	41°44'	14°41'	?
Lusano	?	?	IX-X
Macchiagodena	41°34'	14°24'	X
Magliano	?	?	?
Manardata	?	?	?
Manduria	40°24'	17°38'	VIII
Manfredonia	41°38'	15°55'	VII
Marigliano	40°56'	14°27'	VII
Matrice	?	?	IX
Mazzabodina	?	?	X
Melfi	41°00'	15°40'	IX
Mercato San Severino	40°47'	14°45'	?
Messamolio	?	?	IX
Messina	38°11'	15°33'	V
Mirabella Eclano	41°03'	15°00'	X
Miranda	41°39'	14°15'	IX
Mola di Bari	41°04'	17°05'	VII
Monopoli	40°57'	17°18'	VII
Monte Bone	?	?	?
Montecalvo Irpino	41°12'	15°02'	IX
Montecassino	41°29'	13°48'	VIII
Montecilfone	41°54'	14°50'	IX
Montecorvino	41°31'	15°09'	IX
Monteleone	?	?	X
Monteleone de' Mileti	?	?	X
Morcone	41°20'	14°40'	IX-X
Morice	?	?	VIII-IX
Napoli	40°51'	14°15'	VIII
Nardò	40°11'	18°02'	VIII
Navelli	42°14'	13°44'	IX
Nicone	?	?	?
Nola	40°56'	14°32'	VIII
Oliveto	?	?	IX
Oratino	41°35'	14°35'	IX-X
Oria	40°30'	17°39'	VIII
Ortona	42°21'	14°24'	?
Otranto	40°09'	18°29'	VIII
Paduli	41°10'	14°53'	X-XI
Paglieta	42°10'	14°30'	?
Palma Campania	40°52'	14°33'	VIII
Penne	42°27'	13°56'	VII
Peredote	?	?	X
Pesche	41°37'	14°17'	IX
Pesco	?	?	?
Pescocostanzo	41°53'	14°04'	IX
Pescolanciano	41°41'	14°20'	X
Pescosonnulo	?	?	X

Pessolle	?	?	X
Petrella Tifernina	41°41'	14°42'	IX
Petranova	?	?	?
Pettoranello del Molise	41°34'	14°16'	IX
Pietrelcina	41°12'	14°51'	VIII-IX
Pistolara	?	?	X
Polignano a Mare	41°00'	17°13'	VII
Pompei	41°45'	14°31'	VII
Ponte Corvo	?	?	?
Pontelandolfo	41°17'	14°41'	IX
Popoli	42°10'	13°50'	IX-X
Portocannone	41°55'	15°01'	?
Pozzuoli	40°49'	14°07'	VII
Pratola Peligna	42°06'	15°53'	?
Provvidenti	?	?	?
Quazia	?	?	IX
Rapolla	40°59'	15°41'	IX
Reino	41°18'	14°49'	IX
Riccia	41°29'	14°50'	?
Rionero Sannita	41°43'	14°08'	X
Ripa	?	?	?
Ripalimosano	41°37'	14°40'	X
Ripa Ursa	?	?	IX
Rippe	?	?	?
Rivisondoli	41°52'	14°04'	IX
Rocca Caramanico	42°06'	14°01'	IX-X
Rocca Cinquemiglia	41°49'	14°07'	X
Rocca l'Abbate	?	?	X
Roccamandolfi	41°30'	14°21'	?
Rocca Pia	41°56'	13°59'	IX
Roccaraso	41°51'	14°05'	X
Roccasicura	41°42'	14°11'	X
Roccaspromonte	41°36'	14°33'	IX
Rocchetta a Volturno	41°38'	14°04'	X
Roma	41°54'	12°29'	IV-V
Rossano	?	?	IX-X
Sala (no longer exists)	?	?	X
Salerno	40°41'	14°45'	VII
San Bartolomeo in Galdo	41°25'	15°02'	?
San Giorgio	?	?	IX
San Giovanni in Venere	42°15'	14°28'	VIII
San Giuliano del Sannio	41°27'	14°38'	X
San Giuliano di Puglia	41°41'	14°58'	?
San Lupo	41°16'	14°38'	?
San Marco (Monastero di)	?	?	IX
San Marco	?	?	IX
San Massimo	41°29'	14°25'	X
San Michele (Abazia di)	40°56'	15°37'	?
San Nixin	?	?	?
San Paolo	?	?	IX
San Pietro a Castello	?	?	?
San Pietro Avellana	41°47'	14°11'	XI
San Primiano	?	?	?
Santa Croce nel Sannio	41°23'	14°44'	IX-X
Santagalina	?	?	IX-X
Sant'Agata dei Goti	41°05'	14°30'	IX
Sant'Agata di Puglia	41°09'	15°23'	IX
Santa Maria in Galdo	?	?	?
Mazzocca (Badia di)	?	?	IX
Sant'Angelo	?	?	?
Sant'Angelo d'Alife	41°22'	14°16'	IX
Sant'Angelo Limosano	41°42'	14°36'	IX
Sant'Angelo in Grotte	41°34'	14°22'	?
Sant'Antonio dei Carinci (Badia di)	?	?	IX
Sant'Elena	?	?	IX
Sassinoro	41°22'	14°40'	IX
Sarno	40°49'	14°37'	?
Savignano Irpino	41°14'	15°11'	IX-X
Saxana	?	?	?
Scapoli	41°37'	14°03'	X
Sepino	41°24'	14°37'	X
Sergiello	?	?	IX
Sessa Aurunca	41°14'	13°56'	VII
Sessano del Molise	41°38'	14°20'	IX
Sora	41°43'	13°37'	IX
Sorrento	40°38'	14°22'	VII
Speronasimo (no langer exists)	41°44'	14°27'	X
Spina	?	?	IX-X
Spinete	41°33'	14°29'	X
Sulmona	42°03'	13°56'	VIII-IX
Sulonne	?	?	IX
Tampellania	?	?	?
Taranto	40°29'	17°14'	VII
Teano	41°15'	14°04'	VIII
Teramo	42°40'	13°42'	VIII-IX
Termoli	42°00'	15°00'	VIII
Tharthe	?	?	IX-X
Thicone	?	?	?
Tocco Caudio	41°07'	14°38'	X
Tocco da Casauria	42°13'	13°55'	X
Torella del San.	41°38'	14°31'	X
Torino di Sangro	42°11'	14°32'	?
Toro	41°34'	14°46'	X
Torre	?	?	X
Torre de' Passeri	42°15'	13°56'	X
Tramonti	40°42'	14°38'	VIII-IX
Trani	41°17'	16°25'	VII
Trivento	41°47'	14°33'	?
Trocchia Maggiore	?	?	?
Troia	41°22'	15°19'	IX
Ururi	41°49'	15°01'	?
Vairano Pat.	41°20'	14°08'	VIII
Vasto	42°11'	14°70'	VII
Venafro	41°29'	14°03'	IX
Venosa	40°58'	15°50'	IX
Viady	?	?	X
Vieste	41°53'	16°11'	VII
Vinchiaturo	41°29'	14°35'	X
Viopolani	?	?	?
Vittorito	42°08'	13°49'	?
Vitulano	41°10'	14°39'	X
Volturara Appula	41°30'	15°04'	IX
Zungoli	41°07'	15°12'	IX

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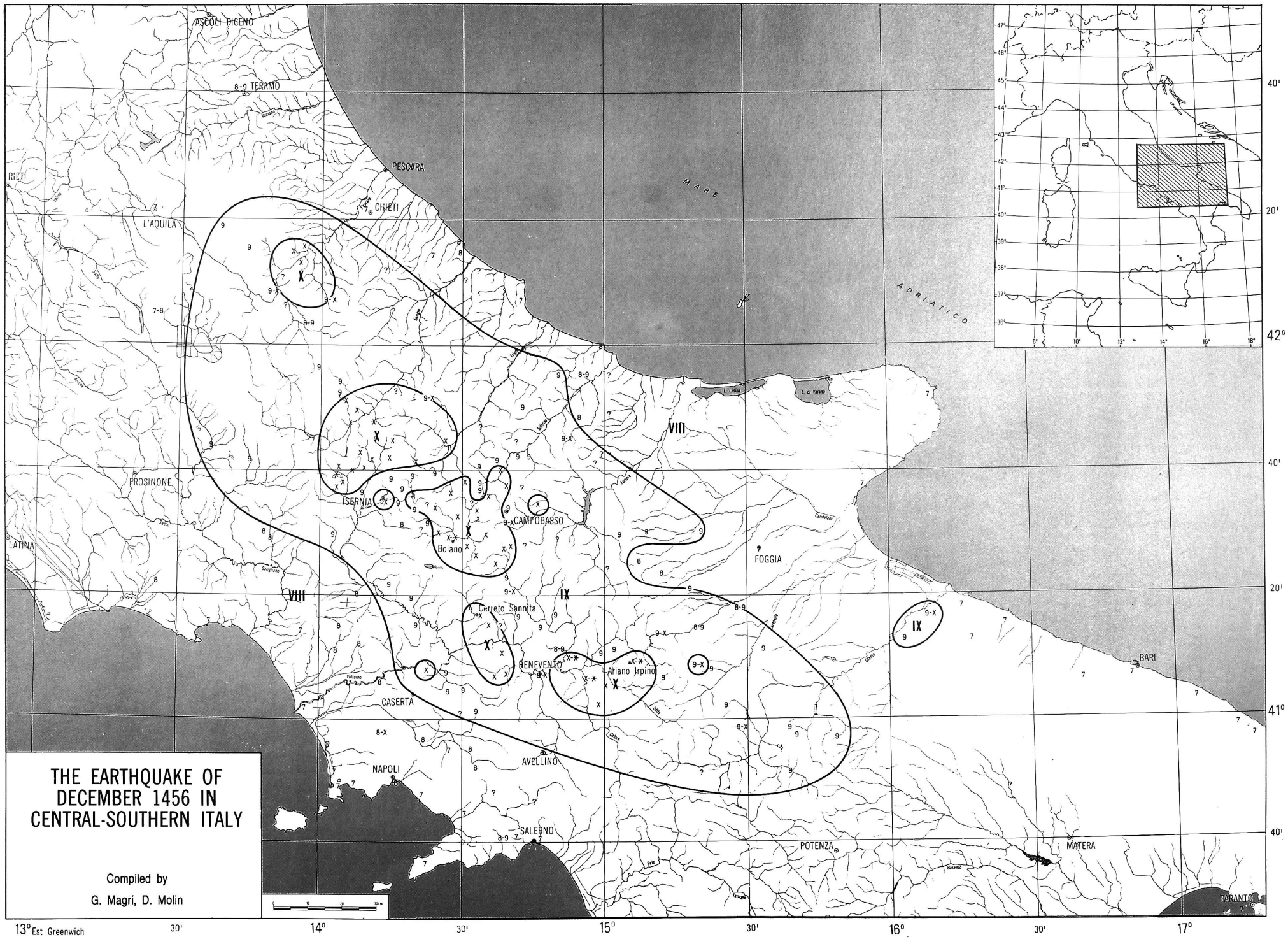
THE EARTHQUAKE OF DECEMBER 1456 IN CENTRAL-SOUTHERN ITALY

Compiled by
G. Magri, D. Molin



The drainage network of this map – scale 1:500.000 – is the same as the "Structural Model of Italy."

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The Modena earthquake of June 5, 1501.

G. Ferrari, E. Manenti, G. Martinelli, D. Postpischl

On June 5, 1501, at 10:00 a.m. GMT, a strong earthquake hit the pedi-Apennine belt of the territory of Modena. The area of descructive effects lies between the valleys of the Secchia and Panaro Rivers.

The catalogues attribute an epicentral intensity of IX MCS to this event. The principal problem in studying this earthquake was locating reliable sources contemporary to the event, which were entirely absent in preceding studies (e.g. Baratta).

The reconstruction of the effects was based essentially on the testimonies of four chroniclers from Modena and one from Reggio as well as archival documentation.

The research carried out on minor centers and the countryside was much more difficult. In fact, aside from the usual problem of general scarcity of sources regarding this epoch, one must also take into account the historical evolution of this area.

The small center of Castelvetro, 18 km. from Modena, was then subject to the Rangoni family, whose archives are inaccessible (to the public). Sassuolo, along with other territories, had for some months passed from the dominion of the Estensi family to that of the Pio di Savoia.

The archives of this family, for the most part dispersed, are preserved in the Biblioteca Ambrosiana in Milano. However, nothing relating to this earthquake could be found. One must add that for these «peripheral» areas, not even the community archives, which in this zone generally preserve documentation after 1501, nor the parochial archives, scarcely utilizable before the reforms of the Concilio Tridentino (Tridentine Council) (1543-1563), could be of any avail.

This justifies the scarcity of evaluation points in the enclosed map. For Castelvetro, the hardest hit center, in addition to the severe damage and partial collapse of the Rocca castle, its surrounding walls, and the church, there is also evidence of total collapse of some houses and partial collapse of others which were all uninhabited. In Castelvetro, a widespread oral tradition still reports that the 1501 earthquake caused a certain number of deaths, an assertion which could not be verified in the documents in our possession, but which is most likely the case.

With regard to Sassuolo, Jacopino de Bianchi summarizes the damage there in — *Ruina de Sasolo* — (*Ruins of Sassuolo*), which is a description of widespread destruction. This description deviates enough from the more detailed ones supplied by Jacopino for other Modenese localities, to make one suspect that the term «rovina» (ruins) actually means widespread damage, but not total destruction.

Other chroniclers describe grave damage to the castle and the inhabited center of Sassuolo without making any reference to total destruction. Moreover, the administrative documentation related to Sassuolo does not mention the earthquake, while it does report the measures adopted on the occasion of a grave plague that occurred in that same area some time later.

In Montegibbio and Maranello, castles collapsed almost completely: in Colombaro di Formigine there were numerous collapses; in Gorzano di Maranello a large house collapsed and one woman died; in Zenzano (a toponym, no longer in existence, localized on the right bank of the Panaro River in front of the inhabited center of Marano sul Panaro) a tower fell; and in Spezzano di Fiorano a tower and a house collapsed.

For these small inhabited nuclei, it is very difficult to say how strong the damage described was to the total constructions; since these localities had scarce importance, there is no precise information concerning them.

For Modena, Jacopino gives a long detailed description of the event. He reports the collapse of numerous huge chimneys, the battlements of the Palazzo del Vescovado (Bishop's Palace) and of the Palazzo del Comune (Town Hall), and the city walls, and mentions the rather severe damage to some of the churches (the Duomo, San Francesco, Sant'Agostino, Sant'Agata).

The church of San Biagio collapsed after four days, perhaps because of the effects of other weaker shocks, which lasted until the ninth of June, according to Pirro Ligorio. There were eight deaths and numerous injured in the city, almost all of which were caused by falling pieces of battlements, especially those of the building facing the square where, at that time, the market was held.

Documentation taken from the Archivio Storico Comunale di Modena (the Historical Town Archives of Modena) records the event of the tower of the Palazzo del Comune, the highest part of which was taken down because of its unsafe condition.

Because of the prevailing direction of oscillation of the soil, one source reports a tremor for which: «la cita' andava da sira in doman» (W-E) «et vene questo teramoto de verso Milan» (WNW-ESE). [the city oscillated from evening to morning (W-E) and the first shock was in the WNW-ESE direction].

The earthquake lasted «per spatio de uno Paternostro» (the duration of the Lord's Prayer - about 40 seconds), and an intense roar propagating from Bologna to Modena was heard. The water in the fountains became turbid and overflowed, and the canals swelled.

A contemporary chronicle reports the collapse of numerous houses in Reggio Emilia. This information should be taken with caution since, in the register of the Consiglio della Comunità (Town Hall Council), ordinary administrative business in that period was reported, but no mention of a shock was made then or afterwards.

Therefore, it is not very plausible that the collapse of «plures domos» in the city did not influence the decisions of the Town Hall of Reggio Emilia, that infact, some years later deliberated an additional charity expense or religious rites for the shocks felt there.

The earthquake was felt in the territory of Bologna, in the territory of Ferrara and, according to some reports (but this affirmation could not be verified in direct sources) in Verona. Research on sources contemporary to the event in Parma, Piacenza, and Mantua, to name the most important, showed negative results.

The meizoseismal area seems to be due to a superficial seismic source immediately south of the city of Modena, in the pedi-Apennine belt.

The resulting distribution of the effects has led us to classify the localities with a IX degree MCS value.

Since the language used in the document could imply a less severe classification, such an attribution must be taken with caution.

From the area outlined in picture, the macroseismic equivalent of magnitude, calculated using the Galanopoulos formula, is ME = 4.7, versus the evaluations of MK = 5.7 (Karnik) and MP = 5.9 (Peronaci) reported in the ENEL Catalogue.

The estimated value of ME, which is relatively low, seems to confirm ever-present perplexities regarding the maximum intensity value of IX MCS.

The following is a comparison of the values of some parameters, respectively reported in the ENEL and Carrozzo et al. Catalogues, and in the present study.

Year	Mo	Da	Ho	Mi	Lat	Long	De	I_o	I_{max}	Me	Mk	Mp	Epic. area
1501	06	05	14	00	44°30'	11°00'		IX			5.7	5,9	Modenese
1501	06	05	09	30	44°30'	10°45'		IX			6,0		
1501	06	05	10	00	44°30'	10°56'		VIII	IX	4,7	5,2		Castelvetro

List of shocked localities:

Locality	Latit.	Long.	I (MCS)
Bologna	44°30'	11°20'	IV-V
Castelvetro di Modena	44°30'	10°57'	IX
Colombaro	44°33'	10°54'	VIII-IX
Ferrara	44°50'	11°37'	V
Forlì	44°13'	12°03'	IV-V
Gorzano	44°31'	10°53'	VIII
Maranello	44°32'	10°52'	IX
Marano sul Panaro	44°27'	10°58'	VIII-IX
Modena	44°39'	10°56'	VII
Montecreto	44°15'	10°43'	VIII
Montegibbio	44°30'	10°47'	IX
Parma	44°48'	10°20'	V
Reggio Emilia	44°42'	10°38'	VI
Sassuolo	44°32'	10°47'	VIII
Spezzano	44°32'	10°54'	VIII
Zenzano	44°26'	10°59'	VIII

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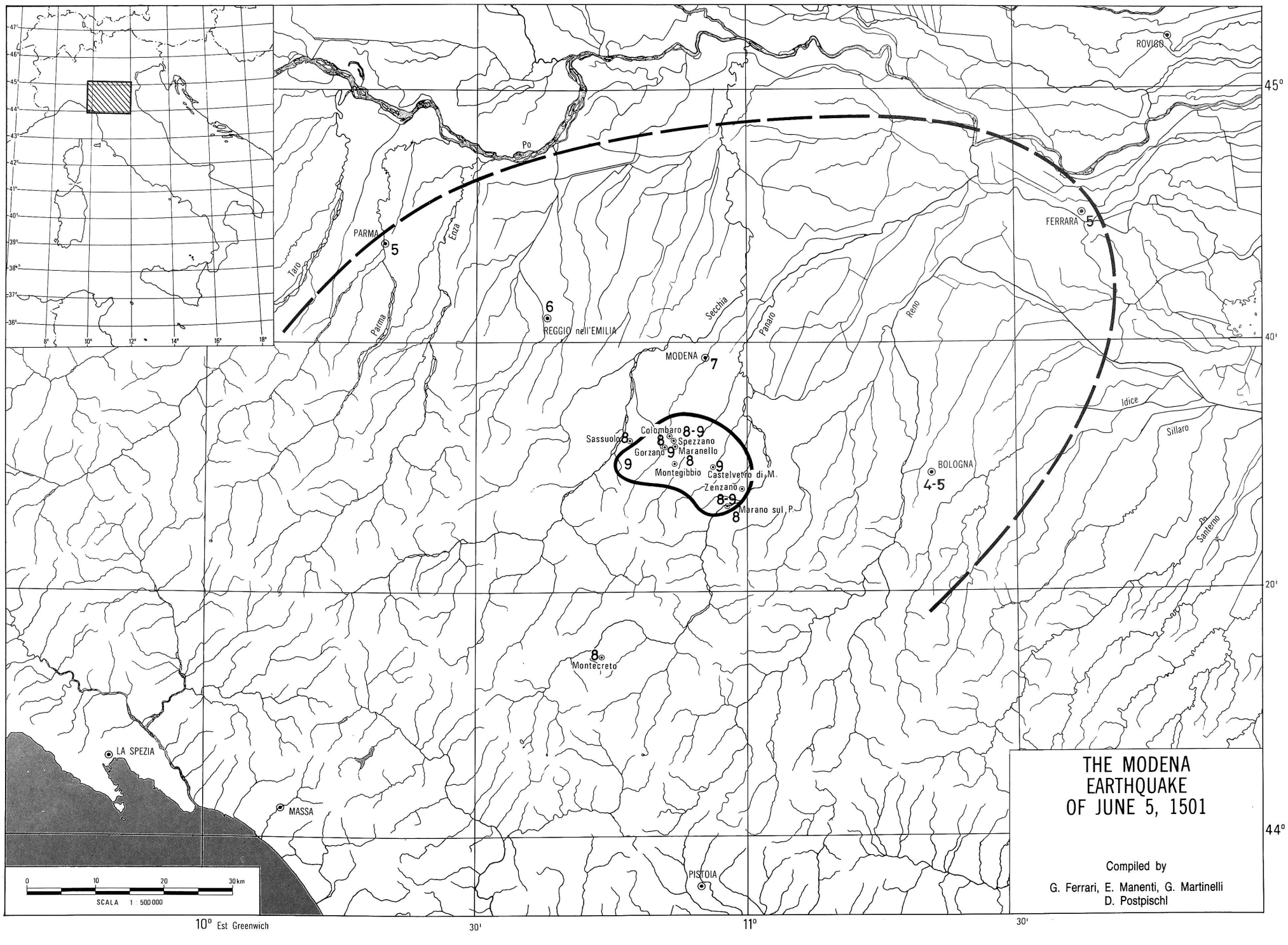

THE MODENA EARTHQUAKE OF JUNE 5, 1501

Compiled by

G. Ferrari, E. Manenti, G. Martinelli
D. Postpischl

The drainage network of this map – scale 1:500.000 – is the same as the "Structural Model of Italy."

G.T.M - Via Marco Marulo 47a - 00143 ROMA

The Bologna earthquake of January 3, 1505.

G. Ferrari, E. Guidoboni, D. Postpischl

The earthquake on January 3, 1505 is reported with an epicentral intensity of IX degree MCS in the ENEL and Carrozzo et al. Catalogues.
There is considerable discordance between the two catalogues as to intensity evaluation of the shocks preceding (December 30) and following the January 3 shock.
The epicentral localization in Bologna of all the shocks of this seismic period is presumably due to the tendency of the sources to give major emphasis to the events happening in the city rather than to those occurring in extraurban areas.
Analysis of the testimonies contemporary to these earthquakes led to the individuation of the effects of the various shocks, changing significantly the framework of the preceding evaluations. These evaluations were taken from the outline presented by M. Baratta, based on later descriptions.
It is necessary to note that the entire seismic period is inserted in a historical context already characterized by economic difficulty and social tensions (a serious famine was hitting the territory of Bologna and an epidemic of plague propagated there during 1505).
The particular social-historical situation and, moreover, the influence of the common supernatural interpretation of earthquakes (seen also, in this particular case, as a premonitory sign of the decline of the lord of the city, which did occur in 1506) probably favoured an amplification of the phenomenon in the successive local chronicle tradition.
Also contributing to the formation of this image was the lack of differentiation between the damage and the different shocks, and between the effects of these shocks and the successive building measures that were taken.
Some leaning towers were dismantled because of their unsafe condition, and later were mistakenly identified as having collapsed.
The historical analysis was carried out by consulting the measures taken by the organs governing the city, the administrative acts regarding the restoration of public buildings, some letters written by a Bolognese nobleman to the Court of Mantua, and contemporary chronicles and annals of Bologna, Ferrara, Reggio Emilia, Cesena, Modena, Venice and Vicenza. The description obtained from these sources was integrated with treatises on earthquakes of the sixteenth century, as well as some iconographic evidence, which has contributed to the determination of the localization of the damage.
Investigation into the Bentivoglio archives (lords of the city at the time of the event) proved negative. Although the documentation has supplied us with precise indications, it is on the whole, as has already been pointed out, limited entirely to the urban area. Therefore, while the estimation of the damage done in the city can be considered satisfactory, that regarding the inhabited centers of the hills and plains, except for the rare reference, is completely deficient. Lack of documentation concerning the extra-urban parishes before the Tridentine Reform (1543-1563) is a known fact (pre-Tridentine apostolic visits of the Bolognese diocese did not take place in this period).
It remains to be observed that the strongest effects of this earthquake seem limited to a narrow band including the city and a suburban zone.
All the chronicles of Emilia Romagna, Venetia, and parts of Lombardy report that this seismic period was preceded by prolungued incursions of foehn, followed by a period of intense rain.
On December 30, 1504, at 11:00 a.m., the first shock was felt, it was a particularly long shock, in fact some sources report that it lasted even «a quarter of an hour». Many chimneys collapsed and two chains in the San Giacomo Church and one in the S. Maria Maggiore Church, broke.
On January 3, at 1:45 a.m. GMT, the strongest shock was felt, to which the major part of the damage can be ascribed. Many church bells tolled until 4:00 a.m. GMT. A comparison of descriptions has permitted an individuation of the type and distribution of the damage. For the most part, there were cracks in vaults, collapsing of cupolas in 2 churches and 1 chapel, broken chains, destruction of some arches of the porticoes and collapsing of a few battlements. In the building interiors, plaster fell and ceilings were damaged, the latter probably due to the collapse of chimneys, but perhaps also to the disconnection of beams (in that period many ceilings and internal walls were made from cane mats and plaster). The number of buildings that collapsed was eight: seven houses, all situated in popular quarters (Paglia, S. Vitale, S. Donato), and one chapel.
The following type of damage is ascribed to higher building structures: from the tops of towers and belfries some «torresini» (small columns supporting metal cupolas) were disconnected; three towers, including the tower of the lord of the city which was completely vaulted, were caused to incline and were cut down at the level of the height of the houses. On the whole, the part of the city where the major damage occurred was indicated by contemporaries as the part towards the plains between the gates of S. Isaia and S. Donato. (table VIII).
In the less damaged zone, the partial collapse of the bell tower of the small church of Santa Maria in Monte (located on a 200 m hill) was probably an effect of topographical amplification. In the hill belt of Bologna, close to Zola, a fissure in the ground opened up out of which «rocks came», according to the testimonies, and there was a landslide in the locality of San Lorenzo in Collina.
In the countryside many dovecotes were damaged and many houses cracked. The vagueness of the sources permits only a very rough approximation of the quantification of the effects related to this area.
Urban sources testify that on January 21, 1505, at about 7:00 a.m. GMT, a third earthquake damaged, above all, the vaulted construction, which was shored and bolted. Due to this shock, some internal staircases and an arch of the clock tower of the Podestà Palace collapsed.
It is often written in later accounts, and also reported in Baratta, that this earthquake lasted forty days. This indication is to be attributed, as in other cases, not to realistic observations, but to the use of the Christian cabala. Quite a few testimonies agree upon the affirmation that the shocks were felt for about a year. A brief note on the earthquake is contained in the Hammer codex of Leonardo da Vinci. In a late sixteenth century account, the earthquake of Bologna is cited as typical of «moto titubativo», characterized by frequent and not very intense shocks protracted for a long period of time.
Indications for locating damaged towers that are no longer in exitence were taken from iconographic sources. Moreover, the design drawn by a contemporary, representing the emergency dwellings put up within the walls of the city shows the background without visible damage, confirming the image of a seismic period which spread a great deal of panic without causing the damage to the building property attributed to it by later sources.
On the whole, this seismic period presents the same evolution found in other seismic period of Bologna, such as those of 1779 and 1929.
The epicentral area is probably located in the territory of the hills near the cited localities of S. Lorenzo and Zola, where it is still difficult to estimate intensity values.
In the city, the effects of each of the two shocks occurring on December 30 and January 3 are not higher than VII MCS, which reduced the data of the previous attributions of IX MCS.
By using the Galanopoulos formula, the affected area, estimated on the basis of information regarding the localities of Ravenna, Lugo and Castrocaro, leads to a macroseismic equivalent of magnitude ME = 4.7, for the main shock; in clear contrast are the estimates MK = 5.7 (Kamik) and MP = 5.7 (Peronaci) reported in the ENEL Catalogue.
The one-year duration of the seismic period is a characteristic that seems to be typical of the earthquakes originating in the external Apennine range (buried pedi-Apenine).
Summing up, the following is a comparison of the values of some parameters, reported respectively in the ENEL and Carrozzo et al. Catalogues, and in the present study.

Year	Mo	Da	Ho	Mi	Lat	Long	De	I	Me	Mk	Mp	Epic. area
1505	01	03	01		44°20'	11°20'		IX		5.7	5.9	Bologna
1505	01	02	02	30	44°30'	11°15'		IX		6.0		
1505	01	03	01	45	44°30'	11°12'		VII	4.7	4.7		S. Lorenzo in collina

List of shocked localities:

Locality	Latit.	Long.	I (MCS)
Bologna	44°30'	11°20'	VII
Zola Predosa	44°29'	11°13'	VII
S. Lorenzo in Collina	44°33'	11°09'	VII
Ferrara	44°50'	11°37'	V
Modena	44°39'	10°56'	VI
Lugo	44°25'	11°55'	IV
Ravenna	44°25'	12°12'	IV
Verona	45°26'	11°00'	IV
Vicenza	45°33'	11°33'	IV
Forlì	44°13'	12°03'	IV
Reggio Emilia	44°42'	10°38'	V

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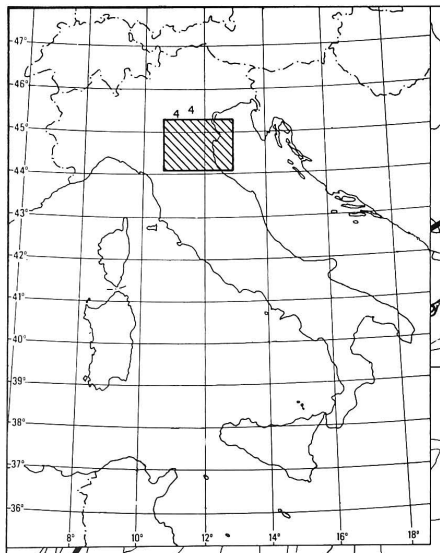

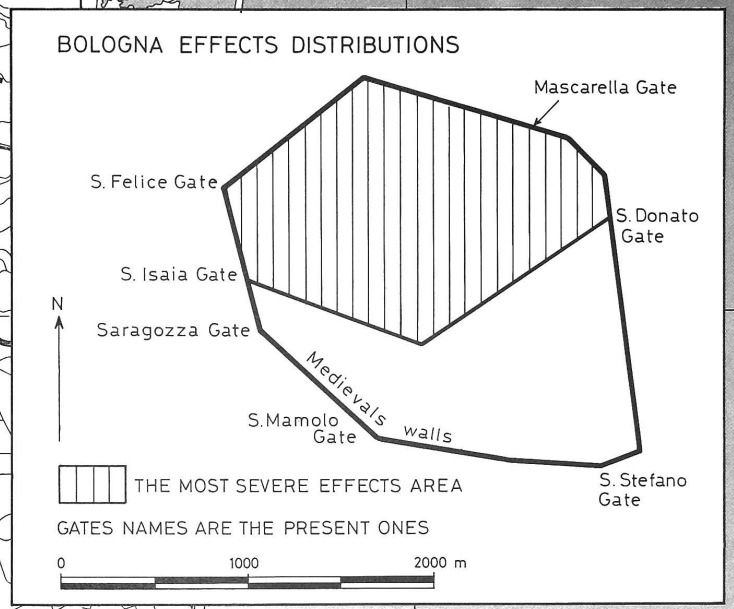

Adige
ROVIGO
Po
FERRARA
Panaro
Secchia
REGGIO nell'EMILIA
MODENA
Reno
Idice
Sillaro
Zola Predosa
VII
BOLOGNA
Santerno
Lugo
RAVENNA
Montone
Savio
FORLI
Cesena
MARE ADRIATICO
45°
40'
20'
0 10 20 30km
SCALA 1 : 500 000
11° Est Greenwich
30'
12°
30'

THE BOLOGNA EARTHQUAKE OF JANUARY 3, 1505

Compiled by
G. Ferrari, E. Guidoboni, D. Postpischl

The drainage network of this map – scale 1:500.000 – is the same as the "Structural Model of Italy."

G.T.M - Via Marco Marulo 47a - 00143 ROMA

The Val di Noto earthquake of December 10, 1542.

M.S. Barbano

The earthquake of 10.12.1542 seems to have been the weakest among the great shocks (Barbano, this issue) which ruined the «Val di Noto», although historical documents did not allow for certain intensity determination. The main shock occurred at 4 p.m. E.M.T.

The meisoseismal area is smaller than for the earthquakes of 1169 and 1693. The hypothesis of a shallow focus should be rejected due to the lack of any information on primary ground deformation which accompanys the biggest shallow earthquakes.

Only Melilli and Sortino are included in the meisoseismal area. The epicenter should, therefore, be close to these two cities. In the old catalogues the epicentre is fixed at Siracusa, the main city of the area. The high intensity value of Grammichele could be due to border effect as in the 1693 earthquake.

The intensity has been evaluated only on the basis of the number of buildings that suffered damages or destruction.

Damages have been divided into three classes:

a) Totally destroyed cities: Sortino, Melilli, Grammichele; IX-X degree.
b) Nearly totally destroyed cities: Siracusa, Vizzini, Licodia Eubea, Mineo, Lentini and other villages in the «Val di Noto» (4); VIII-IX degree.
c) Heavy damage: Catania, Augusta, Noto, Caltagirone, Militello in Val di Catania and about 30 castles (6); VII-VIII degree.

Moreover, in Palermo, Trapani and several other cities in western Sicily (the so-called «Val di Mazzara»), the earthquake was felt, but it is difficult to evaluate the damage.

The aftershocks lasted 40 days.

In the ENEL (1977) catalogue the earthquake is listed as follows:

1542 12 10 22 37°10' 14°50' IX Siracusano

On the basis of the result of the present study, it is possible to give better location and intensity values, though further studies are necessary:

1542 12 10 16 37°10' 15°10' IX-X

List of shocked localities:

Locality	Latit.	Long.	I (MCS)
Grammichele	37°12'	14°38'	IX-X
Melilli	37°09'	15°07'	IX-X
Sortino	37°09'	15°01'	IX-X
Lentini	37°17'	15°00'	VIII-IX
Licodia Eubea	37°09'	14°42'	VIII-IX
Mineo	37°16'	14°41'	VIII-IX
Ragusa	36°55'	14°44'	VIII-IX
Vizzini	37°09'	14°45'	VIII-IX
Augusta	37°14'	15°13'	VII-VIII
Caltagirone	37°14'	14°31'	VII-VIII
Catania	37°30'	15°05'	VII-VIII
Militello in Val di Ct	37°16'	14°48'	VII-VIII
Noto	36°47'	15°04'	VII-VIII
Palermo	38°07'	13°22'	NF
Trapani	38°01'	12°31'	NF

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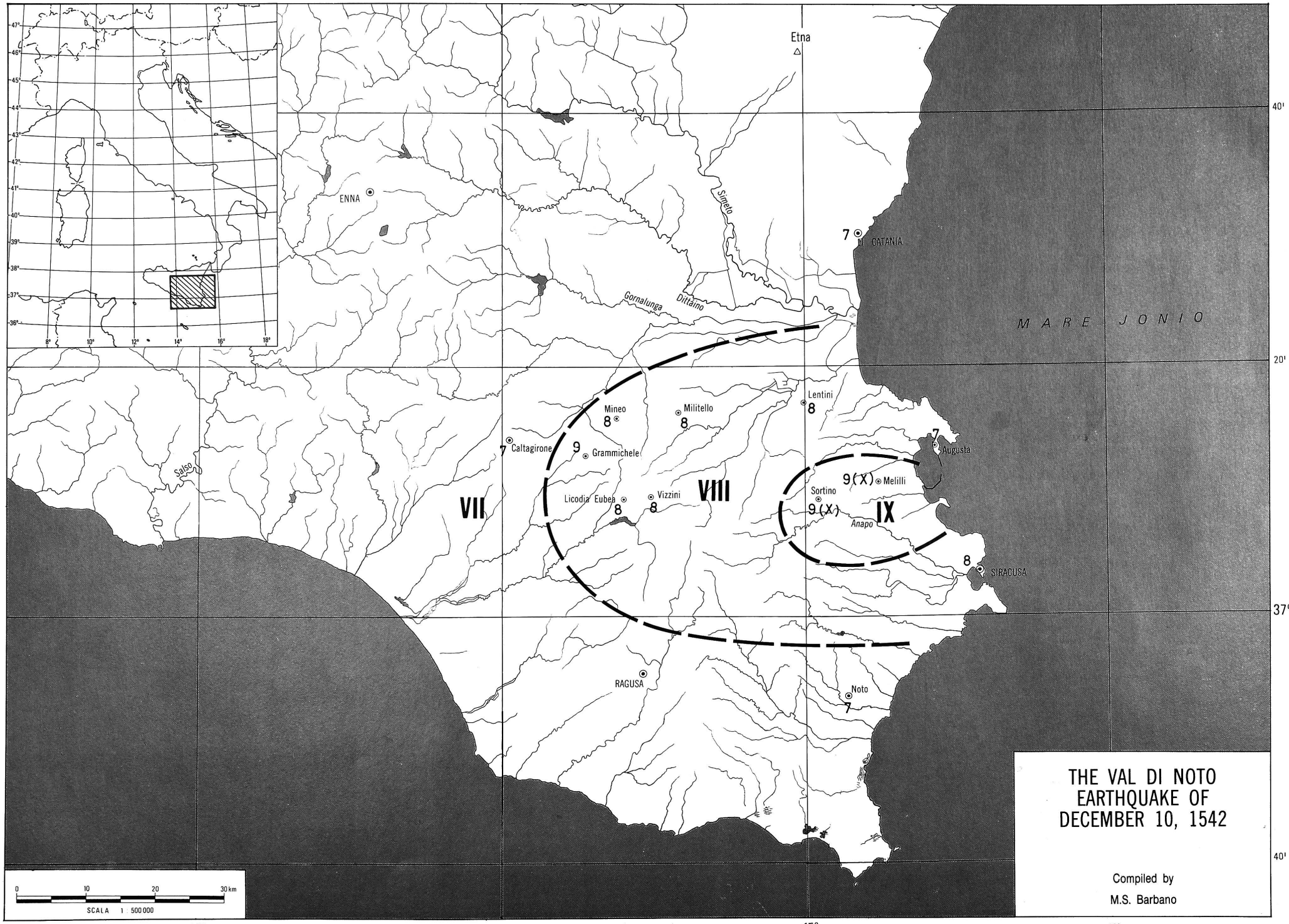

THE VAL DI NOTO EARTHQUAKE OF DECEMBER 10, 1542

Compiled by

M.S. Barbano

The drainage network of this map – scale 1:500.000 – is the same as the "Structural Model of Italy."

G.T.M - Via Marco Marulo 47a - 00143 ROMA

The Ferrara earthquake of November 17, 1570.

G. Ferrari, E. Guidoboni, D. Postpischl

On November 17, at 7:00 p.m. GMT 1570, the most violent earthquake in a seismic period hit Ferrara, preceded by some strong shocks which frightened the population. This unusually long seismic period lasted until the end of 1574.

Destructive effects of the phenomenon involved an extensive area, delimited by the Po and Reno Rivers, approximately centered on the city of Ferrara.

The catalogues report only some of the strongest shocks of the seismic period. The shock at 7:00 p.m. GMT appears with an epicentral intensity of IX MCS.

Historical research on this earthquake and on the shocks that followed was favoured by a particular documentary advantage due to the preservation of the archives of the Este Dukes and to the resonant effects that these earthquakes had on the Italian and European Courts, considering the political and cultural role of Ferrara in the sixteenth century.

The *Segreteria ducale* tended to minimize this event, which appeared to threaten its own political prestige; this motivated the marked differences between philo-Ducal sources, scarce in details and reductive, and other testimonies, which being inserted in a climate of political conflict, reacted by sometimes exaggerating the effects of the earthquake. A certain role was also played by the counter reformational tensions existing at the time, which encouraged the supernatural interpretation of the phenomenon, fomenting collective fear. This explains the fled from the city by over 1,000 people (more than one-third of the population) for an entire year.

In this complex socio-historical context, testimonies from private citizens and personages of the Ducal Court are inserted, including some noted personalities such as Pirro Ligorio, architect and «antiquario di corte», the «procuratore» Ippolito de Robertis, Buonaiuto Dei Rossi, physician and humanist of the Jewish community of Ferrara, and in that period the antique dealer of the Court of Ferrara.

Moreover, three manuscript diaries were utilized in which the day, hour, duration, and effects of the shocks felt in the city have been noted for many months after the main event. Two of these diaries cover a period of four years. The frequent correspondance between Ambassadors Bernardo Canigiani for the *Granduca* of Toscana, and Livio Passeri for the Duke of Urbino, was also used, as was the correspondence between the Court of Ferrara and its Ambassadors in Venice, Turin, and Rome.

A critical evaluation of all the testimonies has allowed us to obtain a comprehensive image of the effects of the various shocks that occurred, especially in the urban area (effects on construction and on soil). Since the documentation concerning the event is particularly rich, the city has turned out to be the privileged point of observation.

The evalutation of the severity of the effects in the surronding area has been more problematic: the aspect of the territory of the Dukedome of Ferrara was significantly different from today, because two-thirds of it was covered by water (swamps and marshes). The town and villages were previously located along river banks and on the natural levees created by the ancient course of the River Po.

For the most important inhabited centers, it was possible to utilize the correspondence between the different «*podestà*» and the *Segreteria ducale*. In fact, the day after the earthquake, the *Segreteria ducale*, in order to evaluate the actual damage undergone, asked the responsible administrators if the earthquake had been felt, at what time, what the quality of it was, and how long it lasted.

The responses which unfortunately present some archivial gaps, have permitted us to evaluate the effects of the various shocks on the inhabited centers. The various «*podestà*» referred to the possible damage done to constructions in masonry, which constituted only a part of the existing constructions. In fact, many of the farmers' and fishermen's house were made of cane and mud.

An Apostolic Visit which took place three years after the first shocks was used to evaluate the effects on the villages. Such a survey was aimed at ascertaining the state of preservation of the ecclesiastical constructions (churches, oratories, rectories, hospitals, etc.).

Since it is not possible, through such descriptions to differentiate the effects of individual shocks, an approximate evaluation of the maximum intensity has been made for each locality, taking into consideration the degradation resulting from lack of restorative measures.

The cumulative effects of the different shocks, and the various testimonies influenced by collective panic, induced the compilers of the preceding catalogues to evaluate the effects of the shock of November 17, at 7:00 p.m. GMT as much more severe than they actually were.

The descriptions of the shocks felt in Ferrara from 3:00 p.m. GMT on November 16 until 7:00 p.m. the following day, have now permitted the evaluation, with obvious approximations, of the contribution of each shock to the picture of total damage.

The refences that follow is intended to motivate new evaluations of this seismic period.

From the beginning of November 1570, intense noises, similar to the roar of water thunder, had been heard and were located along the old course of the River Po di Primaro, in the direction of Ravenna.

On the morning of November 16, small shocks were felt between the hours of 3:15 p.m. and 5:15 p.m. GMT. An earthquake caused the collapse of various chimneys and battlements, opened cracks in houses, and provoked a great deal of panic among the inhabitants.

The following day, November 17, at 1:45 a.m., another shock caused the collapse of 500 to 600 small terraces, causing further damage to residential structures. The same morning, numerous shocks followed, though they did not cause additional damage to the constructions.

At 11:45 a.m. GMT, a new shock opened more cracks in the walls and frightened the population.

Other perceptible shocks followed until about 4:15 p.m. GMT, when a strong one brought about additional damage, while still another one, at 5:15, caused the collapse of the remaining chimneys, battlements and balustrades all located on «summit» positions of the Ferrarese constructions. At 6:15 p.m. the same day, another shock was felt, considered by some testimonies as less intense than the one occurred 1:45 a.m.

At 7:00 p.m. a shock occurred, and in regard to the effects (VIII MCS) and duration (according to a reliable testimony it lasted «half a tenth of an hour»), this is considered to have been the main shock.

The earthquake was first felt as an oscillation in the east-west direction, then north-south.

During that same night, frequent shocks were felt about every quarter of an hour; in all, more than 50 small or medium shocks are said to have occurred.

On the whole, the damage done to the city was noteworthy: it was observed that churches and palaces were the constructions most intensely hit, particularly those isolated at the end of the streets. Some churches totally collapsed and some of them had to be restored. Due to the lack of official recognition of the damage, one must suppose that even minor private buildings were significantly damaged.

Some testimonies recognize the medieval part of the city — the most densely inhabited and constructed area — as severely damaged. A further confirmation of the impact of the earthquake on this urban area is suggested by observations regarding changes in some architectonic elements. For example, filler walls were built between the columns of the porticos to reinforce the buildings and external stairs and small terraces were not build any more. All these alterations are dated, in fact, in the last decades of the sixteenth century.

During the main shock, the water of the castle moat overflowed and the River Po in the vicinity of the village of Stellata underwent a sharp variation in water level; luminous phenomena of the air («Aria rubiconda») and liquefaction of the terrain occurred. Cracks were observed, some of which were of a noteworthy length (up to more than a kilometer), located parallel to the walls of the town (in a NW direction) along the present embankments of the Burana Canal.

Analogous phenomena, with the emergence of black malodorous sand, were testified for various parts of the countryside.

The resulting distribution of the effects of this earthquake on the territory, expressed in terms of MCS intensity, is shown in picture. The isoseismal areas show a marked lengthening in the WNW-ESE direction, in concordance with the direction of the axis of the «Dorsale Ferrarese».

Using the Blake formula, the depth of this earthquake is 7 km.

The shock on November 17, at 7:00 p.m. GMT, was also felt in Venice, Mantua, Bologna, Modena and Pesaro. Application of the Galanopoulos formula to a careful estimate of the felt area gives a macroseismic equivalent of magnitude of Me = 5.6.

In different sources, reference is made to over 2,000 shocks felt in Ferrara from 1570 to 1574, most of which are dated. Table 1 shows a list of the principal shocks felt in Ferrara from November 16, 1570 to November 17, 1574.

Regarding the unusual duration of this seismic period, it must be underlined that the testimonies concerning the shocks are found in sources related to the city, which must be considered as a fixed point of observation, not necessarily as the epicenter. In fact, one cannot exclude a possible distribution of the epicenters along the entire «Ferrarese Ridge». Only in some cases do the sources explicitly indicate the places where the shocks were felt most strongly. Summing up, the following is a comparison of the values of some parameters, reported respectively in the ENEL and Carrozzo et al. Catalogues, and in the present study.

Year	Mo	Da	Ho	Mi	Lat	Long	De	I_o	Me	Mk	Mp	Epic. area
1570	11	17	20	00	44°50'	11°40'		IX		5.7	5.9	Ferrara
1570	11	17	21	30	44°45'	11°30'		IX		6.0		
1570	11	17	19	00	44°50'	11°39'	7	VIII	5.6	5.3		Ferrara

Table 1

Year	Mo	Da	Ho	Mi	I	Epic. area
1570	11	16	16	15	VII	Ferrara
1570	11	17	01	45	VII	Ferrara
1570	11	17	12	15	V	Ferrara
1570	11	17	16	15	VI	Ferrara
1570	11	17	19	00	VIII	Ferrara
1570	11	24	07	00	VI	Ferrara
1570	11	29	06	30	VI	Ferrara
1570	12	01			VII	Ficarolo
1570	12	07	14	00	VI	Ficarolo
1570	12	07	18	40	V	Ficarolo
1570	12	14	22	00	VI	S. Pietro in C.
1570	12	26	19	00	V	Quartesana
1570	12	27	23	00	V	Ferrara
1571	01	11	15	20	V	Portomaggiore
1571	02	02	02	10	V	Portomaggiore
1571	01	28	02	40	V	Ferrara
1572	12	27	15	30	V	Portomaggiore
1574	03	17	03	40	VI	Finale Emilia

List of shocked localities:

Locality	Latit.	Long.	I (MCS)
Aguscello	44°48'	11°40'	VI-VII
Argenta	44°37'	11°50'	V-VI
Bologna	44°30'	11°20'	IV
Canalnuovo	44°59'	11°57'	V
Canaro	44°56'	11°41'	VI-VII
Carpi	44°47'	10°53'	VI
Castel Massa	45°01'	11°19'	VII-VIII
Cento	44°44'	11°17'	VI
Codigoro	44°49'	12°06'	V
Cona	44°48'	11°43'	VII-VIII
Crespino	44°59'	11°53'	V
Ferrara	44°60'	11°37'	VIII
Fiesso	44°31'	11°29'	VI-VII
Finale Emilia	44°50'	11°18'	VI
Focomorto	44°50'	11°41'	VI-VII
Formignana	44°50'	11°52'	VI-VII
Fossalta	44°51'	11°46'	VI-VII
Gaibanella	44°46'	11°39'	VII-VIII
Gambulaga	44°45'	11°47	VII-VIII
Gurzone	44°56'	11°35'	VII
Lugo	44°25'	11°55'	V-VI
Mantova	45°09'	10°46'	V
Masi Torello	44°48'	11°44'	VII
Modena	44°39'	10°56'	IV
Papozze	44°59'	12°01'	VI
Parma	44°48'	10°20'	V
Pesaro	43°54'	12°54'	III-IV
Ravalle	44°56'	11°31'	VI
Reggio	44°42'	10°38'	IV
Rovigo	45°04'	11°47'	V
Runco	44°44'	11°46'	VII
S. Nicolò	44°43'	11°42'	VII
S. Maria Codifiume	44°40'	11°39'	VII-VIII
Stellata	44°57'	11°25'	VII
Tresigallo	44°49'	11°54'	VI-VII
Venezia	44°26'	11°20'	V
Villanova	44°50'	11°49'	V-VI
Voghenza	44°46'	11°45'	VI-VII
Voghiera	44°45'	11°45'	VI-VII

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THE FERRARA EARTHQUAKE OF NOVEMBER 17, 1570

Compiled by

G. Ferrari, E. Guidoboni, D. Postpischl

PADOVA
MANTOVA
PARMA
REGGIO nell'EMILIA
MODENA
BOLOGNA
FERRARA
ROVIGO
Cona
Crespino
Papozze
Stellata
Ravalle
Finale Emilia
Tresigallo
Codigoro
S.Nicolò
Idice
Sillaro
Santerno
RAVENNA
Castel S. Pietro
Imola
Faenza
FORLÌ
Savio
Rabbi
Montone
Chiese
Oglio
Mincio
Adige
Po
Enza
Parma
Secchia
Panaro
Cento
Reno
Savena
V
VI
VII
VIII
MARE ADRIATICO
0 10 20 30 km
SCALA 1 : 500 000
45°
40'
20'
30'
11° Est Greenwich
30'
12°
30'

The drainage network of this map – scale 1:500.000 – is the same as the "Structural Model of Italy."

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The Argenta earthquake of March 18, 1624.

G. Ferrari, E. Guidoboni, D. Postpischl

The earthquake that occurred in Argenta on March 18, 1624, at 7:30 p.m. GMT, represents the most violent shock in a seismic period which began in February and lasted for about a year.
This earthquake was located in the external Apennine range (buried pedi-Apennines) which is characterized, under the sedimentary covering of the Po River Valley, by arc structures alternated with reverse faults. This structure is known as the «Ferrarese Ridge».
Current catalogues record the epicentral intensity of the shock that occurred at 7:30 p.m. as X degree MCS, the highest intensity observed for earthquakes in this area.
The destruction of the parochial and communal archives of Argenta during World War II, and the dispersion of the archives of the Papal Legation (during the Napoleonic occupation) have rendered the reconstruction of the effects of this earthquake particularly difficult. The first local chronicles, which began halfway through the eighteenth century, record this event apparently in great detail.
The description, taken from a dispersed parochial diary, was enriched with evident literary elaboration typical of eighteenth century taste. The only contemporary printed account, utilized by M. Baratta, could not be found in local, national, or Vatican libraries.
Descriptions of this earthquake are found in the seventeenth century chronicles of Ferrara and Bologna, and ample references to it are made in many contemporary chronicles of the major centers of Romagna and Venetia.
The archival material existing regarding the 1624 earthquake had not been consulted by previous authors, and therefore, the description of the event was based on material provided by late local chronicles.
Some letters, written by an agent of the Duke of Este, reporting on the condition of the Ducal properties in the territory of Argenta, were found and have been used as direct testimony. Such documentation therefore constitutes the only direct source regarding Argenta and some surronding villages. In this correspondence, the number of collapsed houses is indicated as 182; in other testimonies, this number oscillates between 150 and 180. Keeping in mind that Argenta had about 1,560 inhabitants, and assuming an average number of 5 inhabitants per construction (as indicated in specific studies on this regional area), the number of houses in this town is calculed as having been perhaps a little over 300.
The percentage of collapsed houses would therefore be about 50%.
These observations seem to confirm the description of the severe damage done, especially to private constructions, while less damage seems to have been done to ecclesiastic edificies. Two churches and various bell towers are listed among the partially collapsed construction.
The collapse of a total of 24 towers, which were said to have surrounded the small town, are also ascribed to this earthquake in the chronicles of the eighteenth century.
The painting of a contemporary local artist was used as iconographic testimony because of the realistic attention given to the representation of the earthquake. The painting (illustrated on the cover of this atlas) depicts lesions and partial collapse of the towers and the town, while most of the small guard towers and the gates of access to the town appear intact. Some belfries, reported in eighteenth century chronicles as having collapsed, are depicted partially collapsed at their top sections.
From the only book of deaths that could be found (belonging to the collegiate church of San Nicolò), seven deaths caused by the earthquake were ascertained, while the sources report 25 deaths in all (about 2% of the population).
From all the testimonies, it appears that the major damage was caused by the giving way of foundations (phenomena of liquefation): this can be explained by the type of soil (superficial water table and sand layers).

The entire area is delimited by the old course (today deviated) of the Po di Primaro River, the Campoto and Comacchio marshes, and ample swamp zone. This particular location, which moreover isolated Argenta from the most inhabited band of the low Po River Valley, justifies the lack of information about the effects of the earthquake in the surrounding area, above all in the south-east section of the zone at the border of the territory of Ravenna.
As far as the evolution of the phenomenon is concerned, October 16, 1623 can be considered the beginning of the seismic period, when some shocks were felt in Argenta as well as Ferrara. On February 2 and February 3, 1624, more intense shocks were felt and continued with minor intensity until March 18, when, at 7:30 p.m. GMT, the shock responsible for major damage to constuction occurred. During that night a few dozen shocks were felt.
The effects on the soil appear very similar to those described for earthquakes in the Ferrara territory from 1570 to 1574. In fact, «malodorous» water and black sand came out of numerous fissures; an embankement of the Primaro branch of the Po River gave way and its waters flooded the town. During the main shock, the waters of the Comacchio and Campotto marshes rose and beat against the embankments. Less intense shocks were felt during the following months (the shock on April 26 is especially remembered) and definitively terminated after a year.
The maximum intensity for Argenta can be estimated as IX degree MCS, while, for the few remaining localities surrounding it, the evalutations do not go over VII degree MCS.
Keeping in mind what was previously said about the phenomena of liquefaction, the resulting distribution of intensities suggests, that the IX MCS degree observed in Argenta resulted from a phenomenon of local amplification due to the particular hydrogeological condition of the territory. It is also notable that the other earthquakes involving Argenta have never had an epicentral intensity greater than VII degree MCS.
In summary, the following is a comparison of the values of some parameters, reported respectively in the ENEL and Carrozza et al. Catalogues, and in the present study.

Year	Mo	Da	Ho	Mi	Lat	Long	De	I_o	I_{max}	Me	Mk	Mp	Epic. area
1624	03	19	20	00	44°35'	11°50'		X			6.2	6.4	Argenta
1624	03	19	20	00	44°30'	11°45'		X			6.0		
1624	03	18	19	30	44°40'	11°55'		VII	IX		4.7		Argenta

List of shocked localities:

Locality	Latit.	Long.	I (MCS)
Argenta	44°37'	11°50'	IX
Bando	44°39'	11°53'	VII
Belriguardo	44°45'	11°45'	VII
Boccaleone	44°38'	11°48'	VII
Bologna	44°30'	11°20'	IV
Copparo	44°54'	11°50'	VI
Ferrara	44°50'	11°37'	VI
Filo	44°35'	11°56'	VII
Porto	44°35'	11°54''	VIII
Ravenna	44°25'	12°12'	V
San Biagio	44°35'	11°52'	VII
Valli di Comacchio	44°40'	12°00'	VII

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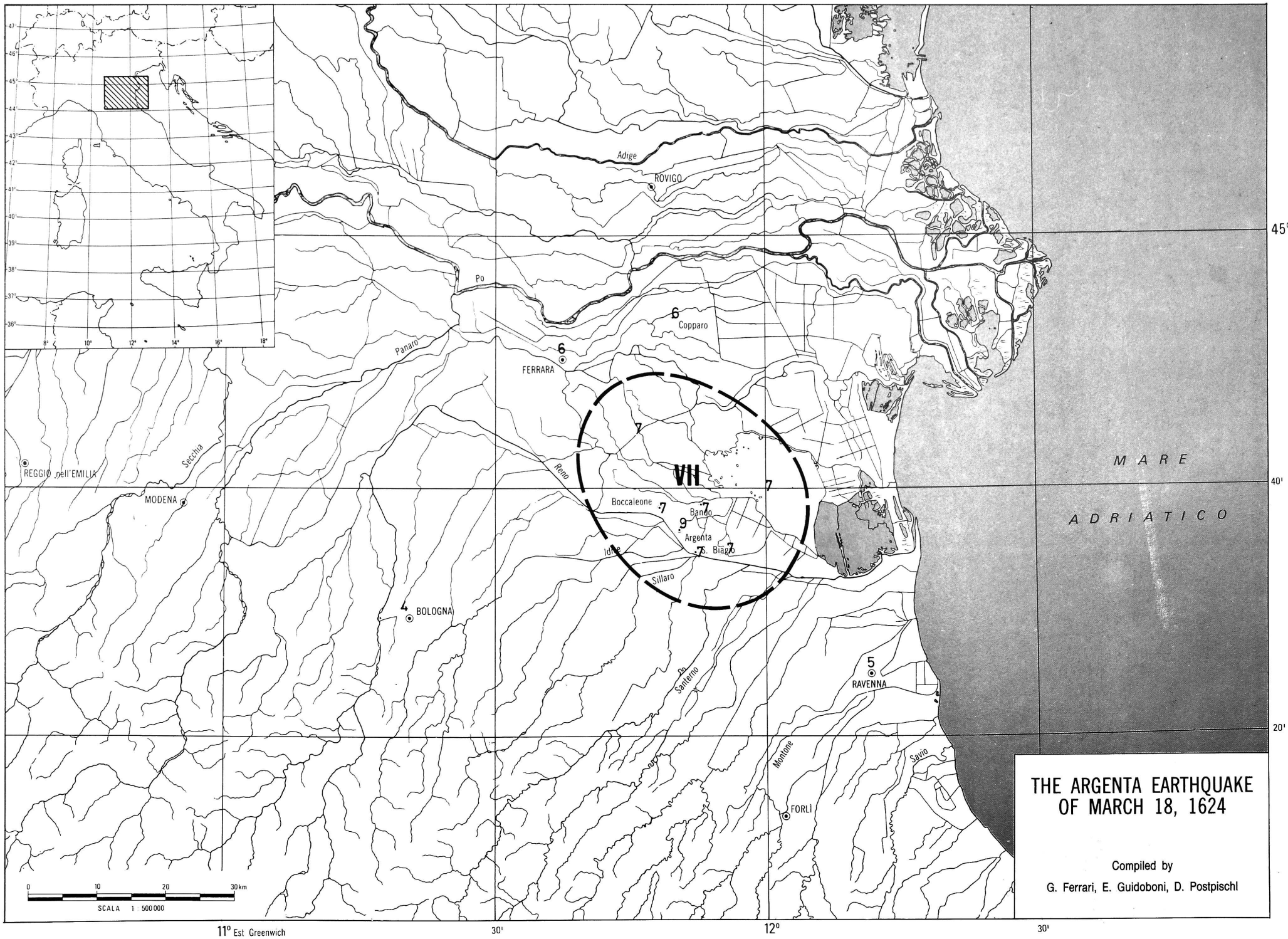

THE ARGENTA EARTHQUAKE OF MARCH 18, 1624

Compiled by

G. Ferrari, E. Guidoboni, D. Postpischl

The drainage network of this map – scale 1:500.000 – is the same as the "Structural Model of Italy."

G.T.M - Via Marco Marulo 47a - 00143 ROMA

The earthquake of July 1627 in the Northern Capitanata.

D. Molin, C. Margottini

This is perhaps the most important event in the seismic history of Apulia. Affecting northern Capitanata and part of Molise with several destructive shocks, it caused the almost complete destruction of several villages, and the victims numbered more than 5,000. It also caused fractures in the ground, variations in the flow of underground waters, and a severe tsunami along the coasts of the Gargano promontory, Molise and southern Abruzzi.

A fairly rich literature exists on the subject, both contemporary and later. The contemporary literature consists of reports, letters and accounts; the later literature includes certain seismological works written at the end of last century and many historical works referring to the towns affected by the earthquake. It is, furthermore, described more or less widely in all the national seismic catalogues.

The manuscript by Antonio Lucchino (59) has proved to be essential for studying the earthquake. At that time, he was living at San Severo, and he was thus an eye witness of the event. His manuscript consists of a detailed, careful report with information about the seismic sequence, the damage caused in a number of villages, the effects of the earthquake on the environment and also the topographical location of the towns and villages that either no longer exist today, or have changed their names.

It is interesting to note that when this earthquake occurred, some of the earliest examples of intensity maps were published, showing the distribution of the damage according to a macroseismic scale with four degrees (57, 62).

There has been no difficulty in fixing the dates of the main earthquakes, since the contemporary writers are all in agreement. However, some later writers do not agree, probably because of errors in interpreting the original texts. Discrepancies exist, in the information concerning the times, but that is to be considered normal given the lack of precision in measuring time at that period.

The seismic sequence probably connected with this event lasted for a good three years, with a number of aftershocks; the figure is difficult to estimate-probably numbering roughly between 1,500 and 2,000.

The four events listed below reached the IX degree of the MCS:

- 30.7.1627, 12.00 local time, 41°47' N, 15°18' E, X-XI MCS
- 30.7.1627, 12.15 local time, 41°47' N, 15°18' E, IX MCS
- 7.8.1627, 18.00 local time, 41°47' N, 15°18' E, X MCS
- 6.9.1627, 17.00 local time, 41°41' N, 15°23' E, IX MCS

As far as these four events are concerned, difficulties occurred both in the estimation of the intensity and the location of the epicentres, since there were no indications given of the effects for all the towns for each shock. On the occasion of the earthquake of 9 September, a noticeable shifting of the epicentre towards the South was noted, determined particularly because of the damage suffered by the town of Lucera.

On the whole, it has been possible to carry out a fairly good estimation of the intensity, owing to the reasonable amount and quality of information available. It must be remembered, however, that the values of the intensities reported in the list and on the isoseismal map are inclusive of the seismic sequence, particularly the four shocks listed above.

The isoseismal lines of the epicentral area prove to be generally quite round, with a slight East-West preferential direction. This direction was also noticed on the occasion of the earthquake of 7 August.

The distribution of the intensity in the Molise-Abruzzi region is still very little defined, due to both the lack of information and the presence of relatively high intensities in towns far from the epicentral area, such as Accumuli, Scanno, and Isernia. This may be due to local effects, or, given the uncertainty of the information, to other earthquakes that occurred in July 1627. However it is not possible to prove this second hypothesis, put forward by M. Baratta, with the information that is available at present.

The same areas involved in the earthquake in question have been involved in a number of others, among them that of 9 August 1895, with its epicentre on the Molise-Abruzzi coast, and that of 17 July 1937, with its epicentre near San Severo, whose isoseismal lines follow those of the 1627 earthquake very closely, in various aspects.

List of shocked localities:

Locality	Latit.	Long.	I (MCS)
Accumoli	42°41'	13°15'	VIII
Andria	41°13'	16°17'	VIII
Apricena	41°47'	15°27'	XI
Ariano Irpino	41°09'	15°05'	VI
Ascoli Satriano	41°12'	15°34'	VII
Avellino	40°33'	14°28'	VI
Benevento	41°08'	14°46'	VI
Bovino	41°15'	15°20'	VII
Campomarino	41°58'	15°02'	VII
Candela	41°26'	15°31'	VII
Canosa di Puglia	41°13'	16°04'	VII-VIII
Castelluccio de'Sauri	41°18'	15°29'	VII
Castelluccio Valmaggiore	41°20'	15°13'	VII
Castelnuovo della Daunia	41°35'	15°08'	VIII-IX
Cerignola	41°16'	15°54'	VII
Chieti	42°21'	14°10'	VI
Chieuti	41°51'	15°10'	IX
Dragonara	41°41'	15°09'	X
Foggia	41°28'	15°33'	VII-VIII
Fossacesia	42°14'	14°29'	VIII
Francavilla a Mare	42°25'	14°17'	VII
Isernia	41°35'	14°14'	VII
Lanciano	42°14'	14°23'	VII-VIII
Lesina	41°52'	15°21'	XI
Loreto Aprutino	42°26'	13°35'	VII
Lucera	41°30'	15°20'	VIII-IX
Masseria San Chirico	41°35'	15°42'	VII
Masseria Negri	?	?	X
Napoli	40°51'	14°16'	V
Ortona	42°21'	14°24'	VII-VIII
Paglieta	42°10'	14°30'	VII-VIII
Rignano Garganico	41°40'	15°35'	VIII-IX
Ripalta	41°51'	15°17'	X
Roseto Valfortore	41°22'	15°06'	VII
San Giovanni in Venere	41°15'	14°28'	VIII
San Giovanni Rotondo	41°43'	15°44'	IX
San Marco in Lamis	41°43'	15°38'	IX
Sannicandro Garganico	41°50'	15°34'	X
San Paolo di Civitate	41°44'	15°16'	XI
San Severo	41°41'	15°23'	X-XI
Santa Croce di Magliano	41°43'	14°35'	IX
Sant'Agata	41°53'	15°14'	IX-X
Scafieta	41°40'	15°54'	VIII
Scanno	41°54'	13°53'	VII-VIII
Serracapriola	41°48'	15°10'	XI
Taverna di Civitate	41°47'	15°14'	XI
Termoli	42°00'	15°00'	VIII-IX
Torre dei Giunchi	41°43'	15°25'	X
Torre di Brancia	41°43'	15°30'	X
Torre di Zecchini	41°43'	15°28'	X
Torre Fortore	41°55'	15°20'	X
Torremaggiore	41°41'	15°23'	X-XI
Trani	41°17'	16°25'	VII-VIII
Tremiti (Isole)	42°07'	15°30'	VIII
Troia	41°22'	15°19'	VII-VIII
Vasto	42°07'	14°42'	VII
Vieste	41°53'	16°10'	?

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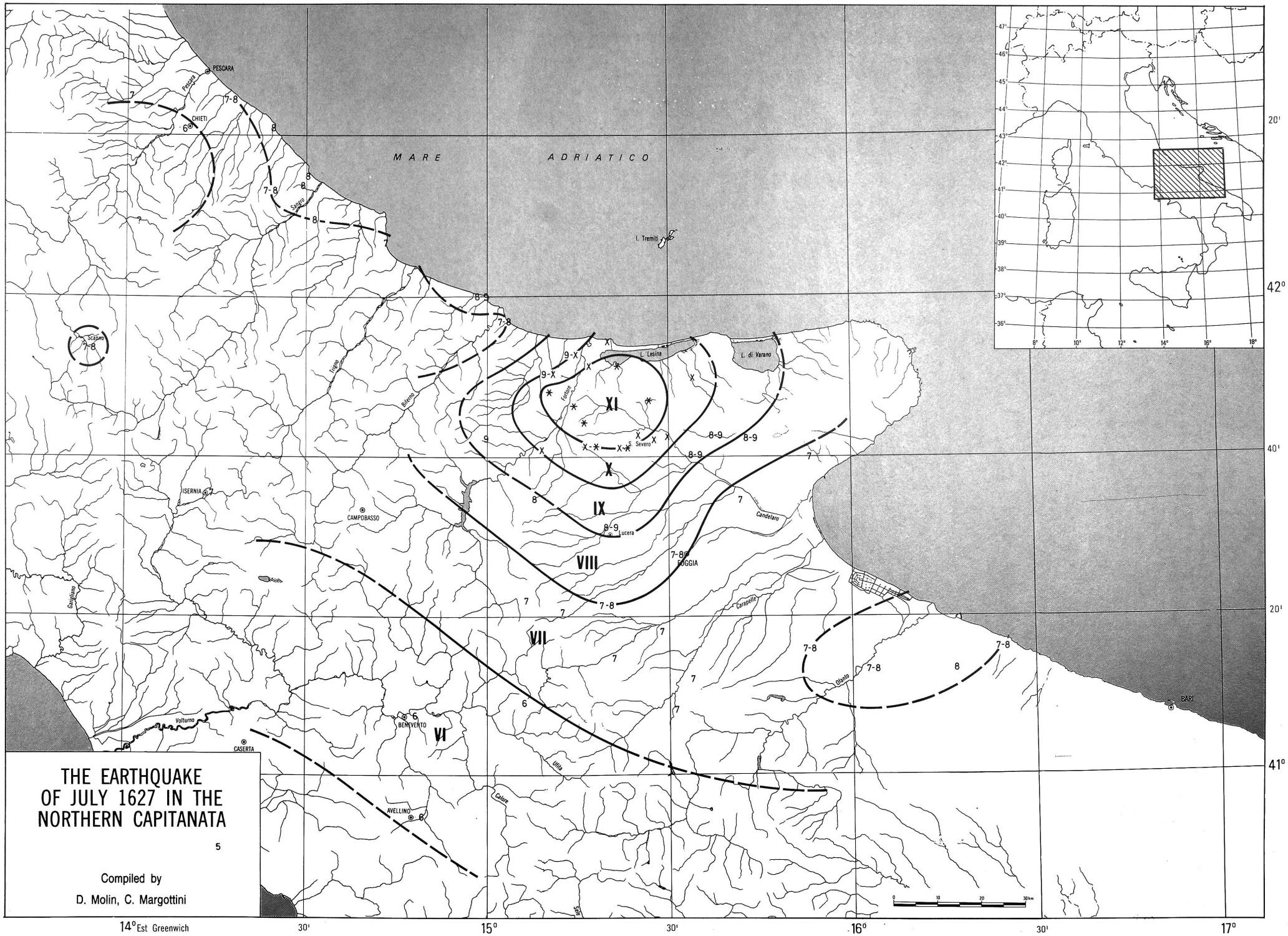

The drainage network of this map – scale 1:500.000 – is the same as the "Structural Model of Italy."

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The Civitella Earthquake of March 22, 1661.

G. Ferrari, E. Guidoboni, D. Postpischl.

The current catalogues classify this earthquake with an epicentral intensity of IX degree MCS.
The hardest hit areas were principally the Apennine Valley of Montone, Rabbi and Bidente, including territories then belonging to the Church State and the Grand Duke of Tuscany. This particular situation has allowed the use of numerous documentary sources pertaining to the two different areas of power. Therefore, the typology of these sources is complex.
Besides specific documentation, such as visits and surveys expressly ordered by Ferdinand II of Tuscany, administrative corrispondence between the local communities and the Legazioni Pontificie (Papal Legations) was also consulted. Information regarding single localities was deduced from the deliberative acts of the community council, material from parochial and private archives, and local chronicles.
An abundant production of printed descriptions and relations, motivated by the consolidation of naturalistic interests, must also be mentioned.
Confirmation of the damage done to single buildings was deduced, among others, by using some epigraphic testimonies.
The interests held in this earthquakes by its contemporaries is explained by the severity of the effects in the meizoseismal area, as well as by the commercial importance of the areas involved.
The possibility, in this case, of recognizing the partial opinion of the urban sources has allowed a satisfactory documentation of the effects of this earthquake as far as the VII degree MCS area.
The desctruction or dispersion of a great deal of the archives of this zone during the last World War, has, instead, rendered very difficult, and has sometimes prevented the classification of the effects corresponding to VI, V and IV degree MCS. While, for some large inhabited centers it has been possible to attribute effects to the III degree MCS.
The highest degree of damage to constructions is attributed to the first shock, which occurred on March 22, 1661, at 1:30 p.m. GTM, and lasted a «creed» (about 3 minutes). The earthquake was accompanied by a violent atmospheric disturbance, (very dark rain clouds, which according to the testimonies, left some drops of rain with an exceptional dimension, and very strong winds). Minor shocks were felt until evening.
The damage in Tuscany seems to be documented with greater precision than that of the papal area: an evaluation of the number of constructions «ruined», the number of deaths, and the number of cattle perished is possible for the towns of Galeata, Rocca San Casciano, Portico, Tredenzio, Modigliana, Marradi, Palazzuolo, Premilcuore, S. Sofia, Castrocaro, Terra del Sole and Dovadola (the Rabbi and the Montone Valleys). The hardest hit centers were Rocca San Casciano, where 76% of the building property was unserviceable, and Galeata, where grave damage and collapse involved 70% of the houses. Data partially related to these documents are reproduced in Baratta, with some transcription errors.
Detailed and specific surveys have been drawn up and provided with plans for the Grand Ducal fortresses surrounding the Montone Valley (Terra del Sole, Castrocaro and Montepoggiolo). Other visits by Grand Ducal agents have also provided indications for the Apennine villages of Tuscany.
In the high valley of the Bidente River, the hardest hit territory was Civitella, including the inhabited center and the rural area.
Printed reports and detailed descriptions, which were widely diffuse, have also provided information for the plains of the Forlì territory. Cracks and fissures in the soil occurred in the territories of Tredozio, Galeata and Valdoppio (loud undedrground noises lasted for quite a few days).
A duration of 40 days was attributed to this earthquake. Recollection was infuenced by the religious tendency of the period.
The diaries related to the parishes of Spinello and San Romano have permitted a verification of the entity of the damage done to each individual church. The interpretation of the effects of this earthquake in terms of the MCS scale has led to the drawing of the enclosed map.

Although the information concerns a satisfactory number of localities, the descriptions do not discriminate between the effects of the main shock and those of successive shocks.
Nonetheless, on the basis of what emerges from the sources, it is plausible that shocks of a significant degree did not occur except for the main one at 1:40 p.m. GMT.
The maximum intensity observed is IX degrees MCS, and it can be attributed to the localities of Rocca S. Casciano, Galeata and Civitella di Romagna.
The surrounding meizoseismal area has an elliptical form and is oriented in a NW-SE direction, nearly parallel to the Apennine axis in this zone. The remaining VIII and VII degree MCS areas, which have been possible to delineate, are elongated approximately to the NE-SW direction. Moreover, these areas show an accentuated destruction in the NW part.
The area concerned extends to Urbino, Florence, Bologna, and Ravenna, and has a value of ME = 4.8 for the macroseismic equivalent of magnitude, calculated by using the Galanopoulos formula.
Regarding the location of the epicenter, corresponding, in the preceding catalogues to the coordinates 44°10' N - 11°57' E, we are faced with a a typical example of propagation of an error, due to lack of analysis of the available documentation. In Baratta, in fact, because of a typographical error, the epicenter is reported as being between Medola and Davola. Successive compilers have reproposed the same coordinates for the epicenter, evidently without carrying out a critical re-examination of the same sources used by Baratta.
The present reconstruction locates the epicenter between Civitella di Romagna and Rocca S. Casciano, corresponding to the coordinates 44°02' N 11°54'E.
Summing up, the followng is a comparison between the values of some parameters, reported respectively in the ENEL and Carrozzo et al. Catalogues, and in the present study.

Year	Mo	Da	Ho	Mi	Lat	Long	De	I	Me	Mk	Mp	Epic. area
1661	03	22	18		44°08'	11°57'		IX-X		5.7	5.7	Romagna
1661	03	22	13	30	44°00'	12°00'		X		6.0		
1661	03	22	12	45	44°01'	11°54'	6	IX	4.8	5.7		Civitella

List of shocked localities:

Locality	Latit.	Long.	I (MCS)
Barberino	44°00'	11°14'	VI
Bertinoro	44°09'	12°08'	VII
Bologna	44°30'	11°20'	IV
Calboli	44°05'	11°54'	VIII
Castel dell'Alpe	43°57'	11°43'	VII
Castrocarro	44°10'	11°57'	VII
Cesena	44°08'	12°15'	VI-VII
Cervia	44°16'	12°21'	III
Civitella	44°00'	11°56'	IX
Cusercoli	44°03'	12°00'	VII-VIII
Dovadola	44°07'	11°53'	VII
Faenza	44°17'	11°53'	VI-VII
Ferrara	44°50'	11°37'	V
Firenze	43°57'	11°15'	III
Forlì	44°13'	12°03'	VII
Forlimpopoli	44°11'	12°08'	VI-VII
Galeata	44°00'	11°55'	IX
Giaggiolo	44°02'	12°03'	VIII
Imola	44°21'	11°43'	IV
Marradi	44°05'	11°37'	VI-VII
Meldola	44°08'	12°04'	VIII
Mercatale	43°59'	11°54'	VIII
Modena	44°39'	10°56'	FELT
Modigliana	44°09'	11°48'	VI
Monte di Telnazzo	?	?	VII-VIII
Montepoggiolo	44°11'	11°57'	VII
Monte Steragia	?	?	VII-VIII
Mortano	43°57'	11°55'	VII-VIII
Pianetto	43°59'	11°54'	VIII
Pieve Salutare	44°08'	11°55'	VIII
Pondo	43°57'	11°55'	VII-VIII
Portico	44°02'	11°47'	VIII
Predappio	44°06'	11°59'	VIII
Premilcuore	44°53'	11°09'	VII
Ravenna	44°25'	12°12'	III
Rimini	44°04'	12°34'	IV
Rocca S. Casciano	44°04'	11°51'	IX
S. Giovanni Squarzarolo	44°03'	11°59'	VIII
S. Godenzo	43°56'	11°37'	V-VI
S. Romano	44°00'	12°07'	VII
S. Sofia	43°57'	11°55'	VIII
Scarperia	44°00'	11°21'	VI
Spescia	43°57'	11°52'	VIII
Teodorano	44°05'	12°06	VIII
Terra del Sole	44°11'	11°58'	VII
Tredozio	43°59'	11°47'	VII
Valdoppio	44°08'	10°59'	VII-VIII

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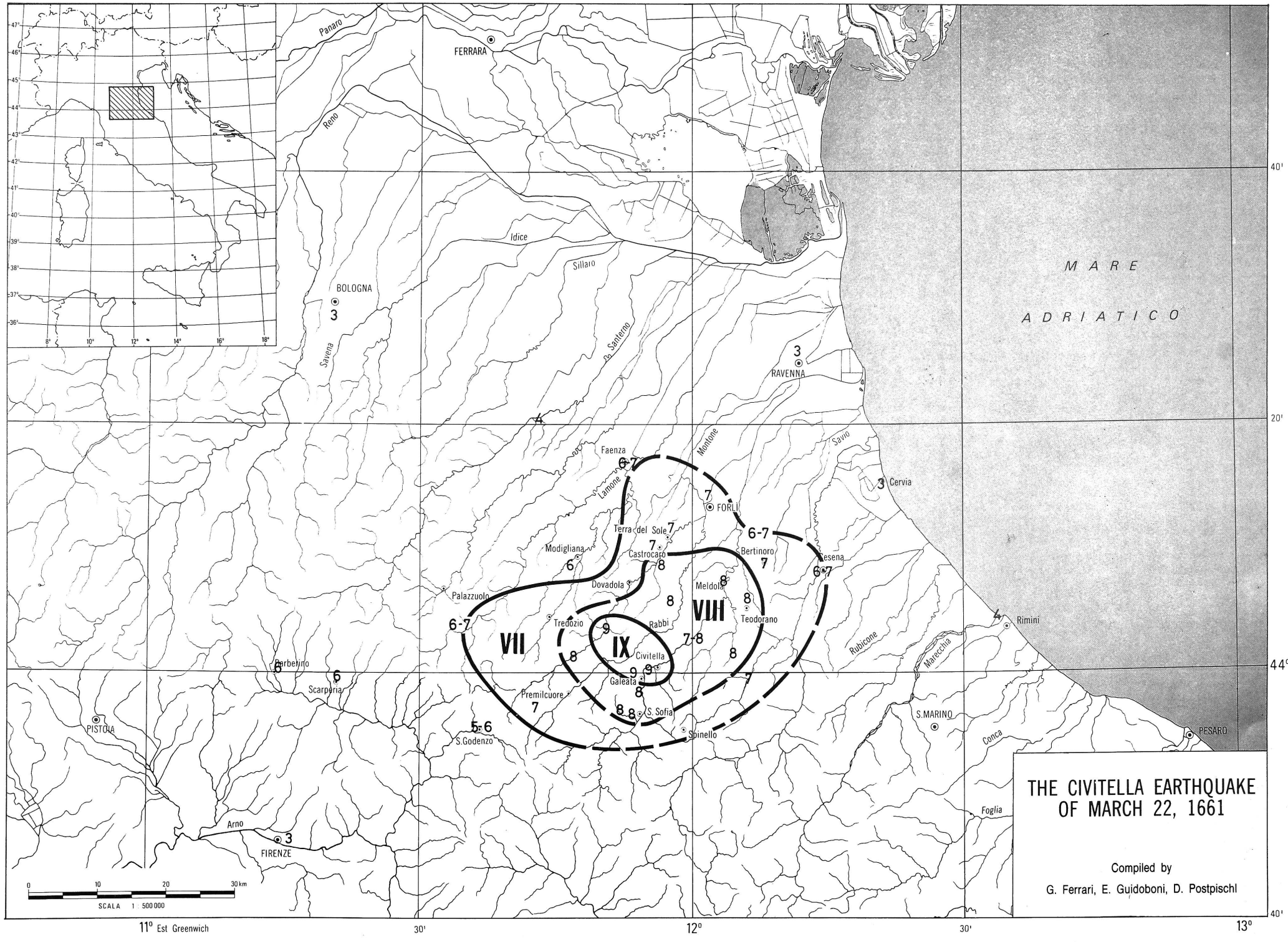

The drainage network of this map – scale 1:500.000 – is the same as the "Structural Model of Italy."

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The Rimini earthquake of April 14, 1672.

G. Ferrari, E. Guidoboni, D. Postpischl.

On April 14, 1672 at 3:15 p.m. GMT, Holy Thursday, a vast littoral and hinterland area of The Marches-Romagna was hit by the desctructive effects of a violent earthquake.
The catalogues agree on ascribing to this earthquake an epicentral intensity corresponding to IX degree of the MCS scale.
The meizoseismal area corresponds to an area on the SE margin of the Po River Valley at the borders of the Apennine range, which is very complex from a structural geological point of view and frequently hit by events with high degrees of intensity. Some of these events — December 12, 1786, March 17, 1875. — have been the subject of recent studies, and appear in this issue.
The administrative organization of the papal province of Romagna in the seventeenth century was structured in such a way that the See of Rome had control over various decentralized administrations: this has allowed access to official sources with highly descriptive details, i.e., the correspondence of the Governo and the legation to the Secretary of State (Secret Vatican Archives).
In addition to the communications sent by the administrators, the reports of bishops, who often gathered testimonies from urban and extra-urban pastors, were also utilized.
Such documentation, however, is not without possible subjective interpretation. The roles performed by the various corrispondents (guarantors of public order or rogators of fiscal exceptions) could have induced a minimization or an exaggeration of the descriptions of the effects. Nevertheless, the documentation as a whole allows a comparison and brings us near the historical truth. In this particular case, for example, the vice-legate, preoccupied with his efficiency as normalizer of public life, which was upset by the earthquake, tended to minimize the effects of the earthquake. In fact, he made appear sufficient the insufficient economic help granted by the Papal Chamber (The Papal See) appear sufficient. According to his testimony, it would have been possible to restore Rimini within six months from the time of the earthquake. Similar statement could not be found in any other sources (including a petition dated January 26, 1673 from the Community of Rimini to the Pope, requesting the use of soldiers to clear the streets that were still impassable because of the ruins of the buildings).
To this archival documentation, widely diffuse printed reports and descriptions are added including diaries and manuscript journals of private citizens, and chronicles of Rimini and of other towns in Emilia-Romagna were used.
The information also covers the surrounding hamlets and castles. In all, testimonies related to 37 localities were gathered.
Some of the information referring to the description of the phenomenon and to some of the effects on inhabitated centers were deduced from the «scientific» treatises of that period.
An element of discordance among the various testimonies is found in the number of deaths, which range from onehundred to five hundred. In order to verify this data, declarations made by pastors for individual parishes were checked. According to these lists, there were 113 deaths in the city, but reference is obviously made only to parish residents; the declaration made by the bishop (that agrees with other testimonies) according to which there were 200 deaths, could include non-parish residents. No data can be ascribed with certainty to the peri-urban and suburban parishes and to those of the countryside. The testimony of 500 deaths, keeping in mind the entity of the damage done to the extra-urban constructions, can therefore be considered as overestimated.
Compared to the description of the damage, the number of deaths in the city still appears high; this might be explained by the fact that the earthquake occurred during a religious festival and therefore caught a great deal of people in churches and in procession.
The damage to urban construction is documented with satisfying precision and confirmed by numerous testimonies. The first shocks were felt between 7:00 and 10:00 a.m. GMT on April 14. The main shock occurred at about 3:15 p.m. GMT on the same day, lasted «a creed» (about three minutes), was preceded by a very loud roar, and accompanied by a violent storm. Major damage was suffered by high constructions: churches, palaces and bell towers. In the churches, above all, the internal collapse of the cupolas caused a high number of deaths. Cornices, chimneys and windows collapsed and walls were damaged. Two private constructions (described as «vaulted small houses») collapsed. All of the sources agree that the major damage to residences was internal: ceilings, garrets and dividing walls gave way (most were made of cane mats and plaster; testified by Riminese surveys carried out for other earthquakes in the eighteenth century).
The parish of S. Maria in Trivio had the highest number of deaths, and many houses belonging to the parish of Sant'Agnese were gravely damaged or semidestroyed. Outside the city, the hamlet of S. Bartolomeo was among those most severely damaged (2/3 of the constructions partially collapsed), whereas in the hamlet of San Giuliano, the damage was minimum and there was only one collapse. (Urban maps of the epoch permit us to localize the city areas).
On the whole, the effects on the city of Rimini, which was certainly among the most damaged, corresponds to VIII degree of the MCS scale. The distribution of the effects in the interior of the city does not appear homogeneous: this may be due to phenomena of local amplification, also found for other Riminese earthquakes.
From the survery carried out by the architect from Cesena, Pier Matteo Angeloni, one may deduce that the total estimate of damage was 159,000 scudi: 90% was related to the city, 43% was attributed to the «abbienti» (wealthy), 20% was attributed to popular constructions («artisans and poor laymen»), and 30% to ecclesiastic and religious property.
In extraurban areas the damage of which corresponds to 10% of the total estimate, 61% of the estimate in scudi was attributed to the abodes of «farmers and the poor».
The distribution of the evalutation points of intensity allows a plausible interpretation in terms of isoseismal lines only as far as VI degree MCS.
The trend of the isoseismal areas points out certain elements, such as the lengthening towards the NW-SE direction, parallel to the Adriatic coast, and the strong attenuation in the direction of San Marino (about NE-SW). These characteristics are confirmed by the other previously mentioned Riminese earthquakes.
The depth, calculated according to the Blake model, is 11 Km. Application of the Galanopoulos formula in a careful estimate of the affected area gives a macroseismic equivalent of magnitude (ME) of 5.9, in agreement with the values calculated for the Rimini earthquakes occurring on April 4, 1786 and March 17, 1875.
The following is a comparison of the values of some parameters, reported respectively in the ENEL and Carrozzo et al. Catalogues, and in this study.

Year	Mo	Da	Ho	Mi	Lat	Long	De	I	Me	Mk	Mp	Epic. area
1672	4	14	20		44°00'	12°45'		IX		5.6	5.4	Rimini
1672	4	14	16		44°00'	12°30'		IX-X.		6.0		
1672	4	14	15	15	44°05'	12°40'		VIII	5.9	5.6		Rimini

List of shocked localities

Locality	Latit.	Long.	I (MCS)
Argenta	44°37'	11°50'	V
Bologna	44°30'	11°20'	III
Cervia	44°16'	12°21'	VII
Cesena	44°08'	12°15'	VI
Faenza	44°17'	11°53'	IV
Fano	43°50'	13°01'	VII
Ferrara	44°50'	11°37'	V
Forlì	44°13'	12°03'	V
Fossomarone	43°41'	12°49'	IV
Imola	44°21'	11°43'	IV
Massa Fiscaglia	44°48'	12°01'	V
Pesaro	43°54'	12°54'	VII-VIII
Ravenna	44°25'	12°12'	V
Rimini	44°04'	12°34'	VIII
S. Marino	43°56'	12°27'	IV
Senigallia	43°43'	13°13'	IV
Urbino	43°44'	12°38'	VI

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THE RIMINI EARTHQUAKE OF APRIL 14, 1672

Compiled by

G. Ferrari, E. Guidoboni, D. Postpischl

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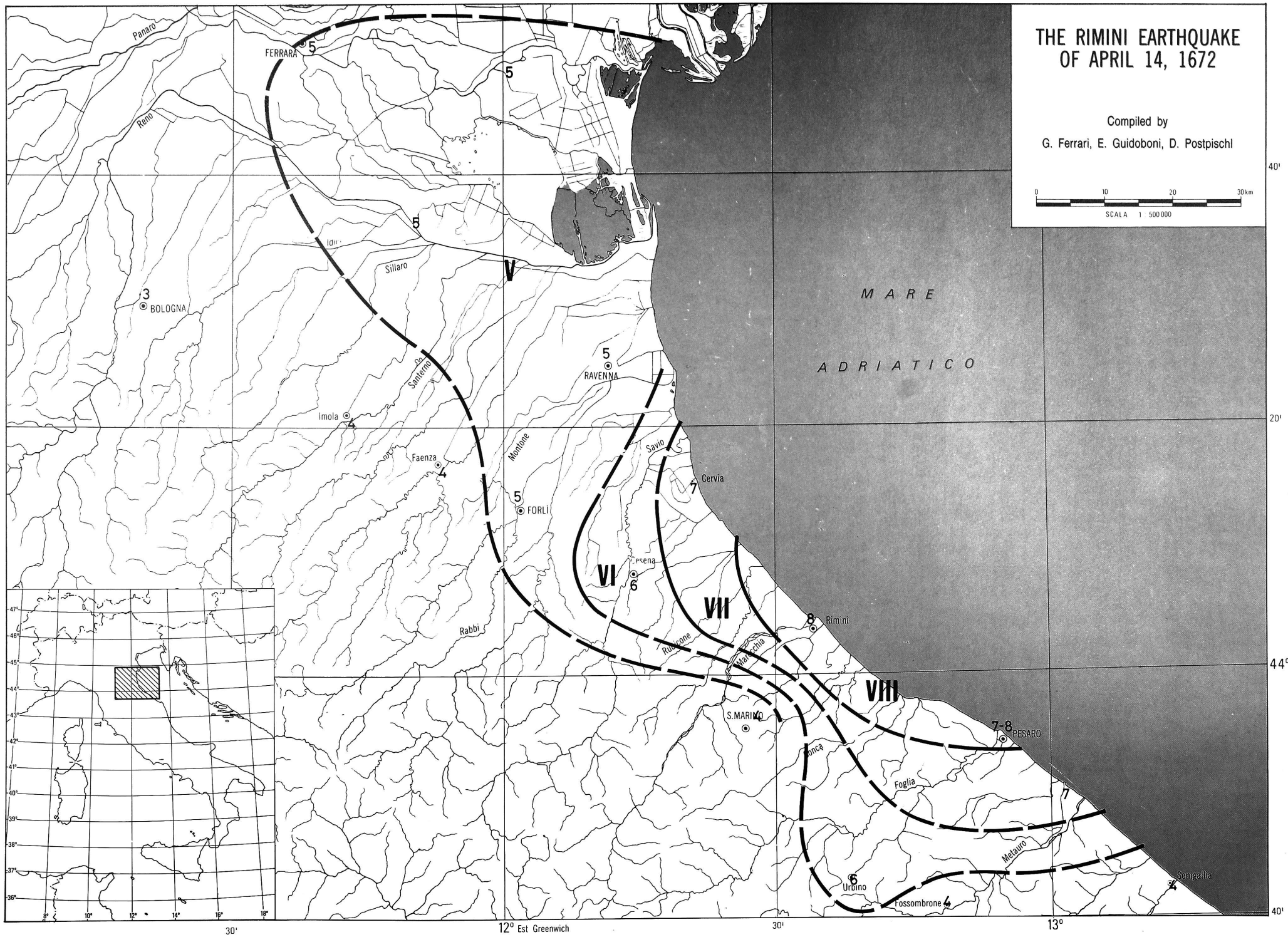
SCALA 1 : 500 000



The drainage network of this map – scale 1:500.000 – is the same as the "Structural Model of Italy."

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The Cotignola earthquake of April 11, 1688.

G. Ferrari, E. Guidoboni, D. Postpischl.

On April 11, 1688, at 11:00 a.m. GTM a vaste area in the southern part of the River Po Valley was hit by the destructive effects of the most violent earthquake in this area in the last 1,000 years.
The present catalogues classify this earthquake with an epicentral intensity of IX-X degree MCS.
The accounts that the bishops and the legati of Ferrara and Ravenna sent to the Segreteria of the Papal State have been used for the historical reconstruction of this earthquake.
Because of the homogeneity of the language used in this correspondence, which began the day after the earthquake, it is possible to get a good idea of the type and distribution of the damage in the territory then included in papal Romagna. In this corrispondence, some reports given by pastors indirectly come together, especially regarding the number of deaths and the number of houses destroyed.
In this period in the Papal State, the practice of carrying out surveys in order to document earthquake damage was not yet consolidated; therefore, this type of source appears only sporadically and related to some noted edifices.
From the registers of the «Tesoreria Provinciale of Ferrara» belonging to the «Camera Pontificia», additional information was deduced of the damage done to the fortresses of Lugo and Massalombarda.
Administrative correspondence between the communities of Cotignola and the administration of Ferrara, on which the rural center depended, and between the administration of Russi and the community of Faenza, have enriched this documentation.
Because of the almost daily acts, the testimonies have allowed a discrimination of the effects of the various shocks, and a separation from the cumulative image of the damage caused by three overflows of the Senio and Lamone Rivers, which occurred about ten days after the earthquake.
These overflows significantly increased the vulnerability of the constructions, which were then further damaged by successive shocks.
A part of the area hit by this earthquake (the hill and pedi-Apennine area) belonged to the Grand Duke of Tuscany.
It was the same central administration of Florence that ordered the surveys for the evaluation of the damage to the Ducal property in Terra del Sole, Castrocaro, Montepoggiolo and Modigliana. These acts were compiled by specialized technicians and were sometimes accompanied by drawings, which allow a visualization of the described damage.
From present-day on-site observations conducted on some of the constructions, it has been possible from their actual state of conservation to find out the measures of repair carried out on them and, consequently, to evaluate the intensity of the event.
Moreover, recourse to local recollections has given us a description of the damage, especially for external areas, and in some cases has allowed us to investigate these described effects.
A landslide in the locality of monte Budrialto, in the territory of Brisighella, was one of the effects of this earthquake.
This phenomenon, frequently described in the documentation mentioned, was accurately drawn by a naturalist of the period. This drawing was enclosed in his description of the earthquake.
The first and most violent shock was felt on Sunday, April 11, at 11:30 a.m. GTM. The sources report that 68 houses in Cotignola were «ruined».
From local historical research, one may reasonably suppose that this town had about 1,000 inhabitants at that time with an average number of 6 inhabitants per house. Therefore the number of houses that collapsed may be estimated at 40% (36 deaths and 64 people injured were reported).
In Bagnacavallo there were 40 collapses (less than 20% of the houses); in addition, 9 churches were severly damaged (some people died and 20 were injured).
In Russi, Lugo and Solarolo, belonging to the legation of Ravenna, the damage done was not numerically quantified, but the descriptions give a picture of serious damage.
On the whole, the degree of damage was less than that described by Baratta.
Precise information regarding the inhabited centers outside of the VII degree MCS area was found only for the city. In fact, documentation related to the rural communities is very scarce.
Other shocks, felt on April 18, caused additional construction collapse in Russi; from April 28 to May 5 there were three overflows of the Senio and Lamone Rivers, which flooded the already damaged inhabited centers. On May 27 at 8:50 a.m. GMT shocks were felt; at 7:50 p.m. on May 27, there were other seven shocks. The shocks continued until December 12 without causing further damage.
It is notable that Baratta and the successive catalogues do not report the shock of April 18, but associate its effects to the shock that occurred on May 27.
Some local chronicles, taken from Baratta, report that this earthquake lasted forty days, an affirmation which could not be found in the surveys utilised and which presumably is to be interpreted, once again, as an element of religious tendencies of the period.
The figure shows both the distribution of values of intensity according to the MCS scale, and the relative interpretation in terms of isoseismal lines for the shock occurring on April 11, 1688.
The meizoseismal area shows a NE lengthening, while the VIII and VII degree isoseismal shows a lengthening towards the west, along the pedi-Apennine range.
The lengthening towards the west of the isoseismal line corrisponding to VIII MCS including the town of Imola, was verified by local documentation belonging to the community administration.
Application of the Galanopoulos formula to an estimate of the affected area gives a macroseismic equivalent of magnitude, ME = 5.2. This differs significantly from the values of 6.0 and 5.9, which both appear in the ENEL Catalogue, and which were respectively obtained using the Karnik formula for Northern Italy and the Peronarci formula.
A comparison of the values of some parameters reported in the ENEL and Carrozzo et al. Catalogues, and in the present study follows.

Year	Mo	Da	Ho	Mi	Lat	Long	De	I	Me	Mk	Mp	Epic. area
1688	4	11	11		44°25'	12°00'		IX-X		6.0	5.9	Romagna
1688	4	11	11		44°30'	12°00'		IX-X		6.0		
1688	4	11	11	30	44°22'	11°57'		IX	5.2	5.7		Cotignola

List of shocked localities:

Locality	Latit.	Long.	I (MCS)
Argenta	44°37'	11°50'	VI
Bagnacavallo	44°25'	11°59'	VIII-IX
Bertinoro	44°09'	12°08'	VII
Bologna	44°30'	11°20'	VI
Cesena	44°08'	12°15'	VII
Conselice	44°31'	11°50'	VI
Cotignola	44°23'	11°56'	IX
Ferrara	44°50'	11°37'	V
Firenze	43°47'	11°15'	III
Forlì	44°13'	12°03'	VII
Fusignano	44°28'	11°58'	VI
Imola	44°08'	12°15'	VII-VIII
Lugo	44°25'	11°55'	VIII
Ravenna	44°25'	12°12'	VII
Rimini	44°04'	12°34'	IV
Russi	44°22'	12°02'	VIII
Solarolo	44°22'	11°51'	VIII
Terra del Sole	44°11'	11°58'	VII

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THE COTIGNOLA EARTHQUAKE OF APRIL 11, 1688

Compiled by

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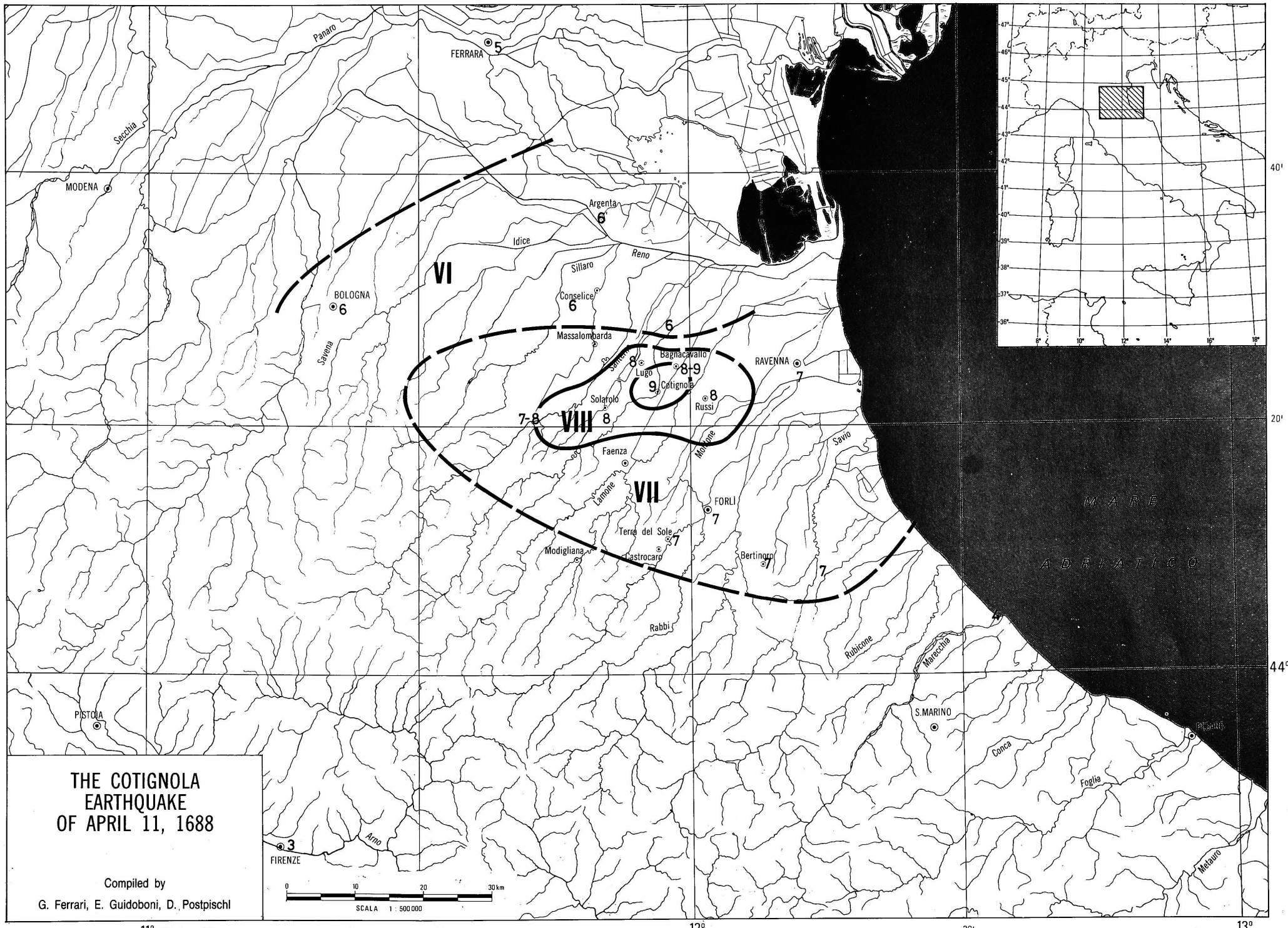

The drainage network of this map – scale 1:500.000 – is the same as the "Structural Model of Italy."

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The earthquake of June 5, 1688 in Campania.

L. Serva

This earthquake particularly affected the towns and villages of the south-west slope of the Monti del Matese, the area around Benevento along the valley of the Calore River, and Irpinia along the valleys of the Ufita and Calore Rivers, causing very serious damage.

It is difficult to arrive at an exact estimate of the number of victims because the writers gave different figures; however, there seem to have been about 10,000 people affected, concentrated above all in Cerreto Sannita, Benevento and Guardia Sanframondi. In addition, some damage was done to the environment, such as fractures in the ground, landslides and variations in the flow of underground waters.

There are a fair number of reports by contemporary writers, allowing the collection of information about roughly 200 towns and villages affected. The reports by anonymous writers (5-10), by P. Sarnelli (62) and letters edited by A. Bulifon (17-21) have been particularly useful.

It has not been possible to fix the exact time of the main earthquake, owing to the differences between the various sources. The most likely time is about 17.15 local time.

Information about the characteristics of the seismic sequence is not abundant. Two shocks are mentioned at Benevento on 13 and 14 February that caused no damage, and then no events were reported until 5 June, when the main earthquake occurred. It lasted for a short time and was preceded by low intensity foreshocks. There were many aftershocks (about fifty), almost all of them noted in Naples, lasting until 26 August. These were of a fairly high intensity, enough to cause further damage in both the area of the epicentre and in Naples. The strongest aftershock was that of 10 June, which caused very severe damage in several towns situated immediately to the north and south-east of Benevento.

It has proved difficult to estimate the degree of intensity in many cases, owing to the insufficient or too brief descriptions of the damage. The maximum intensity, equal to the XI degree of the MCS scale, was noted near Cerreto Sannita and Civitella Licinio, which were almost totally destroyed with a large number of victims. The great variation in degrees of intensity occurring in the limited area SSE of Benevento is to be noted, where towns very close to one another show a difference of even two or three degrees. This may be due to either local effects or imprecise information.

The macroseismic epicentre is probably located near Cerreto Sannita, corresponding to the XI degree area (41°19' Lat. N, 14°34' Long. E). It is noticeable that the XI degree area is eccentric to the X degree one.

The isoseismal lines illustrated, have been drawn only up to the VII-VIII degree. A broken line indicates lack of information in some areas. However, one may notice in the lines:

- a clear direction of major wave propagation toward the Appennines, confirmed by the features of all the isoseismal lines;
- an important series of local increases of intensity, which generally differ by only one degree from the intensity in the surrounding area. There is an exception in the case of Ceppaloni, to the south of Benevento, where the X degree contrasts greatly with the V degree noted in the neighbourhood;
- the very strong attenuation existing south-west of Cerreto Sannita, where in the space of only a few kilometres, there is a change from the XI degree at Cerreto Sannita to the VII degree at San Salvatore Telesino and Ruviano.

By comparing the isoseismal maps of the 1694 earthquake with those of 1702, one may note an almost perfect alignment following the direction of the Appennines, both in the epicentre and in the features of the isoseismal lines.

List of shocked localities:

Locality	Latit.	Long.	I (MCS)
Ailano	41°23'	14°12'	VIII
Alife	41°20'	14°20'	IX
Altavilla Irpina	41°00'	14°47'	?
Alvignano	41°15'	14°20'	IX
Amalfitano	?	?	?
Apice	41°07'	14°56'	X
Apollosa	41°06'	14°42'	VIII
Ariano Irpino	41°09'	15°05'	IX
Arienzo	41°02'	14°30'	?
Atella	40°52'	15°39'	VIII
Aterrana	40°49'	14°49'	VIII-IX
Atripalda	40°33'	14°28'	VIII
Avellino	40°55'	14°47'	VIII-IX
Aversa	40°58'	14°12'	VI
Bagnara	41°04'	14°48'	V
Baranello	41°32'	14°33'	VIII
Baselice	41°24'	14°58'	V
Benevento	41°08'	14°46'	X
Boiano	41°29'	14°28'	VII
Bonea	41°05'	14°37'	?
Bonefro	41°42'	14°56'	?
Bonito	41°06'	15°01'	IX
Calitri	40°54'	15°26'	VIII
Calvi	41°12'	14°09'	VIII
Campobasso	41°33'	14°39'	VIII
Campo di Pietra	41°33'	14°45'	?
Campolattaro	41°17'	14°44'	IX
Campolieto	41°37'	14°46'	?
Capua	41°07'	14°13'	VI
Capo di Picoca	?	?	VIII
Capriati al Volturno	41°28'	14°09'	IX
Carpinone	41°36'	14°19'	?
Casacalenda	41°44'	14°51'	VII
Casalbore	41°14'	15°01'	X
Casalduni	41°16'	14°42'	X
Casalnuovo di Napoli	40°55'	14°20'	?
Castello del Matese	41°22'	14°23'	IX
Castelmozzo	41°01'	14°51'	?
Castelpagano	41°24'	14°48'	IX
Castelpoto	41°08'	14°42'	X
Castelvetere	?	?	?
Cava de' Tirreni	40°42'	14°42'	VII-VIII
Ceppaloni	41°03'	14°45'	X
Cercemaggiore	41°27'	14°43'	VII
Cerreto Sannita	41°17'	14°33'	XI
Cervinara	41°01'	14°37'	VIII
Chianche	41°03'	14°47'	?
Chianchetelle	41°02'	14°47'	VIII
Chieti	42°21'	14°10'	VI-VII
Chiusano San Domenico	40°56'	14°55'	?
Circello	41°21'	14°48'	IX
Cirignano	41°05'	14°39'	?
Ciorlano	41°27'	14°09'	IX
Civitella Licinio	41°19'	14°32'	XI
Colle Sannita	41°22'	14°50'	IX
Conca Casale	41°30'	14°00'	VIII
Conca della Campania	41°20'	13°59'	VIII
Cercepiccola	41°27'	14°40'	VII-VIII
Cucciano	41°03'	14°50'	VIII
Cusano Mutri	41°20'	14°30'	VII-VIII
Dentecane	41°02'	14°53'	?
Domicella	40°53'	14°35'	VII
Faicchio	41°17'	14°29'	VIII-IX
Fontegreca	41°27'	14°11'	IX
Fossaceca	?	?	?
Foiano di Val Fortore	41°21'	14°59'	VIII
Fragneto Monforte	41°51'	14°45'	X
Frigento	41°01'	14°06'	VIII-IX
Galatina	40°10'	18°10'	VII
Gallo	41°28'	14°13'	?
Galluccio	41°22'	13°57'	VIII
Gambatesa	41°31'	14°55'	VII
Gildone	41°31'	14°44'	VIII
Ginestra	?	?	?
Gioia Sannitica	41°18'	14°26'	IX
Greci	41°15'	15°11'	?
Grottolella	40°59'	14°47'	?
Guardialfiera	41°48'	14°47'	VII-VIII
Guardiaregia	41°26'	14°33'	IX
Guardia Sanframondi	41°15'	14°36'	X
Ianinova	?	?	IX
Ielsi	41°31'	14°48'	V
Isernia	41°35'	14°14'	VIII
Lapio	40°59'	14°57'	V
Lauro	40°53'	14°38'	VII-VIII
Lentace	41°03'	14°50'	?
Lesina	41°52'	15°21'	?
Limatola	41°08'	14°23'	VII-VIII
Limosano	41°40'	14°37'	?
Lucera	41°30'	15°20'	V
Maccabei	41°05'	14°46'	V
Macchia Valfortore	41°36'	14°54'	V
Maddaloni	41°02'	14°23'	?
Mancusi	41°04'	14°50'	?
Matrice	41°37'	14°43'	VII
Mirabella Eclano	41°03'	15°00'	X
Molinara	41°18'	14°54'	VIII-IX
Monacilioni	41°36'	14°48'	V
Montaperto	41°00'	14°53'	V
Montecalvo Irpino	41°12'	15°02'	IX
Montecassino	41°29'	13°48'	VI-VII
Montefalcione	40°58'	14°53'	V
Montefusco	41°02'	14°51'	VIII-IX
Montemiletto	41°01'	14°54'	VII-VIII
Monterocchetta	41°03'	14°49'	VIII
Montesarchio	41°04'	14°38'	?
Montoro	40°49'	14°48'	VIII-IX
Montorsi	41°04'	14°47'	VIII-IX
Napoli	40°51'	14°16'	VII-VIII
Nola	40°56'	14°32'	V
Norcone	41°20'	14°40'	IX
Noschiano	40°52'	14°40'	IX
Ottaviano	40°51'	14°28'	VII
Paduli	41°10'	14°53'	X
Pagliara	41°04'	14°45'	VIII
Pago Veiano	41°15'	14°52'	IX
Pannarano	41°01'	14°42'	V
Parrelle	40°49'	14°46'	VIII
Pastene	41°05'	14°50'	VII
Paolisi	41°02'	14°34'	V
Paupisi	41°12'	14°40'	IX
Perrillo	41°05'	14°49'	VII
Pesco Sannita	41°14'	14°48'	IX
Petruro Irpino	41°02'	14°45'	V
Piedimonte Matese	41°21'	14°22'	IX
Pietracatella	41°35'	14°52'	V
Pietra de Fusi	41°02'	14°54'	VII
Pietraroia	41°19'	14°33'	X-XI
Pietrastornina	41°00'	14°43'	VII
Pietrelcina	41°12'	14°51'	IX
Pignano	40°52'	14°37'	VII-VIII
Pomarico	40°31'	16°33'	?
Pontelandolfo	41°17'	14°41'	X
Presenzano	41°22'	14°04'	VIII
Preturo	40°52'	14°45'	VII
Quindici	40°52'	14°39'	VII
Ruviano	41°13'	14°24'	VII
Reino	41°18'	14°49'	IX
Riccia	41°29'	14°50'	VIII
Roccamonfina	41°18'	13°59'	VIII
Roma	41°54'	12°29'	III
Rotondi	41°02'	14°36'	V
Salerno	40°41'	14°45'	VI-VII
S. Giorgio del Sannio	41°04'	14°51'	IX
S. Giorgio la Molara	41°17'	14°55'	VIII-IX
S. Giovanni in Galdo	41°36'	14°45'	?
S. Giuliano del Sannio	41°27'	14°38'	X
S. Gregorio Matese	41°23'	14°23'	IX
S. Leucio del Sannio	41°05'	14°45'	VIII
S. Lorenzo Maggiore	41°15'	14°38'	X
S. Lorenzello	41°17'	14°32'	X
S. Lupo	41°16'	14°38'	X
S. Marco a Monti	41°04'	14°49'	VII
S. Marco dei Gavoti	41°19'	14°53'	VIII-IX
S. Martino Valle Caud.	41°01'	14°40'	?
S. Nazzaro	41°03'	14°51'	VIII
S. Nicola Manfredi	41°04'	14°50'	?
S. Pietro Irpino	41°03'	14°48'	?
S. Potito Sannitico	41°20'	14°24'	IX
S. Salvatore Telesino	41°14'	14°30'	VII
Santa Croce del Sannio	41°23'	14°44'	VIII-IX
Sant'Agnese	41°14'	14°35'	VIII
S. Maria a Toro	41°05'	14°48'	VII
S. Maria del Molise	41°33'	14°22'	IX
S. Maria Ingrisone	41°04'	14°50'	VII
S. Angelo a Cancelli	41°03'	14°52'	VIII-IX
S. Angelo a Cupolo	41°04'	14°48'	IX
S. Angelo a Scala	40°58'	14°44'	?
S. Angelo Limosano	41°12'	14°36'	?
Santa Paolina	41°01'	14°51'	VIII
S. Elia a Pianisi	41°37'	14°52'	V
Sassinoro	41°22'	14°40'	IX
Savignano Irpino	41°14'	15°11'	?
Serino	40°51'	14°52'	?
Solofra	40°50'	14°51'	VIII
Sora	41°43'	13°37'	VIII
Sepino	41°24'	14°37'	IX
Teano	41°15'	14°04'	VIII
Telese	41°13'	14°32'	?
Terranova	?	?	VII
Toccanisi	41°03'	14°50'	VIII
Tocco Caudio	41°07'	14°38'	X
Tora Piccilli	41°20'	14°02'	VIII
Torrecuso	41°11'	14°41'	?
Torre le Nocelle	41°01'	14°55'	VII-VIII
Torremaggiore	41°14'	15°23'	?
Torrioni	41°02'	14°49'	VII
Tufara	?	?	VII
Tufo	41°01'	14°49'	VII
Tuoro	?	?	IX
Tuoro (Roccabascerana)	41°01'	14°43'	VIII
Varoni	41°09'	14°37'	?
Venafro	41°29'	14°03'	VII
Venosa	40°58'	15°50'	VIII
Vigna Veterana	40°49'	14°48'	VIII
Vinchiaturo	41°29'	14°35'	VIII
Vitulano	41°10'	14°39'	IX

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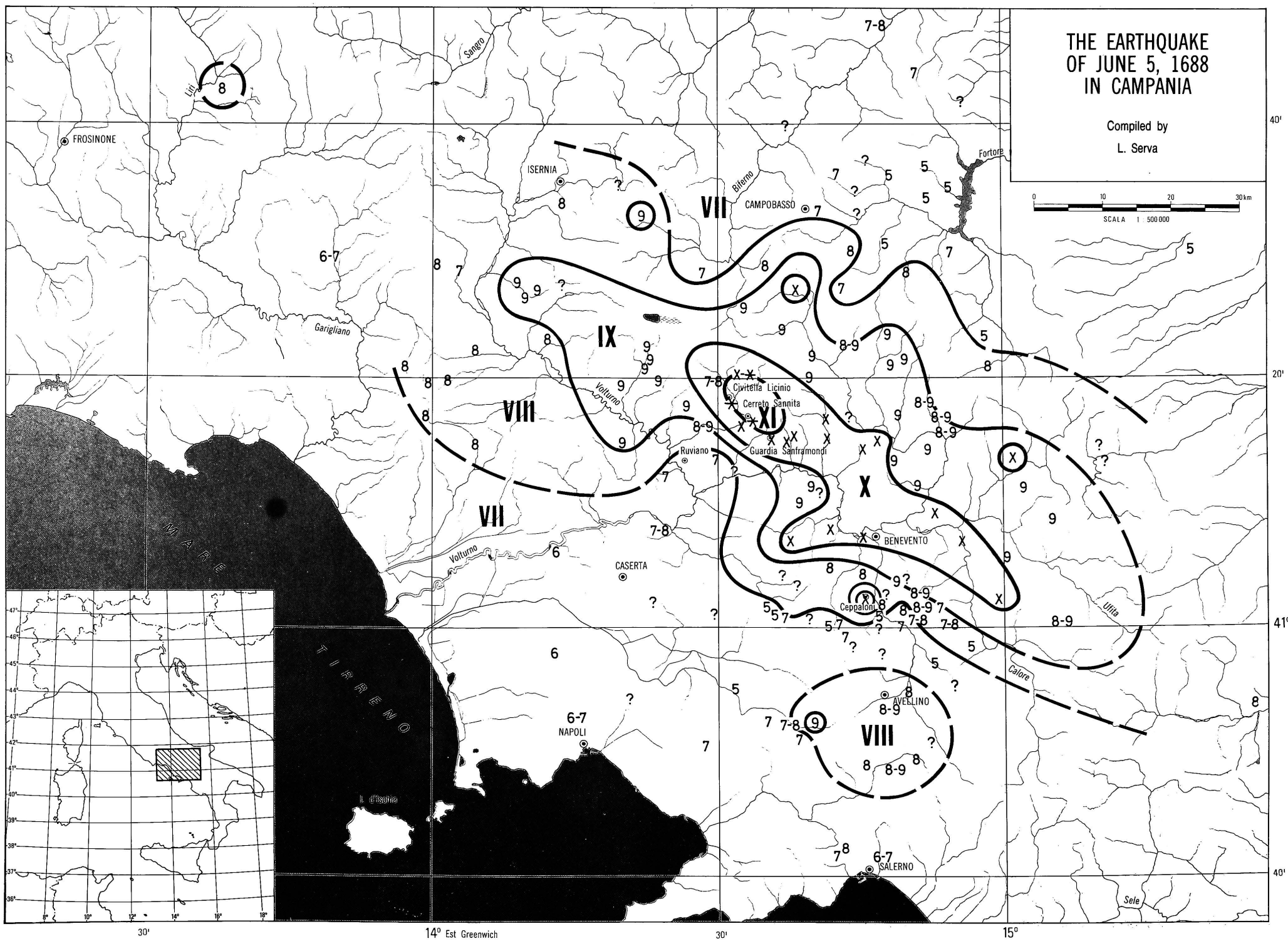
THE EARTHQUAKE OF JUNE 5, 1688 IN CAMPANIA

Compiled by

L. Serva



The drainage network of this map – scale 1:500.000 – is the same as the "Structural Model of Italy."

G.T.M - Via Marco Marulo 47a - 00143 ROMA

The Val di Noto earthquake of January 11, 1693.

M. S. Barbano

The earthquake we are dealing with hit mainly southern Sicily, which today is characterized by a few small shocks but, as can be read in the chronicals, has been ruined by strong quakes in the past.
Major shocks occurred in 1114, 1169, 1542 and 1693.
The seismic sequence that began in January 1693 lasted 2 years. Because of the number of victims (about 60,000) and the size of the destroyed area (more than 45 cities and villages totally disrupted, 5,600 square km with intensity IX - MCS or more) this earthquake may be considered, along with the Messina 1908 earthquake, the strongest reported event of Italian history (5).
Due to the difficulty in locating and interpreting very old documents, for the moment we can not consider as conclusive the definition of the macroseismic field of the 1114, 1169 and 1542 events.
Historical source do not agree on time and epicenter of the first two shocks. It is likely that all the above mentioned shocks had similar characteristics and, referring to the well-documented earthquake of 1693, an attempt has been made to reconstruct the isoseismal maps of the 1169 (Lombardo, this issue) and 1542 (Barbano, this issue) events according to the MCS scale.
In the 1693 event, the assigned epicentral intensity is XI because of the total distruction of buildings and permanent effect on the ground surface.
The intensity of the 1169 earthquake seems comparable or higher, while in 1542 it was certainly lower, though definition is difficult due to the scarce descriptions and lack of ground effect.
The seismic sequence of 1693 began at 9 p.m. on January 9 with one VIII degree shock in Catania, Augusta and Lentini, and VI-VII in Siracusa; another probable foreshock occurred on January 11 at 9.30 a.m. E.M.T. (19).
These shocks caused collective fear. The high death toll in Catania (2/3 of the inhabitants) may be ascribed to the popular belief that shocks must be separated by a 24 hour interval, and after this period people went back of their homes. The main shock happened at 2 p.m. (corresponding to 9 p.m. local time).
Aftershocks lasted 2 years, numbering about 1500.
Vibrations were felt at great distances from the epicenter: the African coast to the South and northern Calabria to the North; while there is no evidence about Greece, the earthquake reached Malta with intensity VIII and the Eolian Islands with intensity VI.
Isoseismals have been traced without any interpretation. Anomalies of the macroseismic field are evident near Noto, Mineo, Grammichele and Palermo.
In Noto, which is situated close to the IX isoseismal, there are effects of XI degree probably due to the lithology of the ground (fracturated marly limestone) Mineo and Grammichele are at the border between the calcareous plateau and the unconsolidated sediments of the Gela trough.
The mesoseismal area, elongated NE-SW, runs from Palazzolo Acreide, Buscemi and the Anapo valley in the South to the Simeto river in the North and opens to the Ionian Sea in the East.
The epicenter was probably in open sea not far from the coast between Augusta and Catania. One tsunami overran the whole eastern Sicilian coast from Pachino to Messina, causing only minor damage (7).
The lower degree isoseismals are elongated to the NNE-SSW, the main propagation channel for the intensity.
In fact, there is a high intensity (VII) in Messina at 110 km, and Malta at 180 km from the epicentral area.
NE-SW, NNE-SSW and NW-SE are the directions most commonly encountered in all the earthquakes of this area (4).
For the time being there are no F.P.S. available for the earthquakes of southeastern Sicily. Therefore, any conclusion on source and propagation effect must be very cautions. The major structure crossing the epicentral area is the Iblei-Malta escarpment running NNW-SSE: if this is responsible for the earthquake, the channelling effect is prevailing.
The tsunami appears comparable with that associated with the 1908 earthquake (20): consequently the probable dip-slip mechanism is compatible with data resulting from microtectonic studies (14).
The Sponheuer estimate of the depth is 20 km (5).
The macroseismic magnitude (11) of 7.1. Schick (20) tentatively gives a value of about 7.7-7.8 that agrees with the extention of the meisoseismal area.
In the ENEL (1977) catalogue the earthquake is listed as follows:

1693	1	11	20	37°25'	15°00'	X	Catanese

On the basis of the results of the present study, it is possible to point out more accurate location's and intensity values to the 1693 earthquake:

1693	1	11	13	37°25'	15°10'	XI

List of shocked localities:

Locality	Latit.	Long.	I (MCS)
Acate (Biscari)	37°02'	14°30'	X
Aci Bonaccorsi	37°35'	15°06'	X
Aci Castello	37°33'	15°09'	X
Aci La Consolazione	37°37'	15°09'	X
Acireale	37°37'	15°10'	X
Aci San Filippo	37°36'	15°08'	X
Aci Sant'Antonio	37°37'	15°07'	X
Aci Trezza	37°34'	15°10'	X
Adrano (Adernò)	37°40'	14°50'	VIII
Agrigento (Girgenti)	37°17'	13°35'	VI
Aidone	37°25'	14°27'	VIII
Augusta	37°14'	15°13'	X
Avola	36°55'	15°08'	X
Belpasso (Fenicia)	37°35'	14°59'	IX
Biancavilla (Li Greci)	37°39'	14°52'	VIII
Borrello	37°36'	14°59'	X
Bronte	37°45'	14°50'	VI-VII
Buccheri	37°07'	14°51'	X
Buscemi	37°05'	14°53'	X
Butera	37°11'	14°11'	VI-VII
Calatabiano	37°49'	15°14'	VIII-IX
Calatafimi	37°55'	12°52'	VII
Caltagirone	37°14'	14°31'	VIII-IX
Caltanissetta	37°29'	14°04'	VI
Capomulini	37°34'	15°10'	X
Carlentini	37°17'	15°01'	XI
Cassaro	37°06'	14°57'	XI
Castiglione di Sicilia	37°52'	15°08'	VIII
Catania	37°30'	15°05'	X
Centuripe (Centorbiy)	37°37'	14°44'	VIII
Chiaramonte Gulfi	37°02'	14°42'	X
Comiso	36°57'	14°36'	VIII
Ferla	37°06'	14°54'	XI
Fiumefreddo	37°47'	15°13'	IX
Floridia	37°05'	15°09'	X
Francavilla	37°54'	15°08'	VIII-IX
Francoforte	37°14'	14°53'	X
Gela	37°04'	14°15'	VII
Giarratana	37°03'	14°47'	X
Grammichele (Occhiolà)	37°12'	14°38'	X
Ispica (Spaccaforno)	36°47'	14°55'	IX
Lentini	37°17'	15°00'	XI
Licata	37°06'	13°56'	VII
Licodia Eubea	37°09'	14°42'	IX
Linguaglossa	37°50'	15°08'	VIII-IX
Lipari	38°28'	14°57'	VI
Malta	35°50'	14°25'	VIII
Mascali	37°45'	15°11'	IX
Mascalucia	37°34'	14°03'	X
Massannunziata	37°40'	15°06'	X
Mazzarino	37°18'	14°13'	VII
Melilli	37°09'	15°07'	XI
Messina	38°11'	15°33'	VIII
M. Etna	37°45'	15°00	VIII-IX
Militello in Val di CT	37°16'	14°48'	IX
Mineo	37°16'	14°41'	X
Misterbianco	37°30'	15°00'	X
Modica	36°51'	14°46'	IX
Monterosso Almo	37°05'	14°46'	X
Motta S. Anastasia	37°30'	14°58'	X
Naso	38°07'	14°47	VI
Nicosia	37°45'	14°23'	VII-VIII
Niscemi	37°07'	14°23'	VIII-IX
Noto	36°47'	15°04'	XI
Oriolo	42°02'	16°26'	NF
Pachino	36°43'	15°06'	IX
Palagonia	37°20'	14°45'	IX
Palazzolo Acreide	37°04'	14°54'	X
Palermo	38°07'	13°22'	VII
Paternò	37°34'	14°54'	VIII-IX
Patti	38°08'	14°58'	VI-VII
Pedara	37°37'	15°02'	X
Piazza Armerina	37°23'	14°22'	VII
Plachi	?	?	X
Ragusa	36°55'	14°44'	IX-X
Randazzo	37°52'	14°57'	VII-VIII
Reggio di Calabria	38°07'	15°38'	VI
San Giovanni la Punta	37°34'	15°05'	X
San Gregorio	37°34'	15°06'	X
San Michele di Ganzeria	37°17'	14°26'	VIII
Sant'Agata li Battiati	37°33'	15°05'	X
Sciacca	37°30'	13°05'	NF
Scicli	36°47'	14°43'	X
Scordia	37°18'	14°51'	IX
Siracusa	37°04'	15°18'	X
Sortino	37°09'	15°01'	XI
Taormina	37°50'	15°18'	IX
Trapani	38°01'	12°31'	NF
Trecastagni	37°34'	15°04'	X
Tremestieri	37°37'	15°06'	X
Troina	37°47'	14°36'	VII-VIII
Valverde	37°35'	15°06'	X
Viagrande	37°36'	15°06'	X
Villa San Giovanni	38°13'	15°38'	VII
Vittoria	36°57'	14°32'	VIII
Vizzini	37°09'	14°45'	IX

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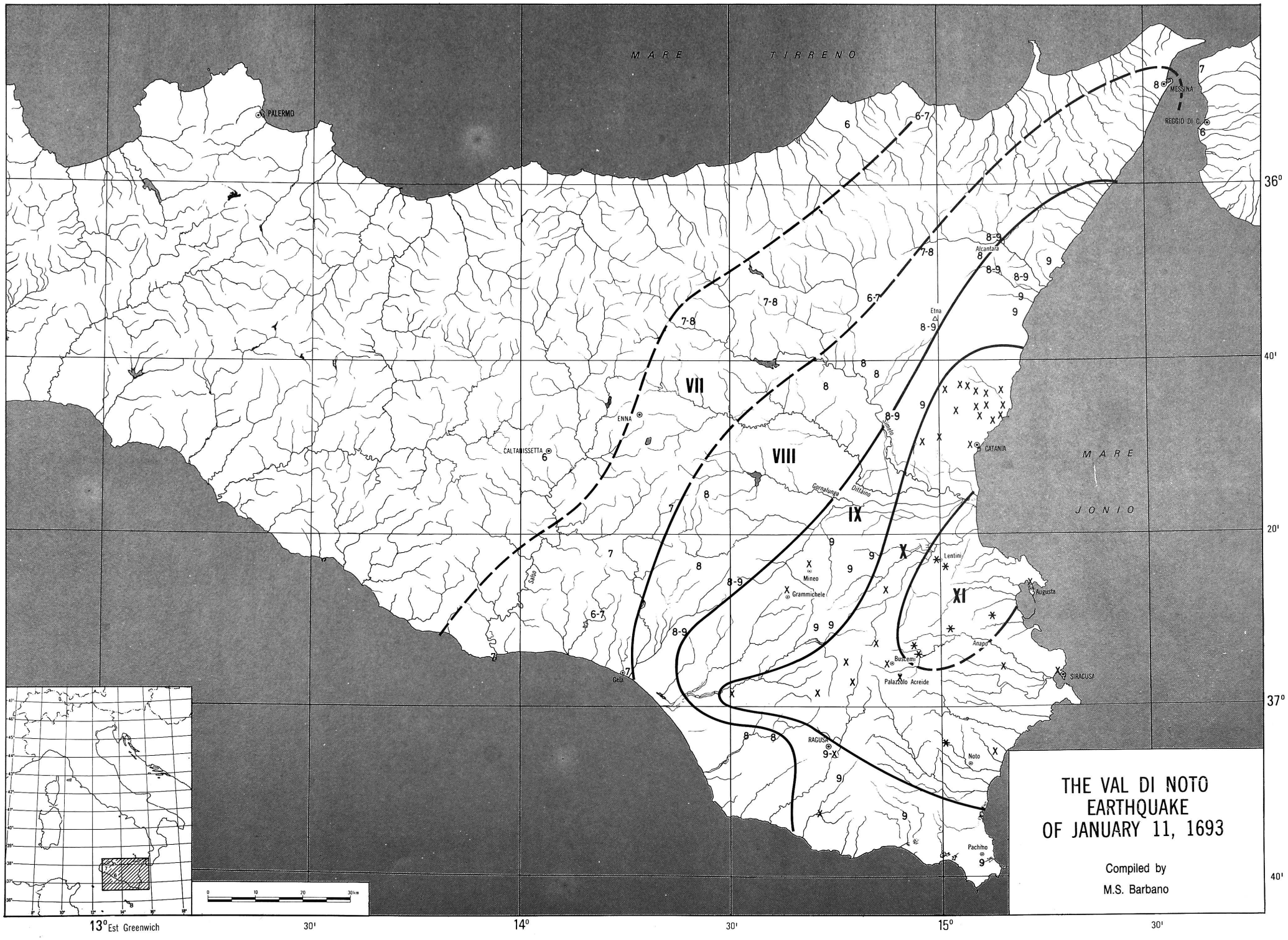

THE VAL DI NOTO EARTHQUAKE OF JANUARY 11, 1693

Compiled by

M.S. Barbano

The drainage network of this map – scale 1:500.000.– is the same as the "Structural Model of Italy."

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The earthquake of September 8, 1694 in Campania-Lucania.

L. Serva

This earthquake affected almost the whole of Irpinia in its highest degrees of intensity, as well as part of the provinces of Potenza and Salerno. It caused enormous damage in a large number of villages.

It is difficult to calculate the exact number of victims, owing to the differences of opinion existing in the different sources; the number, in fact, varies from a minimum of 4,000 people to a maximum of 15,000. Adding together the data collected in each town, a number between 4,000 and 6,500 people is reached, according to whether one takes the lowest or the highest estimate. However, considering that numbers of victims that are not precise have been quoted for some towns, while there is no information available for other towns, (particularly those situated in the area of the epicentre), it may be stated that the total number of victims was higher than 4,000 or even 6,500. The villages affected most badly were Calitri, Bella and Muro Lucano; these alone suffered about 3,000 victims.

In addition to the damage done to buildings, there were a number of averse effects on the environment, such as landslides, fractures and frequent variations in the flow of underground waters, with the disappearance of some springs, appearance of some new ones, and the dirtying of others.

The literature available is not abundant, but it has, in any case, allowed us to collect information about roughly 180 towns. The most important contributions have been made by the three contemporary reports, two of them by anonymous writers (2-3), and the third by G.B. Pacichelli (21).

There is almost complete agreement among the authors on the date and time. The main shock occurred on 8 September, at about 1 p.m. local time; it lasted for a long time, and was repeated several times.

The information on the seismic sequence is scarse and uncertain. However, it seems to have begun directly with the main event and then continued at least throughout the first days of January 1695. The aftershocks were not very strong, with the possible exception of that of 9 October, which caused damage at Avellino.

The attribution of a degree of intensity for every town concerned has, on many occasions, proved to be uncertain because the information is too brief and contradictory.

The highest degree of intensity attributed, X-XI on the M.C.S. scale, refers to those towns or villages that were almost wholly destroyed, and had a very high number of victims. On the isoseismal map, these sites are scattered inside the area of the X degree; it seems likely that an attribution of the X-XI degree is concerned with local effects or uncertainty.

The epicentre is also rather difficult to place, due to the irregular distribution of the intensity. However, generalizing the isoseismal lines, it may be placed to the south of Calitri (40°52' Lat. N, 15°26' Long. E).

The isoseismal lines are limited to those of the VI-VII degree and are often drawn in broken lines, because of the uncertainty about them and the lack of information in certain areas. From their progress, we may note:

- a direction of greater spread towards the Appennines. This line is almost perfectly aligned with those of 1688 and 1702 earthquakes, and is near both of them, as far as area and time are concerned;
- the epicentral area is quite irregular and seems to consist of at least two distinct areas, one in the area of Sant'Angelo dei Lombardi, and the other in the area of Bella;
- the line of the VIII-IX degree indicates a main spread along the lower valley of the Ofanto River; another spread is shown by the line of the VII-VIII degree, in the direction of the Sorrento Peninsula;
- There is an area of large attenuation along the upper valley of the Sele River.

Finally, comparing the isoseismal map of this event with that of the recent earthquake (November 23, 1980), it may be noted that both of them have affected more or less the same area, with various similarities in the features of the isoseismal lines. Other similarities include the notable length of the lines and the characteristics of the main event which were probably multiple shocks.

List of shocked localities:

Locality	Latit.	Long.	I (MCS)
Abriola	40°30'	15°49'	VIII-IX
Accadia	41°10'	15°20'	IX-X
Acerenza	40°48'	15°56'	VIII
Acerno	40°44'	15°04'	VIII
Acquaviva delle Fonti	40°54'	16°51'	VII
Albano di Lucania	40°35'	16°02'	VIII
Andretta	40°56'	15°20'	IX
Angri	40°44'	14°34'	VII
Aquilonia	40°59'	15°29'	IX
Ariano Irpino	41°09'	15°05'	IX
Ascoli Satriano	41°12'	15°34'	X
Atella	40°52'	15°39'	X
Atena Lucana	40°27'	15°33'	VIII-IX
Atripalda	40°33'	14°28'	VIII
Avella	40°58'	14°36'	VII-VIII
Avellino	40°55'	14°47'	VIII
Aversa	40°58'	14°12'	VIII
Avigliano	40°44'	15°43'	VIII-IX
Bagnoli Irpino	40°54'	15°05'	VIII
Balvano	40°39'	15°31'	X
Baragiano	40°41'	15°36'	IX
Bari	41°07'	16°52'	VI
Barile	40°57'	15°41'	IX
Bella	40°45'	15°33'	X-XI
Bisaccia	41°01'	15°23'	IX-X
Brindisi	40°38'	17°57'	V
Buccino	40°38'	15°23'	VIII
Buonabitacolo	40°16'	15°38'	VII-VIII
Caggiano	40°36'	15°30'	VIII
Cairano	40°54'	15°22'	X-XI
Calabritto	40°47'	15°14'	VIII
Calciano	40°35'	16°12'	VII
Calitri	40°54'	15°26'	X-XI
Calvello	40°28'	15°52'	VIII
Cancellara	40°44'	15°56'	VIII
Canosa	41°13'	16°04'	IX
Capitignano	40°43'	14°55'	VII
Caposele	40°49'	15°14'	IX
Capua	41°07'	14°13'	VII
Carife	41°02'	15°13'	X-XI
Casali di Nola	?	?	VII
Castel Baronia	41°03'	15°12'	X
Castelgrande	40°47'	15°26'	X
Castelmezzano	40°32'	16°03'	VIII
Castellamare di Stabia	40°42'	14°29'	VII
Castelcivita	40°30'	15°14'	VII
Castelnuovo di Conza	40°49'	15°19'	VIII
Cava de' Tirreni	40°42'	14°42'	VIII
Chieti	42°21'	14°10'	V
Cogliano	?	?	VIII
Colliano	40°43'	15°17'	IX
Contursi	40°49'	15°15'	VII-VIII
Conza della Campania	40°52'	15°20'	X
Craco	40°23'	16°26'	VII
Flumeri	41°05'	15°10'	VIII-IX
Forenza	40°52'	15°02'	VIII
Garaguso	40°33'	16°14'	VIII
Genzano di Lucania	40°51'	16°02'	VII-VIII
Gesualdo	41°00'	15°05'	VIII-IX
Gragnano	40°41'	14°31'	VI
Grassano	40°38'	16°17'	VII
Grottaminarda	41°24'	15°04'	IX
Guardia dei Lombardi	40°58'	15°13'	X
Lacedonia	41°03'	15°26'	IX
Lagonegro	40°07'	15°46'	VIII
Lanciano	42°14'	14°23'	V
Lauro	40°53'	14°38'	VIII-IX
Lavello	41°03'	15°48'	VIII
Laviano	40°47'	15°18'	IX
Lecce	40°21'	18°11'	V
Lipari	38°28'	14°56'	VIII
Maiori	40°39'	14°39'	VII-VIII
Marsico Nuovo	40°25'	15°45'	VIII
Maschito	40°55'	15°50'	VII
Matera	40°40'	16°46'	VII
Melfi	41°00'	15°40'	IX
Mercato S. Severino	40°47'	14°45'	VIII
Mercogliano	40°55'	14°44'	VII-VIII
Mesagne	40°34'	17°49'	V
Messina	38°11'	15°33'	V
Mirabella Eclano	41°03'	15°00'	IX
Modugno	41°05'	16°47'	VI
Montecorvino Rovella	40°42'	14°58'	VII
Monteleone di Puglia	41°10'	15°56'	VII-VIII
Montemurro	40°18'	16°00'	VII
Monteverde	41°00'	15°32'	IX
Montoro Superiore	40°49'	14°48'	VIII
Morra de Sanctis	40°56'	15°15'	X
Mugnano del Cardinale	40°57'	14°38'	VIII
Muro Lucano	40°45'	15°29'	X-XI
Napoli	40°51'	14°15'	VII
Nocera	40°44'	14°38'	VII
Nola	40°56'	14°32'	VIII
Oliveto Citra	41°41'	15°14'	VIII-IX
Ortona	42°21'	14°24'	V
Ottati	40°28'	15°20'	VII
Ottaviano	40°51'	14°28'	VII
Paduli	41°10'	14°55'	VIII
Palomonte	40°40'	15°18'	VIII
Paternopoli	40°58'	15°02'	IX
Pescopagano	40°50'	15°24'	X
Picerno	40°38'	15°39'	IX
Pietragalla	40°45'	15°53'	VIII
Pignola	40°34'	15°48'	VIII
Policastro Bussentino	40°05'	15°32'	VII
Polla	40°31'	15°30'	VIII
Pomarico	40°31'	16°33'	VII
Potenza	40°38'	15°48'	VIII
Prepezzano	40°43'	14°54'	VII
Rapolla	40°59'	15°41'	IX
Rapone	40°51'	15°30'	X
Ricigliano	40°40'	15°29'	X
Rionero in Vulture	40°56'	15°41'	IX
Ripacandida	40°55'	15°42'	IX
Rocca San Felice	40°57'	15°10'	X
Rocchetta A. Antonio	41°06'	15°28'	IX
Romagnano al Monte	40°38'	15°28'	VIII
Ruoti	40°43'	15°42'	X
Ruvo del Monte	40°51'	15°38'	X-XI
Sala Consilina	40°24'	15°36'	VIII
Salandra	40°32'	16°20'	VIII-IX
Salerno	40°41'	14°45'	VII
Salza Irpina	40°55'	14°54'	VIII
S. Barbato	42°08'	14°34'	VIII
S. Fele	40°49'	15°33'	X
S. Gregorio Magno	40°39'	15°24'	VIII-IX
S. Mango sul Calore	14°58'	40°57'	IX
S. Martino d'Agri	40°15'	16°04'	VII
S. Mauro Forte	40°29'	16°15'	VIII
San Michele di Serino	40°52'	14°51'	VIII
S. Nicola Baronia	41°04'	15°12'	VIII-IX
S. Pietro al Tanagro	40°27'	15°29'	VIII
S. Rufo	40°26'	15°28'	VIII
S. Sossio Baronia	41°05'	15°12'	IX
Sant'Agata di Puglia	41°09'	15°23'	X
Sant'Agente	?	?	X
Santa Lucia di Serino	40°52'	14°52'	VIII
Santa Maria Capua Vetere	41°05'	14°15'	VII
Sant'Andrea di Conza	40°51'	15°22'	X
Sant'Angelo dei Lombardi	40°56'	15°11'	X
S. Guglielmo di Convento al Goleto	40°54'	15°09'	X
Sant'Angelo le Fratte	40°32'	15°34'	IX
Sant'Arsenio	40°28'	15°29'	VIII
Santomenna	40°48'	15°20'	IX-X
Saracena	40°45'	16°10'	?
Sarconi	40°15'	15°54'	VII
Sasso di Castalda	40°29'	15°41'	VIII
Satriano di Lucania	40°32'	15°39'	IX
Senerchia	40°44'	15°12'	VII-VIII
Serino (Sala)	40°51'	14°52'	VIII
Sicignano degli Alburni	40°33'	15°19'	VII
Somma Vesuviana	40°52'	14°27'	VII
Sorbo Serpico	40°55'	14°53'	VIII
Sorrento	40°38'	14°22'	VII
Spinazzola	40°58'	16°05'	VII-VIII
Stigliano	40°23'	16°14'	VII
Teggiano	40°23'	15°33'	VIII
Teora	40°51'	15°15'	X-XI
Tito	40°35'	15°41'	X
Torchiati (Montoro Sup.)	40°49'	14°48'	VIII
Torella dei Lombardi	40°57'	15°07'	X
Torre le Nocelle	41°01'	14°55'	VIII
Tramonti	40°42'	14°38'	VIII
Trevico	41°03'	15°14'	X
Tricarico	40°38'	16°09'	VIII
Trivigno	40°35'	16°00'	VIII
Vaglio Basilicata	40°40'	15°55'	VIII
Vallata	41°02'	15°15'	X
Valva	40°44'	15°16'	VIII-IX
Valvano	?	?	IX
Venosa	40°58'	15°50'	VIII
Vico Equense	40°40'	14°26'	VII
Vietri di Potenza	40°36'	15°31'	IX
Villamaina	40°58'	15°06'	IX
Villanova del Battista	41°07'	15°10'	IX
Zungoli	41°07'	15°12'	VIII-IX

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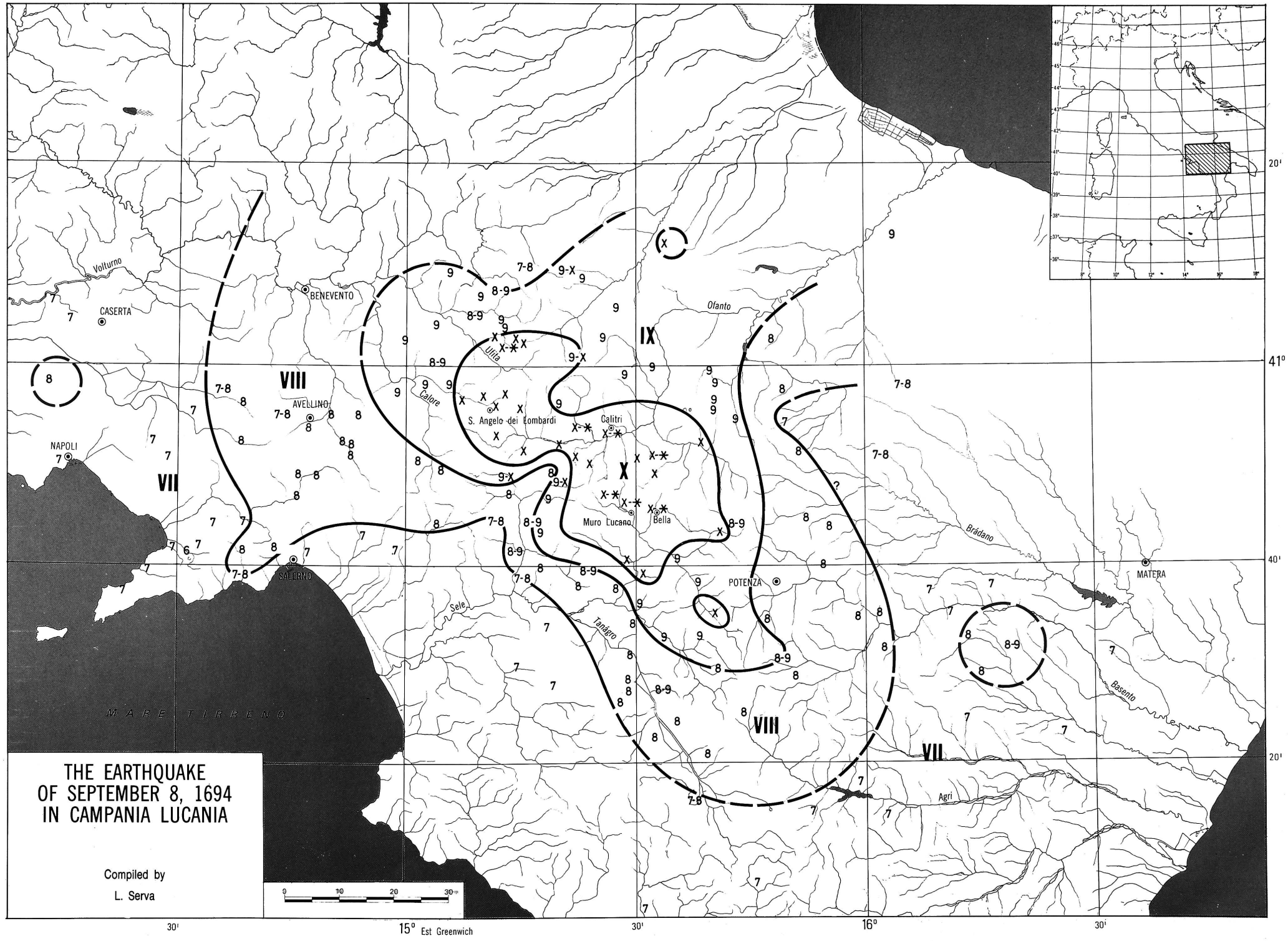

THE EARTHQUAKE OF SEPTEMBER 8, 1694 IN CAMPANIA LUCANIA

Compiled by

L. Serva

The drainage network of this map – scale 1:500.000 – is the same as the "Structural Model of Italy."

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The Bagnoregio earthquake of June 11, 1695

C. Margottini, D. Molin, E. Ramacci

This is the most important event to have taken place in the province of Viterbo in historic times. It struck with maximum strength in a restricted area at Bagnoregio, and caused more or less serious damage in the whole area between Lake Bolsena and the Tiber valley.

About 50 people were killed, most of them in Bagnoregio. The number of victims could have been a great deal higher if a strong foreshock three hours before the main event had not made the frightened people leave their homes.

A large amount of contemporary literature has been collected on the subject, taken from the archives of various towns involved in the earthquake, particularly from Viterbo and Bagnoregio. The literature, together with certain reports by contemporary writers, allows us to estimate fairly accurately almost all the major characteristics of the earthquake.

There has been no difficulty in estimating the date and time, since these have been reported without contradiction by many contemporary writers. On the other hand, there are noticeable contradictions between later writers on the date and time of both the main earthquake and the others. It must be noted that the time is taken to the nearest quarter of an hour, given the imprecision of the means of measuring time that existed at that period.

The seismic sequence began on 7 June, with a few slight shocks, followed by one of the VII degree on the MCS scale on 8 June. Then, after an interval of two days, the main event took place on 11 June, at 3.30 a.m. local time. However, it was preceded by a strong foreshock that caused people to flee from their homes, thus limiting the number of victims. There were many aftershocks during the following ten days, and these continued less frequently until the middle of July. After this, there is no information about further shocks until 5, 10 and 11 June 1696, when some events with an intensity of about the IV degree on the M.C.S. scale were noted. It is very likely that all the events of the seismic sequence had their epicentre near Bagnoregio.

The highest intensity was registered at Bagnoregio, where no house was left undamaged. Many buildings partially collapsed, and within the town itself fractures in the ground and landslides occurred making several houses fall into the gorges below.

In spite of the amount of information and the various descriptions of the damage, the intensity of the earthquake at Bagnoregio is still attributed at between the IX and X degrees, since it has not been possible to estimate the different types of damage.

The epicentre proved to be at Bagnoregio itself (42°38' Lat. N, 12°06' Long. E), since less serious damage was reported in the villages nearby, even in those very near to Bagnoregio.

The isoseismal map proves to be very incomplete in the degrees of intensity less than the VIII degree. In fact, compared with the relative abundance of information on the higher degrees of intensity, there is a remarkable lack of data for the lower degrees. The affected area must have been quite wide, as the earthquake was felt in Rome and the Alban Hills at an intensity of the IV degree, and in Perugia and Assisi at the VI degree.

The isoseismal curves clearly show a greater spread of the intensity in a roughly NW-SE direction.

List of shocked localities:

Locality	Latit.	Long.	I (MCS)
Acquapendente	42°42'	11°52'	VI
Assisi	41°04'	12°37'	VI
Bagnoregio	42°58'	12°06'	IX-X
Bolsena	42°59'	12°00'	VIII
Capodimonte	42°33'	11°35'	VI
Castel Rubello	42°41'	12°05'	VIII
Castiglione in Teverina	42°39'	12°12'	VII
Celleno	42°54'	12°08'	VIII-IX
Civita Castellana	42°17'	12°25'	VI
Civitella d'Agliano	42°37'	12°11'	VII-VIII
Frascati	41°18'	12°41'	IV
Gradoli	42°59'	11°52'	VI
Graffignano	42°35'	12°12'	VII
Grotte Santo Stefano	42°31'	12°10'	VIII
Latera	42°58'	11°50'	VI
Lubriano	42°58'	12°07'	IX
Montefiascone	42°32'	12°02'	VII
Orvieto	42°43'	12°07'	VIII
Ponzano	42°58'	12°05'	IX
Perugia	43°07'	12°23'	VI
Porano	42°41'	12°06'	VIII
Roccalvecce	42°34'	12°10'	VIII
Rocca Ripensena	42°44'	12°03'	VIII
Roma	41°54'	12°29'	IV
San Michele in Teverina	42°36'	12°10'	VIII
Sugano	42°43'	12°03'	VIII
Tivoli	41°58'	12°48'	IV
Torre San Severo	42°40'	12°04'	VIII
Tuscania	42°25'	11°53'	VI
Vetralla	42°19'	12°03'	V
Vetriolo	42°36'	12°07'	IX
Viterbo	42°25'	12°06'	VI

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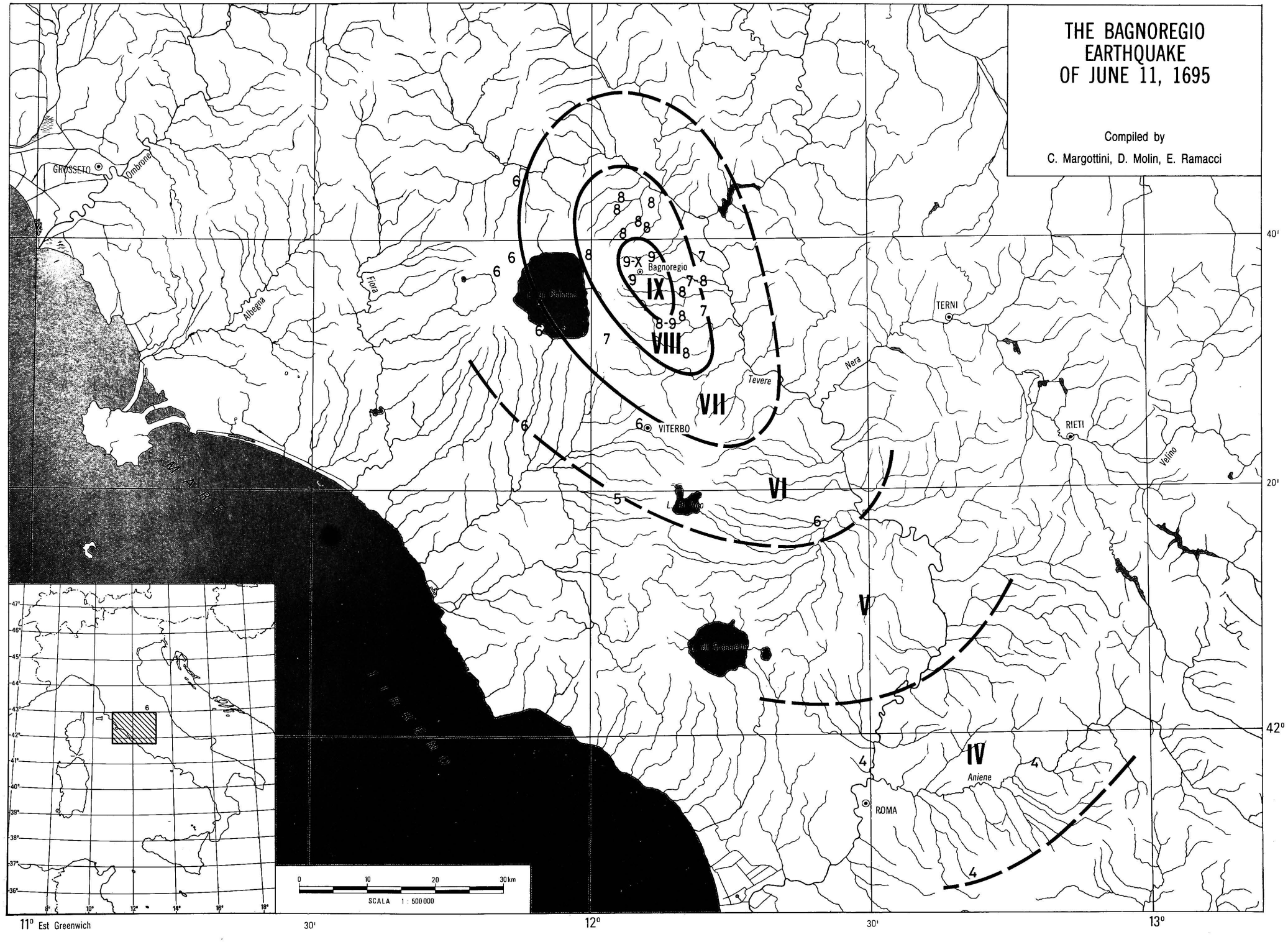
THE BAGNOREGIO EARTHQUAKE OF JUNE 11, 1695

Compiled by

C. Margottini, D. Molin, E. Ramacci



The drainage network of this map – scale 1:500.000 – is the same as the "Structural Model of Italy."

G.T.M - Via Marco Marulo 47a - 00143 ROMA

The Irpinia earthquake of March 14, 1702.

D. Molin, L. Serva

This earthquake principally hit the area located approximately between Benevento and Ariano Irpino. The most severely damaged inhabited centers were Apice, Ariano Irpino, Mirabella Eclano, Pietrelcina and Sant'Arcangelo Trimonte.
The number of victims is not precisely known. However, it is considered to have been about 500. The number could have been considerably higher if there had not been a premonitory foreshock just before the main one, which frightened people and made them leave their houses.
The most important bibliographic works regarding the event are without a doubt, the reports written by contemporary authors (4, 5, 26 and 28). Equally important is a note written by M. Baratta (8), who, besides supplying very useful bibliographic information, also gives an overall description of the event.
The hour of the main shock (6:15 local time) is reliable, since the only discrepancy found among contemporary authors regarded minutes.
Not very much information could be found regarding the duration and the structure of the seismic period. Before the main shock, there were at least three foreshocks: two were weak, while the one occurring at 5:45 (local time) has been evaluated as VIII degrees MCS. In Benevento, a great number of aftershocks was reported as lasting until April 6, 1702. They generally had a medium-low intensity, except for the ones occurring on April 2 and 6 at 7:00 a.m. and 6:00 p.m. (local time) respectively, which had intensities of about VIII-IX degree MCS.
The maximum intensity observed (X degree MCS) occurred in various inhabited centers located in the valleys of Calore and Ufita Rivers. It is also notable that the evaluation of intensity was uncertain in many cases because of the lack of available information.
The unsatisfactory evaluation of the intensities also leads to uncertainty regarding the location of the epicenter, which, according to the data available, can be placed near Apice (lat. 41°07'N, long. 14°57'E).
A satisfactory isoseismal map could not be drawn up for the same reasons, in addition to the fact that there is very little information available regarding localities with intensities less than IX degree MCS.
In any case, the epicentral area shows a trend of maximum propagation in approximately an ESE-WNW direction, which is similar to the trend seen for other earthquakes occurring in the same zone. This zone, located between Benevento and Ariano Irpino, is certainly to be considered among the most seismically active in Italy, since it has been hit by many other destructive earthquakes.

List of shocked localities:

Locality	Latit.	Long.	I (MCS)
Apice	41°07'	14°06'	X
Aquilonia	40°59'	15°29'	VIII-IX
Ariano Irpino	41°09'	15°05'	X
Aversa	40°58'	14°12'	VI
Benevento	41°08'	14°46'	IX-X
Castel Baronia	41°03'	15°12'	IX
Flumeri	41°05'	15°10'	IX
Fontanarosa	41°01'	15°02'	IX
Fragneto l'Abate	41°16'	14°47'	IX
Gesualdo	41°00'	15°05'	IX
Grottaminarda	41°24'	15°04'	IX-X
L'Aquila	42°21'	13°23'	?
Lucera	41°30'	15°20'	?
Mirabella Eclano	41°03'	15°00'	X
Montecalvo Irpino	41°12'	15°02'	IX
Monte Miletto	41°01'	14°54'	VIII-IX
Napoli	40°51'	14°15'	VI
Paduli	41°10'	14°53'	IX-X
Pago Veiano	41°15'	14°52'	VIII-IX
Pietrelcina	41°12'	14°51'	X
Roccamonfina	41°18'	13°59'	?
San Giorgio del Sannio	41°04'	14°51'	IX
Sant'Arcangelo Trimonte	41°10'	14°56'	X
Tocco Caudio	41°07'	14°38'	IX
Trevico	41°03'	15°14'	IX

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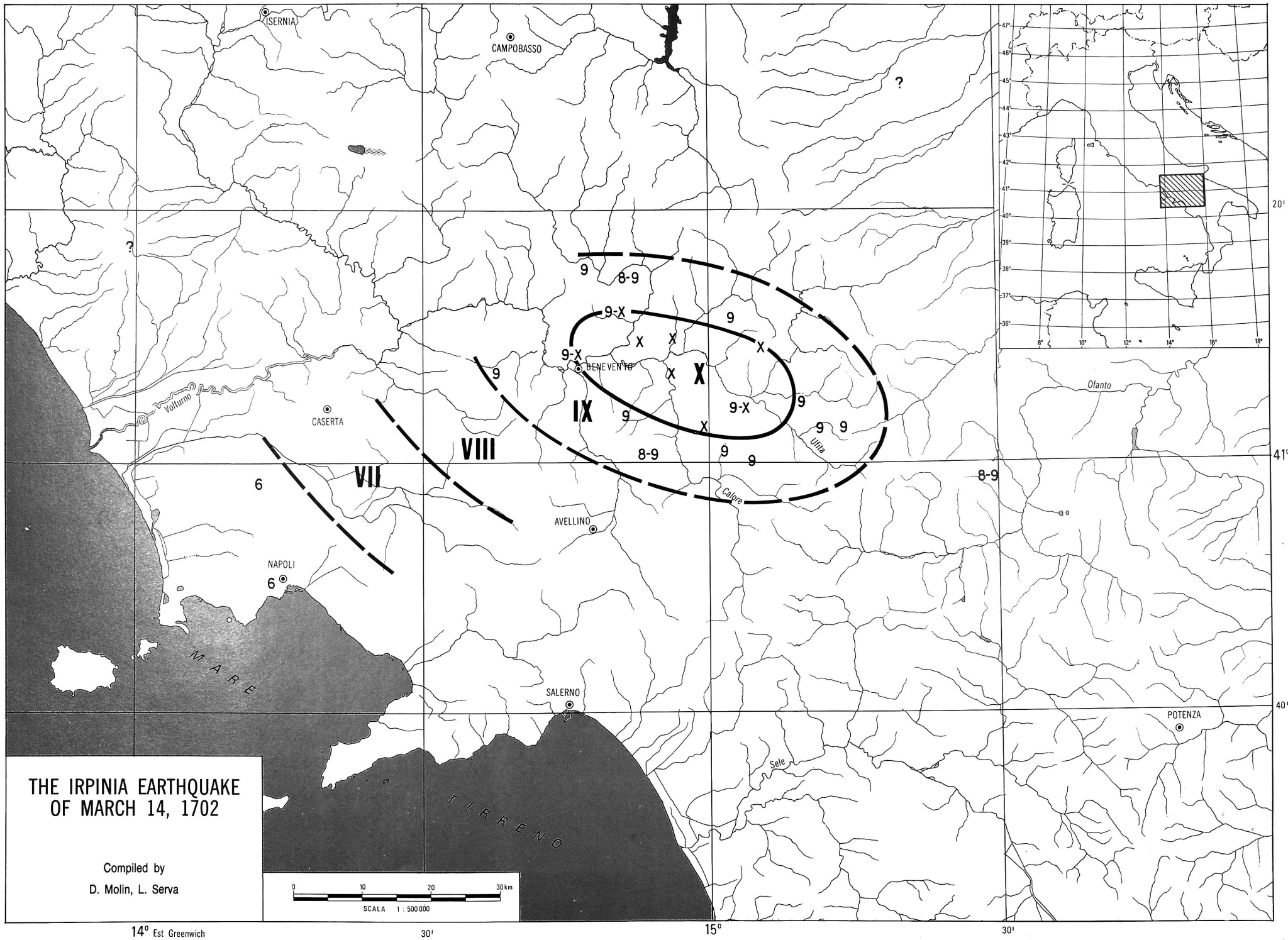

THE IRPINIA EARTHQUAKE OF MARCH 14, 1702

Compiled by

D. Molin, L. Serva

The drainage network of this map – scale 1:500.000 – is the same as the "Structural Model of Italy."

G.T.M - Via Marco Marulo 47a - 00143 ROMA

The earthquakes in Central Italy, January-February 1703. Some questions, some preliminary answers.

M. Stucchi

Foreword.

The sequence of earthquakes which occurred in January and February of 1703 has to be considered as a highly relevant historical, geological and seismological event for a wide area of Central Italy.

The size of the catastrophy is documented by the death toll (around 10,000); by the vast extension of damaged area within which several villages were completely abandoned and the ruins of which are still visible today; and by the huge number of religious services which took place in the area, mainly in Rome, which suffered only little damage but lived many months in a situation of stress.

The problems involved with these earthquakes are so complex that the present level of research is to be considered inexhaustive.

Problems.

The earthquakes of 1703 are classified in (1) and (2), as follows:

	Year	Month	Day	Time (GMT)	ep.	coord.	Magn.	MCS int.
	1702	Oct	18	–	4100	1500	–	Felt
	1702	Nov	14	–	4100	1500	–	Unkn
	1703	Jan	14	01 00	4200	1300	6.5	X
	1703	Jan	16	14 00	4200	1300	7.5	XI
(1)	1703	Jan	20	13 00	4500	1000	5.5	VII
	1703	Jan	21	–	4200	1300	–	Felt
	1703	Jan	25	–	4200	1300	–	Felt
	1703	Feb	02	01 00	4200	1300	7.5	XI
	1703	Feb	04	02 00	4200	1300	–	Dama
	1703	Feb	15	23 30	4200	1300	–	Felt
	1702	Oct	18	13 00	4245	1300	3.25	IV-V
	1702	Nov	14	–	4255	1240	4.5	VII
	1703	Jan	14	01 00	4245	1305	6.0	X
(2)	1703	Jan	16	20 00	4235	1310	6.0	X
	1703	Jan	21	–	4250	1335	4.0	VI
	1703	Jan	25	–	4230	1300	3.5	V
	1703	Feb	02	17 00	4227	1320	6.0	X
	1703	Feb	03	19 45	4230	1315	5.0	VIII
	1703	Feb	15	23 30	4230	1300	4.0	VI

The main source is (3), whose references are considerable. Based on these references, an isoseismal map is available for the cumulative effects of the 14 and 16 January shocks.

While trying to solve problems connected with the assessment of the location, with the maximum intensity and the epicentral area of the main shocks, it is necessary to meet the problem of discriminating the damaging grades of single shocks within cumulative reported effects.

This problem refers to a very well-known seismological one, that is:

for seismotectonic investigations it can be useful to discriminate single events; for studies related to hazard or risk maps, such a distinction may be misleading.

How should this information be classified, mapped and used? In the present phase, efforts have been concentrated on the location, intensity and influence of the 16/1/1703 shock.

Sources

The considerable bibliography of M. Baratta is composed of primary and secondary, though mostly contemporary sources. Most of these sources were compiled and printed in Rome, therefore causing particular stress to be given to afterquake effects in the city. Reports from the regions then belonging to the 'Church State' are more detailed than those referring to regions then belonging to the Kingdom of Naples.

By carrying on this research, several new sources have been found, including;

— more printed contemporary sources, with particular reference to the Ascoli Piceno area;

— unpublished reports concerning Cascia, Leonessa and Foligno;

— archive files in the Valnerina and Macerata areas;

— local non-contemporary chronicles, reporting useful information on remote villages, taken from archive files which often are no longer easily accessible.

The problem of correctly interpretating the hours of day reported on the chronicles required a great deal of work.

Results

The three main shocks are classified with the same epicentral coordinates in (1). This stresses the compiler's point of view, that the seismogenetic zone is unique. In (2), following Baratta's interpretation, the three shocks are located in three different areas.

Archive sources suggest a re-evaluation of the influence of the 10 October 1702 shock, located between Norcia and Cascia. Damages and requests for repairs were reported. A VII MCS degree is proposed here, together with the suggestion of taking into account the influence of this shock on the following quakes.

The 14 January shock caused damages estimated to be not less than IX MCS in the localities of Umbria and also in Amatrice, Cittareale, Leonessa (in the latter locality, religious services are still celebrated every year). Lack of data does not allow for a verification of Antrodoco, Posta and Montereale.

The 16 January shock does not seem to have been responsible for severe damages and life-toll. Furthermore, some localities which were damaged on 14/1 are explicitely reported to have been destroyed on 2/2, and not 16/1.

The elevated life-toll on 2/2 is chiefly related to be concentration of people in the churches for Mass at the time of the shock.

The relevance of this shock and the dimensions of the damaged area remain to be checked with a search in the archives of the region.

At present it is not possible to assess MCS intensity for most localities, but only to classify them in three damage categories (definition on the map), and then only for the 14/1 shock.

At the present state of work, the following interpretation can be proposed for the three more intense events:

14/1/1703 (06.00 p.m. GMT)
Maximum intensity not lower than X MCS.
Norcia is the northernmost spot of the most affected area.

16/1/1703 (01.00 p.m. GMT)
Maximum intensity not higher than VII MCS.
Epicentral area: Montereale (?). This point, as well as the width and the shape of the area, cannot be confirmed.

2/2/1703 (10.00 p.m. GMT)
Maximum intensity around IX MCS.
Epicentral area ranging from Antrodoco/Sigillo (surface effects reported) to L'Aquila and further, 30 to 35 km wide, orientation N 110.

Further contributions: Vittorio Giorgetti, Floriana Pergalani, Silvia Grassi, Sergio Raccichini

List of shocked localities:

Locality	Latit.	Long.	I (MCS)
Agnano (Camerino)	43°10'	13°04'	VIII
Amandola	42°59'	13°21'	VII
Belforte del Chienti	43°10'	13°14'	VIII
Caldarola	43°08'	13°14'	VIII
Camerino	43°08'	13°04'	IX
Casale (Camerino)	43°07'	13°02'	VII
Castelraimondo	43°13'	13°03'	VIII
Cerreto (San Ginesio)	43°04'	13°18'	VIII
Cessapalombo	43°06'	13°15'	IX-X
Esanatoglia	43°15'	12°57'	VII
Fano	43°50'	13°01'	V
Fiastra	43°02'	13°09'	VII
Fiungo (Camerino)	43°08'	13°09'	VIII
Gualdo (Sarnano)	43°04'	13°20'	VIII
Letegge (Camerino)	43°09'	13°07'	IX
Matelica	43°15'	13°01'	VII
Morico (San Ginesio)	43°06'	13°16'	VIII-IX
Muccia	43°05'	13°03'	VII
Pian di Pieca (San Ginesio)	43°04'	13°17'	VIII
Pievebovigliana	43°04'	13°05'	VII
Pioraco	43°11'	12°59'	VIII
Polverina (Camerino)	43°05'	13°07'	VIII
Pozzuolo (Camerino)	43°09'	13°08'	IX
Rocca d'Aiello (Camerino)	43°11'	13°04'	VIII
San Ginesio	43°06'	13°19'	VII-VIII
San Severino	43°14'	13°11'	VIII
Santa Lucia (Camerino)	43°07'	13°05'	IX
Sarnano	43°02'	13°18'	VIII
Serravalle	43°04'	12°57'	VII
Statte (Camerino)	43°09'	13°09'	IX
Teramo	42°40'	13°42'	III-IV
Torricelle (Castelraimondo)	43°12'	13°04'	IX
Tuseggia (Camerino)	43°10'	13°05'	VIII
Vallicchio (Muccia)	43°05'	13°03'	VIII
Varano (Camerino)	43°07'	13°07'	VIII
Villa d'Aria (Serrapetrona)	43°11'	13°09'	IX

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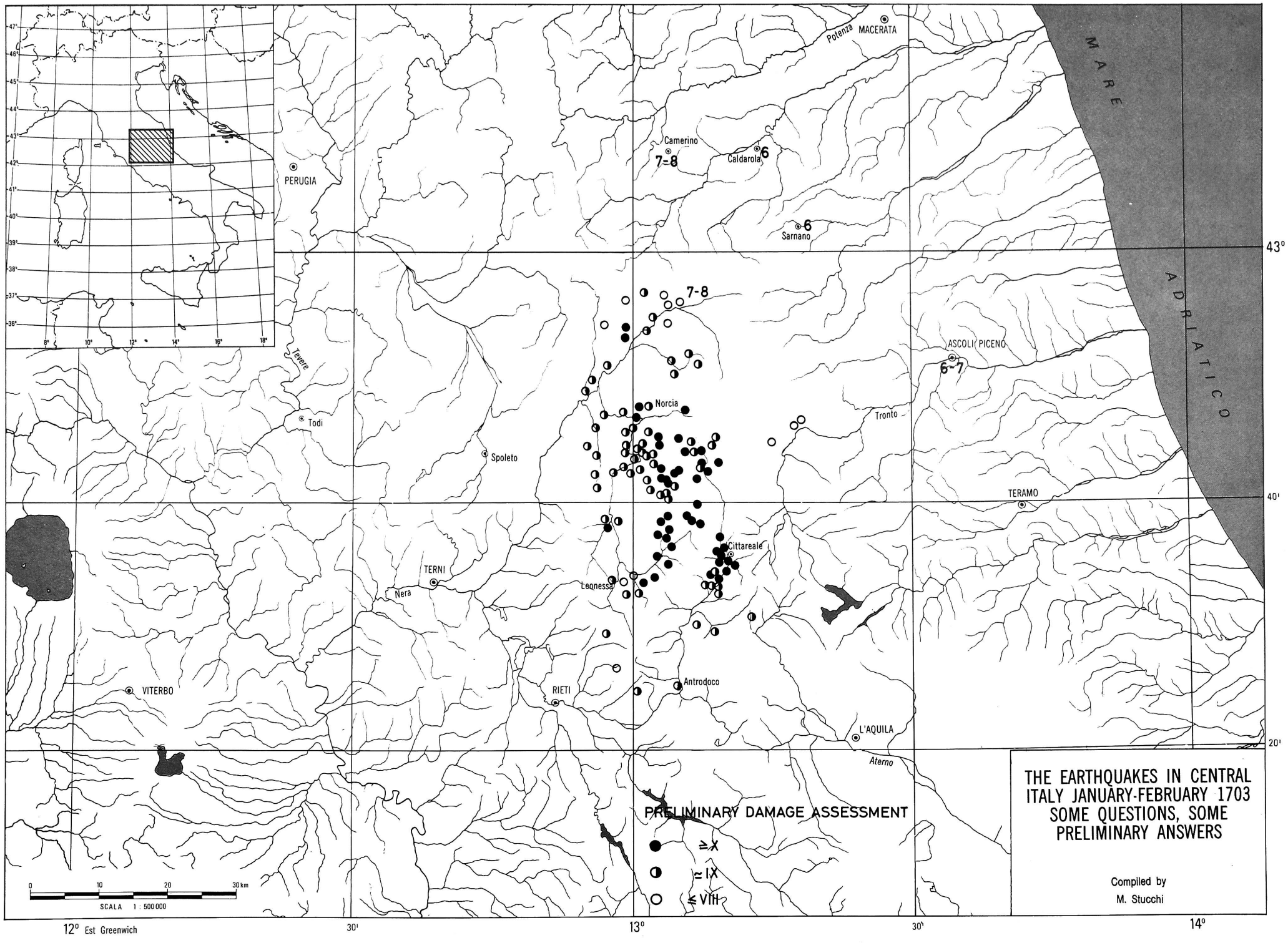

The drainage network of this map – scale 1:500.000 – is the same as the "Structural Model of Italy."

G.T.M - Via Marco Marulo 47a - 00143 ROMA

The Foggia earthquake of March 20, 1731.

D. Molin

The area of maximum intensity was very small. The town of Foggia was almost entirely destroyed. Many buildings collapsed and all the others were so damaged that they were uninhabitable.

The casualties, according to the examined literature, range from a minimum of 600-700 to a maximum of 1,500 people. Most of the deaths occurred in the town of Foggia; only 300 people died in other villages or towns.

There is not very much literature available. Among the examined works, a preminent importance is given to reports by contemporary writers (2-5) which give almost all of the used data.

No difficulties have been encountered in fixing the time of the main event (3 a.m.). It is to be noted that, because of the imprecise measuring of the period, the minutes have been taken to the nearest half of an hour.

Two low intensity foreshocks, 5.5 and 2.5 hours before the main event, seem to have occurred. The main event, according to the literature, lasted a very long time and probably was a multipleshock (at least a train of three events, the second of which was the destructive one).

The main shock was followed by many aftershocks which lasted almost one year; they were felt in localities spread over a wide area. Among the aftershocks, that of 17 October 1731 has to be noted since it caused damages at Barletta and Canosa di Puglia.

The maximum intensity (X degree of the MCS scale) was at Foggia and the macroseismic epicentre should be located near this locality (41°28' lat. N, 15°33' long. E).

The intensity at Cerignola was close to the IX degree of the MCS scale.

The isoseismal lines are shown in the figure; because of the lack of macroseismic information they have to be considered sketched. Nevertheless, both the extent of the VII-VIII degree isoseismal line and the anomalous spreading towards the Ofantc valley are significant; this fact has also been noted for other earthquakes (i.e. the northern Apulia earthquake of 29 July 1627).

The affected area must have been extremely large since in Rome the multiple-shock main event was felt clearly.

List of shocked localities:

Locality	Latit.	Long.	I (MCS)
Andria	41°14'	16°35'	VIII
Ascoli Satriano	41°12'	15°34'	?
Aversa	40°58'	14°12'	V
Bari	41°07'	16°52'	VI-VII
Barletta	41°19'	16°17'	VIII
Canosa di Puglia	41°13'	16°04'	VIII
Cassino	41°29'	13°50'	V
Cerignola	41°16'	15°54'	IX
Foggia	41°28'	15°33'	X
Giovinazzo	41°11'	16°40'	?
Lucera	41°30'	15°20'	?
Manfredonia	41°38'	15°55'	VIII
Melfi	41°00'	15°40'	VIII
Molfetta	41°10'	16°35'	VIII
Montecassino	41°29'	13°48'	V
Napoli	40°51'	14°15'	V
Orta Nova	41°20'	15°43'	VII
Roccamonfina	41°18'	13°59'	VI
Roma	41°54'	12°29'	IV
Rutigliano	41°01'	17°00'	VI-VII
San Giovanni Rotondo	41°30'	15°44'	VII
San Severo	41°41'	15°23'	VIII
Trani	41°17'	16°25'	VII-VIII
Troia	41°22'	15°19'	VII

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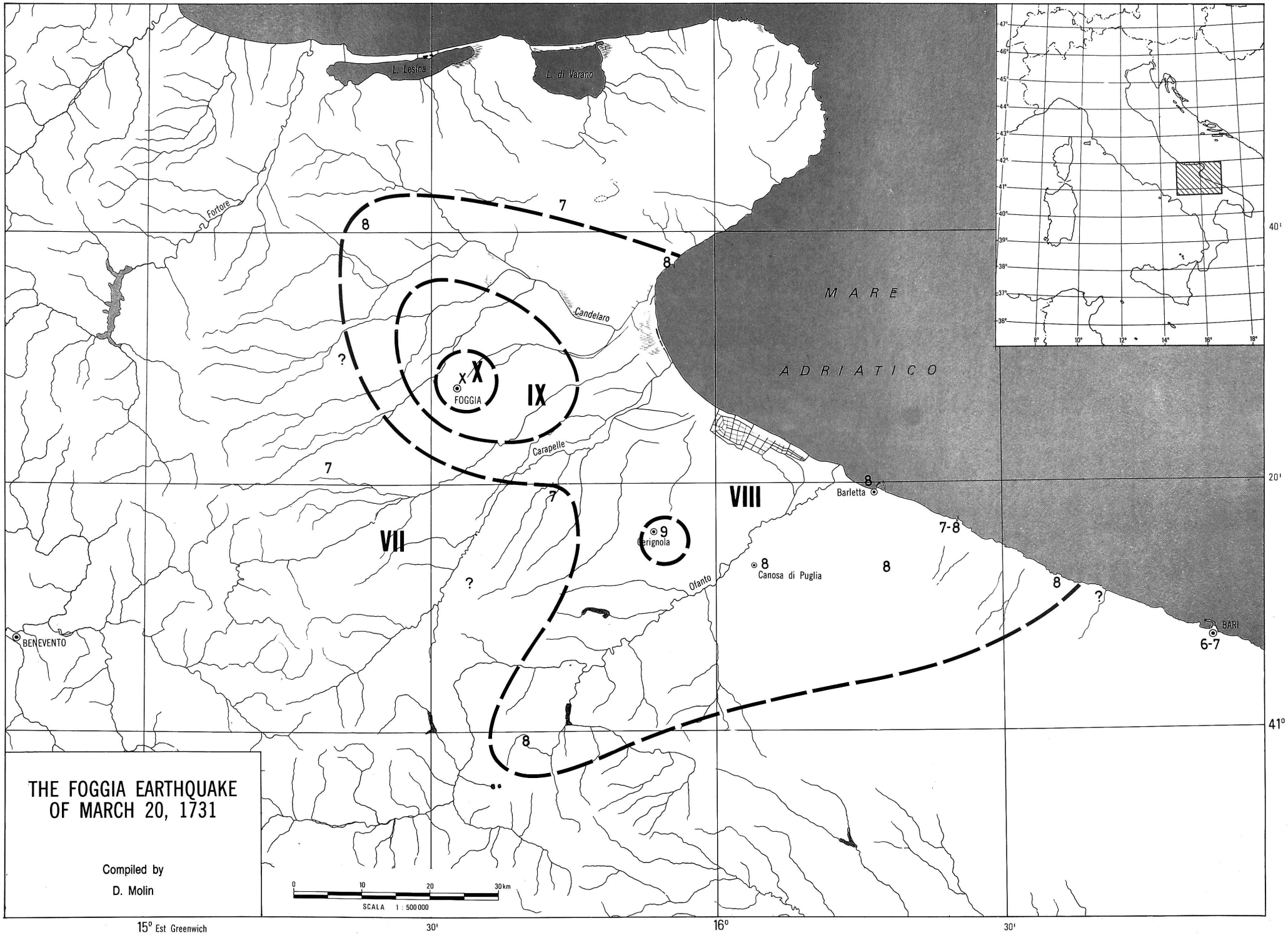

THE FOGGIA EARTHQUAKE OF MARCH 20, 1731

Compiled by

D. Molin

The drainage network of this map – scale 1:500.000 – is the same as the "Structural Model of Italy."

G.T.M - Via Marco Marulo 47a - 00143 ROMA

Comment of the Irpinia earthquake of November 29, 1732.

M.C. Spadea, M. Vecchi, P. Gardellini, S. Del Mese

On 29 November a very violent shock occurred in Irpinia at 12^h20^m (GMT), preceded by a slight tremor at 4 a.m.
The area damaged and otherwise affected extended over most of Central-Southern Italy.
Scandone F. (1) reports.

From: «Montefusco, 1731-1733».
«1732, September 29, *Arch. stor. per le prov. nap., Racconto di varie notizie, Vol. XXX, p. 878.*
(...) The sad news was heard of the damage caused by the earthquake in the province of Montefusco seu Principato Ultra at the same hour (13 1/2 Italian time), with the ruin of many lands (...). In Montefuscoli five persons died, and 20 (were) injured, with 86 houses collapsing and all the others damaged and torn open. The hamlets of Calvi, S. Nazaro, S. Paolina, S. Pietro and S. Angelo (...) counted 90 houses fallen and two churches, with six deaths».

From: «Montefusco, 1731-1733».
«1732, December 6, *Viglietti Vicereali, vol. 3208.*
The Viceroy received the report on the damage caused by the latest earthquake in Montefuscolo. The palace of the R.Ud. is uninhabitable and funds must be approved for its repair. The court is presently sitting in a hut».

From: «Montefusco, 1731-1733».
«1733, March 31, *Coll. Cur., vol. 183, fol. 88t.*
From a report of 17th from the Fiscal Advocate of the R.Ud. of Montefuscolo, the viceroy learned that "owing to the fearful earthquake of 29th November 1732, the President had to leave the Royal Palace as it was no longer safe to live in, nor convenient to administer justice in».

From: «Montefusco, 1731-1733».
«1734. Carafa Tiberio, *Relazione sulla guerra del 1734*, in: Arch. stor. nap., vol. VII, p. 299.
The prince of Chiusano (Tib. Carafa), appointed Vicar General (by the Austrian viceroy) "of the province of P.U., commonly known as Montefuscolo", declared that "the universities could no longer afford the additional scaffolding work after the fearful earthquake recently suffered (...) some were completely flattened, half of the remainder were ruined and the other half so badly damaged that they could not be inhabited without danger».

From: «Pago, 1700-1776».
«1733, September 19, *Part. Coll., vol. 1346, fol. 85.*
(...) The church (of the archpriest of Pago, author's note) replied that the protest was irrelevant, since the archpriest had never requested anything from the baronial lands. The preceding order referring to the "poor archpriest's church of Pago, completely ruined and tumbledown after the scourge of the recent dreadful earthquake" is hereby renewed».

1732, 29 November. —
«1732 was a remarkable year for the earthquakes in Sicily and the Naples area (...)». This is what Muratori wrote of the earthquakes in the Naples area, particularly the one that occurred on 29 November: «hundreds of persons were crushed beneath the ruins of the houses. Only a few buildings did not receive damage, and the latter amounted to some million ducats. It was worse in the provinces of Terra di Lavoro, and the two Calabrias. Ariano, Avellino, Apici, Mirabello and more than thirty villages were mostly razed to the ground. I saw a long list of other places badly affected by this great disaster, and of those who died in it».
Perrey speaks of 1940 dead and 1455 injured. These numbers would have certainly been greater if the earthquake had happened in the evening or at night. As mentioned in the bibliographic sources, the population at that hour was already at work in the open country.
Great damage was done to the environment.
Even though abundant data are available, they are not reliable enough to allow a degree of intensity to be assigned to the many localities marked on the map. Indeed, we consider that the damage described has been overestimated. It has thus been difficult to accurate determine data especially for the high intensities (VIII, IX, X).
However, an attempt has been made to map the macroseismic field in order to illustrate the damaged area, which has been found to extend over about 8000 km.
The aftershocks were numerous and continued until March of the following year (1733). The two heaviest occurred in 1733, one on 15 January and the other on 23 March.

List of shocked localities:

Locality	Latit.	Long.	I (MCS)
Accadia	41°10'	15°25'	IX
Altavilla Irpina	41°00'	14°47'	IX
Andretta	40°56'	15°19'	VIII-IX
Apice	41°07'	14°56'	X
Apollosa	41°06'	14°42'	IX
Ariano	40°39'	15°01'	X
Arpaia	41°02'	14°33'	VIII
Atripalda	40°55'	14°50'	VIII
Avellino	40°55'	14°47'	IX
Bagnoli Irpino	40°50'	15°04'	VIII
Benevento	41°08'	14°47'	IX
Biccari	41°24'	15°12'	VIII
Bisaccia	41°01'	15°23'	VIII-IX
Bonito	41°06'	15°00'	X
Buonalbergo	41°13'	14°59'	VIII
Cairano	40°54'	15°22'	VIII-IX
Calvi	41°04'	14°52'	IX
Campolattaro	41°17'	14°44'	VIII
Candida	40°56'	14°53'	IX
Caposele	40°50'	15°13'	VII-IX
Capriglia (Irpina)	40°57'	14°46'	IX
Carbonara di Nola	40°53'	14°35'	VIII
Carife	41°02'	15°13'	X
Casalduni	41°16'	14°42'	VIII
Cassano Irpino	40°52'	15°02'	VIII
Castel Baronia	41°03'	15°11'	X
Castel Franci	40°56'	15°03'	IX
Castelvetere sul Calore	40°56'	14°59'	VII
Celle di San Vito	41°20'	15°11'	VIII
Ceppaloni	41°03'	14°46'	IX
Chianche	41°03'	14°47'	IX
Chianchetelle	41°02'	14°47'	IX
Chiusano San Domenico	40°56'	14°55'	IX
Conza della Campania	40°52'	15°20'	IX
Dentecane Campanarello	41°02'	14°54'	VII
Flumeri	41°05'	15°09'	X
Fragneto l'Abate	41°16'	14°47'	VIII
Fragneto Monforte	41°15'	14°46'	VII-IX
Frigento	41°01'	15°06'	IX
Gesualdo	41°00'	15°04'	IX
Ginestra	40°56'	15°44'	VII
Ginestra degli Schiavoni	41°17'	15°02'	VIII
Grottaminarda	41°04'	15°03'	X
Guardia Lombardi	40°57'	15°13'	X
Lapio	40°59'	14°57'	IX
Lioni	40°53'	15°11'	IX
Mancusi	?	?	VIII-IX
Manocalzati	40°56'	14°51'	VIII-IX
Melfi	41°00'	15°39'	VII
Mercogliano	40°55'	14°44'	VIII
Mirabella Eclano	41°03'	15°00'	X
Molinara	41°18'	14°55'	VIII
Montaperto	41°00'	14°53'	VIII
Montecalvo Irpino	41°12'	15°02'	IX
Montefalcone di Val Fortore	41°20'	15°01'	VIII
Montefuscolo	41°02'	14°51'	IX
Montella (Dintorni di)	40°51'	15°01'	IX
Montemarano	40°55'	15°00'	IX
Montemiletto	41°01'	14°55'	VIII
Monte Rocchetta	41°03'	14°49'	IX
Montesarchio	41°04'	14°38'	IX
Monteverde	41°00'	15°32'	VIII
Morra de Sanctis	40°56'	15°15'	VIKII-IX
Napoli	40°51'	14°16'	VII
Nusco	40°53'	15°05'	IX
Ospedaletto d'Alpinolo	40°56'	14°45'	VIII
Pago Veiano	41°15'	14°52'	VIII
Pannarano	41°01'	14°42'	IX
Paolise (Parolise)	40°56'	14°53'	IX
Paternopoli	40°58'	15°02'	IX
Pesco la Mazza (Pesco Sannita)	41°14'	14°49'	VIII
Piano di Sorrento	40°38'	14°25'	VII
Pietradeifusi	41°02'	14°52'	IX
Pietrelcina	41°12'	14°51'	VIII
Pontelandolfo	41°17'	14°42'	VIII
Pozzuoli	40°49'	14°07'	VI
Prata (di Principata Ultra)	40°59'	14°50'	IX
Preturo	40°50'	14°46'	IX
Reino	41°17'	14°49'	VIII
Rocca Bascerana	41°01'	14°43'	IX
San Giorgio del Sannio	41°04'	14°51'	IX
Rocca San Felice	40°57'	15°10'	IX
Roma	41°54'	12°29'	IV
Roccamonfina	41°17'	13°59'	VII
Salerno	40°41'	14°46'	VI
Salza Irpina	40°55'	14°53'	IX
San Barbato	40°57'	14°51'	VIII
San Giorgio la Molara	41°16'	14°55'	VIII
San Lupo	41°16'	14°38'	VIII
San Marco dei Cavoti	41°19'	14°53'	VIII
San Martino Valle Caudina	41°01'	14°40'	VIII
San Michele a Serino	40°53'	14°51'	IX
San Nazzaro	41°03'	14°51'	IX
San Nicola Baronia	41°03'	15°12'	IX-X
San Nicola Manfredi	41°04'	14°49'	IX
San Pietro Irpino	41°03'	14°48'	IX
San Polito Ultra	40°56'	14°52'	IX
San Sossio	40°52'	14°53'	X
Sant'Agata dei Goti	41°05'	14°30'	VIII
Santa Maria a Tora	41°04'	14°49'	IX
Santa Maria Ingrisone	41°04'	14°50'	IX
Sant'Andrea di Conza	40°51'	15°22'	VIII
Sant'Angelo (a Cancelli)	41°02'	14°51'	IX
Sant'Angelo all'Esca	41°00'	15°00'	IX
Sant'Angelo a Scala	40°58'	14°44'	IX
Sant'Angelo dei Lombardi	40°56'	15°11'	IX
Santa Paolina	41°02'	14°51'	IX
Santo Stefano del Sole	40°54	14°52'	IX
Serra Rotondi	?	?	VIII
Solofra	40°50'	14°51'	VIII
Sorbo	40°51'	15°00'	IX
Sorrento	40°37'	14°23'	VII
Summonte	40°57'	14°45'	IX
Taurasi	41°00'	14°57'	VIII-IX
Teora	40°51'	15°15'	IX
Toccanisi	41°03'	14°49'	IX
Torella dei Lombardi	40°56'	15°07'	IX
Torrecuso	41°11'	14°41'	VIII
Torre le Nocelle	41°01'	14°55'	IX
Treviso	41°03'	15°14'	X
Tufo	41°01'	14°49'	VIII
Vallata	41°01'	15°15'	X
Vitulano	41°10'	14°39'	VIII
Vulturara Irpina	40°53'	14°55'	IX

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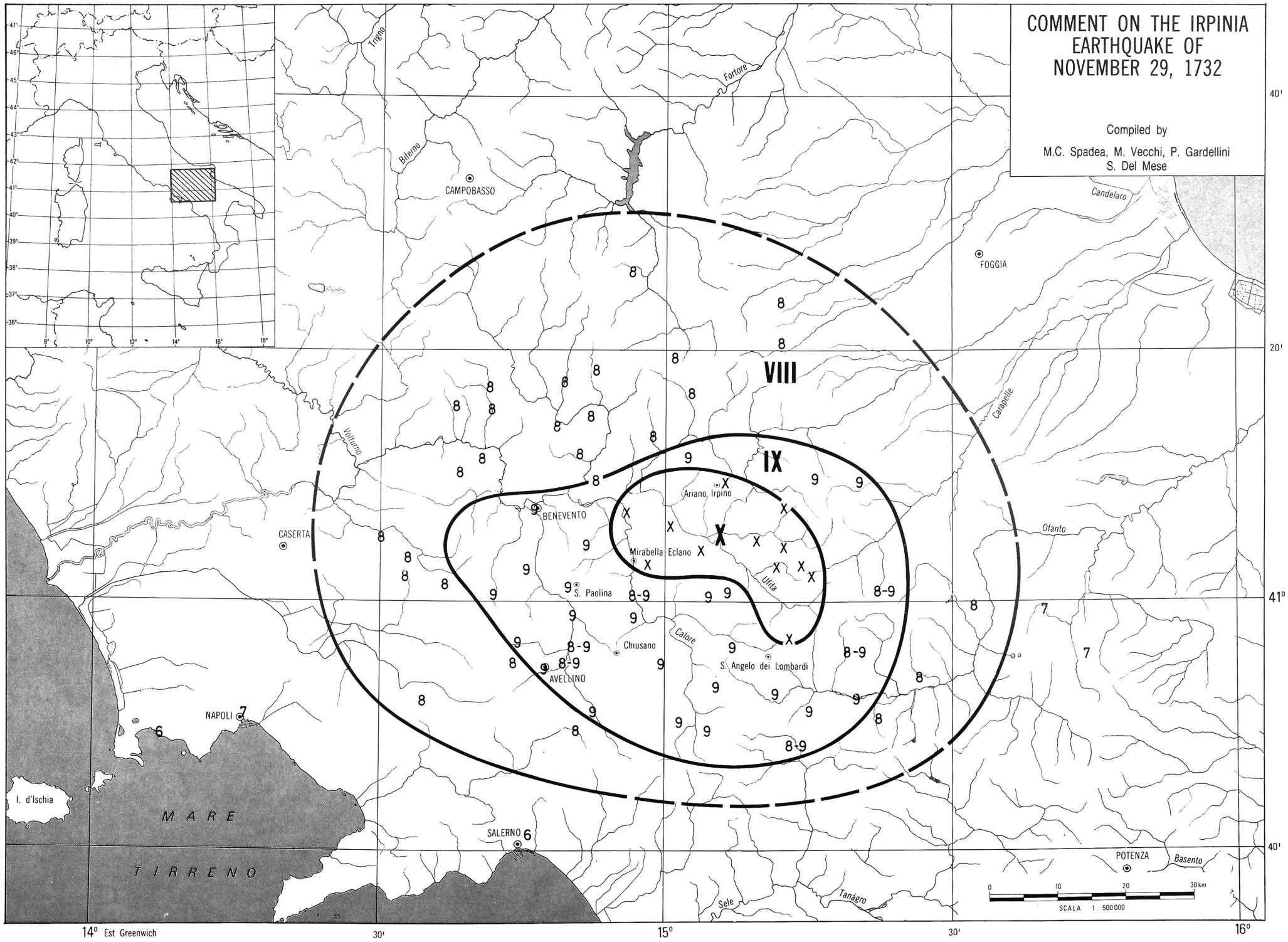

The drainage network of this map – scale 1:500.000 – is the same as the "Structural Model of Italy."

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The earthquake of February 20, 1743, in the Ionian Sea

C. Margottini

This earthquake, even though its epicenter is located in the Ionian Sea, can be listed among the most destructive earthquakes of Italy's history because of its high intensity in the Peninsula of Salento. It was also felt in Naples, Barletta, in some localities of the Po River Valley and of the Calabrian-Peloritana area, as well as in Corfù, Cephalonia and Malta.

It was not possible to find any information contemporary to the event giving a summarized description of its effects. For this reason, it was necessary to carry out a detailed investigation into both historical recollections and archival material of the period.

The bibliographical research is quite thorough for the Peninsula of Salento, while it is less complete for the other areas hit.

Reports written by the following contemporary authors were consulted: P. Cagnes and N. Scalese (24) for Brindisi; G.C. Leo (56) for Francavilla Fontana; F.A. Piccinni (80) for Lecce; D. Saracino (86) for Manduria; O. De Carlo (33) and F. Carafa (28) for Nardò. The earthquake is also commemorated on various memorial stones in important churches and palaces.

Contemporary works of a certain interest were also found for localities situated outside the Peninsula of Salento, such as those by G. Toaldo (94), the chronicler Cama (25), and an anonymous author (9).

Almost all the authors contemporary with the event agree on both the day and the hour (5:30 p.m. TMEC) the earthquake occurred.

The information gathered and utilized for the evaluations of intensity proved quantitatively and qualitatively sufficient only for the Peninsula of Salento. Information on the areas hit was rather scarce.

In Italy, the maximum intensity was observed in Nardò, reaching the IX degree on the MCS scale. It is very probable that this value of intensity is partly due to effects of amplification of the seismic energy due to lithological factors. In fact, the built-up area of Nardò rises, at the center of a vast region of sediment of the lower Pleistocene, with a thickness more than thirty meters, transgressing the calcareous and dolomite rock of the Cretaceous period.

The epicenter is unspecifically indicated by M. Baratta (20) as «in the East», and in the UNDP/UNESCO catalogue (96) it is reported with the reliable coordinates of 39° lat N and 20° long E (south of the island of Corfù). If one also considers the effects felt in Malta and in the Calabrian-Peloritana area, its location in the southern part of the Ionian Sea (approximately 38° lat N, 18° long E) is more plausible.

The distribution of intensities is so irregular (see picture) that it is impossible to map out the isoseismal lines. Also contributing to this impossibility are the gaps in information in various zones, particularly Central Italy, Campania and Basilicata.

The relatively high values of intensity found in the area between Brindisi and Taranto at the northern margin of the Peninsula of Salento, may represent a strip of «increase of intensity» corresponding to the limit between two areas with different tectonic behavior: in the North, a considerably stable area represented by the Table Mountains of Bari; and in the South, the Peninsula of Salento, the unstable behavior of which is seen by partial sinkings and emergences in the extreme southeast areas during the Eocene epoch, in the central areas during the Miocene epoch, and on practically the entire peninsula during the early Pleistocene epoch.

In a very recent geological period (during the last one-hundred thousand years), the tectonic instability at the northern extremity of the peninsula has been demonstrated in the area of Taranto by the inclination of the ancient Eutyrrhenian coastline.

List of shocked localities:

Locality	Latit.	Long.	I (MCS)
Bagnara	38°17'	15°49'	?
Barletta	41°19'	16°07'	VII
Brindisi	40°38'	17°57'	VIII-IX
Castrignano del Capo	39°50'	18°21'	VIII
Cosenza	39°18'	16°15'	?
Francavilla Fontana	40°32'	17°35'	VIII-IX
Gallipoli	40°03'	17°59'	VI
Fasano	40°50'	17°22'	V
Lecce	40°21'	18°11'	VII
Lizzanello	40°18'	18°13'	?
Manduria	40°24'	17°38'	VIII
Mantova	45°09'	10°48'	?
Mesagne	40°34'	17°49'	VIII
Messina	38°11'	15°33'	VII
Milazzo	38°14'	15°15'	V
Napoli	40°51'	14°15'	V
Nardò	40°11'	18°02'	IX
Oria	40°30'	17°39'	VIII
Otranto	40°09'	18°29'	?
Padova	45°25'	11°52'	?
Palmi	38°21'	15°40'	?
Parma	44°48'	10°20'	III
Racale	39°58'	18°06'	VII
Reggio Calabria	38°06'	15°39'	VII
Taranto	40°29'	17°14'	VIII
Venezia	45°26'	12°20'	III
Vicenza	45°33'	11°33'	IV

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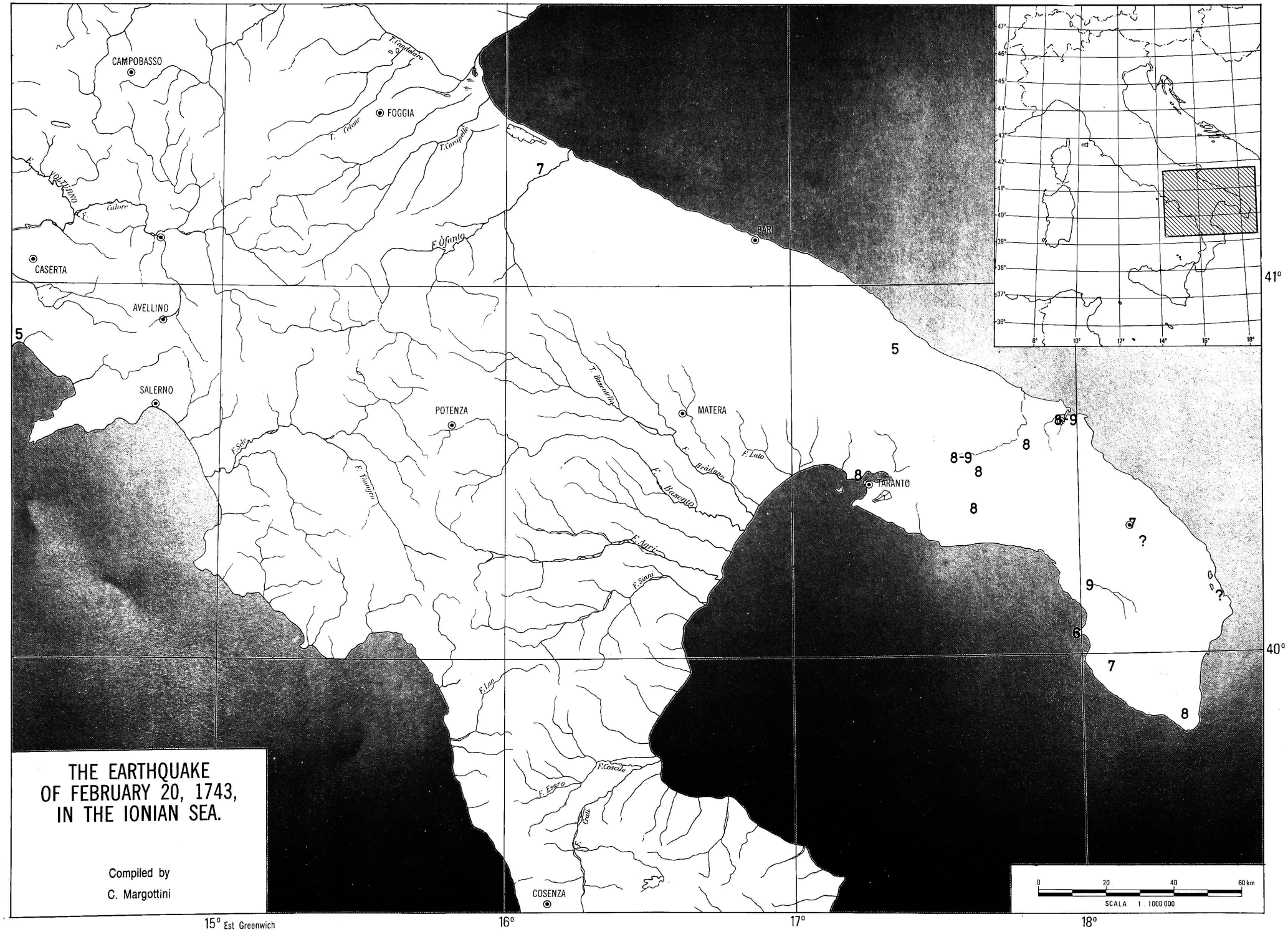
THE EARTHQUAKE OF FEBRUARY 20, 1743, IN THE IONIAN SEA.

Compiled by

C. Margottini



The drainage network of this map – scale 1:1.000.000 – is taken from the official production of the IGM! – Firenze.

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The earthquakes of Brisighella, April 4, 1781 and Faenza/Forlì July 17, 1781.

G. Ferrari, E. Guidoboni, D. Postpischl

On April 4, 1781 at 9:20 p.m. GMT, and on July 17 at 9:10 a.m. GMT, two violent shocks hit the territories of Brisighella and Forlì respectively with destructive effects. These two earthquakes are classified with a value of IX MCS in the ENEL and Carrozzo et al. Catalogues.

Since the same area was involved and the documentation is the same, the descriptions of the two events may be unified. The two earthquakes are temporally located, within a series of violent shocks that hit Romagna and The Marches (both then belonging to the Church State), and have epicenters in seismogenetic zones adjacent but distinct. On June 3 of the same year, a third shock hit the towns of Cagli, Apecchio and Sant'Arcangelo in Vado (in The Marches), causing destruction.

The entity of the damage in the two Papal provinces induced particular measures to be taken by the central administration in order to set a plan of economical aids, asking to the local administrations the description of the damages of the buildings in town and in the countryside.

The documentation requested by the Papal Government includes detailed reports on the effects of the shocks occurring on April 4, and July 17, and of the minor ones occurring on July 10 and 11. This material is preserved in the Archives of the State in Rome and belongs to the archives of the «Sacra Congregazione Pontificia del Buon Governo».

Further information concerning the area of destruction was deduced from other archival sources (deliberative acts of the Community, administrative correspondence, etc.).

In order to survey the damage caused by the April 4 shock, which prevalently hit the hill belt of Faenza, the «Elders» (Counsilors) of the community of Faenza themselves followed the work of the builders during the reconstruction of the urban houses and guaranteed the papal Congregation of the Buon Governo that they had been eye-witnesses to the description of the surveyors. In extra-urban areas, this role was performed by pastors. In less than ten days, the survey was completed and the corresponding report was sent to Rome.

The damage was described for each house. On the whole, considering the ecclesiastic edifices as well, 247 buildings were reported damaged in Faenza, about 13% of the entire building property; the rest had undergone minor damage, especially to the roofs. The extra-urban localities were the hardest hit: almost 61% of the buildings in the suburbs, and over 21% in the countryside were severely damaged. Altogether, out of 2,241 constructions, 171 (6%) were abandoned, 279 (13,4%) were «rovinose con pericolo» (dangerous), and 245 (11%) were severely damaged; totalling 695 houses, 46 churches and 47 rectories. That is to say that more than 13% of the entire rural building property, belonging to 58 localities distributed over a surface of about 250 km^2, was unserviceable.

Information related to the more external areas was taken from local recollections and from periodicals contemporary to these events.

For some localities, the precise transcriptions of administrative documents and deliberations made by Baratta belonging to community and parochial archives since destroyed or dispersed have proved valuable.

Between July 10 and 11, other shocks caused damage, especially in the territories of Tebano and Pideura.

On July 17, still another strong shock was the cause of further damage and some deaths: the hardest hit territories were those belonging to the lowland of Forlì and to the hill belt of Faenza. The surveys that were carried out following these last shocks describe the damage to 20 localities distributed over a territory of about 650 km^2.

Part of the pedi-Apennine territory of Faenza, which had already been damaged by the April 4 earthquake, underwent further damage: it was found that another 336 urban buildings and 70 rural buildings needed considerable repair.

The figure shows the distribution of the effects for the April 4, 1781 earthquake, in terms of MCS intensity values.

The maximum intensity, IX MCS, has been attributed to the localities of Montecchio, Vezzano, Quartolo and S. Ruffillo.

The IX degree isoseismal area shows a marked lengthening in the NW-SE direction, parallel to the Apennine range in that area.

The VIII degree MCS area, although maintaining a general lengthening in the NW-SE direction, shows, in particular, a strong propagation towards the South.

It has not been possible to close the VII degree MCS isoseismal line because of the scarcity of information on the damage in the Apennine area northwest of the Lamone River.

Application of the Galanopoulos formula to an estimate of the affected area leads to a macroseismic equivalent of magnitude ME = 4.6, clearly inferior to the values of MK = 5.7 and MP = 5.2 appearing in the ENEL Catalogue.

The figure shows instead the distribution of the effects for the July 17, 1781 earthquake in terms of MCS intensity values.

The VIII and VII degree MCS areas show a lengthening in the NW-SE direction; moreover, the VII degree area shows a reinforcement of intensity values in the direction of Faenza, corresponding to the pedi-Apennine territory of Faenza hit by the VII and VI degree MCS effects of the April 4 earthquake.

Although the compilers of the surveys were particularly careful in the individuation of the effects of the two earthquakes, the building property had already been weakened by the April 4, 1781 shock and by successive ones, and this may be the reason for the probable increase of intensity of the effects of the July 17 shock in this zone.

Application of the Galanopoulos formula to an estimate of the area concerned gives a macroseismic equivalent of magnitude ME = 5.2, inferior to the value of MK = 5.7 and agreeing with MP = 5.2, both reported in the ENEL Catalogue.

The following is a comparison of the values of some parameters, respectively reported in the ENEL and Carozzo et al. Catalogues, and in the present study.

Year	Mo	Da	Ho	Mi	Lat	Long	De	I	Me	Mk	Mp	Epic. area
1781	04	04	02		44°14'	11°50'	3	IX		5.7	5.2	Brisighella
1781	04	04	02		44°15'	11°45'		IX		5.0		
1781	04	04	21	20	44°15'	11°45'	3	IX	4.6	5.4		S. Ruffillo
1781	07	17	8	17	44°15'	12°00'	3	IX		5.7	5.2	Faenza-Forlì
1781	07	17	7	17	44°13'	12°03'		IX		6.0		
1781	07	17	9	10	44°17'	11°58'		VIII	5.2	4.9		Faenza-Forlì

Brisighella earthquake of April 4, 1781

List of shocked localities:

Locality	Latit.	Long.	I (MCS)
Argenta	44°37'	11°50'	V
Biancanigo	44°18'	11°47'	VII-VIII
Boesimo	44°08'	11°52'	VII
Bologna	44°30'	11°20'	IV
Brisighella	44°13'	11°47'	VIII
Campiano	44°18'	11°46'	VII-VIII
Casale	44°11'	11°46'	VII-VIII
Castelbolognese	44°19'	11°48'	VII
Castelnuovo	44°21'	11°48'	VI
Castel Raniero	?	?	VIII
Cavina S. Pietro	44°12'	11°41'	VII-VIII
Celle	44°17'	11°50'	VII
Cesena	44°08'	12°15'	VI
Chiozzano	44°12'	11°44'	VI-VII
Cottignola	44°12'	11°47'	VII-VIII
Errano	44°16'	11°50'	VIII
Faenza	44°17'	11°53'	VII
Firenze	43°46'	11°15'	IV
Fiumana	44°09'	11°59'	VI
Fognano	44°12'	11°44'	VII
Forlì	44°13'	12°03'	VI-VII
Fornazzano	44°09'	11°37'	VI
Fossombrone	43°41'	12°49'	IV
Gorgognano	44°21'	11°25'	VI-VII
Ladino	44°11'	11°58'	VII
Marsignano	44°07'	11°57'	VIII
Marzeno	44°13'	11°52'	VII
Meldola	44°08'	12°04'	VII
Modigliana	44°09'	11°48'	VII-VIII
Montecchio	44°15'	11°47'	VIII-IX
Montefortino	44°12'	11°54'	VI-VII
Moronico	44°13'	11°51'	VIII
Oriolo	44°14'	11°55'	VII
Paglia	44°12'	11°48'	VIII
Parma	44°48'	10°20'	III
Pergola	44°17'	11°48'	VII-VIII
Pesaro	43°54'	12°54'	IV-V
Pideura	44°16'	11°47'	VIII-IX
Poggio	44°14'	11°49'	VIII-IX
Ponte del Castello	44°19'	11°49'	VII
Predappio	44°06'	11°59'	VI
Quartolo	44°15'	11°49'	VIII-IX
Ritortolo	44°13'	11°47'	VIII
Rivalta	44°14'	11°53'	VII
Rontana	44°13'	11°45'	VII-VIII
Sarna	44°14'	11°50'	VIII
S. Biagio	44°13'	11°54'	VI
S. Cassiano	44°09'	11°41'	VI
Scavignano	44°13'	11°48'	VII-VIII
S. Eufemia	44°10'	11°41'	VI
S. Giorgio in Ceparano	44°13'	11°51'	VII-VIII
S. Lucia delle Spianate	44°15'	11°54'	VII
S. Mamante	44°13'	11°55'	VI-VII
S. Maria della Pace	?	?	VII
S. Martino in Gattara	44°07'	11°40'	VI
S. Martino in Monte	44°11'	11°48'	VIII
S. Michele in Quarneto	44°13'	11°42'	VII
S. Pietro in Laguna	44°19'	11°52'	VII
S. Ruffillo	44°14'	11°47'	IX
S. Silvestro	44°19'	11°53'	VI-VII
Tebano	44°18'	11°47'	VIII
Undecimo	?	?	VI-VII
Valpiana	?	?	VI-VII
Vespignano	44°14'	11°43'	VII
Vicenza	45°33'	11°33'	V
Villa S. Giorgio in Vezzano	44°16'	11°45'	IX
Zerfognano	?	?	VI

Faenza/Forlì earthquake of July 17, 1781

List of shocked localities:

Locality	Latit.	Long.	I (MCS)
Albareto	?	?	VII
Argenta	44°37'	11°50'	VI
Basiago	44°17'	11°57	NF
Bertinoro	44°09'	12°08'	NF
Brisighella	44°13'	11°44'	VI
Camajore	43°56'	10°18'	III
Castel Bolognese	44°19'	11°48'	NF
Cesata	?	?	VIII
Cesena	44°08'	12°15'	NF
Comacchio	44°42'	12°11'	VI
Corleto	44°16'	11°58'	VIII
Faenza	44°17'	11°53'	NF
Ferrara	44°50'	11°37'	NF
Firenze	43°47'	11°15'	V
Forlì	44°13'	12°03'	NF
Modena	44°39'	10°56'	NF
Molinella	44°37'	11°40'	IV
Montefiascone	42°32'	12°02'	NF
Oriolo	44°14'	11°55'	VII
Padova	45°24'	11°53'	III
Prada	?	?	VII
Ravenna	44°25'	12°12'	VI-VII
Reda	?	?	VII-VIII
Saldino	?	?	VIII
S. Barnaba	?	?	VIII
S. Giovanni in Quartireggio	?	?	VIII
S. Lucia delle Spianate	44°15'	11°54'	VII
S. Mamante	44°13'	11°55'	VII
S. Sepolcro	43°34'	12°08'	III
S. Silvestro	44°19'	11°53'	VII
Vicenza	45°33'	11°33'	IV

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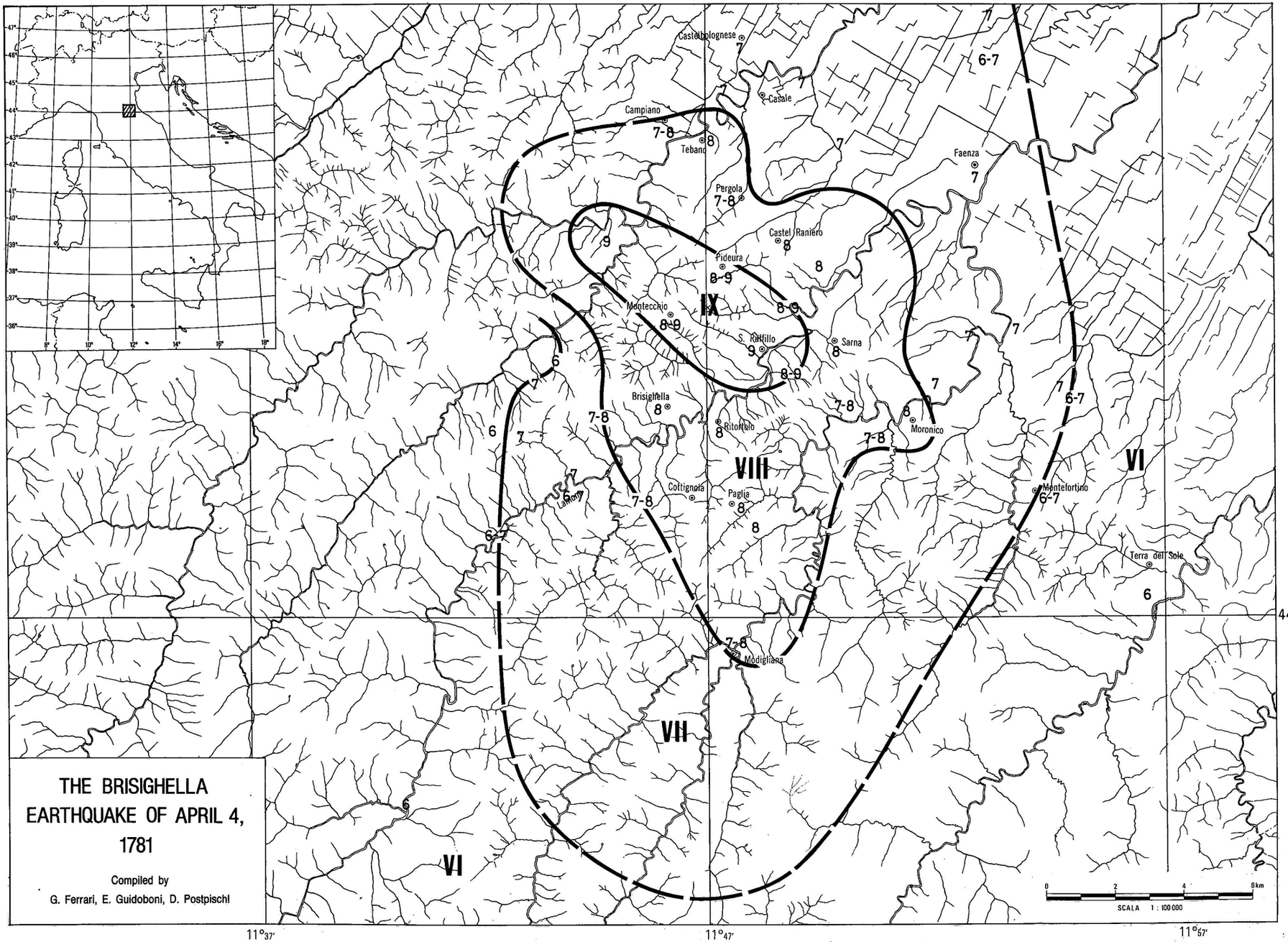
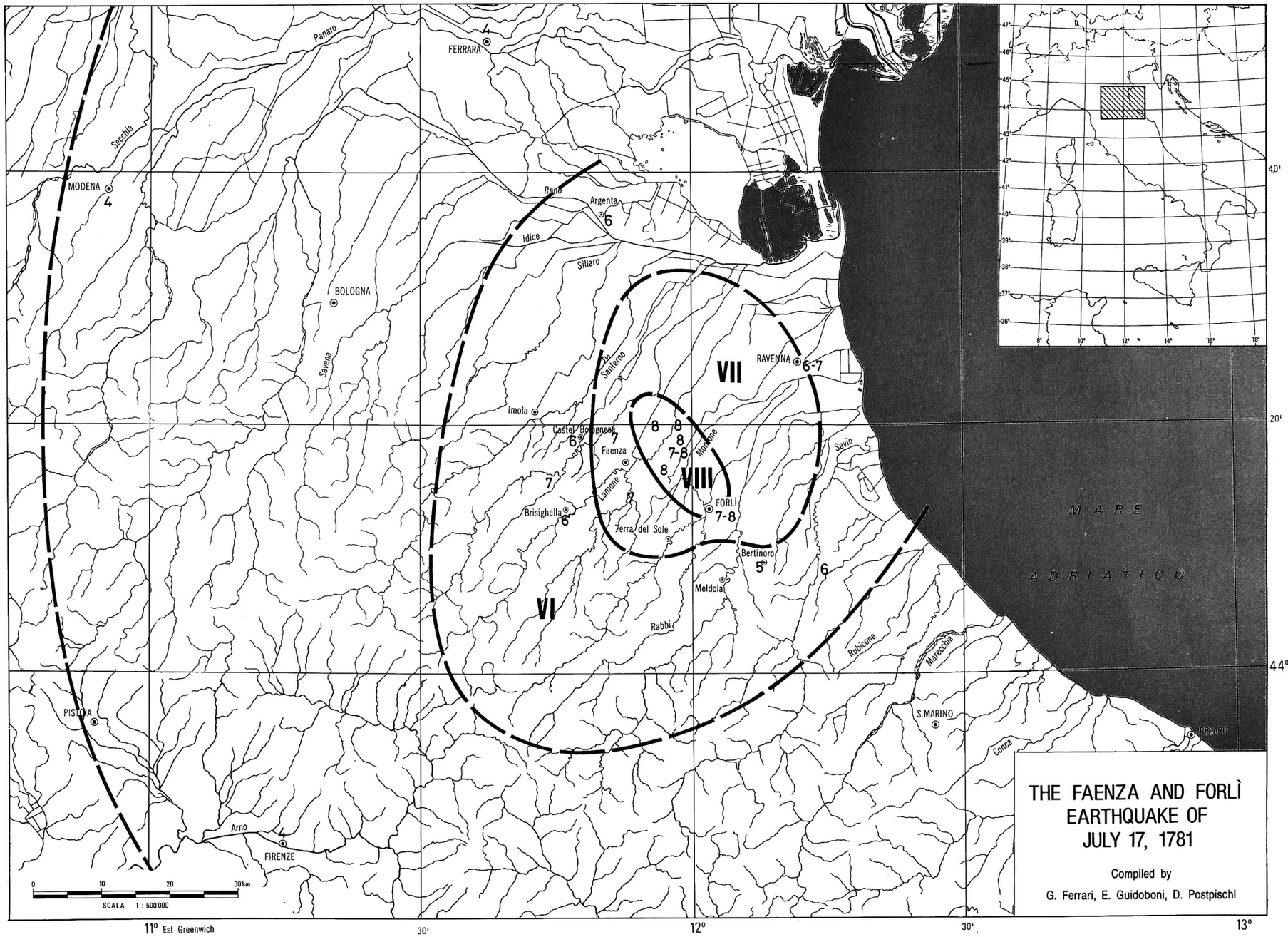


THE BRISIGHELLA EARTHQUAKE OF APRIL 4, 1781

Compiled by
G. Ferrari, E. Guidoboni, D. Postpischl

The drainage network of this map – scale 1:100.000 – is taken from the official production of the IGMI – Firenze.

G.T.M - Via Marco Marulo 47a - 00143 ROMA



THE FAENZA AND FORLÌ EARTHQUAKE OF JULY 17, 1781

Compiled by

G. Ferrari, E. Guidoboni, D. Postpischl

The drainage network of this map – scale 1:500.000 – is the same as the "Structural Model of Italy."

G.T.M - Via Marco Marulo 47a - 00143 ROMA

The Rimini earthquake of December 25, 1786.

G. Ferrari, E. Guidoboni, D. Postpischl

The shock on December 25, 1786, was the most intense shock of a seismic period which began the previous day. The area hit by destructive effects was a strip along the Atlantic Coast, centered approximately on the city of Rimini. The same area was hit by the 1672 and 1875 earthquakes (described in this issue) as well as the 1916 earthquake.

In the ENEL and Carrozzo et al. Catalogues, this event is classified with an epicentral intensity of IX MCS. At 7:00 and 8:00 a.m. GMT, on December 24, two shocks lasting approximately 4-5 seconds were felt by the population of Rimini and Cesena, with oscillations in the NE-SW direction «from Greco to Garbino» (name of local winds).

After the religious services of Christmas Eve, a very strong shock, lasting 15-16 seconds, surprised the inhabitants of Rimini and the surrounding towns in their sleep at about 1:00 a.m. GMT. The description of the testimonies reported in Baratta, related to this seismic period, and in particular to the main shock, has been enriched by a great number of sources, some precise and detailed. In fact, research led to the location of administrative documentation fundamentally important for the recostruction of the effects of this earthquake.

In particular, it was possible to find the two manuscript surveys that, perhaps because of an administrative competence conflict, had been simultaneously ordered by Pope Pios VI and by the Legate of Romagna, Nicola Colonna.

The surveyors were the architects Giuseppe Veledier for the Roman See, and Camillo Morigia for the lagation of Romagna. The surveys were completed within the six month following the main shock of December 25, 1786.

Each survey contains an estimate of the damage done to the constructions: 2,191 constructions are included for the city of Rimini, 1,594 for the *barigellato* (a belt of hamlets), and 3,220 for the castles of the countryside. The officialness of the documents guarentees the accuracy of these findings, although, because of the political and social situation, some of the estimates were altered. However, historical analysis has pointed out these changes.

The content of these surveys has enabled us to evaluate the effects on the 52 localities of the territory surrounding Rimini, over which the city had administrative jurisdicion, thus allowing a delineation of the VII and VIII degree MCS areas.

Data on more external areas were deduced from local tales and recollections in addition to periodicals.

That means that the representation of the distribution of the effects shown on the isoseismal map, is not to be considered complete for the areas outside VII degree MCS.

Although the testimonies describe a relatively recent historical period, the research of documentation regarding areas subjected to the nondestructive effects of the earthquake was particulary burdensome, and at times scarcely productive.

In this period, local chronicles were widely substituted by printed periodicals, and the communal deliberative acts therefore assumed a more operative and technical role and ceased to be the great diary of the community.

A lively scientific and philosophical confrontation about the origin and nature of this earthquake had also developed.

This situation supplied us with a rich collection of observations on the phenomena that preceded, accompanied and succeeded the main shock.

All the direct sources agree on the hour of the main shock on December 25, which was approximately 9:00 a.m. Italian time, corresponding to 01:00 a.m. GMT.

The different sources describe the effects of the shocks of this seismic period with different degrees of detail.

It is still difficult, however, to differentiate the effects of the principal shock and those of the successive ones.

According to the surveys, almost all the public and private constructions of the city of Rimini were more or less damaged. About half of them underwent serious damage; 7% underwent partial collapse; while only 1% totally collapsed. The damage in the city was not uniformly distributed: the port, and the hamlets of S. Giuliano and S. Andrea were less damaged than the rest of the city.

This lack of uniformity is also found in the case of the Rimini earthquakes on April 14, 1672, March 17, 1875 and May 18, 1916.

In some cases it was verified that the most damaged constructions were those poorly repaired after the earthquake of April 14, 1672.

There is a slight discordance among the different sources as to the number of victims. The most reliable number, since it is justified by official lists of the deaths, is 12 for the city and 18 for the diocese.

Regarding the direction of oscillation estimated in the city of Rimini, Abbot Vannucci lists some evidence supporting a NE-SW direction. For example, the disconnection and movement of the tower of S. Giuliano away from the abbey, the collapse and jutting out of the walls of the city in the same direction. The territory of Rimini was visibily fissured in many places. In the mountains near Rimini, boulders fell.

The earthquake was felt along the Adriatic Coast, from Trieste to Fermo, and inland as far as Genoa. Application of the Galanopoulos formula to a careful estimate of the earthquake area leads to a macroseismic equivalent of magnitude ME = 5.9, in concordance with the values estimated for the April 14, 1672 and March 17, 1875 earthquakes.

The following is a comparison of the values of some parameters, respectively reported in the ENEL and Carrozzo et al. Catalogues, and in the present study.

Year	Mo	Da	Ho	Mi	Lat	Long	De	I	Me	Mk	Mp	Epic. area
1786	12	25	01		44°03'	12°38'	27	IX		5.7	5.4	Rimini
1786	12	25	01		44°15'	12°30'		IX		6.0		
1786	12	25	01		44°00'	12°36'		VIII	5.9	5.2		Rimini

List of shocked localities:

Locality	Latit.	Long.	I (MCS)
Agello	43°56'	12°37'	VIII
Albereto	43°56'	12°31'	VII-VIII
Bellaria	44°09'	12°27'	VI-VII
Besanigo (S. Andrea in Besanigo)	43°59'	12°37'	VII-VIII
Bordonchio	44°08'	12°28'	VII
Borgo S. Giovanni	44°03'	12°35'	VII
Castelleale	43°57'	12°37'	VIII
Cattolica	43°58'	12°44'	VII
Cerasolo	43°59'	12°32'	VIII
Cerreto	43°52'	12°38'	VI-VII
Cevolabbate	43°55'	12°37'	VIII
Coriano	43°58'	12°36'	VIII
Corpolò	44°01'	12°27'	VIII
Croce	43°55'	12°35'	VIII
Gemmano	43°54'	12°35'	VIII
Il Crocefisso	44°03'	12°33'	VII
Marazzano	43°54'	12°33'	VII-VIII
Meleto	43°59'	12°41'	VII
Misano	43°55'	12°42'	VIII
Monte Colombo	43°51'	12°33'	VI
Montegridolfo	43°58'	12°41'	VII
Monte Tauro	43°55'	12°35'	VII
Morciano	43°58'	12°39'	VII-VIII
Mulazzano	43°52'	12°32'	VIII
Onferno	43°57'	12°33'	VII-VIII
Passano	44°04'	12°36'	VII
Rimini	44°00'	12°34'	VIII
Riccione	43°52'	12°40'	VIII
Saludecio	43°56'	12°40'	VII
S. Clemente	44°02'	12°38'	VIII
S. Fortunato	44°00'	12°33'	VIII
S. Lorenzo in Correggiano	44°00'	12°40'	VIII
S. Lorenzo in Strada	43°56'	12°38'	VIII
S. Marino	44°04'	12°27'	IV
S. Martino in Riparotta	44°01'	12°31'	VIII
S. Martino in Venti	44°01'	12°30'	VIII
S. Martino Monte l'Abate	44°00'	12°35'	VIII
S. Paolo	43°59'	12°38'	VII
S. Salvatore	43°56'	12°38'	VIII
S. Savino	44°05'	12°36'	VII
S. Vito di Rimini	43°59'	12°27'	VII-VIII
S. Cristina	44°04'	12°28'	VIII
S. Giustina	44°00'	12°29'	VII
S. Maria in Cerreto	43°56'	12°34'	VII
S. Andrea in Casale	44°01'	12°39'	VII-VIII
S. Aquilina	44°03'	12°31'	VII
Spadarollo	44°02'	12°31'	VII
Vergiano		12°30'	VIII

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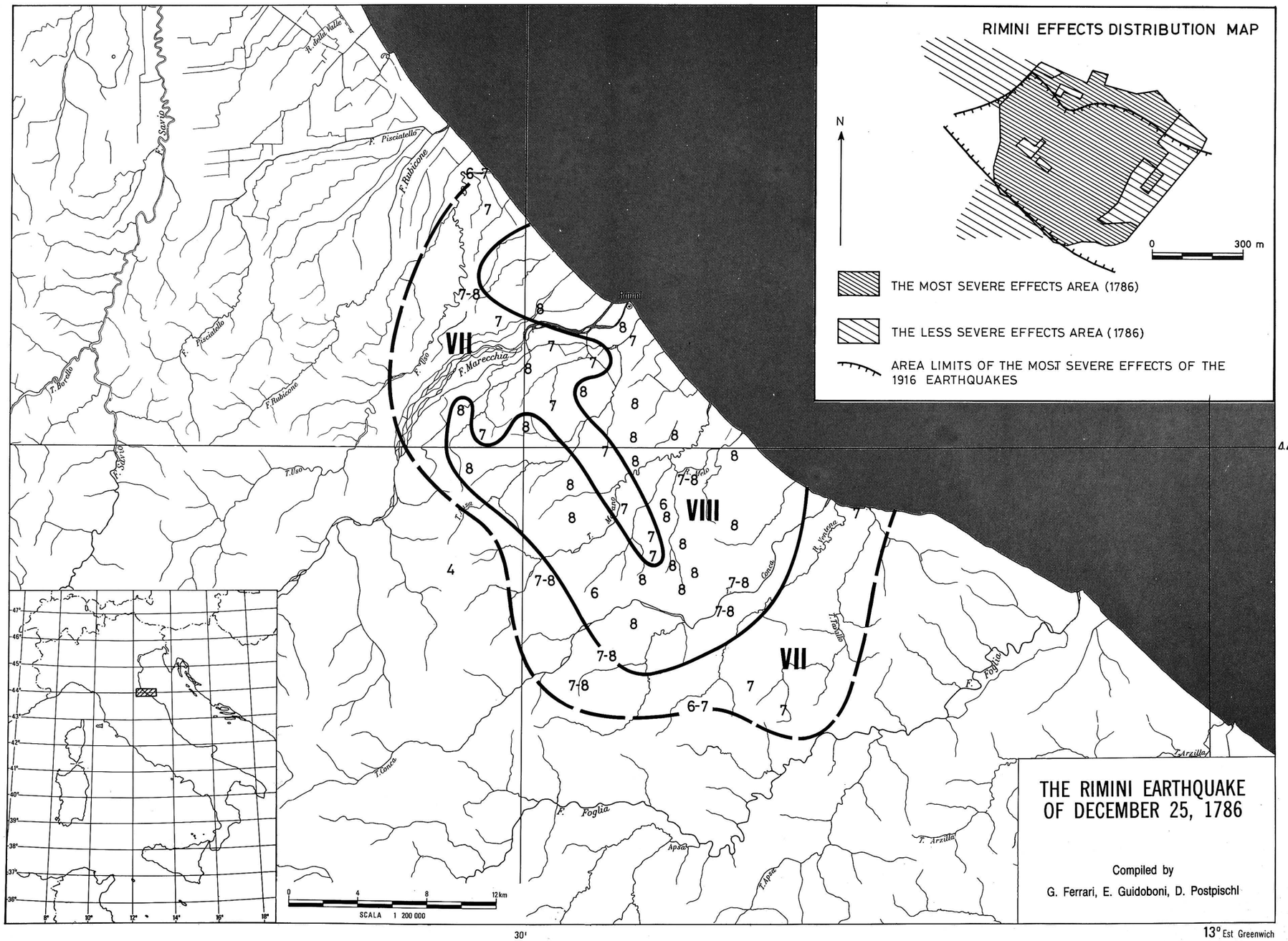

The drainage network of this map – scale 1:200.000 – is taken from the official production of the IGMI – Firenze.

The Camerino earthquake of July 28, 1799.

F. Pergalani, G. Monachesi, M. Stucchi

Problems

The earthquake in discussion, currently known as the «1799, Camerino earthquake», is classified in (1) and (2) as follows:

	Year	Month	Day	Time (GMT)	ep. coord.	Magn.	MCS int.
(1)	1799	July	28	16 00	4300 1300	5.5	VII
	1799	July	29	20 00	4300 1300	6.5	X
(2)	1799	July	28	–	4310 1310	4.0	VI
	1799	July	28	17 00	4310 1310	3.5	V
	1799	July	28	22 00	4310 1310	5.0	VIII
	1799	July	29	01 00	4310 1310	5.5	IX
	1799	July	29	06 00	4310 1310	3.0	IV

No isoseismal maps existed at the beginning of the research. The problems which have been investigated are the assessments of the epicentral area and the maximum intensity affected site, with reference to the influence of foreshocks and aftershocks on the main shock intensity.

Sources

The main source for Baratta (3) is the work of Moreschini (4), a doctor who came to Camerino one year after the event and collected information from eye witnesses. Following (5) and (6), several sources were found in the Archives of Camerino (7, 8, 9), including the relevant report of the architect A. Vici (10), Vanvitelli's pupil, who also came to Camerino one year after the quake to estimate and repair the damages of some public buildings.

Information has also been collected by a survey of the «Riformance» and «Liber Mortuorum» of many Communes (11) and Parish Church (12) Archives. While performing this search, some contemporary manuscript chronicles were found (13, 14, 15, 16, 17); the three last have been published recently (18).

The complex period in which the event took place (struggle of the «Insorgenti» against the French Army) seems to be the reason for the absence of a global damage assessment survey in the area surrounding Camerino, and for the concentration of information on the town repair activity. This is also the reason why the event has always been classified, localized and mapped as the «Camerino earthquake».

Results

The sequence of the most relevant shocks, as deducted from a comparison of the sources, is as follows:

Year	Month	Day	GMT	Max. Intensity
1799	July	28	13	IV-V
1799	July	28	18	VI-VII
1799	July	28	22	IX-X

The final date is different from previous catalogues because of the problems of translating local times of that age into G.M.T. See (19).

In Camerino most people seemed to have preferred to return after the second shock, although it is not easy to believe Moreschini's point that they went back home though the buildings were damaged. However, in Cessapalombo it is certain that half of the inhabitants remained outside for fear of further shocks.

The global toll is presumed to be about 100, though definite reports were only found for 85; Camerino's death toll was about 43 out of a popolation of 6000. The high percentage in mortality and the heaviest damage rate was found in the area of Cessapalombo, S. Ginesio and Sarnano. This could agree with the behaviour described above.

The heaviest damaged site is Cessapalombo for which it is not possible to determine the intensity value between IX and X MCS, due also to the difficulty of evaluating the influence of the foreshocks.

Information permits only the definition of the IX and VIII MCS areas. There are still some uncertainties in the southern part of the IX degree area due to the lack of settlements and consequently of information.

Both areas are elliptic, with major axes oriented N 130. This direction is consistent with another earthquake (1873) trend, and the heaviest hit area includes the well-known low energy activity zone of Caldarola (1936, 1951), in which a cluster of epicentres is also shown by recent scientific evidence.

List of shocked localities

Locality	Latit.	Long.	I (MCS)
Agnano (Camerino)	43°10'	13°04'	VIII
Amandola	42°59'	13°21'	VII
Belforte del Chienti	43°10'	13°14'	VIII
Caldarola	43°08'	13°14'	VIII
Camerino	43°08'	13°04'	IX
Casale	43°07'	13°02'	VII
Castelraimondo	43°13'	13°03'	VIII
Cerreto (San Ginesio)	43°06'	13°19'	VIII
Cessapalombo	43°06'	13°15'	IX-X
Esanatoglia	43°15'	12°57'	VII
Fano	43°50'	13°01'	V
Fiastra	43°02'	13°09'	VII
Fiungo (Camerino)	43°07'	13°09'	VIII
Gualdo (Sarnano)	43°04'	13°20'	VIII
Letegge (Camerino)	43°09'	13°07'	IX
Matelica	43°15'	13°01'	VII
Morico (San Ginesio)	43°06'	13°16'	VIII-IX
Muccia	43°05'	13°03'	VII
Pian di Pieca (San Ginesio)	43°04'	13°17'	VIII
Pievebovigliana	43°04'	13°05'	VII
Pioraco	43°11'	12°59'	VIII
Polverina (Camerino)	43°05'	13°07'	VIII
Pozzuolo (Camerino)	43°09'	13°08'	IX
Rocca d'Aiello (Camerino)	43°11'	13°04'	VIII
San Ginesio	43°06'	13°19'	VII-VIII
San Severino	43°14'	13°11'	VIII
Santa Lucia (Camerino)	43°07'	13°05'	IX
Sarnano	43°02'	13°18'	VIII
Serravalle	43°04'	12°57'	VII
Statte (Camerino)	43°09'	13°09'	IX
Teramo	42°40'	13°42'	III-IV
Torricella (Castelraimondo)	43°12'	13°04'	IX
Tuseggia (Camerino)	43°10'	13°05'	VIII
Vallicchio (Muccia)	43°05'	13°03'	VIII
Varano (Camerino)	43°07'	13°07'	VIII
Villa d'Aria (Serrapetrona)	43°11'	13°09'	IX

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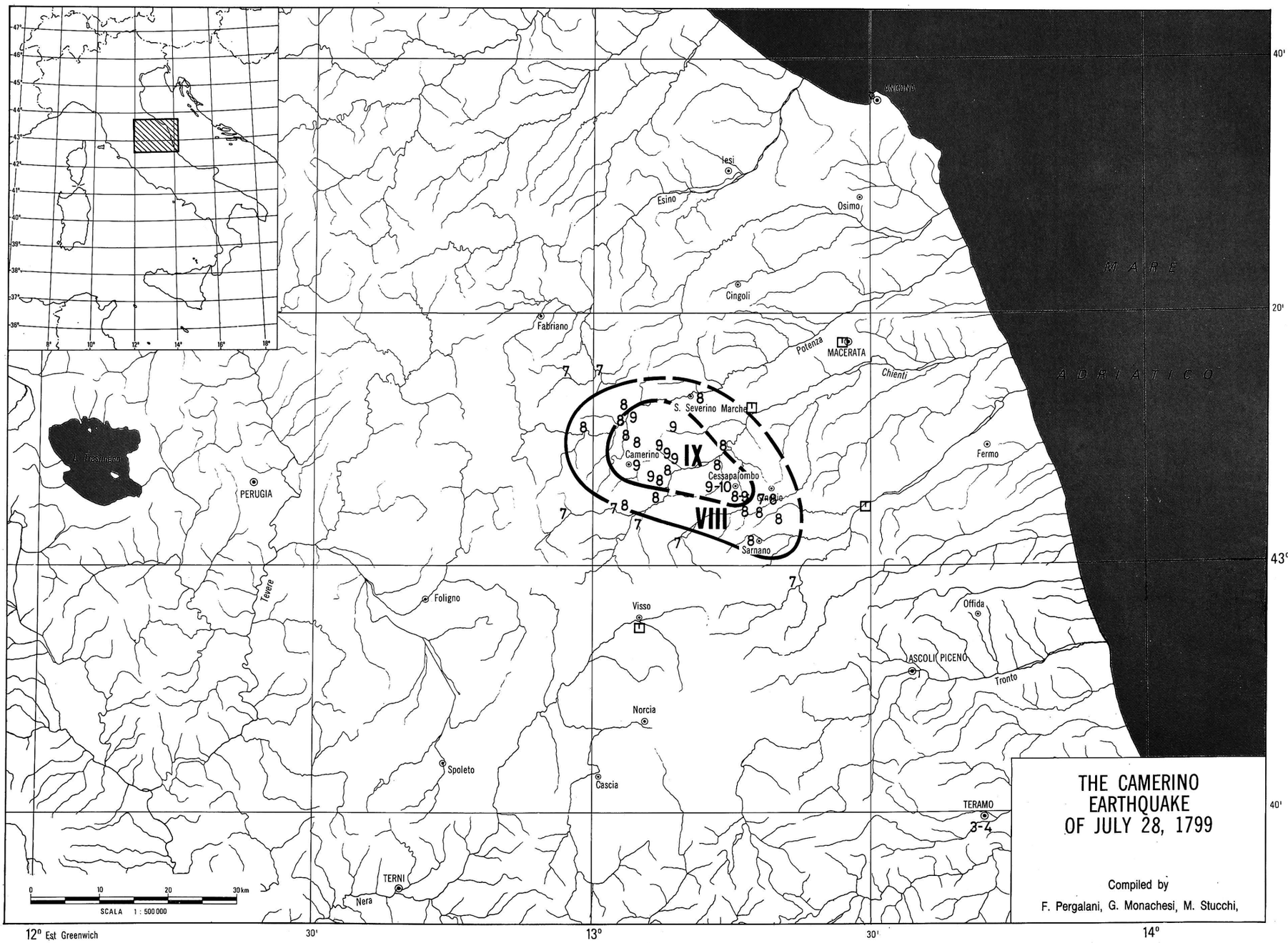

THE CAMERINO EARTHQUAKE OF JULY 28, 1799

Compiled by
F. Pergalani, G. Monachesi, M. Stucchi,

The drainage network of this map – scale 1:500.000 – is the same as the "Structural Model of Italy."

G.T.M – Via Marco Marulo 47a - 00143 ROMA

The Soncino earthquake of May 12, 1802.

F. Brega, M. Stucchi, G. Bassi, M. De Martin

The earthquake, currently known as the «1802 Soncino earthquake», is classified in (1) and (2), as follows:

	Year	Month	Day	Time (GMT)	ep. coord.	Magn.	MCS int.
(1)	1802	May	12	09 30	4524 0952	5.6	IX
(2)	1802	May	12	09 30	4523 0952	5.2	VIII

The main problem is the assessment of the maximum intensity and the extent of the heaviest area.
The main printed source for this earthquake is the work of M. Baratta (3), which is not contemporary to the event but contains many indications for finding local sources. The search in the Archives is presently insufficent: because of the political situation of that period – Napoleonic rule in Northern Italy – it has been impossible to find global or detailed surveys. Reports were lacking for many localities close to the most damaged sites, which are presumed to have suffered severe damage. Some information from financial support files has been found for the region west of the River Oglio; towns and villages east of this river were ruled by other administrations, and no data have been found yet.
Only one foreshock is reported: it occurred on May 11, and was felt in the same area as the main one. Maximum intensity for this foreshock is estimated to be not higher than V MCS as no influence on people and buildings has been reported for this shock.
Some injuries but no deaths are reported for the main shock. All sources indicate Soncino as the most damaged locality and a VIII MCS intensity has been assigned to this town. For Orzinuovi, which is not far from Soncino, the same degree of damage is reported, though sources refer specifically to the poor quality of the buildings.
Data allow a delineation of the VIII degree area with good approximation. Areas corresponding to VII and VI are still uncertain. All areas are elliptic, with major axis oriented N 60 approximatively.
Attenuation seems to be more elevated in the ENEL direction than WSW.

List of shocked localities:

Locality	Latit.	Long.	I (MCS)
Albera	45°22'	09°48'	VIII
Alessandria	44°55'	08°37'	V
Asti	44°55'	08°12'	IV
Bardi	44°38'	09°48'	IV
Berna	46°56'	07°31'	III-IV
Bordolano	45°18'	09°59'	VI-VII
Brescia	45°33'	10°13'	V
Caravaggio	45°30'	09°39'	VI
Casalbuttano	45°15'	09°58'	VI-VII
Casaletto di sopra	45°25'	09°47'	VIII
Chiari	45°32'	09°56'	VI
Chiavari	44°19'	09°19'	IV
Codogno	45°10'	09°42'	V-VI
Credera	45°18'	09°39'	VII
Crema	45°22'	09°41'	VII-VIII
Cremona	45°08'	10°01'	V
Cumignano	45°21'	09°50'	VIII
Fontanella	45°28'	09°48'	VII
Gallignano	45°26'	09°50'	VIII
Genova	44°25'	08°54'	V
Lodi	45°19'	09°30'	VI
Longhena	45°26'	10°04'	V-VI
Mantova	45°09'	10°46'	IV-V
Melotta	45°25'	09°48'	VIII
Milano	45°28'	09°11'	V
Moscazzano	45°18'	09°41'	VII
Novi Ligure	44°46'	08°47'	IV
Offanengo	45°23'	09°45'	VIII
Oneglia	43°53'	08°02'	IV
Orzinuovi	45°21'	09°55'	VIII
Orzivecchi	45°25'	09°58'	VI
Padova	45°24'	11°53'	IV
Parma	44°48'	10°20'	IV-V
Pavia	45°11'	09°10'	V
Piacenza	45°03'	09°42'	V
Romanengo	45°23'	09°47'	VIII
Roveredo	45°16'	11°27'	IV
Salò	45°36'	10°31'	IV-V
Salvirola	45°21'	09°47'	VIII
Sergnano	45°26'	09°42'	VII
Soncino	45°24'	09°52'	VIII
Ticengo	45°22'	09°50'	VIII
Torino	45°04'	07°40'	IV
Torre Pallavicina	45°27'	09°53'	VII-VIII
Verona	45°26'	11°00'	IV-V
Vicenza	45°33'	11°33'	IV
Villanuova	45°26'	09°52'	VIII
Voghera	45°00'	09°01'	V
Zurigo	47°23'	08°32'	III-IV

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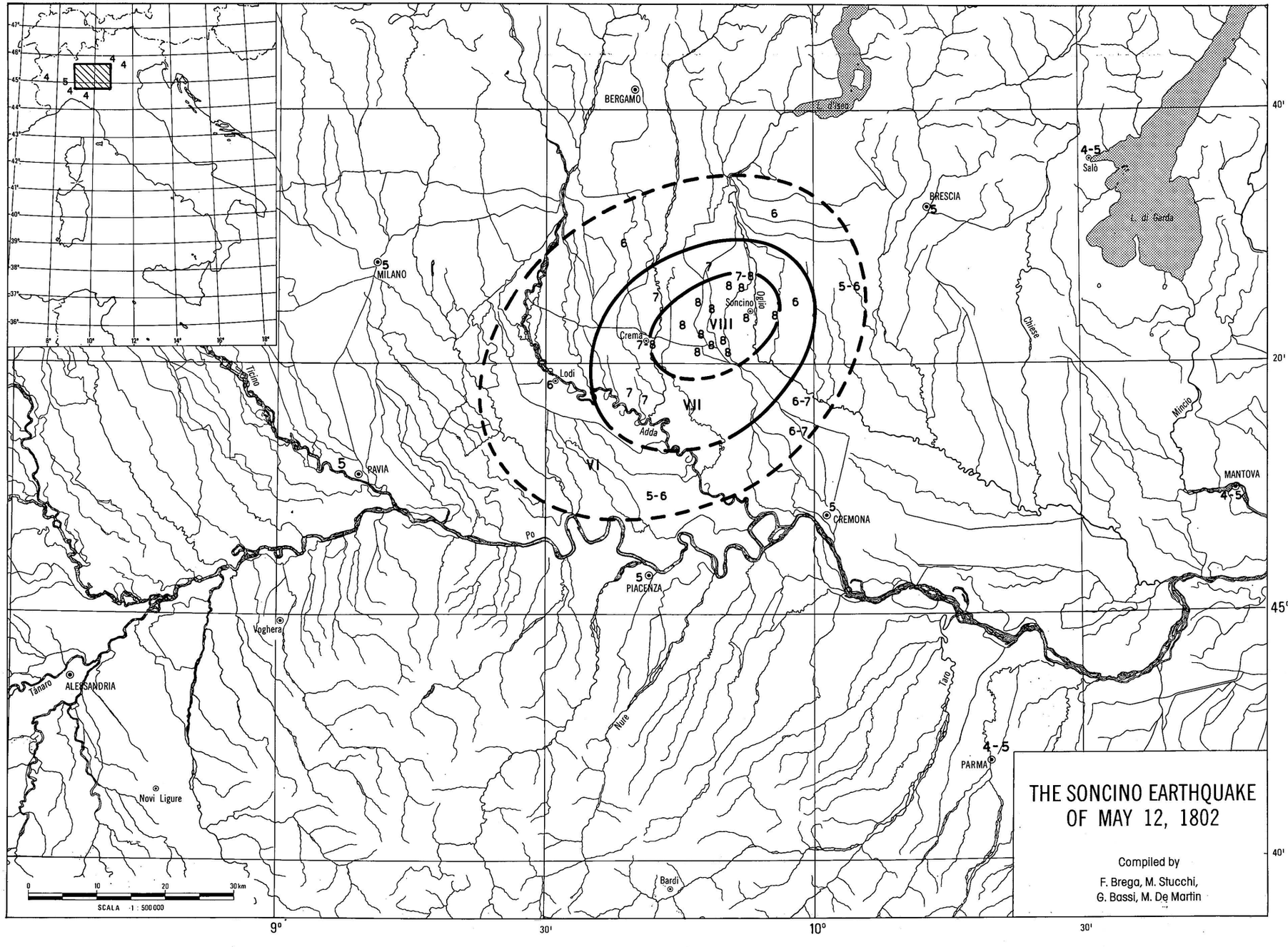

THE SONCINO EARTHQUAKE OF MAY 12, 1802

Compiled by
F. Brega, M. Stucchi,
G. Bassi, M. De Martin

The drainage network of this map – scale 1:500.000 – is the same as the "Structural Model of Italy."

The Baranello earthquake of July 26, 1805.

M.C. Spadea, M. Vecchi, P. Gardellini, S. Del Mese

As is often the case, despite the abundant bibliographic references available the data are either too scanty or too copious, thus giving rise to contradictions.
During the day and night preceding the main shock, several warning tremors were felt in various towns and villages in the area.
A number of warning signs were observed: (1, 2, 3) several days earlier, increasingly intense rumbling had been heard; animals were very restless; many snakes left their nests; the water of the Boiano was observed to be turbid and to have become warmer; a number of fountains dried up in the town of Isernia; and atmospheric anomalies had been observed in the months and days preceeding the disaster.
The earthquake of 26 July caused a large number of casualties. According to Poli (6), 5573 persons died and 1583 were injured, almost all in Molise.
Again according to Poli, the towns situated in the Boiano valley between Isernia and Campobasso at the foot of the Matese Mts. suffered greater damage than those on the mountain slopes.
Statues and crucifixes, twirled the latter being bent and twisted. Parts of buildings were displaced quite large distances.
There were large geological upheavals with extensive rock falls, and the rise and subsidence of large areas of land. Enormous chasms opened, one of considerable depth that blocked the course of the Tammaro River and caused an actual lake to form. Some springs disappeared and others began to pour forth evil-smelling, muddy water.
At Boiano, three large new torrents were born and flowed into the surrounding countryside, flooding it. The phenomenon began to abate appreciably only some 20 days later.
The lake of Matese became very rough and muddy, silting up considerably because of the large boulders falling into it from the surrounding mountains.
There was a large tidal wave between the islands of Capri, Ponza and Ventotene and the Sorrento coast.
The main event was followed by frequent powerful aftershocks, one of which occurred about an hour and a half after the main shock and was felt in Naples as well. More aftershocks occurred on 29 July, 4, 6, 9, 15, 20, 23, 24, 25 and 29 August; 2 September; 8 December; and on 30 May and 2 June of the following year (1806).
On the strenght of the data available, the maximum intensity may be evaluated as X MCS. The great size of the epicentral zone and the reports of geological upheavals occurring in it seem to indicate that the intensity may have even been higher inside this zone.
The isoseismal map is fairly generalized owing to the low reliability of the data from the various towns and villages. Discrepancies in the data do not always allow the degree of intensity to be assigned with any certainty.
Analysis of the macroseismic field shows that the epicentral zone was very large and the preferential propagation direction was NW-SE, i.e. along the Apennines.
The parameters referring to this seismic period may be summed up as follows.

List of shocked localities:

Locality	Latit.	Long.	I (MCS)
Acquaviva	41°52'	14°45'	VIII
Agnone (Caccavone)	41°48'	14°22'	VIII
Airola	41°04'	14°33'	VII
Anagni	41°45'	13°09'	VI
Apollosa	41°06'	14°42'	VII
Arpaia	41°02'	14°33'	VIII
Avellino	40°55'	14°47'	VIII
Aversa	40°58'	14°12'	VII
Baduli	41°10'	14°53'	VII
Bagnoli	41°05'	14°26'	VIII
Baranello	41°32'	14°33'	X
Bojano	41°29'	14°28'	X
Busso	41°33'	14°34'	X
Calitri	40°54'	15°26'	VIII?
Camerino	43°08'	13°04'	IV
Campobasso	41°33'	14°40'	IX
Campochiaro	41°27'	14°30'	IX
Campodipietra	41°33'	14°45'	IX
Campolattaro	41°17'	14°44'	VIII
Cantalupo nel Sannio	41°31'	14°24'	X
Capovilli	41°43'	14°18'	VII
Capracotta	41°50'	14°16'	VIII
Capriglia	40°57'	14°46'	VII
Carpione	41°36'	14°20'	IX
Casalciprano	41°35'	14°22'	X
Caserta	41°02'	14°20'	VII
Castelfranco in Miscano	41°18'	15°05'	VII-VIII
Castelpagano	41°24'	14°48'	IX
Castelpetroso	41°34'	14°21'	IX
Castelpizzuto	41°31'	14°18'	VIII-IX
Castelvetere in Valfortore	41°26'	14°56'	VII-VIII
Castiglione ?	?	?	VII
Castropignano	41°37'	14°34'	IX
Ceppaloni	41°03'	14°46'	VII
Cercemaggiore	41°28'	14°43'	VIII-IX
Cercepiccola	41°28'	14°40'	VIII
Cerreto Sannita	41°17'	14°34'	VIII
Circello	41°21'	14°48'	VIII
Civitacampomarano	41°47'	14°41'	VIII
Civitanova?	?	?	VIII
Civitanova del Sannio	41°40'	14°24'	IX
Colle d'Anchise	41°31'	14°31'	IX
Colle Sannita	41°22'	14°51'	VIII
Cosenza	39°18'	16°15'	IV
Ferrazzano	41°32'	14°40'	VIII
Foiano	41°21'	14°59'	VII
Foligno	42°57'	12°42'	IV
Fontanarosa	41°01'	15°01'	VII
Forino	40°52'	14°44'	VII
Fornelli	41°36'	14°09'	VIII
Fossalto? (Fossaceca)	41°40'	14°33'	VIII
Fragneto l'Abate	41°16'	14°47'	VIII
Fragneto Monforte	41°15'	14°46'	VIII
Frosolone	41°36'	14°27'	X
Gesualdo	41°00'	15°04'	VII
Gildone	41°31'	14°44'	IX
Guardiaregia	41°26'	14°33'	IX
Guardia Sanframondi	41°15'	14°36'	VIII
Ischia	40°45'	13°57'	V
Isernia	41°36'	14°14'	IX
Jelsi	41°31'	14°48'	IX
Lecce	40°21'	18°10'	IV
Longano	41°31'	14°15'	VII
Lucito	41°44'	14°41'	VIII
Lupara	41°46'	14°44'	VIII
Macchiagodena	41°33'	14°24'	X
Macchia d'Isernia	41°34'	14°10'	VIII
Maddaloni	41°02'	14°23'	VII
Matera	40°40'	16°36'	V
Melfi	40°59'	15°39'	VI
Mirabella Eclano	41°03'	15°00'	VII
Mirabello Sannitico	41°31'	14°40'	X
Miranda	41°38'	14°15'	VIII
Molinara	41°18'	14°55'	VII-VIII
Molise	41°38'	14°30'	VIII-IX
Montecassino	41°29'	13°49'	VI
Montefalcione	40°58'	14°53'	VII
Montefusco	41°02'	14°51'	VII
Monteroduni	41°31'	14°11'	VIII
Morcone	41°20'	14°40'	VIII
Napoli	40°51'	14°16'	VI
Ospedaletto?	?	?	VII
Paupisi	41°12'	14°40'	VIII
Pesche	41°37'	14°17'	IX
Pescolanciano	41°41'	14°20'	VIII
Petrella Tifernina	41°41'	14°42'	VIII
Pettoranello del Molise	41°34'	14°17'	VIII
Pietralcina	41°12'	14°51'	VII
Pozzuoli	40°49'	14°07'	VI
Pratola Serra	40°59'	14°51'	VII
Provvidenti	41°43'	14°49'	VIII
Reino	41°17'	14°49'	VIII
Riccia?	41°29'	14°50'	VIII
Ripabottoni	41°41'	14°48'	VIII
Ripamolisano	41°37'	14°40'	IX
Roccamandolfi	41°30'	14°21'	VIII
Roccasicura	41°42'	14°14'	VIII
Roma	41°54'	12°29'	V
Salerno	40°41'	14°46'	VI
San Bartolomeo in Gualdo	41°25'	15°01'	VII
San Biase	41°43'	14°35'	VIII
San Giovanni del Sannio	41°27'	14°38'	IX
San Giovanni in Galdo	41°35'	14°45'	IX
San Marco dei Cavoti	41°19'	14°53'	VII
San Martino?	?	?	VIII
San Maruso?	?	?	VIII
San Massimo	41°30'	14°25'	X
San Pietro Avellana	41°47'	14°11'	VIII
San Polomatese	41°28'	14°30'	IX
San Potito	40°56'	14°52'	VIII
San Severo	41°41'	15°23'	VI
Sant'Agata dei Goti	41°05'	14°30'	VII
Sant'Angelo all'Esca	41°00'	15°00'	VII
Sant'Angelo in Grotte	41°34'	14°22'	X
Sant'Angelo Limosano	41°41'	14°36'	VIII
Sant'Arcangelo Trimonte	41°10'	14°56'	VII
Sant'Elena Sannita	41°34'	14°28'	X
Sant'Elia a Pianisi	41°37'	14°52'	VIII
Sassinoro	41°22'	14°40'	X
Segni	41°41'	13°01'	VI
Sepino	41°24'	14°37'	IX
Serino (... e Casali)	40°51'	14°51'	VII
Sessano del Molise	41°38'	14°20'	IX
Solofra (... e Casali)	40°50'	14°51'	VII
Solopaca	41°11'	14°33'	VIII
Spinete	41°33'	14°29'	X
Spoleto	42°44'	12°44'	IV
Taurasi	41°00'	14°57'	VII
Torella del Sannio	41°38'	14°31'	IX
Toro	41°34'	14°46'	X
Torrecuso	41°11'	14°41'	VIII
Ventotene	40°48'	13°30'	V
Veroli	41°41'	13°25'	VI
Vinchiaturo	41°30'	14°35'	X
Vitulano	41°10'	14°39'	VIII

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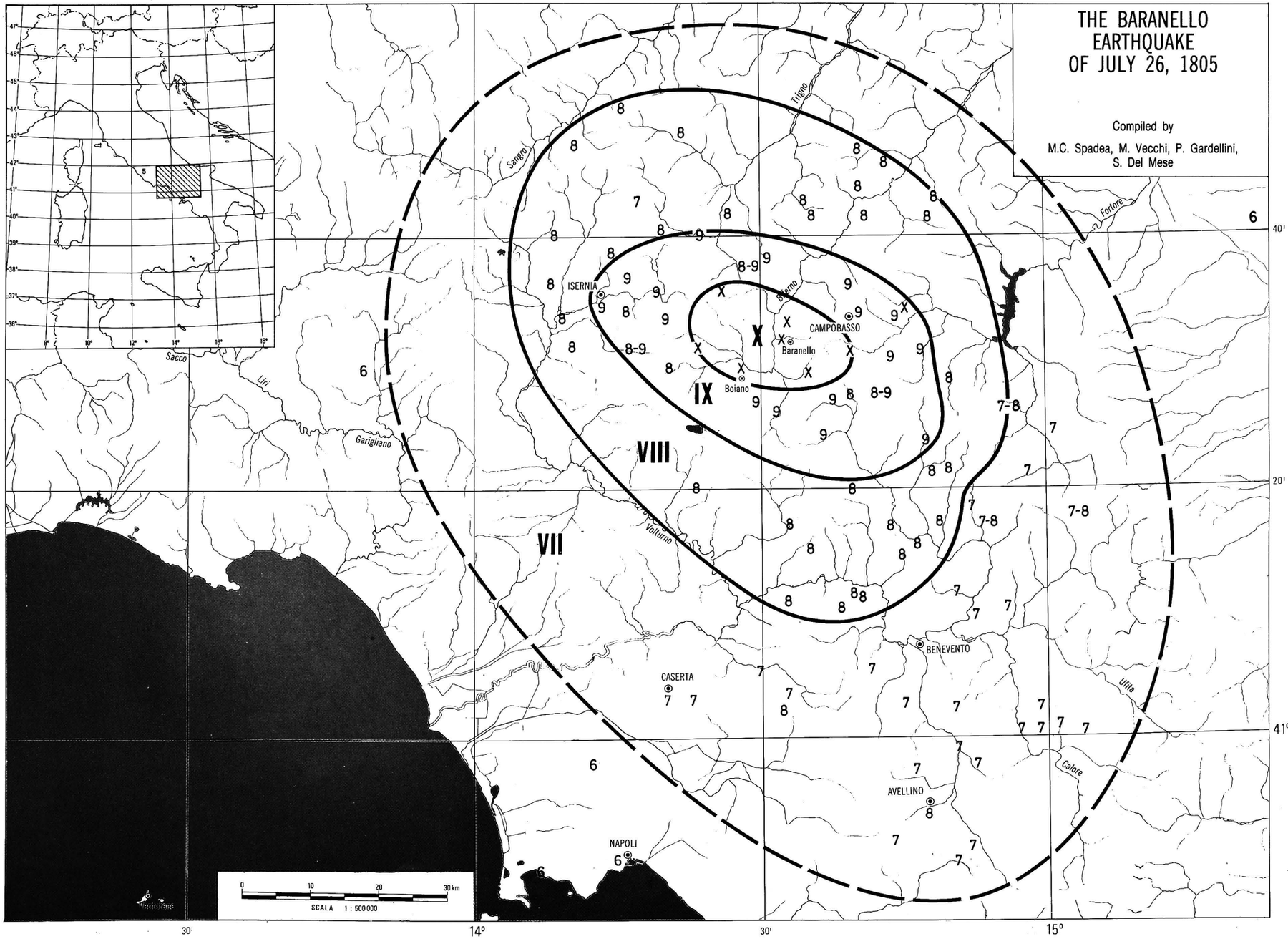

The drainage network of this map – scale 1:500.000 – is the same as the "Structural Model of Italy."

G.T.M - Via Marco Marulo 47a - 00143 ROMA

The Nemi Earthquake of August 26, 1806.

M.C. Spadea, M. Vecchi, P. Gardellini, S. Del Mese

The seismic phenomena accompanying the Latium hills earthquake began with a short tremor felt in Rome on 25 August at 22^{h}54^m (G.M.T.) The main shock followed at 07^{h}35^m (G.M.T.) on 26 August.
The worst hit area was the Latium hills, comprising the towns of Rocca di Papa, Nemi and Velletri.
The seismic period was fairly short and there was only a small number of aftershocks. In fact, available bibliographic sources refer only to a slight aftershock felt in Rome on the same day and two further light ones, again in Rome, on the 28.
The event was classified as follows in the CNEN General Catalogue of Earthquakes from Beginning of Christian Age to 1971 - Published 1973:

Year	Mo	Da	Ho	Mi	Lat	Long	I_o
1806	Aug	25	21	20	41°45'	12°45'	Felt
1806	Aug	26	06	20	41°45'	12°45'	VIII-IX
1806	Aug	26	06	30	41°45'	12°45'	Felt
1806	Aug	28	12	30	41°45'	12°45'	Felt
1806	Aug	28	19	00	41°45'	12°45'	Felt

and in the ENEL File of Italian Earthquakes from 1000 up to 1975 - Unpublished - 1977:

Year	Mo	Da	Ho	Mi	Lat	Long	I_o	
1806	Aug	26	3	30	41°45'	12°45'	III	Vulcano laziale
1806	Aug	26	6	20	41°45'	12°45'	VIII	Vulcano laziale
1806	Aug	26	12	30	41°45'	12°45'	III	Vulcano laziale
1806	Aug	28	6	9	41°45'	12°45'	III	Vulcano laziale
1806	Aug	28	12	30	41°45'	12°45'	III	Vulcano laziale

The following bibliographic sources were used to study this earthquake (1, 2, 3, 4, 5).
Despite the lack of data referring to a number of localities affected by the earthquake, we consider the epicentral zone and maximum intensity to have been determined reliably enough. The data referring to the worst hit towns and villages, especially the abundant documentation regarding the town of Velletri, have led us to assign a maximum MCS intensity of VIII to this event.
Observation of the isoseismal map we have plotted, reveals several points:
1) the epicentral zone takes in a rather large area of the Latium hills;
2) the VII and VI isoseisms display a large SE projection along the southwest edge of the Lepini Mountains;
3) the earthquake affected a very large area, with II-III degree tremore detected as far away as Naples.

List of shocked localities:

Locality	Latit.	Long.	I (MCS)
Albano	41°44'	12°40'	VII
Ardea	41°37'	12°33'	V
Ariccia	41°43'	12°40'	VII
Cisterna	41°35'	12°50'	VII
Civitalavinia?	—	—	VII
Cori	41°39'	12°55'	VII
Frascati	41°48'	12°41'	VII
Genzano	41°42'	12°41'	VII-VIII
Giuliano (Giulianello)	41°41'	12°53'	VII
Marino	41°46'	12°40'	VII
Monterotondo (ora Artena)	41°44'	12°55'	VI
Napoli	40°51'	14°16'	III
Nemi	41°43'	12°43'	VIII
Nettuno	41°28'	12°40'	V
Rocca di Papa	41°46'	12°43'	VIII
Rocca Massima	41°41'	12°55'	VII
Roma	41°54'	12°29'	VI
Sermoneta	41°33'	12°59'	VII
Sezze	41°30'	13°04'	VII
Terracina	41°17'	13°14'	V
Velletri	41°41'	12°47'	VIII
Zagarolo	41°50'	12°50'	VII

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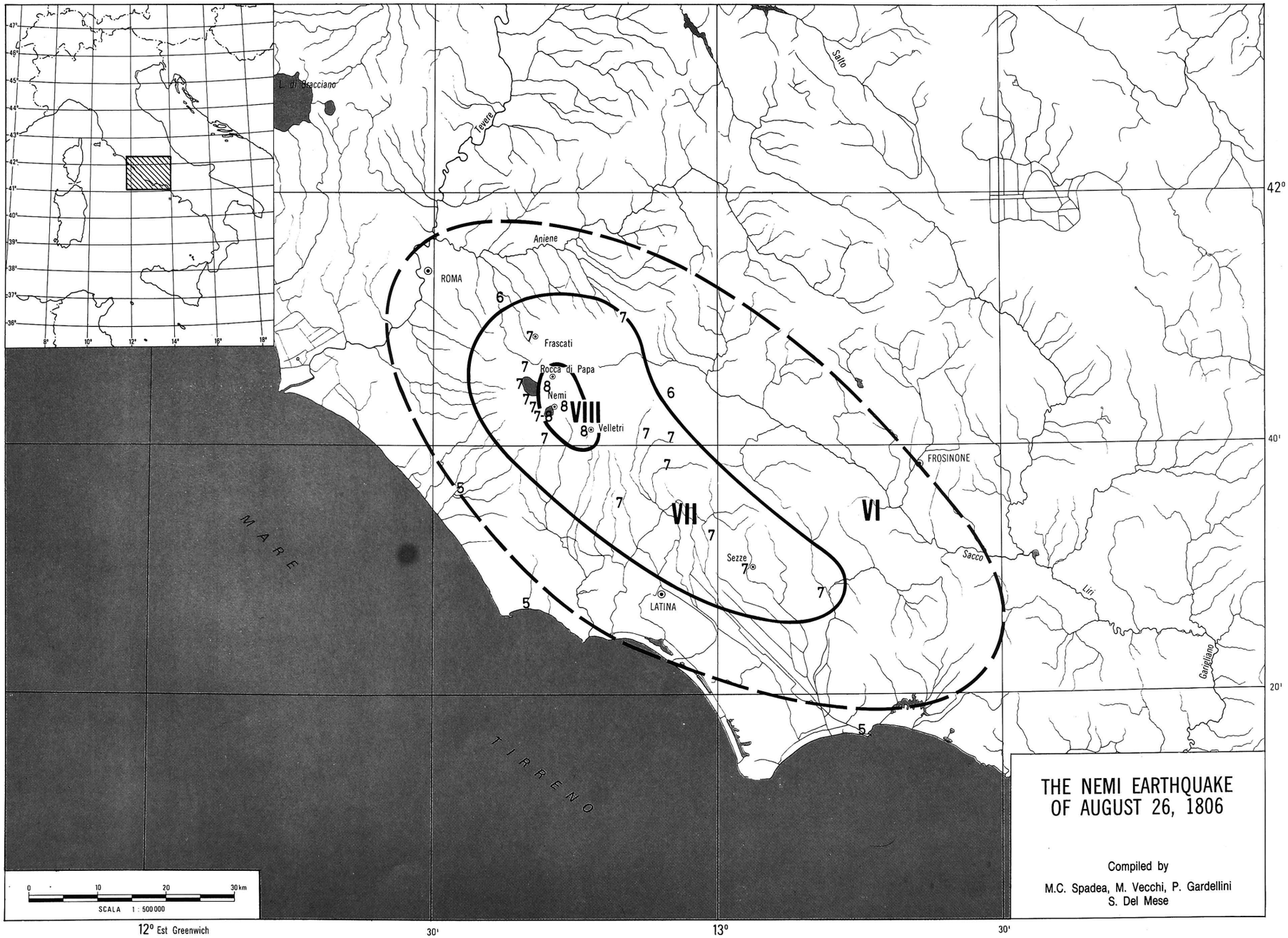

THE NEMI EARTHQUAKE OF AUGUST 26, 1806

Compiled by

M.C. Spadea, M. Vecchi, P. Gardellini
S. Del Mese

The drainage network of this map – scale 1:500.000 – is the same as the "Structural Model of Italy."

G.T.M - Via Marco Marulo 47a - 00143 ROMA

The Pinerolo earthquake of April 2, 1808.

M. Cattaneo, F. Merlanti

The Pinerolo area is characterized by frequent seismic activity with low energy events, but sometimes with shocks of notable intensity. Among the historical earthquakes we can underline the 2 April 1808, since a sufficient amount of available information allowed a macroseismic study.

In particular we used the monographs of Vasalli-Eandi (1808), Mercalli (1897), Baratta (1901) and Rothè (1941), as well as a great number of descriptions in newspapers, revues and reports, the most notable of which is «Recueil de lettres de quelques habitants des Vallées de Pignerol sur le tremblement de terre de 1808», published by the Correspondance Vaudoise. This information was grouped according to locality and then revalued on the MCS scale.

This eartquake inflicted great damage at Luserna, Torre S. Germano, San Giovanni, Torre Pellice, Bricherasio, Pinerolo and Angrogna.

The shock was felt at notable distances, particularly towards the West, e.g. Gap and Briançon. The heaviest damages were concentrated in the Po and Pellice Valleys as well as in the Pinerolo area. The total amount of damages in the Pinerolo area only was at that time evaluated to be more than 1.000.000 francs.

Also reported were effects on the ground surface, such as a landslide (between Torre and Villar Pellice), cracks and fissures (None, Riva, Airasca), and variations of flow and clearness of sources.

Chronicles mentioned a contemporaneous strong atmospheric disturbance with wind which thinned out the leaves of trees and bent the trunks towards the north. Some damages, mainly regarding the ground fissures, could be reduced with the aid of technical reports ordered just after the event (cf. «Rapport fait au conseil des Mines, sur les tremblements...», by M. Muthuon, Chief Engineer of Mines, Turin).

No losses were reported due to the fact that the population was on the alert as some foreshocks had been felt in preceding days. Moreover, since it was late afternoon, most people were in the open air.

From the bibliography, macroseismic data for about 70 localities have been recognized. These data have been revalued according to the MCS scale and have been mapped; from this basis we have drawn the relevant isoseismal lines from the VIII MCS to the IV MCS. The latter are merely indicative.

The macroseismic epicenter was evaluated to be 44°52' Lat. N and 7°15' Long E.

The 4 April 1808 earthquake was followed by a great number of aftershocks (more than 130 were felt) which lasted one year. Some of these were particularly strong, e.g. the event of 16/4/1808 which reached the VI MCS and caused further damages in the areas that had been even more strongly affected by the main shock.

List of shocked localities:

Locality	Latit.	Long.	I (MCS)
Abbadia	44°53'	7°19'	VIII
Abries	44°47'	6°56'	VI
Aix-en-Provence	43°31'	5°28'	IV
Angrogna	44°52'	7°11'	VIII
Antibes	43°34'	7°07'	III
Asti	44°54'	8°12'	IV-V
Barge	44°44'	7°19	VII
Bibiana	44°48'	7°17'	VII
Biella	45°34'	8°03'	II-III
Bobbio Pellice	44°49'	7°07'	VI
Briancon	44°54'	6°38'	VI
Bricherasio	44°49'	7°18'	VIII
Burlasco	44°52'	7°25'	VI
Carmagnola	44°50'	7°37'	V-VI
Casale Monferrato	45°08'	8°28'	II
Castell'Alfero	44°59'	8°13'	IV
Cavour	44°47'	7°22'	VII
Chambery	45°34'	5°55'	III-IV
Champoleon	44°43'	6°16'	V-VI
Cumiana	44°59'	7°22'	V
Embrun	44°34'	6°34'	IV
Fenestrelle	45°02'	7°03'	V
Gap	44°34'	6°05'	V
Garcin (Bourg d'Oisans)	45°03'	6°02'	V
Genova	44°25'	8°54'	III
Ginevra	46°12'	6°09'	IV
Grenoble	45°11'	5°43'	IV
Incisa Scapaccino	44°49'	8°22'	IV
Ivrea	45°28'	7°52'	II-III
La Motte	44°58'	5°44'	V
Lione	45°46'	4°50'	III
Luserna San Giovanni	44°49'	7°15'	VIII
Macon	46°12'	4°49'	II
Magliano Alpi	44°28'	7°48'	IV
Malvicino	44°34'	8°25'	IV
Marsiglia	43°17'	5°23'	III-IV
Meano	44°59'	7°11'	VI
Milano	45°28'	9°11'	II
Molines en Queyras	44°44'	6°51'	V-VI
Montbrison	45°36'	4°04'	III
Monticello d'Alba	44°43'	7°57'	IV
Nizza	43°41'	7°17'	III
Orcieres	46°01'	7°08'	V
Osasco	44°51'	7°20'	VII
Ospizio del Frejus	45°08'	6°36'	IV
Ospizio Moncenisio	45°14'	6°56'	IV-V
Paesana	44°41'	7°17'	VI
Perosa Argentina	44°58'	7°11'	VI
Pinasca	44°56'	7°14'	VII
Pinerolo	44°53'	7°19'	VII
Pocapaglia	44°43'	7°53'	V
Pomaretto	44°58'	7°11'	VI
Porte Val Chisone	44°53'	7°16'	VIII
Ristolas	44°46'	6°57'	VI
Roletto	44°52'	7°20'	VI
Saint Bonnet	44°42'	6°05'	V
Saint-Jacques-en-Valgodem	44°46'	6°03'	V-VI
San Germano Chisone	44°54'	7°14'	VIII
San Giovanni	44°50'	7°16'	VIII
San Secondo di Pinerolo	44°52'	7°19'	VII
Sanfront	44°39'	7°19'	VI
Savona	44°19'	8°29'	III
Tolone	43°08'	5°56'	III
Torino	45°04'	7°40'	IV
Torre Pellice	44°49'	7°13'	VIII
Vigone	44°50'	7°30'	VI
Villar Pellice	44°49'	7°09'	VII
Villar Perosa	44°55'	7°15'	VII

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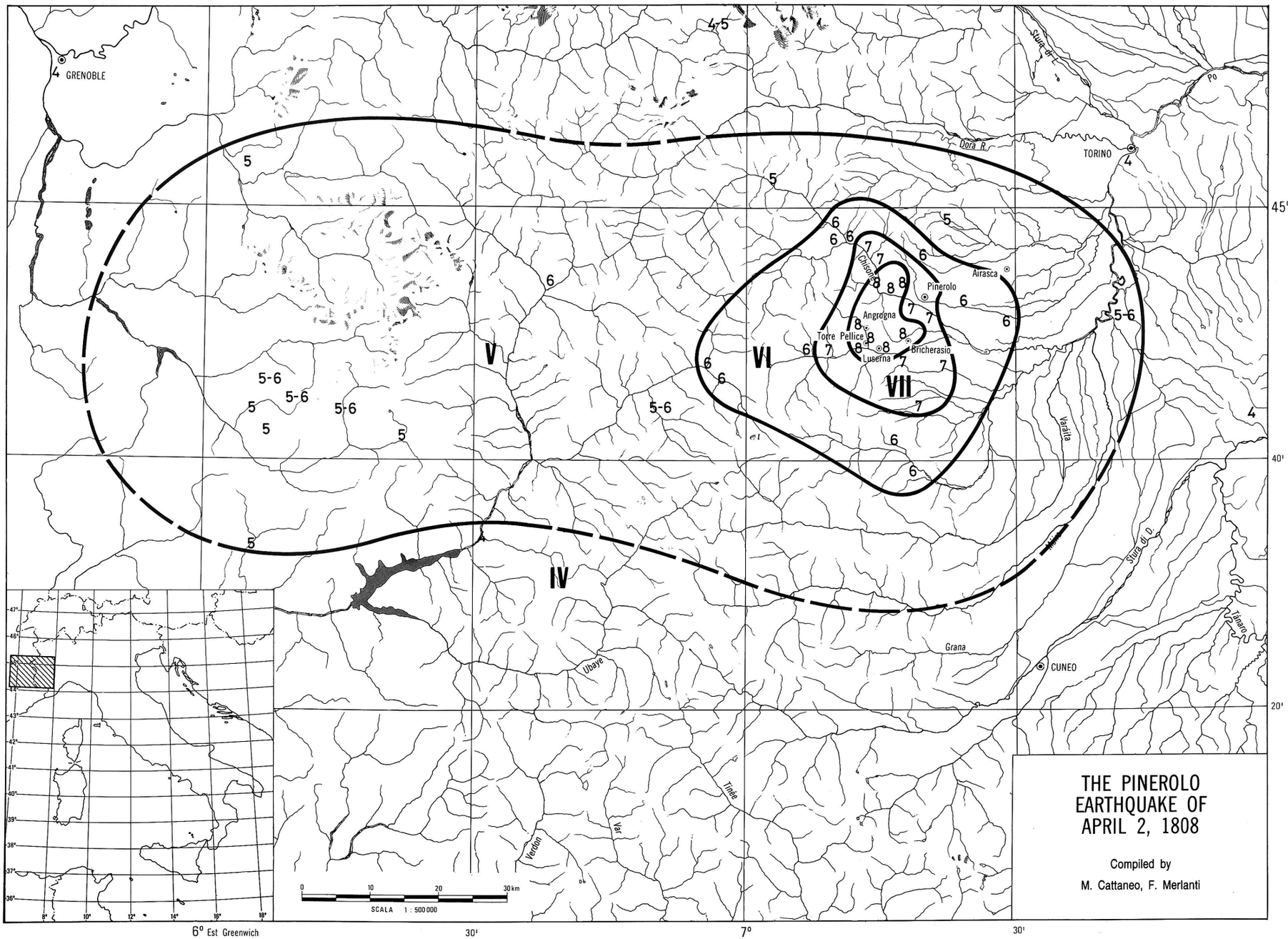

The drainage network of this map – scale 1:500.000 – is the same as the "Structural Model of Italy."

G.N.D.T. - Via Marco Mario 47a - 00143 ROMA

The Etna earthquake of February 20, 1818.

S. Imposa, G. Lombardo

Most Etnean shocks are characterized by strong energy released in a very narrow area. The 20.2.1818 earthquake, on the countrary, is one of the few shocks that is characterized by the spreading of effects in quite a large area. In fact, this earthquake was felt in a large part of Sicily and in southern Calabria.

The seismic event took place at the beginning of the 19th century, a period in which systematic studies on the volcano and its geodynamic phenomena had not started yet.

Despite the extent of the phenomenon, only a few bibliographic references having scientific characteristic have been found, though it seems likely that further information might be obtained by looking for contemporary cronicles and reports in historical archives.

Nevertheless, the information gathered allows a good characterization of the macroseismic field of the shock, using mostly the accurate descriptions given by an author contemporary to the event (3).

The earthquake occurred at 18.20 (G.M.T.) and ruined several villages of the southeastern flank of Mt. Etna. Aci Consolazione and Aci Platani were nearly completely destroyed, while Aci S. Antonio, Acicatena, S. Giovanni Galermo, Mascalucia and Nicolosi were heavily damaged. The shock was also strongly felt in Catania and descriptions of falling objects and rotation of monuments and crosses are often reported.

The more or less disastrous effects were distributed throughout the Etna area, with two maxima of intensity in Maletto and Piedimonte, where heavy damage and some house collapse occurred.

Because of the great number of houses collapsed in many villages, there were 72 victims in total. The maximum was in Zafferana (3), due to the fact that they were grouped inside a church where the roof collapsed.

A great number of phenomenon in the ground and in underground water were observed in the mesoseismal area. In particular, deep fractures, some metres long, were found in Aci Catena, S. Giovanni la Punta, Viagrande and Pozzillo. In a spring close to Acicatena, changes were observed in its regime, and the same thing happened in the salted thermal spring close to Paternò. Moreover, spouts of salted water and slight oscillations of the sea level were observed close to the mouth of the Simeto river.

Both the above mentioned phenomena in the ground and the amount of damages described indicate intensity IX as the maximum intensity in the mesoseismal area.

The isoseismal map (see figure) demonstrates that the earthquake was more or less felt in almost all Sicily. From Siracuse and Noto to Palermo, people panicked and clocks stopped. The area where the shock was felt reached southern Calabria and Malta as well (1).

Several slight aftershocks took place until 2 March of the same year. In particular, the shocks of 21 and 28 February, were felt in the surrounding of Acireale.

The focal depth, calculated using macroseismic methods, was about 5 km.

The mesoseismal area of this earthquake is very irregular and rather wide (44.25 km^2) in comparison to that of the majority of Etnean shocks. Considering the extent of the seismic event, it seems possible that a complex mechanism at the source, with the activation of more than one fault line, was responsible for this shock. Comparison between lobes of the complex mesoseismal area with the orientation of fractures and faults, obtained from field surveys, shows agreement and thus offers some support to this hypothesis.

List of shocked localities:

Locality	Latit.	Long.	I (MCS)
Aci Bonaccorsi	37°33'	15°06'	IX
Acicastello	37°33'	15°09'	VI
Acicatena	37°36'	15°08'	IX
Aci Consolazione	37°35'	15°08'	IX
Aci Platani	37°36'	15°08'	IX
Acireale	37°37'	15°10'	VIII
Aci S. Antonio	37°37'	15°06'	IX
Aci S. Filippo	37°35'	15°08'	IX
Aci S. Lucia	37°37'	15°08'	IX
Acitrezza	37°34'	15°09'	VI
Adrano	37°40'	14°50'	VI
Belpasso	37°35'	14°59'	VIII
Biancavilla	37°38'	14°53'	VI
Borrello	37°36'	14°59'	VIII
Bronte	37°47'	14°51'	VII
Calatabiano	37°50'	14°38'	VI
Caltagirone	37°14'	14°30'	IV
Camporotondo Etneo	37°33'	14°59'	VIII
Castiglione di Sicilia	37°52'	15°07'	VIII
Catania	37°31'	15°05'	VI-VII
Enna	37°34'	14°18'	IV
Fiumefreddo	37°47'	15°12'	VI
Giarre	37°43'	15°11'	VI
Gravina	37°34'	15°03'	VIII
Maletto	37°49'	14°52'	VIII
Malta	35°55'	14°30'	NF
Mascali	37°36'	15°12'	VI
Mascalucia	37°34'	15°02'	IX
Messina	38°11'	15°33'	IV
Misterbianco	37°31'	15°01'	VII
Motta Sant'Anastasia	37°32'	14°48'	VIII
Nicolosi	37°36'	15°06'	IX
Nicosia	37°45'	14°24'	IV
Noto	36°54'	14°24'	IV
Palermo	38°07'	13°21'	V
Palmi	38°22'	15°51'	III
Paternò	37°34'	14°54'	VII
Piazza Armerina	37°24'	14°24'	IV
Piedimonte Etneo	37°48'	15°11'	VIII
Randazzo	37°53'	14°57'	VII
Reggio Calabria	38°06'	15°39'	III
S. Agata li Battiati	37°33'	15°04'	VIII
San Giacomo	37°36'	15°08'	IX
S. Giovanni Galermo	37°33'	15°02'	IX
S. Giovanni la Punta	37°35'	15°06'	VIII
S. Gregorio	37°33'	15°06'	IX
S. Pietro Clarenza	37°34'	15°02'	VIII
Siracusa	37°04'	15°18'	IV
Taormina	37°31'	15°17'	V
Trappeto	37°32'	15°03'	VII
Tremestieri	37°34'	15°05'	IX
Valverde	37°34'	15°07'	VIII
Zafferana Etnea	37°41'	15°07'	VII

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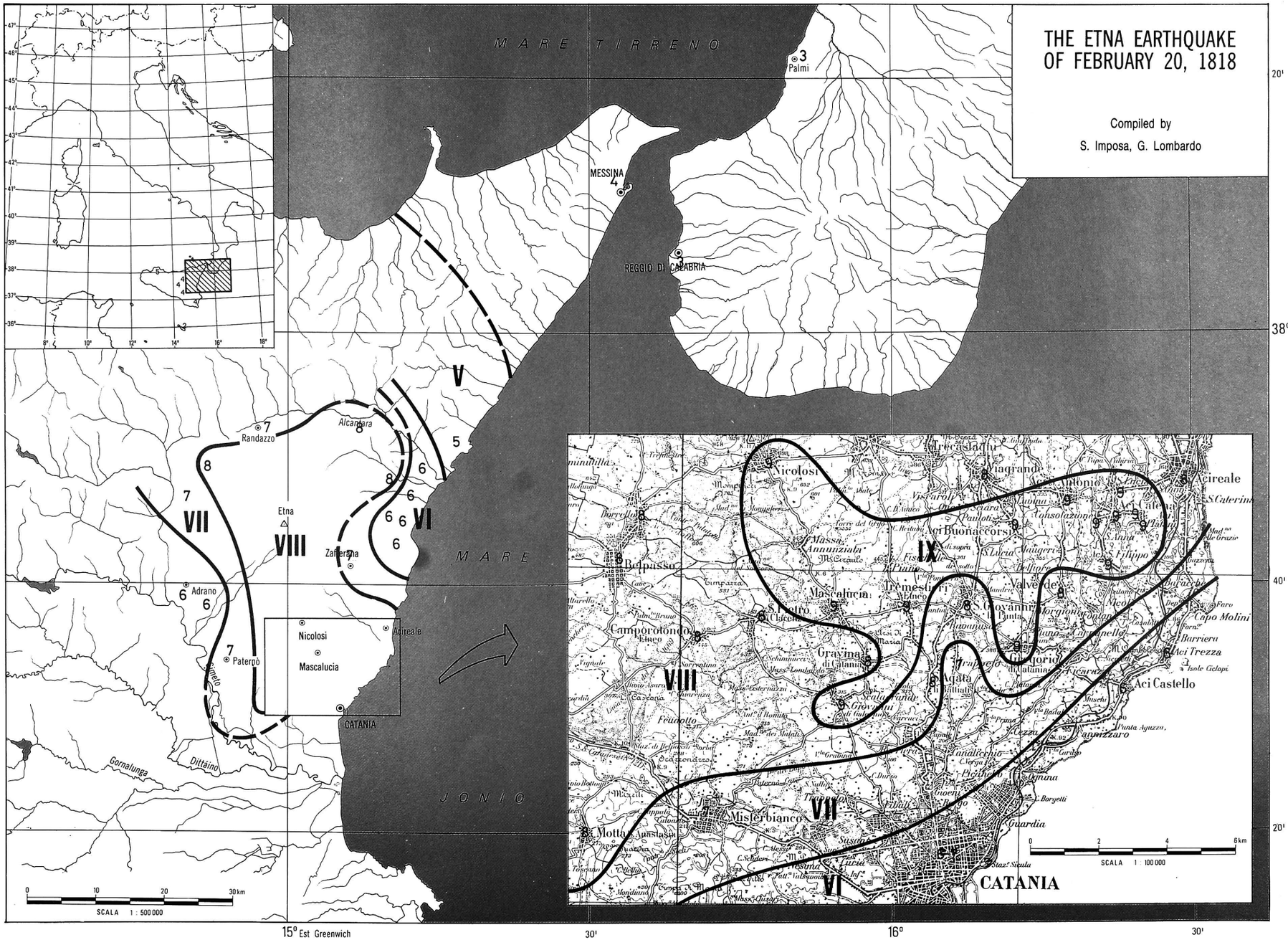

The drainage network of this map – scale 1:500.000 – is the same as the "Structural Model of Italy."

G.T.M - Via Marco Marulo 47a - 00143 ROMA

The Cefalù earthquake of March 5, 1823.

A. Bottari, B. Federico, E. Lo Giudice, C. Pandolfo

The time, 16^{h}37^m GMT, on 5 March 1823, reported in the official references is trustworthy as it was announced by the sismological observatory of Palermo. Three foreshocks are recorded before the main shock: at 22^h on 16 February, at 12^{h}30^m and at 14^h on 5 March. The last two are rather large as foreshocks, as they were perceived with more intensity in Palermo and in Naso.
The aftershocks picture is not at all clear. A few shocks are recorded until August of the same year in areas of western and eastern Sicily.
According to Baratta (n. 1) these shocks were not aftershocks, but shocks from other foci. Only two shocks, of all the numerous aftershocks listed, are very likely to be connected to the main event of 5 March. They were perceived with strong rumbles on 6 March at 6^{h}45^m and at 8^{h}30^m in S. Lucia del Mela and in Messina.
The available references are restricted to Mercalli, 1897 (n. 3); Baratta, 1901 (n. 1) and Ferrara, 1823 (n. 2). The main source of information is the contemporary Francesco Ferrara; two localities only, Corleone and Montemaggiore, are reported by Baratta. The Abbot Ferrara personally felt both the main shock and the foreshock in Palermo. The data are unfortunately limited in quality and the distribution areas are not comparable. The information, mainly concerning monasteries, churches, and monumental buildings, suddenly stopped along the eastern slopes of Pizzo Carbonara, at the longitude of Finale, roughly at the present boundaries of the province of Palermo. The data are less frequent east of Naso; only ten localities are reported as far as Messina and Eolian Islands. The gap certainly concerns a zone not densely populated, in which there are, however, important towns as Mistretta and S. Stefano Camastra. Due to the short time elapsed between the event and the drawing up of the note issued the same year, it may be that the Abbot Ferrara could have easily collected data and information within the sphere of political-administrative jurisdictions and in the circle of the religious orders in Palermo.
The macroseismic field is limited by these restrictions; and its outline is consequently lacking and interpretative. Some distinctive features are, however, clear and indisputable:

— the VIII grade seems more definite for the dimension of damages;

— the field is oriented EW-W is the preferential direction of propagation and E, along the Peloritan chain, the one of greatest absorption;

— the epicentral area seems eccentric to E and in the sea;

— there is a negative anomaly zone constituted by limestone formations overlying soft layers of great thickness (Flysh Numidico).

The most damaged area was the coast between Capo d'Orlando and Capo Calavà, and the zone from Naso, the most ruined town, to Patti. Ferrara connects the earthquake to the volcanic phenomenology of the Eolian Islands. Baratta, ascribing to this a tectonic origin located the epicenter, certainly more convincing along the above mentioned coastal tract. According to us a western epicentre, located exactly in the area of the Cefalù basin east and west of the structural sheafs of the Naso and Tindari-Giardini line, would be in better agreement with the field's trend. The above mentioned structural sheafs, in a NNW-SSE direction, would be the reason of the great absorption along the Peloritan chain; the EW structures to the west of this chain would be responsible for the preferential propagation towards Palermo. This hypothesis may be supported by these elements:

— the character of the event (intensity VIII or more) observed along the coast near Cefalù and Finale and inland;

— the tsunami broke fiercely over this coastal tract and less strongly at the west as far as Palermo;

— the relative low grade in the Lipari and Salina Islands (no damages were observed); unfortunately there is no information about Alicudi and Filicudi, which, at that time, were not very, populated;

— the strong absorption east of Naso along the Peloritan chain, characterized by NNE and ENE structures, in particular in the Naso-Patti zone;

— the foreshocks were perceived more intensely (at least VI grade) in Naso than in Palermo; we are not aware of the perception of the event in Patti.

Even though the field drawing is lacking, considering the intensity at the epicenter, the limit of perception and the trend of the field, the hypocenter can be said to be crustal.
The most damaged town was Naso; it has features between IX and X degree. The latter intensity attributes Naso as the epicenter. The population fled to the country just because of the great intensity of the two foreshocks, so only two people died. There was one dead person and one wounded in Ciminna due to the downfall of the clock tower. In Palermo there were 19 deaths, 25 wounded and greater damage that is to be considered anomalous. According to many authors, there is satisfying evidence of the earthquake that consists of:

— peculiar topographical-geological features;

— bad foundations;

— very poor state of preservation of buildings, often badly constructed, without foundations or good frames but very high; and,

— the damages mainly concentrated in districts and in houses previously ruined by the strong earthquake of 1726 during which 400 people died.

List of shocked localities

Locality	Latit.	Long.	I (MCS)
Agrigento	37°19'	13°35'	IV
Alcamo	37°59'	12°58'	V
Alimena	37°42'	14°07'	VII
Altavilla	38°02'	13°33'	VII-VIII
Barcellona Pozzo di Gotto	38°09'	15°13'	≥VI
Bolognetta (Previously Ogliastro)	37°58'	13°27'	≥VII
Caltavuturo	37°49'	13°53'	VI-VII
Capaci	38°10'	13°14'	VII
Castelbuono	37°56'	14°05'	VII
Castellamare del Golfo	38°01'	12°53'	V
Catania	37°30'	15°05'	≤IV
Cefalù	38°02'	14°01'	VIII
Cerda	37°54'	13°49'	VII-VIII
Ciminna	37°54'	13°34'	≤VII
Collesano	37°55'	13°56'	VIII
Corleone	37°49'	13°18'	VI
Ficuzza, Rocca Busambra	37°53'	13°23'	VII
Finale	38°01'	14°10'	≤VIII
Geraci Siculo	37°51'	14°09'	VII
Godrano	37°54'	13°26'	VII
Gratteri	37°58'	13°58'	≥VII
Isnello	37°57'	14°00'	VII
Lascari	38°00'	13°56'	VIII
Lipari	38°28'	14°44'	≥VI
Meri	38°10'	15°15'	VI
Messina	38°11'	15°33'	≥VI
Milazzo	38°13'	15°14'	V
Modica	36°51'	14°46'	NF
Monreale	38°05'	13°17'	VII
Montemaggiore	37°51'	13°46'	≤VIII
Naso	38°07'	14°47'	IX-X
Palermo	38°07'	13°21'	≥VIII
Patti	38°08'	14°58'	VIII
Piana degli Albanesi	38°00'	13°17'	VI-VII
Pioppo	38°03'	13°14'	VII
Pollina	38°00'	14°09'	VIII
Porto Palo, Capo Passero	37°34'	12°54'	NF
Roccapalumba	37°48'	13°38'	≥VII
S. Mauro Castelverde	37°55'	14°11'	VII
S. Agata (NW of Collesano)	37°57'	13°54'	VIII
S. Lucia del Mela	38°08'	15°17'	V
S. Maria di Salina	38°34'	14°39'	VI
Scillato	37°51'	13°54'	VI-VII
Siracusa	37°05'	15°17'	III
Stromboli, S. Vincenzo	38°49'	15°01'	≥VI
Termini Imerese	37°59'	13°42'	VIII
Torretta	38°08'	13°14'	VII
Trabia	38°00'	13°39'	VII-VIII
Trapani	38°01'	12°33'	IV

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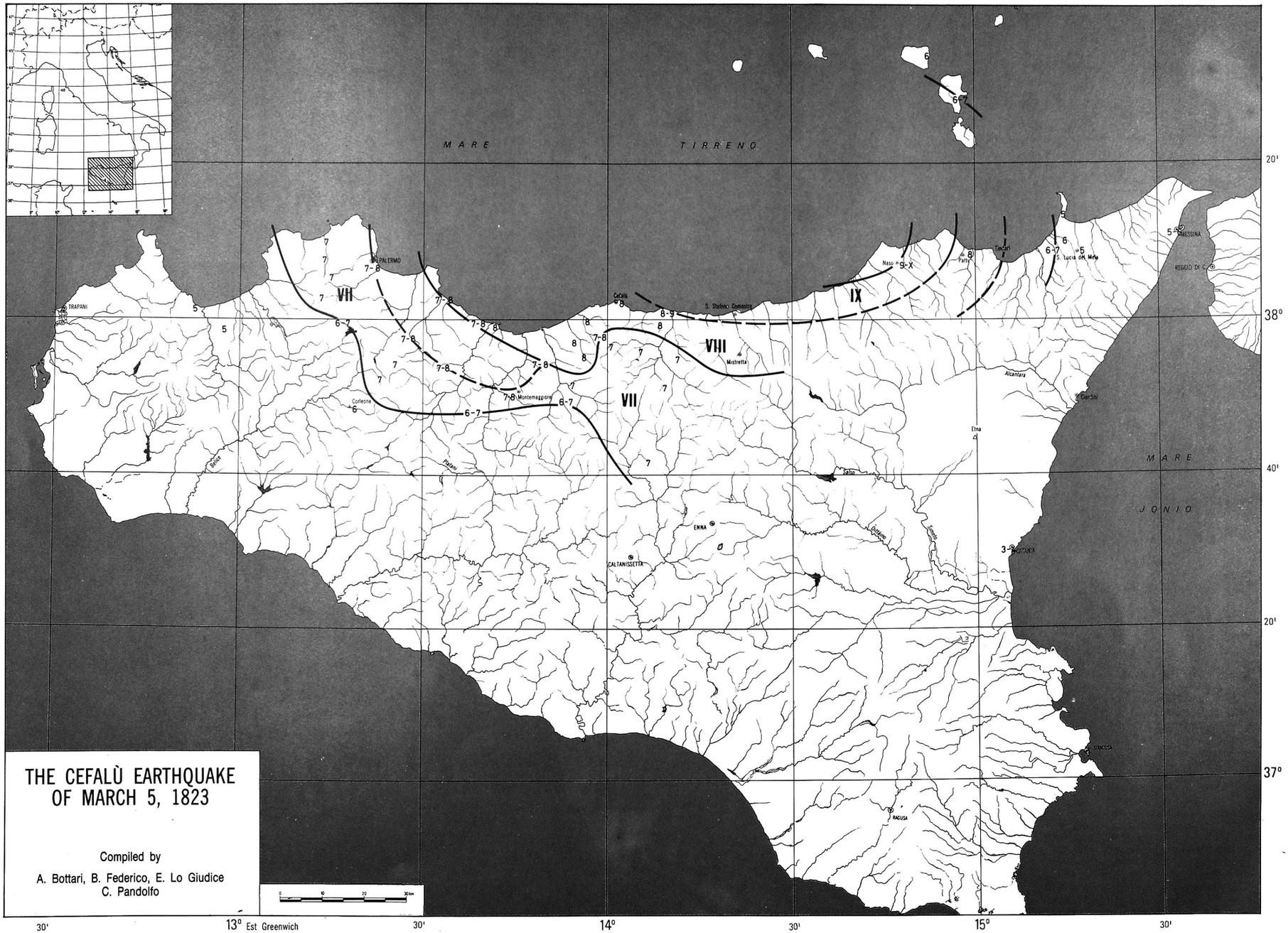

THE CEFALÙ EARTHQUAKE OF MARCH 5, 1823

Compiled by

A. Bottari, B. Federico, E. Lo Giudice
C. Pandolfo

The drainage network of this map – scale 1:500.000 – is the same as the "Structural Model of Italy."

G.T.M - Via Marco Marulo 47a - 00143 ROMA

The Melfi earthquake of August 14, 1851.

G. Magri, D. Molin

This has been called the Vulture earthquake, but in fact it had a severe effect on the towns situated along the eastern edge of the volcano, spreading noticeable towards the East.
It destroyed almost completely the town of Melfi and partially destroyed nearby villages, causing the death of about 700 people. The first of the two destructive events of 14 August was almost entirely responsible for the deaths, though the second one was stronger. Furthermore, the earthquake was responsible for fractures in the ground, landslides and changes in the flow of the underground waters.
Given the importance of this event, there are a fair number of reports and memoirs by contemporary writers; the works of G.M. Paci (35), L. Palmieri & A. Scacchi (36) and A. Perrey (37) are essential for research.
The seismic sequence related to this earthquake seems to have begun at the end of March 1851, when earthquakes up to the VI degree of the M.C.S. scale began to be felt in Melfi and in nearby villages. There were additional shocks during June, and probably also in the days immediately preceding the major earthquakes, since «deep rumbles» were heard. Then on 14 August, the two main events were felt, as follows:
– 14.8.1851, 14.24 local time, 40°59' Lat. N, 15°39' Long. E, IX MCS;
– 14.8.1851, 15.50 local time, 40°59' Lat. N, 15°39' Long. E, X MCS.
The times should be considered fairly accurate since they were registered by the Astronomical Observatory in Naples.
A great number of aftershocks was noticed, throughout the first half of 1852. Events occurred occasionally after, so that it is difficult to determine whether they were actually continuous with the first. The great majority of the aftershocks had their origin in the narrow epicentral area of the major earthquakes, though some took place in the Gargano and Capitanata areas.
This region, during the earthquakes of 14 August, was affected by a local increase of intensity. The VII degree shock felt at Canosa di Puglia should also be noted; this location is rather far away from the epicentral area, but it is inside the area of primary spreading towards the East, determined by the isoseismic curve of the VII-VIII degree.
About 200 aftershocks occurred between 14 August 1851 and June 1852.
The maximum cumulative intensity due to the two earthquakes was at Melfi, where it reached the X degree of the MCS scale; the macroseismic epicentre should be located near this locality.
The intensity values recorded on the isoseismal map and in the list area are related to the cumulative damage that occurred during the seismic sequence, particularly that caused by the two destructive earthquakes of 14 August.
We know that the earthquake was felt all over Apulia, in Calabria even beyond Catanzaro, and – towards the North – even in Latium and in the Abruzzi.
From the isoseismal map, two local increases of intensity can be noted, one of the VIII degree corresponding to Accadia, and the other of the VII degree in Capitanata (including the area between Foggia, San Severo and Lucera).
Furthermore, the main spread of the isoseismal lines of the VI-VII and VII-VIII degree is evident towards the East, with values of the VII degree up to Barletta and Trani on the Adriatic coast. The shape of the isoseismal line of the VII-VIIIth degree must be quite significant from the seismotectonic point of view, since it is almost exactly repeated, as far as shape, extent and also intensity are concerned, during the 1857 Basilicata earthquake.

List of shocked localities:

Locality	Latit.	Long.	I (MCS)
Accadia	41°10'	15°20'	VIII
Anzano di Puglia	41°07'	15°18'	VI
Apricena	41°47'	15°27'	VI
Aquilonia	40°59'	15°29'	VII
Ascoli Satriano	41°12'	15°34'	VII-VIII
Atella	40°52'	15°39'	VIII
Avellino	40°55'	14°47'	VI
Avigliano	40°44'	15°43'	VI
Bari	41°07'	16°52'	VI
Barile	40°57'	15°41'	IX-X
Barletta	41°19'	16°17'	VII
Biccari	41°24'	15°12'	VI
Bisaccia	41°01'	15°23'	VII
Bovino	41°15'	15°21'	VII
Cagnano Varano	41°39'	15°47'	VI
Calitri	40°54'	15°26'	VI
Campagna	40°40'	15°07'	VI
Candela	41°26'	15°31'	VIII
Canosa di Puglia	41°13'	16°04'	VII-VIII
Casalnuovo Monterotaro	41°37'	15°07'	VI
Casaltrinità	?	?	VI
Caserta	41°04'	14°19'	?
Castelluccio dei Sauri	41°18'	15°29'	VI
Cerignola	41°16'	15°54'	VII
Deliceto	41°13'	15°23'	VI
Foggia	41°28'	15°33'	VII
Forenza	40°52'	15°02'	VI
Ginestra	40°56'	15°44'	VII-VIII
Ischia	40°44'	13°57'	V
Lacedonia	41°03'	15°26'	VI
Lavello	41°03'	15°48'	VIII
Lecce	40°21'	18°11'	?
Lucera	41°30'	15°20'	VII
Maschito	40°55'	15°50'	VI
Matera	40°40'	16°36'	VI
Melfi	41°00'	15°40'	X
Monteverde	41°00'	15°32'	VIII
Muro Lucano	40°45'	15°29'	VI
Napoli	40°51'	14°15'	V
Ordona	41°19'	15°38'	VI
Rapolla	40°59'	15°41'	IX-X
Rionero in Vulture	40°56'	15°41'	IX
Ripacandida	40°55'	15°42'	VIII
Rodi Garganico	41°56'	15°53'	VI
Ruvo del Monte	40°51'	15°33'	VI
Ruvo di Puglia	41°07'	16°29'	VII
San Fele	40°49'	15°33'	VI
San Michele (Convento di)	40°59'	15°37'	VIII-IX
Sannicandro Garganico	41°50'	15°34'	VI
San Severo	41°41'	15°23'	VII
Sant'Agata di Puglia	41°09'	15°23'	VI
Serracapriola	41°48'	15°10'	VI
Stornarella	41°16'	15°44'	VI
Trani	41°17'	16°25'	VII
Venosa	40°58'	15°50'	VIII-IX

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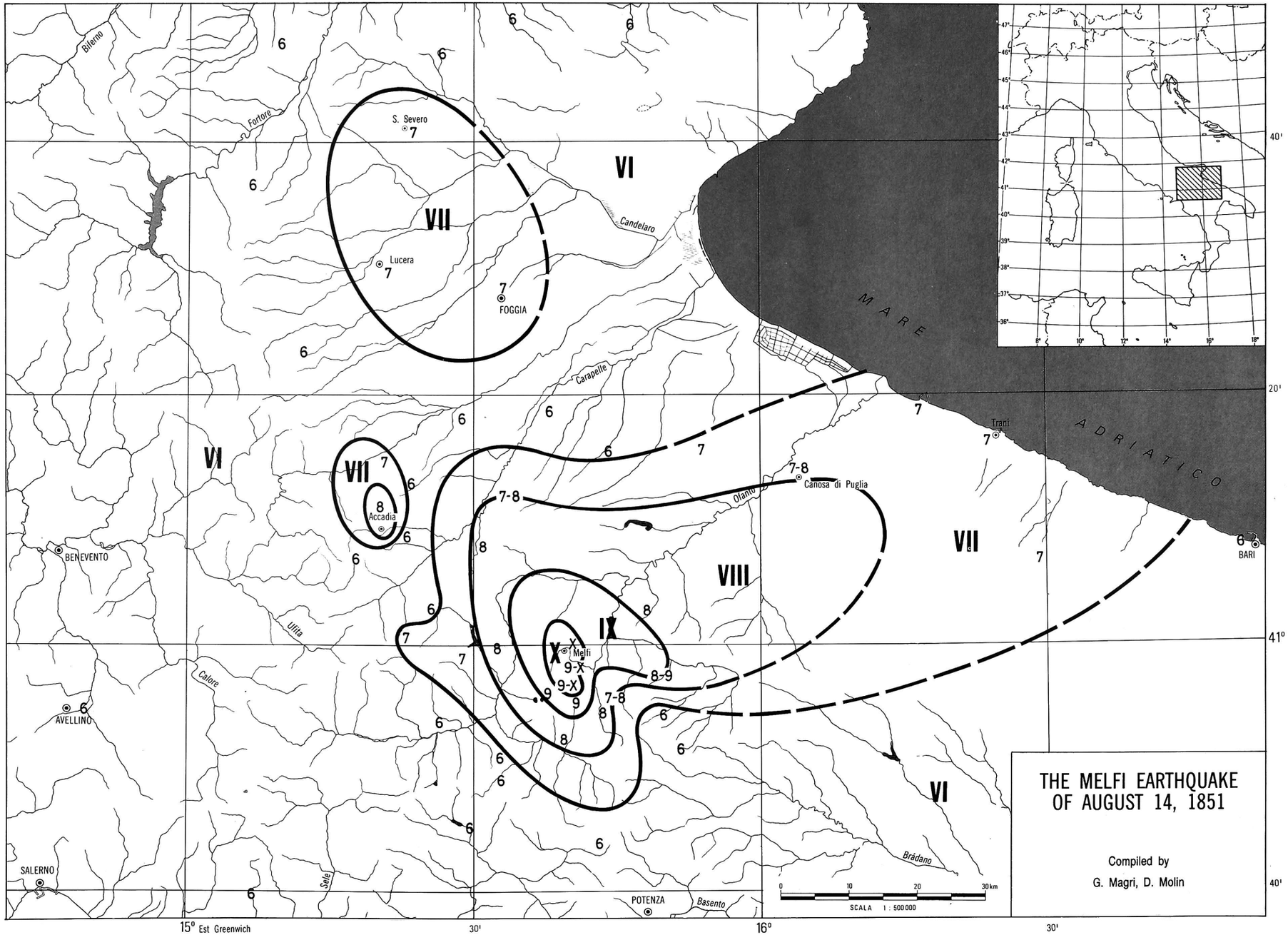

THE MELFI EARTHQUAKE OF AUGUST 14, 1851

Compiled by

G. Magri, D. Molin

The drainage network of this map – scale 1:500.000 – is the same as the "Structural Model of Italy."

G.T.M - Via Marco Marulo 47a - 00143 ROMA

The Caposele earthquake of April 9, 1853.

G. Magri, D. Molin

This earthquake involved the area that includes the upper valleys of the Sele and Ofanto Rivers, and the towns Caposele and Teora in particular; there were twelve victims in the former town. In the epicentral area both landslides and fractures in the ground were reported.

There is not very much literature available. However, it is sufficient to define the main characteristics of the event. The works by G.M. Paci (14) and A. Perrey (15) are basic for research, but a good deal of information was also taken from contemporary newspapers.

No difficulties have been encountered in fixing the time of the main event (13:45 local time); it is to be noted that, because of the imprecise measuring of the time, the minutes have been taken to the nearest quarter of an hour.

The seismic sequence connected to the earthquake began on 9 April with the main shock. It seems to have been the continuation of the seismic sequence related to the 14 August 1851 Vulture earthquake which occurred in a nearby region. The main event was followed by many aftershocks which occurred both on the same day and in following days. Aftershocks lasted for eight weeks, showing a monotonous decrease in the number with some temporary sharp increases. A total number of about 100 shocks with intensity up to the VI degree of the MCS scale was reported.

The intensity reached the IX degree of the M.C.S. scale at Caposele and Teora, though the damage was less extensive in the latter.

The epicentre was between these two towns, and had the following coordinates: 40°50' Lat. N, 15°14' Long. E.

The collected data enable us to draw a fair isoseismal map up to the VII degree of the MCS scale. For lower intensity, no data for either north and east were available. No particular anomalies are to be noted in the distribution of the intensities, except for a prominence in the curve of the VI-VII degree towards the west.

List of shocked localities:

Locality	Latit.	Long.	I (MCS)
Acerno	40°44'	15°04'	VII
Ariano Irpino	41°09'	15°05'	V
Atripalda	40°33'	14°28'	VI
Avellino	40°55'	14°47'	VI
Bagnoli Irpino	40°54'	15°05'	VII
Baronissi	40°45'	14°46'	?
Calabritto	40°47'	15°14'	VIII
Campagna	40°40'	15°07'	VII
Caposele	40°49'	15°14'	IX
Caserta	41°04'	14°19'	?
Cava dei Tirreni	40°42'	14°42'	?
Chiusano di San Domenico	40°56'	14°55'	VI-VII
Colliano	40°43'	15°17'	?
Contursi	40°39'	15°15'	?
Eboli	40°38'	15°04'	VI-VII
Ercolano	40°48'	14°21'	III
Foggia	41°28'	15°33'	III
Laviano	40°47'	15°18'	?
Lioni	40°53'	15°12'	VIII
Marano di Napoli	40°54'	14°11'	III
Melfi	41°00'	15°40'	III
Montecorvino Rovella	40°42'	14°58'	VII
Monteforte Irpino	40°54'	14°33'	VI
Montella	40°50'	15°02'	VII
Montoro Superiore	40°49'	14°48'	VII
Napoli	40°51'	14°15'	III
Nocera Inferiore	40°44'	14°38'	?
Nocera Superiore	40°45'	14°41'	?
Nola	40°56'	14°32'	III
Nusco	40°53'	15°06'	VII
Pollena-Trocchia	40°51'	14°23'	IV
Postiglione	40°34'	15°14'	VI-VII
Potenza	40°38'	15°48'	III
Quaglietta	40°45'	15°15'	VII-VIII
Salerno	40°41'	14°45'	VI-VII
Sarno	40°49'	14°37'	V
Sant'Angelo dei Lombardi	40°56'	15°11'	VII
Senerchia	40°44'	15°12'	VII-VIII
Serre	40°35'	15°11'	?
Solofra	40°50'	14°51'	VII
Solopaca	41°11'	14°33'	II-III
Teora	40°51'	15°15'	IX

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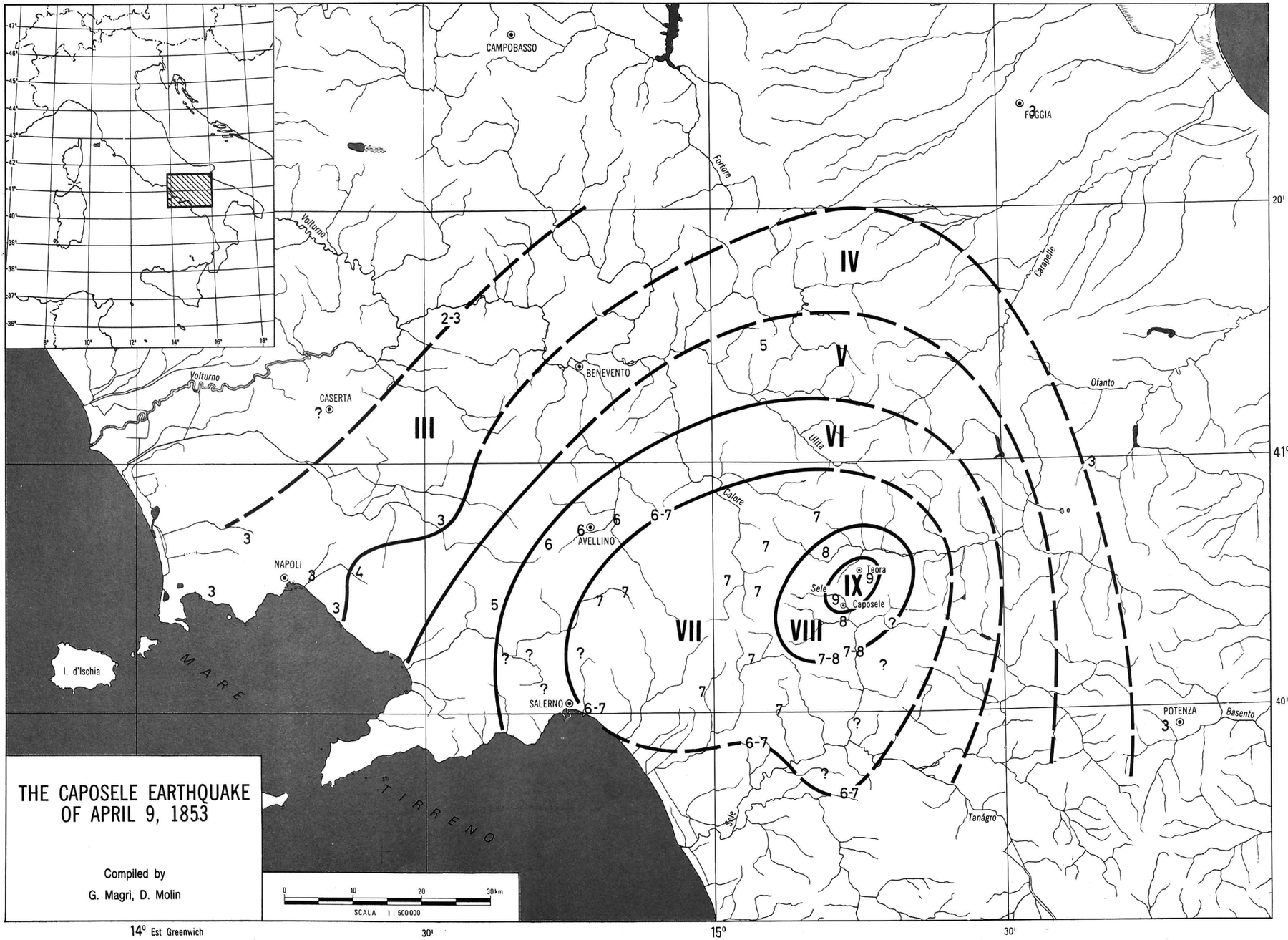

THE CAPOSELE EARTHQUAKE OF APRIL 9, 1853

Compiled by
G. Magri, D. Molin

The drainage network of this map - scale 1:500.000 - is thè same as the "Structural Model of Italy."

The Basilicata Earthquake of December 16, 1857

A. Branno, E.G.I. Esposito, A. Marturano, S. Porfido, V. Rinaldis

The earthquake on 16 December 1857 has been located in the southernmost axial part of the Apennine range, between Molise and southern Calabria, which are to be considered homogeneous as far as seismotectonic characteristics are concerned. (De Vivo et al. 1979).
This earthquake is characterized by a strong foreshock, which occurred two minutes before the main shock, and by the different distribution of the effects, particularly evident in the areas of maximum damage (Branno et al., in press).
The study has been based principally on the material found in the Fondo Intendenza dell'Archivio di Stato di Potenza (The State Intendance Archives of Potenza).
These archives contain, among other things, a collection of correspondence between the Intendant of the Kingdom in Basilicata and both district authorities (subintendants and judges) and community authorities (majors, urban leaders and pastors), as well as a collection of verifications carried out by community commissions. The great availability of material necessitated an accurately chosen method of comparison and verification in order to reduce problems of interpretation to a minimum.
The information for each locality was organized in the following fashion:

- temporal: the documents nearest in time to the main event were analyzed, screening out the influence of the emotional component by using later documents;
- multiple testimonies: the descriptions of the damage, reported by various authorities, were evaluated for each site, in order to eliminate problems of different descriptions due to more or less particular personal interests;
- official reports of commissions: because of their detailed listing of the damage these documents, when available, allowed verification of the elements taken from the analyses of the other documents.

Correspondence regarding only Basilicata necessitated the utilization of the study by Mallet (1862) as a source of information for the limitrophe principalities, evaluating his description in regard to the localities of Basilicata.
It has already been said that the main shock was preceded by a foreshock. In order to determine the hour of these two shocks, we have used data reported in a letter signed by the Director of the Osservatorio Astronomico di Napoli (Astronomic Observatory of Naples), since it was not possible to refer to data nearer to the epicentral area because of the great uncertainty regarding the measuring of time in that epoch.
The conversion of local time into universal time (G.M.T.) was carried out by using the formula $Tu = Tm.l. - \lambda^{min}$, where Tm.l. is the mean local time and λ is the difference in latitude between Naples and Greenwich.
The calculated values are:
foreshock 21h. 12m. 56s. ± 20s.
main shock 21h. 14m. 56s. ± 20s.
The classification of the effects was carried out on the MCS scale.
The choice of such a scale of reference was motivated by the better degree of corrispondence between the description in our possession and the criteria of evaluation provided by this scale as opposed to another one. In fact, costruction in the area at the moment of the event, was made chiefly of natural stone or hewn stones grouted with mortar.
Since the scale is made up of discrete and noncontinuous values, a limit of maximum and minimum damage has been defined for each degree of intensity.
The analyses have allowed us to define the intensity in 289 localities, from a maximum of XI degrees for Montemurro and Grumento Nova (Saponara), down to a «non-felt» value for Albano (LT) in the North and Catanzaro in the South.
From the examination of the isoseismal lines traced using interpolation of the intermediate values, an extremely elongated X degree area emerges, and from the superior vertex of the Vallo di Diano, reaches the high Valle dell'Agri and includes a very eccentric XI degree area.
Such a trend is justified by the dynamics of the phenomenon. It has been possible to ascertain that the major felt area of the foreshock is concentrated in the northernmost part of the VIII degree isoseismal area, even if it has not been possible to differentiate the effects of the two shocks due to the brief interval of time separating them.
The areas of minor intensity stretch assume an elliptical form, narrower in its highest part. Evident in these areas in the pocket of attenuation corresponding to Pietra Pertosa, S. Mauro Forte and S. Chirico Nuovo, as is the line of amplification on the directrix of Atella, Canosa and S. Margherita di Savoia, the latter being difficult to represent in the drawing of the isoseismal lines.
The VI, V and IV degree areas confirm the trend delineated by the VII degree area, even if the drawing of the isoseismal lines depends principally on the data related to the localities near the Adriatic and Tyrrhenian coasts.

List of shocked localities:

Locality	Latit.	Long.	I (MCS)
Abriola	40°30'	15°49'	VIII
Accettura	40°29'	16°09'	VII
Acerenza	40°48'	15°66'	VII
Acerra	40°57'	14°22'	V
Acquaviva delle Fonti	40°54'	16°51'	VI
Aieta	39°56'	15°49'	VI
Albano	41°44'	12°40'	NF
Aliano	40°19'	16°14'	IX
Alianello	40°17'	16°15'	X
Altamura	40°50'	16°33'	VI-VII
Anzi	40°31'	15°55'	VIII
Arena Bianca	40°18'	15°42'	VIII
Armento	40°18'	16°04'	IX
Ascoli Satriano	41°12'	15°34'	VII
Atella	40°53'	15°39'	VIII
Atena Lucana	40°27'	15°33'	X
Auletta	40°34'	15°26'	IX
Avella	40°58'	14°36'	VII
Avellino	40°55'	14°47'	VI
Aversa	40°58'	14°12'	VI
Avigliano	40°44'	15°43'	VII
Balvano	40°39'	15°31'	VIII
Baragiano	40°41'	15°35'	VII
Bari	41°06'	16°51'	VI
Barile	40°57'	15°40'	VIII
Barletta	41°19'	16°17'	V-VI
Baronissi	40°45'	14°46'	VII
Bella	40°46'	15°32'	VII
Bernalda	40°24'	16°41'	VII
Binetto	41°01'	16°43'	IV
Bitetto	41°02'	16°45'	IV
Bitonto	41°06'	16°41'	IV
Boiano	41°29'	14°28'	VI-VII
Bosco	40°04'	15°27'	VI
Bovino	41°15'	15°20'	VII
Bracigliano	40°49'	14°43'	VII
Brienza	40°29'	15°38'	X
Brindisi	40°38'	15°57'	IV
Brindisi di Montagna	40°37'	15°56'	VI
Buccino	40°38'	15°23'	VIII
Caggiano	40°34'	15°29'	VIII
Cagnano Varano	41°50'	15°47'	V
Calabritto	40°47'	15°13'	VI
Calvello	40°29'	15°51'	X
Calvera	40°09'	16°09'	VIII
Campagna	40°40'	15°06'	VII
Campobasso	41°33'	14°40'	V
Campomaggiore	40°34'	16°04'	VII
Cancellara	40°44'	15°55'	VIII
Cannalonga	40°15'	15°18'	VII
Canosa	41°13'	16°04'	VIII
Capaccio	40°25'	15°05'	VI
Caposele	40°49'	15°13'	NF
Capri	40°33'	14°15'	IV-V
Capua	41°06'	14°13'	V
Carbone	40°08'	16°05'	IX
Carpinone	41°36'	14°20'	V
Casalbuono	40°13'	15°41'	VII
Casaletto Spartano	40°09'	15°37'	VI
Caselle in Pittari	40°10'	15°33'	VI
Caserta	41°04'	14°20'	V
Cassano delle Murge	40°53'	16°46'	VII
Castelcivita	40°30'	15°14'	VII
Castelgrande	40°47'	15°26'	VII
Castellabate	40°17'	14°57'	V
Castellammare	40°42'	14°29'	VI
Castellaneta	40°38'	16°56'	VI
Castelluccio Cosentino	40°35'	15°20'	VII
Castelluccio Inferiore	40°00'	15°59'	VII
Castelluccio Superiore	40°01'	15°59'	VII
Castelnuovo Cilento	40°13'	15°11'	V
Castel San Giorgio	40°47'	14°42'	VII
Castelsaraceno	40°10'	16°00'	VII
Castronuovo S. Andrea	40°11'	16°11'	VIII
Castrovillari	39°49'	16°12'	VI
Catanzaro	38°55'	16°35'	IV
Cava dei Tirreni	40°42'	14°42'	VI-VII
Celle di Bulgheria	40°06'	15°24'	VI-VII
Centola	40°04'	15°19'	VI-VII
Cerignola	41°16'	15°54'	VI-VII
Cersosimo	40°03'	16°21'	VI
Chiaramonte	40°07'	16°13'	VII
Cirigliano	40°23'	16°10'	VII
Cisterna di Latina	41°35'	12°50'	NF
Colobraro	40°11'	16°26'	VIII
Corbara	41°14'	13°58'	V
Corleto Monforte	40°26'	15°23'	VII
Corleto Perticara	40°23'	16°02'	IX
Cosenza	39°18'	16°15'	V
Craco	40°23'	16°26'	VIII
Deliceto	41°13'	15°23'	VII
Eboli	40°37'	15°03'	VII
Episcopia	40°04'	16°06'	VII
Fardella	40°07'	16°19'	VII
Ferrandina	40°30'	16°27'	VIII
Foggia	41°28'	15°33'	VI
Fondi	41°21'	13°26'	IV
Forenza	40°52'	15°51'	VI
Formia	41°16'	13°37'	IV-V
Francavilla in Sinni	40°05'	16°12'	VII
Gaeta	41°13'	13°34'	IV
Gallicchio	40°17'	16°08'	VIII
Genzano	40°51'	16°02'	VII
Ginosa	40°35'	16°45'	VII
Gioia del Colle	40°48'	16°55'	VI
Gorgoglione	40°24'	16°09'	VIII
Gragnano	40°41'	14°31'	VII
Grassano	40°38'	16°17'	VIII
Gravina di Puglia	40°49'	16°25'	VI-VII
Grottole	40°36'	16°23'	VII
Grumento Nova	40°17'	15°53'	XI
Grumo Appula	41°01'	16°42'	VI
Guardia Perticara	40°22'	16°06'	IX
Guglionisi	41°55'	14°55'	V
Irsina	40°45'	16°15'	VII
Itri	41°17'	13°32'	NF
Lagonegro	40°07'	15°46'	VII
L'Aquila	42°21'	13°24'	IV
Laterza	40°37'	16°48'	VI
Latronico	40°05'	16°01'	VIII
Laurenzana	40°28'	15°58'	IX
Lauria	40°03'	15°50'	VIII
Laurino	40°20'	15°20'	VII
Laurito	40°10'	15°24'	VI-VII
Lavello	41°03'	15°48'	VII
Laviano	40°47'	15°18'	VII
Lecce	40°21'	18°10'	V
Lesina	41°52'	15°21'	V
Licusati	40°03'	15°22'	VI-VII
Maddaloni	41°02'	14°23'	V
Maiori	40°39'	14°39'	VI
Manfredonia	41°37'	15°54'	V
Margherita di Savoia	41°22'	16°09'	VII
Maratea	40°00'	15°43'	VII
Marsico Nuovo	40°25'	15°44'	X
Marsico Vetere	40°23'	15°49'	IX
Maschito	40°55'	15°50'	VI
Matera	40°40'	16°36'	VII
Melfi	41°00'	15°39'	VII
Miglionico	40°34'	16°30'	VII
Minori	40°39'	14°38'	VI
Missanello	40°17'	16°10'	X
Moio della Civitella	40°15'	15°16'	VI
Molfetta	41°12'	16°36'	V
Moliterno	40°14'	15°52'	VIII
Monopoli	40°57'	17°18'	V
Montalbano	40°17'	16°34'	VI
Montano Antilia	40°10'	15°22'	VI
Montemilone	41°02'	15°58'	VII
Montemurro	40°18'	15°59'	XI
Monte San Giacomo	40°20'	15°33'	VII
Montesano sulla Marc.	40°17'	15°42'	VIII-IX
Monte S. Angelo	41°42'	15°58'	V
Montescaglioso	40°33'	16°40'	VII
Monticchio	40°57'	15°34'	VI
Muro Lucano	40°45'	15°29'	VII
Nocera Inferiore	40°45'	14°38'	VII
Nocera Superiore	40°45'	14°40'	VII
Noci	40°48'	17°07'	VI-VII
Noepoli (Noia)	40°05'	16°20'	VII
Nola	40°56'	14°32'	VI
Nova Siri (Bollita)	40°09'	16°32'	VII
Olevano sul Tusciano	40°39'	15°01'	VI-VII
Oliveto Citra	40°41'	15°14'	V
Oppido Lucano (Palnira)	40°46'	16°00'	VII
Orta Nova	41°20'	15°42'	VI
Ostuni	40°44'	17°35'	V
Ottati	40°28'	15°19'	VII
Ottaviano	40°51'	14°29'	VI
Otranto	40°09'	18°29'	V
Padula	40°20'	15°40'	IX
Paestum	40°25'	15°01'	VI
Pagani	40°45'	14°37'	VI
Palagiano	40°35'	17°02'	VI
Palazzo	40°56'	15°59'	VI-VII
Paola	39°22'	16°02'	V
Paterno	40°23'	15°44'	X
Pertosa	40°33'	15°27'	IX
Pescopagano	40°50'	15°24'	VI
Piaggine Lottane	40°21'	15°23'	VI
Picerno	40°38'	15°38'	IX
Piedimonte Matese	41°21'	14°22'	V-VI
Pietragalla	40°45'	15°53'	VI
Pietrapertosa	40°31'	16°04'	VII
Pignola	40°34'	15°47'	IX
Pimonte	40°59'	14°33'	VII
Pisciotta	40°06'	15°14'	VI
Pisticci	40°23'	16°33'	VII
Poderia	40°06'	15°23'	VI
Policastro	40°04'	15°31'	VI
Polignano a Mare	41°00'	17°13'	V
Polla	40°31'	15°30'	X
Pomarico	40°31'	16°33'	VII-VIII
Postiglione	40°33'	15°14'	VII
Potenza	40°38'	15°48'	VIII
Pozzuoli	40°49'	14°07'	V-VI
Priverno	41°28'	13°11'	IV-V
Rapolla	40°59'	15°40'	VI

Rapone	40°51'	15°30'	VII
Reggio Calabria	38°06'	15°39'	III-IV
Resina (Ercolano)	40°48'	14°21'	V-VI
Ricigliano	40°40'	15°29'	VII-VIII
Rionero in Vulture	40°55'	15°40'	VI
Ripacandida	40°55'	15°43'	VI
Rivello	40°05'	15°45'	VII
Roccanova	40°13'	16°12'	IX
Roscigno	40°42'	14°51'	VII-VIII
Rotonda	39°57'	16°02'	VI
Rotondella	40°10'	16°32'	VII
Ruoti	40°43'	15°41'	VIII
Ruvo del Monte	40°51'	15°32'	VII
Ruvo di Puglia	41°07'	16°29'	V
Sacco	40°23'	15°23'	VI
Sala Consilina	40°24'	15°36'	VIII
Salandra	40°32'	16°19'	IX
Salerno	40°41'	14°46'	VII
Salvitelle	40°35'	15°28'	VII
S. Chirico Nuovo	40°41'	16°05'	VII
S. Chirico Raparo	40°11'	16°05'	VIII
S. Fele	40°49'	15°32'	VI
S. Giovanni a Piro	40°03'	15°27'	VI
S. Giorgio Lucano	40°07'	16°23'	VII
S. Gregorio Magno	40°39'	15°24'	VIII
S. Martino d'Agri	40°14'	16°03'	IX
S. Mauro Cilento	40°14'	15°03'	VI-VII
S. Mauro Forte	40°29'	16°15'	VI
S. Michele di Serino	40°53'	14°51'	VII
S. Nicola Arcella	39°51'	15°48'	V-VI
S. Paolo Albanese (Casalnuovo)	40°02'	16°20'	VII
S. Pietro al Tanagro	40°27'	15°29'	VII-VIII
S. Rufo	40°26'	15°28'	VIII
Sant'Andrea di Conza	40°51'	15°22'	VII
Sant'Angelo le Fratte	40°33'	15°34'	X
Sant'Arcangelo	40°15'	16°16'	IX
Sant'Arsenio	40°28'	16°29'	VII-VIII
Sant'Elia Fiumefreddo	41°39'	13°32'	NF
Sant'Eramo in Colle	40°48'	16°45'	VI-VII
San Valentino Torio	40°48'	14°36'	VI-VII
Sanza	40°15'	15°33'	VI
Sarconi	40°15'	15°53'	X
Sassano	40°20'	15°34'	VII
Sasso	40°29'	15°41'	VIII
Satriano di Lucania (Pietrafesa)	40°33'	15°38'	VIII
Savoia di Lucania (Salvia)	40°34'	15°33'	VII
Scalea	39°49'	15°48'	V-VI
Senerchia	40°44'	15°42'	NF
Senise	40°09'	16°17'	VII
Serino	40°51'	14°52'	VII
Sermoneta	41°33'	12°59'	IV-V
Sessa Aurunca	41°14'	13°56'	V
Sezze	41°30'	13°04'	IV-V
Siano	40°48'	14°42'	VII
Sicignano degli Alb.	40°33'	15°19'	VIII
Sigliano	?	?	VII
Solofra	40°50'	14°51'	VII
Somma Vesuviana	40°52'	14°26'	V-VI
Sperlonga	41°15'	13°26'	V
Spinazzola	40°58'	16°05'	VII
Spinete	41°33'	14°29'	V
Spinoso	40°16'	15°58'	X
Stigliano	40°24'	16°14'	VIII
Taranto	40°28'	17°15'	VI
Teana	40°08'	16°09'	VI
Teggiano	40°23'	15°32'	VII
Terlizzi	41°08'	16°33'	IV-V
Termoli	42°00'	15°00'	V
Terragna	?	?	IV
Tito	40°35'	15°41'	X
Tolve	40°42'	16°01'	VIII
Torre Annunziata	40°45'	14°28'	VII
Torre del Greco	40°47'	14°22'	VI
Torre Orsaia	40°08'	15°28'	VI-VII
Tortora	39°56'	15°48'	VI
Tramonti	41°20'	14°10'	VI
Tramutola	40°19'	15°47'	X
Trani	41°17'	16°25'	V-VI
Trecchina	40°02'	15°47'	VII
Tricarico	40°37'	16°09'	VII
Trinitapoli	41°21'	16°05'	V
Trivigno	40°35'	15°59'	VIII
Tursi	40°15'	16°28'	VIII
Vaglio Basilicata	40°40'	15°55'	VIII
Vallo di Lucania	40°14'	15°16'	VII
Valva	40°44'	15°16'	VII
Valsinni (Favale)	40°10'	16°27'	VII
Velletri	41°41'	12°47'	NF
Venosa	40°58'	15°49'	VII
Vieste	41°53'	16°11'	V
Vietri di Potenza	40°36'	15°31'	VIII
Vietri sul Mare	40°40'	14°44'	VI
Viggianello	39°58'	16°05'	VII
Viggiano	40°20'	15°54'	X

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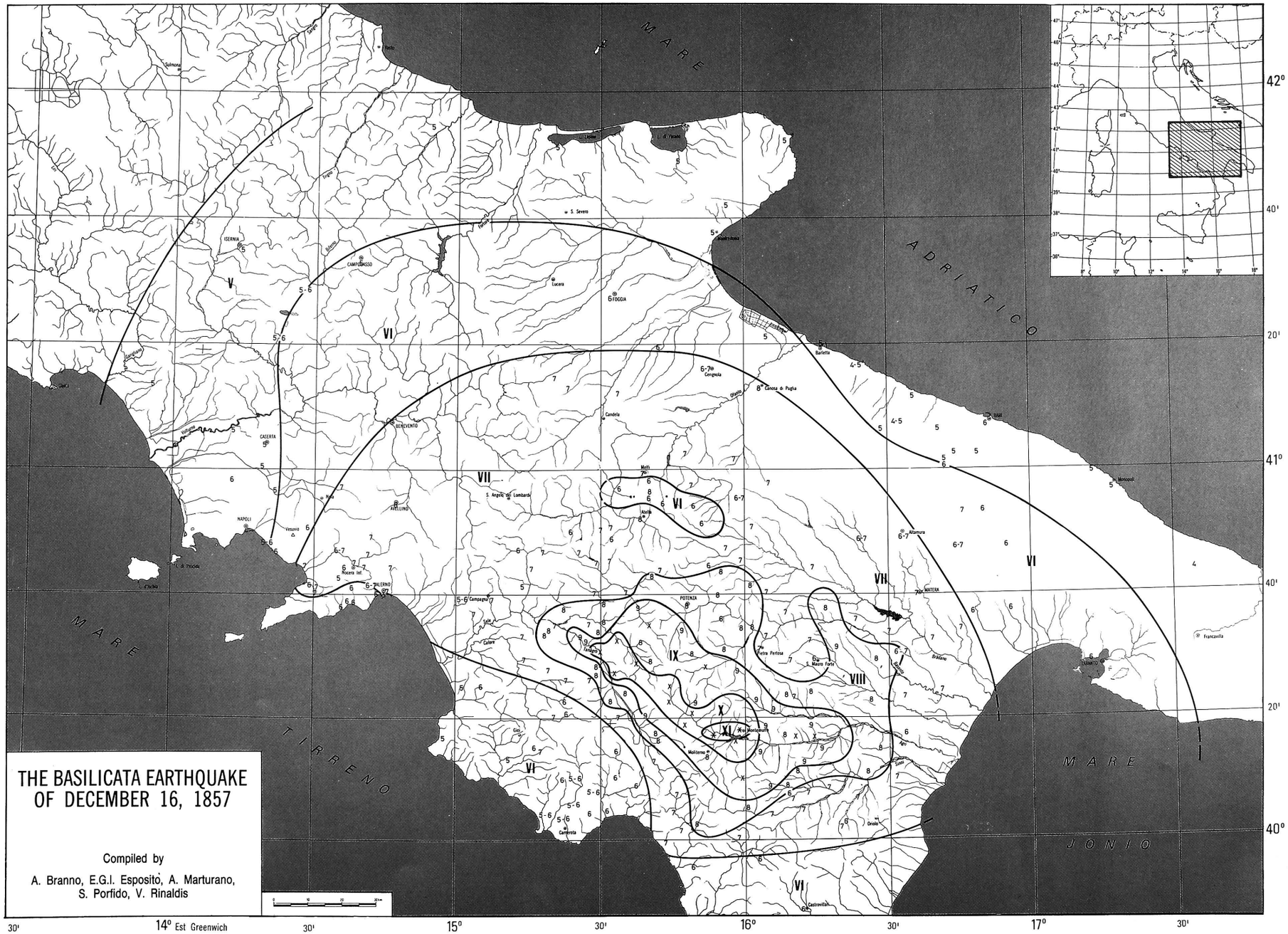

THE BASILICATA EARTHQUAKE OF DECEMBER 16, 1857

Compiled by

A. Branno, E.G.I. Esposito, A. Marturano, S. Porfido, V. Rinaldis

The drainage network of this map – scale 1:500.000 – is the same as the "Structural Model of Italy."

G.T.M - Via Marco Marulo 47a - 00143 ROMA

The Mangone earthquake of October 4, 1870.

A. Bottari, B. Federico, E. Lo Giudice, C. Pandolfo

The earthquake completely destroyed this small Calabrian town which is about 50 km SE of Cosenza. The earthquake hit also the centres of the Crati valley from Rogliano to Serra Pedace.
The mesoseismic area, (IX and X), including 8 towns, develops in a NS direction unlike the areas delimited by the other isoseismal lines which develop in a NE-SW direction, although there are some doubts due to the inadequacy of quoted points, especially in the eastern sector.
The IX area is especially developed on the eastern side of the high Crati valley where, as Conti refers, landslides and fissures are more evident along the Celico road and the crossroads which lead to Sila.
The external isoseismal line IX field shows a clear preferential propagation in a NE-SW (40° E) direction.
The direction of the greater diameter of VIII, and successive isoseismal lines, coincide with the line mentioned by Conti and Perrey «which joins Cellara-S. Stefano-Longobucco-Rossano», which makes up the axis of the 55 km-wide band where the same authors found the greatest damage. We believe this note to be unjustified considering the points of the graph built up by the data provided by the same authors. In fact, while we have information concerning the inhabited areas NW of this line, we have no data concerning the SE area. The preferential propagation already discovered seems probable, especially in the SW direction (seen on the map up to Messina) and characterized by a ratio of the isoseismal line: semiaxis equal to 2:1.
Unfortunately the lack of points quoted outside the mesoseismic area limits a satisfactory characterization of the macroseismic field and discourages a more detailed interpretation of the earthquake.
We have found the following parameters:
— macroseismic epicentre: 38°18'N; 16°18'E
— epicentral locality: Mangone (39°12'N; 16°20'E)
— epicentral intensity: X
— hypocentral normal depth: (12.9 ± 0.9) km
— origin time: 16^h55^m (October 4, 1870)
— spread coefficient: 6.6 ± 0.4

Assuming the baricentre of the IX area (2 km N of Mangone) as epicentre, we obtain for the calculation of the local depth h_2 the value $h_L = 2.0$ km. The epicentre E_N, to be referred to the normal hypocentre ($h_N = 12.9$ km), has 39° 17' N; 16° 25' E coordinates and can be assimilated to the baricentre of the isoseismal areas outside the IX; it is 10 km far from E_L along the mentioned Mangone-Longobucco axis.
We finally report in the table the elements which characterize the geometry of the isoseismal lines, i.e. the maximum (r_{max}) and minimum (r_{min}) radii which refer to the epicentre. E_L is the first isoseismal line (IX) and E_N the others.
This research has been carried out using the sources in the bibliography, except those from «La verità di Monteleone» which we did not have access to.

List of shocked localities:

Locality	Latit.	Long.	I (MCS)
Amantea	39°08'	16°05'	VII-VIII
Aprigliano	39°14'	16°20'	IX
Bisignano	39°31'	16°17'	VI-VII
Castrolibero	39°18'	16°12'	VII
Catanzaro	38°55'	16°35'	V
Celico	39°19'	16°20'	IX
Cellara	39°13'	16°20'	IX
Corigliano Calabro	39°36'	16°31'	VII-VIII
Cosenza	39°18'	16°15'	VIII
Figline Vegliaturo	39°13'	16°20'	IX
Fuscaldo	39°25'	16°02'	V
Guardia Piemontese	39°28'	16°00'	V
Lagonegro	40°07'	15°46'	NF
Longobardi	39°13'	16°04'	V-VI
Longobucco	39°27'	16°37'	VIII-IX
Mangone	39°12'	16°20'	X
Messina	38°11'	15°33'	III-IV
Montalto Uffugo	39°24'	16°09'	VI
Monterosso Calabro	38°43'	16°17'	IV-V
Motta (Domanico)	39°13'	16°13'	VIII
Napoli	40°51'	14°16'	≤ III
Palermo	38°07'	13°21'	III-IV
Palmi	38°21'	15°51'	III-IV
Paola	39°22'	16°02'	V
Piane Crati	39°14'	16°20'	IX
Pietrafitta	39°16'	16°20'	VIII
Pizzo	38°44'	16°10'	V
Reggio Calabria	38°06'	15°39'	III-IV
Rogliano	39°11'	16°19'	≤ VIII
Roseto Capo Spulico	39°59'	16°36'	≤ IV
Rossano	39°34'	16°38'	≥ VII
Rovella	39°18'	16°17'	VIII
S. Pietro	39°24'	16°02'	V
S. Sosti	39°40'	16°02'	≥ IV
S. Domenica	38°40'	15°52'	IV
S. Stefano di Rogliano	39°12'	16°19'	IX
Scalea	39°49'	15°48'	≥ IV
Serra Pedace	39°17'	16°21'	IX
Squillace	38°47'	16°31'	≤ V
Tropea	38°40'	15°54'	III-IV
Vibo Valentia	38°40'	16°06'	IV
Zumpano	39°19'	16°17'	VIII

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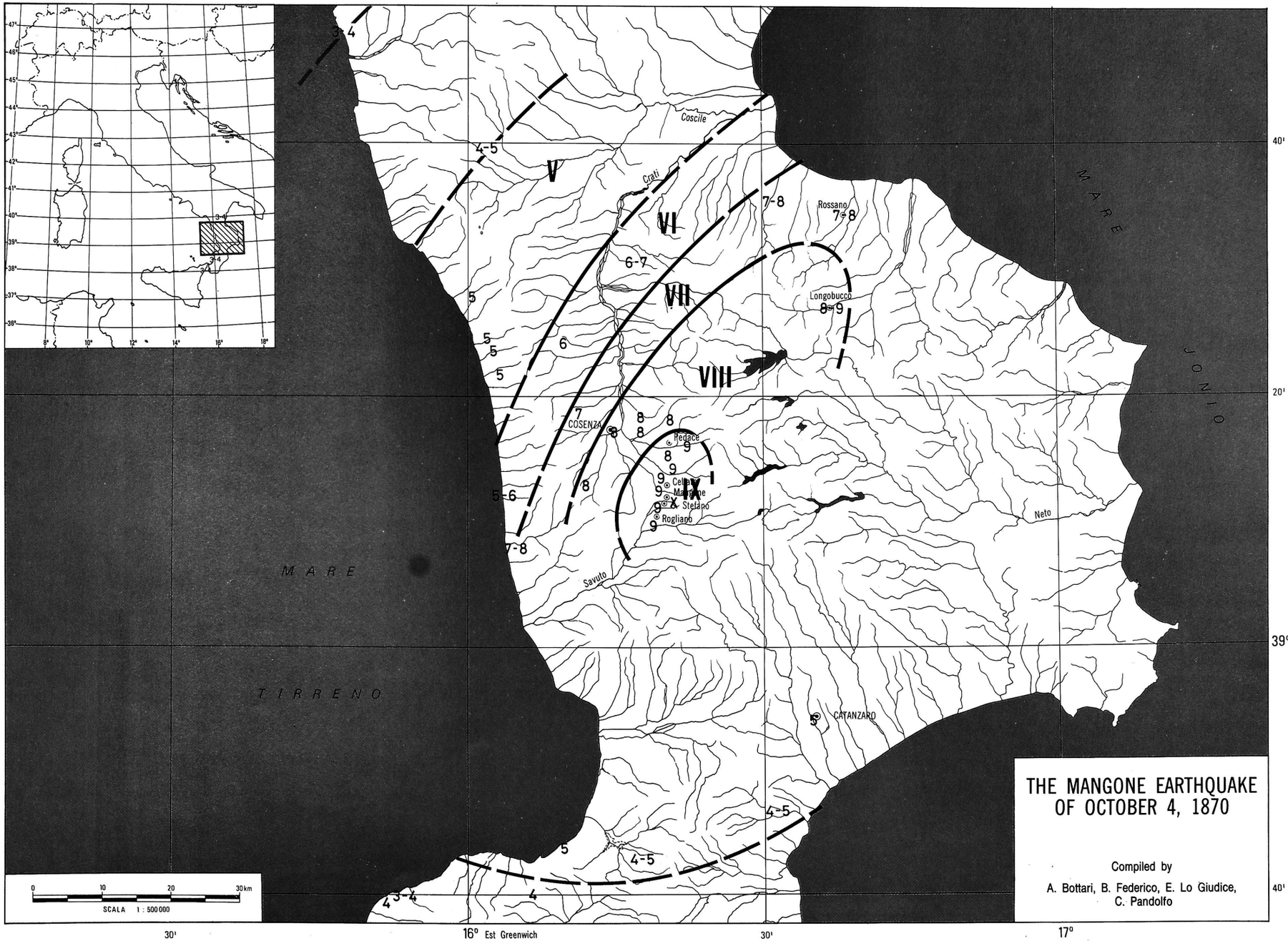

The drainage network of this map – scale 1:500.000 – is the same as the "Structural Model of Italy."

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The Alpago earthquake of June 29, 1873.

F. Gentile, M. Poropat, G. Renner, A.M. Riggio, D. Slejko

On 29 June, 1873 at 03:55 GMT a strong earthquake shook the region of Alpago, east of Belluno. The shock was felt in a large area from Rome to Augsburg and from Rijeka to Torino (1, 2, 3, 4). The most severe damages occured in Alpago and in the valley of the River Piave, in the town of Belluno, and in the plain of the River Meschio, where the town of Vittorio Veneto is located (3). Thirty-two villages in Alpago and twenty in the Treviso area were destroyed (5, 6).

A considerable amount of general literature is available for this earthquake and many detailed studies were performed (3, 7, 8, 9, 10). The goal of these works is the explanation of the «earthquake» phenomenon; consequently a detailed geological description of the affected area is usually given together with the sequence of the possible foreshocks and aftershocks (e.g. 3, 8). In the present work, newspapers were examined as well: the reported news can generally be considered an acceptable description of the damages suffered both by people and buildings. It is necessary to investigate a period many days after the shock because early news reports are often strongly influenced sometimes exaggerated by emotional impressions. In some cases the popularized news was consciously distorted with political or economical purposes.

Puos, Cornei, Farra, Spert, Borsoi, Chies, Lamosano, Funes, Pedol, Montanes, Alpaos, Curago, Plois, Pieve, Torres and Quers in the Alpago area, Soccher, Arsié, Ponte nelle Alpi and Visome in the Piave valley, and Ranè and Gava di Montaner in the Meschio valley collapsed (3, 4, 11).

In the opinion of Fiorentini (7), Fadalto should be considered the epicentre of the shock. In this village almost all the houses were razed to the ground.

Valdenogher, Tambre, Tambruz, Lavina, Irrighe, Codenzan, Villa, Schiucaz and Sidran in Alpago, Santa Croce and Capodiponte near Alpago, and Cappella, Sarmede, Osigo, Villa di Villa and Colle Umberto in the Treviso area were damaged in different ways. Two-thirds of the houses of Belluno were destroyed or severely damaged, and one-third of the buildings of Vittorio Veneto was ruined, while the remainder received heavy damages (1, 4, 12, 13, 14, 15). Close to the ruins of the cathedral and the central zone of Belluno were some undamaged districts. In Vittorio Veneto the tower of the cathedral was broken and the St. Giorgio church had to be demolished (7). At Fadalto and Visome many walls were ruined and the churches of all the villages in the epicentral area were severely stricken (16, 17). The bell-tower of the destroyed church of Arsiè was broken in four parts: the first fixed to the ground, the second shifted, the third rotated and the forth fallen on the ground.

In some cases, descriptions of damages for different districts of the same village are available (3, 12, 16). Usually, they are located in the epicentral area (Cornei, Plois and Torres with macroseismic intensity IX-X MCS); or around it (Canevoi, Irrighe and Lastreghe with intensity VII MCS). This kind of data has been taken into account in the global valuation.

We must also notice that sometimes in the same place different damages are reported: both Tambre and Tambruz, for example, were only slinghtly hurt in their upper parts while their lower parts, needed strengthening to buildings to stand on (4). Cugnan, Roncan, Losego, Quantin, Cadola and Nogarè suffered damages less serious than those in the neighbouring villages (4, 12, 14). No heavy damages were reported for the Treviso plain or for Friuli. Only Stevenà, Sarone, Montereale, Maniago, Fanna and Cavasso Nuovo (all placed at the beginning of the Prealpi) suffered cracks in buildings. At Pieve di Cadore, a few kilometers north of the epicentral zone, the quake was only slightly felt (3). This peculiar behaviour of the Alpago area was noticed soon after the seismic event (3).

In the field around Lavina cracks 20 cm wide appeared, though the inn of Borsoi was not seriously hit. Many border walls of the fields in the epicentral zone had their positions completely changed. In the Campitello square of Belluno a crack 60 metres long and 15-20 cm wide was observed after the shocks of 29 June (3). Some landslides occured near Funes and near the Lapisini lakes, and a slow movement in Mount Messer caused a displacement of 22 metres in the main road.

Some strange phenomena are also reported: the level of the lake of Santa Croce increased one Austrian foot before and during the earthquake and a fountain of dirty water sprung near Poiatte. A pond appeared near Farra, in the province of Venezia: some springs emitted hot water that destroyed plants all around and the ground sank about 5 metres (18).

The newspaper of Belluno (12) wrote on 30 June: «The town has not resumed its usual behaviour. People are shaken by frequent aftershocks, by the view of the damages, but principally by their excited fantasy». But on 2 July the same newspaper said: «There are scores of dead and injured, the material damage is estimated in millions of Italian lire ... a few waves more, and Belluno and its province would be only ruins».

Thirty persons died in Alpago, fifty in the Treviso area and four in Belluno. It is important to note that in Alpago (8,885 inhabitants at that time (4)) most of the houses were old, previously damaged, badly constructed and had heavy covers of stone of the roof against the wind. To support this weight, the columns were backed with wooden poles. Many of the house walls were destroyed with a low number of losses of human lives; most likely this was due to the resistance of the backed columns during the earthquake when people were sleeping. Churches were also poorly maintained. Since 29 June was the Catholic holiday of SS. Peter and Paul, there were many casualties during the ceremony: 42 in the church of San Pietro di Feletto (7, 18) and few in the chapels of Alpago where the only priest of the villages celebrated later in the morning the ceremony (3). The collapse of churches caused the death of worshippers except for one boy (4).

The eartquake was extremely strong at Agordo, Treviso, Venezia, S. Vito. Udine. Spilimbergo, Trieste, Verona, Nave, Salò and Rovereto; it was very strong at Tolmezzo, Cividale, Pordenone, Palmanova, Trento and Vicenza; it was strong at Ljubljana, Padova, Rovigo, Mantova, Brescia and in the Collio area; it was mediocre at Ferrara, Chiari, Lodi, Milano, Bergamo and Como; slight at Pola, Ancona, Rimini, Forlì, Bologna, Parma, Borgotaro, Sarzana, Piacenza, Voghera, Genova, Biella and Torino; and very slight at Camerino, Perugia, Livorno and Firenze (1, 19, 20, 21).

Remarkable seismic activity occured in Northern Italy during June 1873: one shock was felt at Tolmezzo and in the Fella valley and some slight quakes were noted at Piacenza and Cenobbio. During the night before the strong earthquake, were felt in the provinces of Trento and Treviso. Aftershocks of the Alpago earthquake, some slight shocks were felt in the provinces of Trento and Treviso. Aftershocks of the Alpago earthquake were felt in the epicentral area for about one year, including every day during July and August. After a decrease of the activity in September, October and November, shocks became frequent once more in December, and on Christmas Day, an earthquake with intensity similar to that of 29 June occured (8).

List of shocked localities:

Locality	Latit.	Long.	I (MCS)
Agordo	46°17'	12°02'	VI
Ala	45°45'	11°00'	IV
Ancona	43°36'	13°30'	III
Andreis	46°12'	12°37'	VI-VII
Arsié	46°10'	12°20'	VIII-IX
Ausburg	?	?	VI
Auservillgratten	?	?	VI
Aviano	46°04'	12°35'	VII
Barcis	46°11'	12°34'	VII-VIII
Battaglia	?	?	VII
Belluno	46°09'	12°13'	VIII-IX
Bergamo	45°42'	09°40'	IV
Biella	45°34'	08°03'	III
Bologna	44°30'	11°20'	V
Bolzano	46°30'	11°21'	V
Borgo di Valsugana	45°55'	12°26'	IV
Borgotaro	44°29'	09°46'	IV
Borsoi	46°09'	12°25'	X
Brescia	45°33'	10°13'	IV-V
Brunico	46°48'	11°56'	VII
Cadola	46°10'	12°18'	VI
Caldaro	46°25'	11°14'	II
Camerino	43°08'	13°04'	VII
Canevoi	46°10'	12°18'	VII-VIII
Capodiponte	?	?	VII
Cappella	45°58'	12°22'	V
Casarsa	45°57'	12°51'	VII-VIII
Castion	46°07'	12°14'	VII
Cavasso Nuovo	46°12'	12°46'	IV
Chiari	45°32'	09°53'	IX
Chies	46°10'	12°24'	VII-VIII
Cimolais	46°17'	12°26'	IV
Cittanova	44°39'	10°51'	VI
Civezzano	46°05'	11°11'	V
Cividale	46°06'	13°26'	VII-VIII
Claut	46°16'	12°31'	VI
Cles	46°22'	11°02'	VII-VIII
Codenzano	46°09'	12°23'	V
Codroipo	45°58'	12°59'	V-VI
Colle Santa Lucia	46°27'	12°01'	IV-V
Collio	45°49'	10°20'	IV
Como	45°49'	09°05'	VII
Conegliano	45°53'	12°18'	VII
Cordignano	45°57'	12°25'	VII
Cortina d'Ampezzo	46°32'	12°08'	VI
Cordovado	45°51'	12°53'	V
Cugnan	46°09'	12°17'	VII
Curago	46°11'	12°22'	X
Cusighe	46°10'	12°13'	VII-VIII
Denno	46°16'	11°03'	V-VI
Fadalto	46°04'	12°20'	IX
Fanna	46°11'	12°45'	VII
Farra d'Alpago	46°07'	12°21'	VIII
Feletto	?	?	VIII
Feltre	46°01'	11°54'	VII
Ferrara	44°50'	11°37'	IV
Firenze	43°47'	11°15'	III
Fiume	45°20'	14°20'	IV
Forlì	44°13'	12°03'	III
Formegano	46°05'	12°02'	VI-VII
Fregona	46°00'	12°20'	VII
Funes	46°11'	12°24'	X
Garna	46°09'	12°22'	VIII
Gorizia	45°57'	13°37'	VI
Gussago	45°35'	10°09'	IV-V
Innsbruck	47°33'	11°24'	V
Irrighe	46°10'	12°24'	VII
Iseo	45°40'	10°03'	IV-V
Karlstadt	49°58'	09°46'	IV
Klagenfurt	46°37'	14°20'	III-IV
Krapina	46°10'	15°53'	IV
Lamosano	46°10'	12°23'	X
Lavina	46°09'	12°25'	VIII-IX
Livorno	43°33'	10°19'	III
Lodi	45°19'	09°30'	IV
Longarone	46°16'	12°18'	VI-VII
Losego	46°09'	12°17'	VII
Lubiana	46°03'	14°30'	V
Lucerna	47°03'	08°16'	V
Malé	46°21'	10°55'	VI
Malles-wen (Malz)	46°41'	10°33'	V
Maniago	46°10'	12°42'	VII
Mantova	45°09'	10°46'	IV-V
Martello (Martell)	46°34'	10°47'	V
Merano	46°40'	11°10'	V
Milano	45°28'	09°11'	V
Modena	44°39'	10°56'	V
Monaco di Baviera	48°10'	11°32'	V-VI
Montaner	46°00'	12°23'	VIII
Montanes	?	?	X
Montereale	46°09'	12°39'	VII
Monte Serva	?	?	IV
Mortegliano	45°57'	13°10'	VI
Nave	46°04'	12°04'	VI
Nauders	46°47'	11°42'	V
Nogaré	45°49'	12°01'	VII
Nova Levante	46°26'	11°32'	V
Obladis	47°05'	10°38'	III
Ortisei	46°34'	11°40'	V
Padova	45°24'	11°53'	V-VI
Palmanova	45°54'	13°19'	V-VI
Parma	44°48'	10°20'	IV
Pedecastello	46°08'	12°14'	VIII
Perugia	43°06'	12°23'	II-III
Piacenza	45°03'	09°42'	IV
Pieve d'Alpago	46°10'	12°21'	IX-X
Pieve di Cadore	46°26'	12°22'	III
Pisino (= Pazin)	45°15'	13°57'	V
Pola	44°52'	13°51'	IV
Polcenigo	46°02'	12°30'	VII
Polpet	46°11'	12°17'	VII-VIII
Ponte nelle Alpi	46°11'	12°17'	VIII
Porcia	45°58'	12°37'	VI-VII
Pordenone	45°58'	12°40'	V-VI
Primiero	46°11'	11°50'	VI
Puos d'Alpago	46°08'	12°22'	IX
Quantin	46°07'	12°18'	VII
Rimini	44°04'	12°34'	III-IV
Riva	45°53'	10°51'	VI
Roe Basse	46°08'	12°07'	VI-VII
Roma	41°54'	12°29'	IV
Roncan	46°09'	12°18'	VII
Rovato	45°34'	10°00'	IV-V
Rovereto	45°53'	11°02'	VI
Rovigo	45°04'	11°47'	V-VI
Salisburgo	47°48'	13°01'	IV
Salò	45°36'	10°31'	VI
Santa Croce	46°05'	12°20'	VIII
San Giovanni di Polcenigo	46°01'	12°31'	VII
Santa Giustina	46°05'	12°03'	VI-VII
San Gregorio	46°06'	12°02'	VI-VII
San Pietro di Feletto	?	?	VII-VIII
Sacile	45°57'	12°30'	VI-VII
Sarmede	45°59'	12°23'	VIII
Sarone	46°00'	12°28'	VIII
Sedico	46°06'	12°06'	VII
Sequals	46°10'	12°50'	VII
Sesto al Reghena	45°51'	12°49'	V
Sillian	?	?	IV-V
Soccher	46°11'	12°19'	IX
Spert	46°07'	12°24'	VIII
Spilimbergo	46°07'	12°54'	VI
Stevenà	45°58'	12°27'	VII
Tambre	46°08'	12°25'	IX
Tambruz	46°08'	12°26'	IX
Tenna	46°01'	11°16'	VI
Terlan (Terlano)	46°32'	11°15'	V-VI
Terres	46°19'	11°01'	V-VI
Tignes	46°09'	12°21'	IX
Tolmezzo	46°24'	13°01'	V
Torino	45°04'	07°40'	III
Trento	46°04'	11°07'	VI
Trieste	45°39'	13°47'	VI
Treviso	45°40'	12°15'	VI
Tres	46°19'	11°06'	VI
Udine	46°04'	13°14'	VI
Urbino	43°44'	12°38'	III
Val di Nogher	?	?	IX
Venezia	45°26'	12°20'	VI
Veroa	45°26'	11°00'	VI
Vicenza	45°33'	11°33'	VI
Villa di Villa	45°58'	12°23'	VIII

Vilpian	46°33'	11°13'	V-VI
Visome	46°07'	12°12'	X
Vittorio Veneto	45°59'	12°18'	VIII
Voghera	45°00'	09°01'	III
Ziracco	46°07'	13°20'	V

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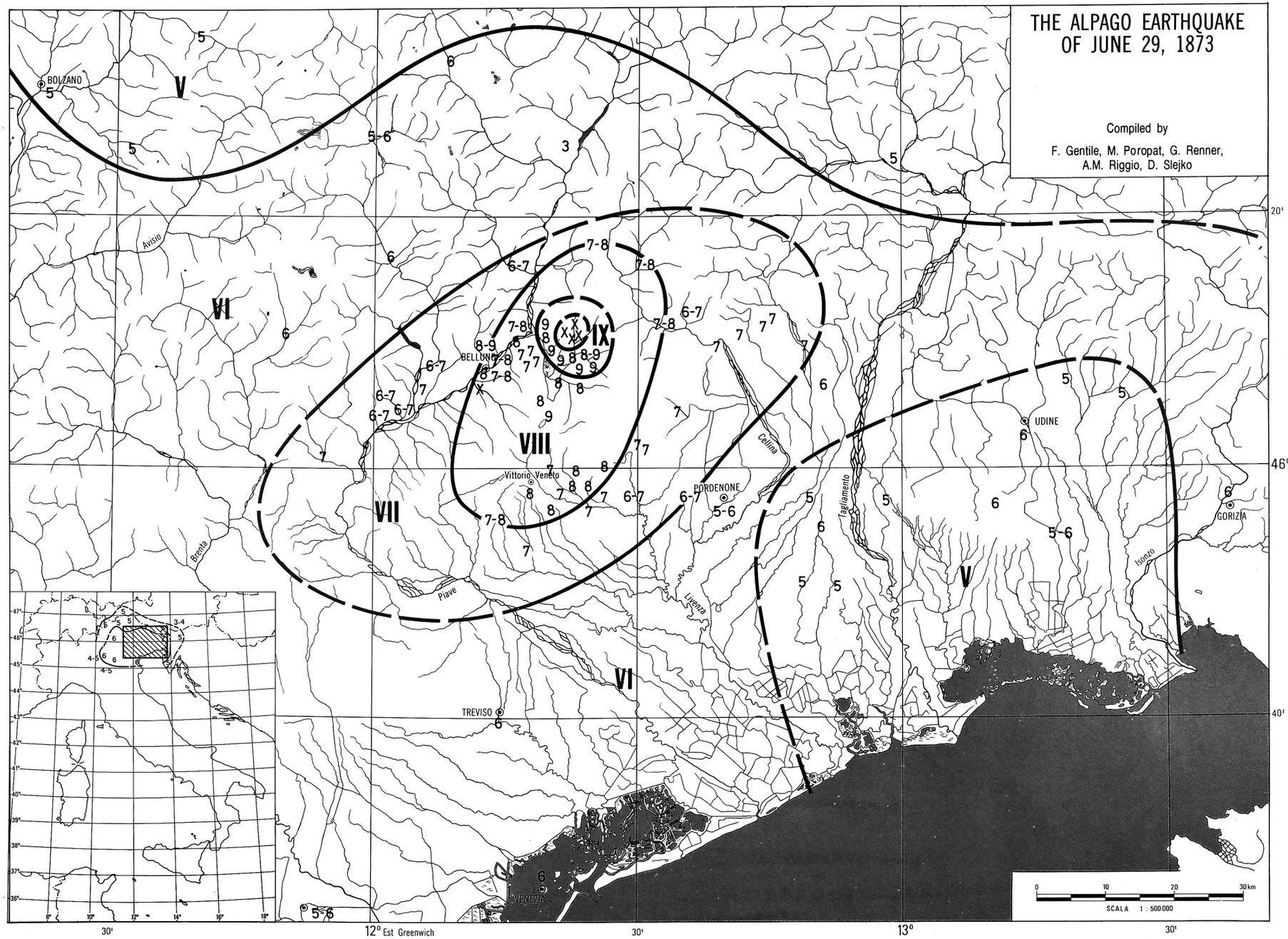

The drainage network of this map – scale 1:500.000 – is the same as the "Structural Model of Italy."

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The Rimini earthquake of March 17, 1875.

G. Ferrari, D. Postpischl

On March 17, 1875, the territory of Rimini was hit by a strong earthquake, which the catalogues classify with an epicentral intensity of VIII degree MCS.

Unlike the Rimini earthquakes occurring on April 14, 1672 and December 12, 1876 (described in this issue), this earthquake was not included in the revision program of earthquakes by the Progetto Finalizzato Geodinamica. The rich scientific documentation available has motivated the reconstruction of the effects of this earthquake for a better understanding of the seismic response characteristics of the area.

Alessandro Serpieri, the well-known Italian seismologist of the last century, left us a very rich description of the effects of this earthquake as well as others; interesting comparisons with other Riminese earthquakes; and interpretative hints about the origin of earthquakes in this particular area at the border of the Padana Plain in its intersection with the Apennine range.

As he had already done for the March 12, 1873 earthquake (Io = VIII Camerino), Serpieri organized the gathering of information through correspondence with observers and both Italian and foreign meteorologic stations (principally on the Dalmatian coast), thus anticipating and perhaps suggesting the use of the macroseismic questionnaire in Italy. The letters he sent principally requested information concerning the date and the hour the shock was felt, the prevailing direction of the oscillation and the force of the earthquake in the place of observation; he asked for useful information in order to determine the reliability of the hour of the shock.

Out of the total 101 localities in which Serpieri gathered information, 21 were provided with seismometers. Fortunately, their registration could be found.

Serpieri organized the gathered data into two different forms, one condensed and the other unabridged, published at different times. The unabridged version contains the communications received from the observers for each locality, while the condensed version is represented by a scheme in which, for every locality, the following characteristics appear: hour of the «first» shock; directions of the shocks referred to as first and second; type of movement (undulatory or subsultory, based on what was used in that epoch); the pause between two successive phases; total duration of shock; force expressed in units on the De Rossi macroseismic scale; and the occurrence of an occasional roar before or during the earthquake.

Finally, the condensed scheme is accompanied by reproductions of some instrumental registrations of this earthquake taken in Florence, Bologna, Forlì, Perugia and Urbino.

The descriptions of the earthquake rich in homogeneous information, which is often regularly verified and accompanied by evaluations regardings reliability, have proved sufficient for the attribution of values of intensity to each locality, and have not motivated additional investigation for the present time.

The classification of the effects of this earthquake according to the MCS scale has moreover offered us the possibility of a further comparison between this scale and the De Rossi scale (used by Serpieri), leading to a confirmation of the relation existing between the two scales, as investigated previously by the authors.

On Wednesday, March 17, 1875, the main shock caused the clock at the Rimini railroad station to stop between 11:53 and 11:54 p.m.

Rimini, Cesenatico, Pesaro, Cervia and San Marino were the localities hardest hit by this earthquake.

In Rimini, major damage was done to constructions having wooden garrets with beams oriented approximately in the NE-SW direction, while very slight damage occurred when the beams were oriented in the opposite direction.

Numerous observations regarding the damage done to individual buildings, as well as testimony gathered of the action of objects inside and outside the houses, had led Serpieri to conclude that in Rimini the prevailing direction of oscillation was first NE-SW and then NW-SE, although, as it has already been said, major damage is ascribed to the former movement.

In approximately one-third of the localities, especially in the areas that suffered destructive effects, the shocks were preceded, or in many case accompanied, by roars. In numerous cases strange, luminous phenomena were observed, which Serpieri hypothesized were due to electrical phenomena consequent to the effects of the earthquake.

Changes in the psycho-physical state of people and in the normal behavior of domestic animals also occurred. Testimonies report that dogs, cats and horses became excited a few seconds before the main shock.

Numerous fishermen, who were in their boats at sea between Rimini and Cervia, felt the shock, and some noticed the formation of waves. This last phenomenon was also observed from the beach: one fisherman in particular «first heard the roar and after this he felt a slight shock, noticing that, at the same time, the sea went from low to high tide».

Fissures in the soil were noticed in Cervia: «...along the road from Cervia to Cesenatico, for approximately one kilometer, one can still see a fissure that, in certain points, is up to 15 cm. wide». In Cesenatico there was «... a fissure in the ground of the square, with a length of a few meters, ... parallel to the canal...».

The distribution of the effects of this earthquake is shown in terms of MCS intensity on the enclosed map.

The trend of the isoseismal areas proposes again the principal elements of propagation observed for the April 14, 1672 earthquake and in part for the one that occurred on December 25, 1786 (both in this issue), such as the NW-SE lengthening and the marked attenuation to the NE-SW direction.

The depth, calculated with the Blake formula, is about 13 km, which contrasts clearly with the evaluation of 40 km that appears in the ENEL Catalogue.

The macroseismic equivalent of magnitude, calculated by application of the Galanopoulos formula to an estimate of the felt area is ME = 5.9: this value agrees with the evaluation of MP in the ENEL Catalogue, while it considerably deviates from the value MP = 5.2, calculated with the Karnik formula.

The following is a comparison of the values of some parameters, reported respectively in the ENEL and Carozzo et al. Catalogues, and in this study.

Year	Mo	Da	Ho	Mi	Lat	Long	De	I	Me	Mk	Mp	Epic. area
1875	03	17	23	51	44°12'	12°24'	40	VIII		5.2	5.9	Alto Adriatico
1875	03	17	23	51	44°12'	12°24'		VIII		5.7		
1875	03	17	23	51	44°10'	12°30'	13	VIII	5.9	5.2		Alto Adriatico

List of shocked localities:

Locality	Latit.	Long.	I (MCS)
Acqualagna	43°37'	12°40'	IV
Alfonsine	44°30'	12°03'	IV
Amandola	42°59'	13°21'	IV
Ancona	43°36'	13°30'	V
Ascoli Piceno	42°51'	13°35'	III
Bagnacavallo	44°25'	11°59'	IV
Bagno di Romagna	43°50'	11°58'	IV
Belluno	46°09'	12°13'	II
Bibbiena	43°42'	11°49'	IV-V
Bologna	44°30'	11°20'	III-IV
Brisighella	44°13'	11°47'	IV
Cagli	43°33'	12°39'	V
Camaiore	43°56'	10°18'	II
Camerino	43°08'	13°04'	IV-V
Castelbolognese	44°19'	11°48'	VI
Castiglione	44°16'	12°15'	VII
Cervia	44°16'	12°21'	VII
Cesena	44°08'	12°15'	VI-VII
Cesenatico	44°12'	12°24'	VIII
Chieti	43°21'	14°10'	II
Chioggia	45°13'	12°17'	IV
Cingoli	43°22'	13°13'	IV
Città di Castello	43°27'	12°14'	II
Empoli	43°43'	10°57'	II
Fabriano	43°20'	12°54'	V
Faenza	44°17'	11°53'	V-VI
Fano	43°50'	13°01'	VI
Fermo	43°10'	13°43'	IV-V
Ferrara	44°50'	11°37'	V-VI
Firenze	43°57'	11°15'	III
Fognano	?	?	II
Forlì	44°13'	12°03'	VI
Frascati	41°48'	12°41'	I
Fusignano	44°28'	11°58'	III
Jesi	43°31'	13°15'	V
L'aquila	42°21'	13°24'	II
Lugo	44°25'	11°55'	IV
Lussin	44°32'	14°27'	IV
Macerata	43°18'	13°27'	VI
Mantova	45°09'	10°46'	IV
Massa Lombarda	44°27'	11°50'	V
Meldola	44°08'	12°04'	V-VI
Mezzano Glorie	44°28'	12°05'	V-VI
Milano	45°28'	09°11'	I
Modigliana	44°09'	11°48'	V
Moncalieri	45°00'	07°42'	I
Mondaino	43°51'	12°40'	V
Montignoso	?	?	II
Montughi	?	?	IV
Napoli	40°51'	14°16'	I
Padova	45°24'	11°53'	V
Parma	44°48'	10°20'	IV-V
Pavia	45°11'	09°10'	II
Pennabilli	43°49'	12°16'	III-IV
Penne	42°27'	13°56'	II
Perugia	43°06'	12°23'	IV-V
Pesaro	43°54'	12°54'	VI-VII
Pola	44°52'	13°52'	IV
Pontetetto	?	?	IV
Pordenone	44°58'	12°40'	III
Porretta T.	44°09'	10°59'	II-III
Portico	44°02'	11°47'	IV
Porto San Giorgio	43°11'	13°48'	III
Ravenna	44°25'	12°12'	VI
Rijeka	45°20'	14°26'	II
Rimini	44°04'	12°34'	VIII
Ripatransone	43°00'	13°46'	IV-V
Rocca S. Casciano	44°04'	11°51'	IV-V
Roma	41°54'	12°29'	I
Rovigno	45°05'	13°38'	III
Russi	44°22'	12°02'	V
San Marino	43°56'	12°28'	VI-VII
Sant'Angelo in Vado	43°40'	12°25'	VI
Santa Sofia	43°57'	11°55'	IV
San Ginesio	43°06'	13°19'	IV
San Godenzo	43°56'	11°37'	III-IV
San Severino	43°14'	13°11'	III-IV
Schio	45°43'	11°21'	I
Senigallia	43°43'	13°13'	V
Serrungarina	43°45'	12°53'	IV
Siena	43°19'	11°20'	II-III
Sienne	?	?	V
Sinalunga	43°13'	11°44'	IV
Spoleto	42°44'	12°44'	IV
Trento	46°04'	11°07'	IV
Treviso	45°40'	12°15'	IV
Trieste	45°39'	13°47'	II-III
Udine	46°04'	13°14'	II-III
Umbertide	43°18'	12°20'	II
Urbino	43°44'	12°38'	V-VI
Velletri	41°41'	12°47'	II
Venezia	45°26'	12°20'	III-IV
Verona	45°26'	11°00'	NF
Vicenza	45°33'	11°33'	IV
Villafranca	44°50'	11°04'	NF
Volterra	43°24'	10°52'	II
Zara	44°07'	15°14'	II

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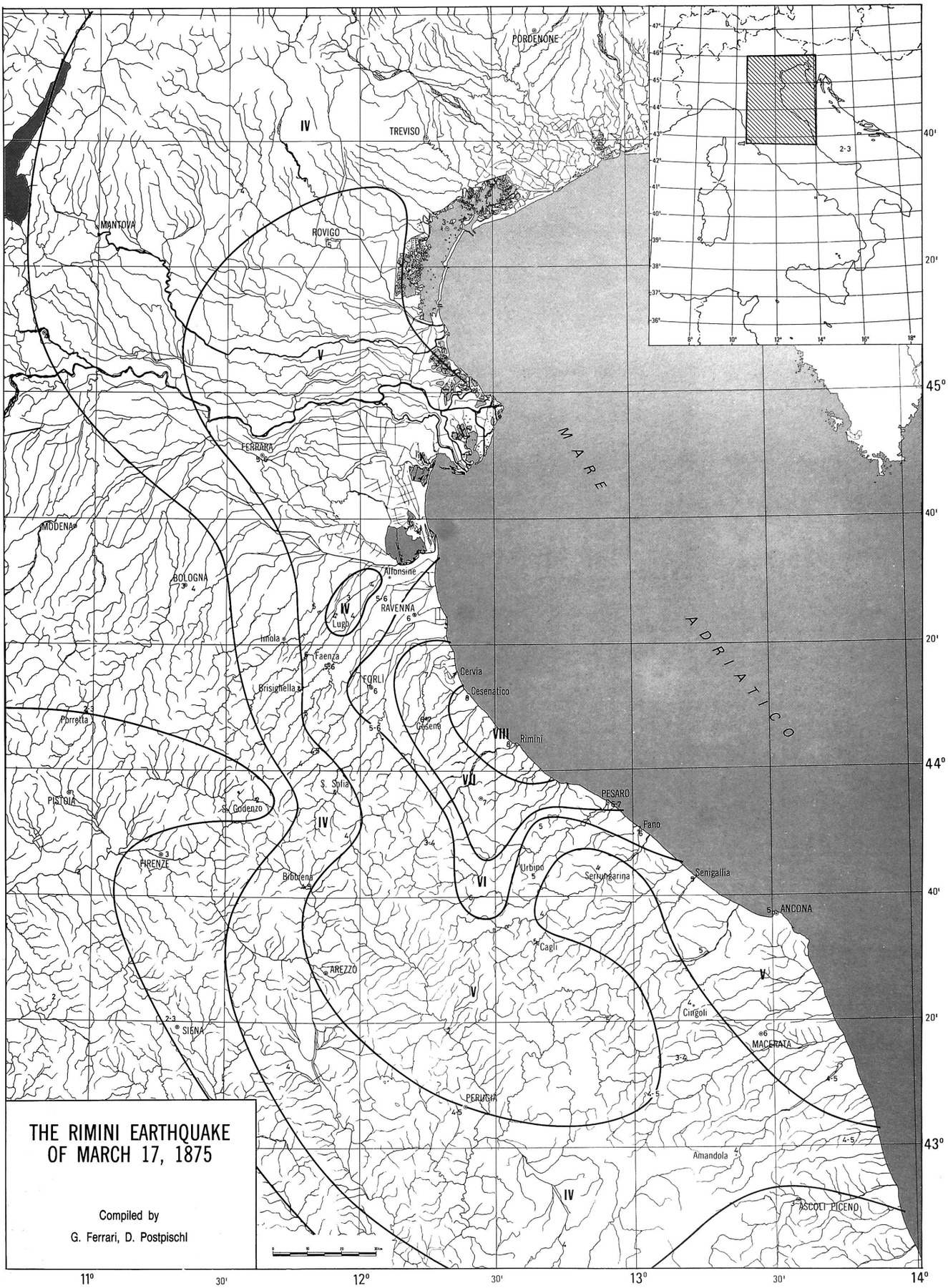

THE RIMINI EARTHQUAKE OF MARCH 17, 1875

Compiled by

G. Ferrari, D. Postpischl

The drainage network of this map – scale 1:500.000 – is the same as the "Structural Model of Italy."

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The Ligurian earthquake of February 23, 1887

G. Capponi, M. Cattaneo, F. Merlanti

On the basis of historical seismicity we can assert that the western Ligurian and northern Ligurian Seas are endowed with fairly strong seismic activity, though not as strong as in the main seismic zones of Italy (Calabria, Friuli, Sicilia, etc.).
The earthquakes which contributed the most to local damages, with the largest disturbed areas, are those located in the Ligurian Sea. Among these, the 23 February 1887 earthquake probably is not the largest historical event in the region. Nevertheless, it holds a particular interest due to the large amount of available macroseismic data.
Many authors, e.g. Mercalli-Taramelli (1888), Agamennone (1931), Issel (1888), etc., carried out special studies on this event, allowing a complete reconstruction of the macroseismic effects. The epicenter was located in the sea off the Imperia shore; the seism was felt in a very large area, from France to southern Switzerland.
The main shock occurred at 6:20 a.m., followed closely by two aftershocks of lower intensity, but still damaging. The seismic period lasted many months, with a large number of aftershocks.
The amount of damage and the considerable number of losses seem not strictly ascribable to the intensity of the main shock, but probably are related to many conjoint causes which enhanced the effects.
Indeed, the buildings of the region had been seriously damaged by the 26.5.1831 and 29.12.1854 earthquakes, and roughly repaired. Moreover, the fact that many people were in the churches when the earthquake happened, caused a number of losses larger than the usual number for similar intensity levels. This is confirmed by the report of a larger number of deaths than of wounded.
The macroseismic data of the 23 February 1887 earthquake are grouped on the basis of the effects on people, buildings, field, sea water and other. The lack of space compels us to report only the most important of these.
a) Effects on people: the verified number of losses was larger than 600 (640 according to Taramelli-Mercalli, 1888; 634 in Maineri, 1894; 635 in Issel, 1888), while Taramelli-Mercalli claims there were 566 wounded, Maineri 532 and Issel, 555. In many villages people stayed clustered in the churches for the Christian feast of Ash Wednesday.
This coincidence contributed to the number of losses. For example, in Baiardo the vault of the church (badly built and already damaged by the 1854 earthquake) collapsed and killed 217 people, although the intensity level evaluated for this zone did not exceed VII MCS.
b) Effects on buildings: to understand the great amount of damage on buildings, we must remember that at that time most of the houses were built with unsquared blocks, wooden trusses and were poorly cemented. Moreover, in many villages (e.g. Bussana, Taggia, Ceriana, Castellaro), buildings had been damaged by the 1831 and 1854 earthquakes and had just been repaired. This fact justifies the high level of damages in western Liguria inside the I=VII isoseism, while in the mesoseismic area the quake was often completely destructive.
The total amount of damages has been evaluated, by Taramelli-Mercalli (1888), to be more than 22.000.000 Italian lire in Liguria and about 3.000.000 francs in the neighbourhood of Nice.
c) Effects on ground surface: these are not described systematically. We can recall the great number of landslides, e.g. Capo Mele. Ground fractures were observed in many localities, e.g. Castellaro, Oneglia, P. Maurizio and Castelvecchio di S. Maria Maggiore (Issel, 1888; Maineri, 1894). Only at Vado Ligure were effects of ground liquefaction, with the characteristic mud volcanoes, reported (Bertelli, 1888). Lastly, there are many reports on the variations of flow and clearness of sources, e.g. Moltedo, Piani, Poggi, Torrazza, Borgomaro, Maro Castello, Dolcedo, etc.
d) Effects on the sea water: many references reported that the main shock generated tsunami phenomena.
The sea, first receded uncovering large strips of coast, and then the water flooded the beaches for long distances. The maximum height of the tsunami wave was about 1 m at Porto Maurizio, Diano Marina, and Alassio and 30-40 cm at Sanremo, Oneglia, Andora.
e) Other effects: according to the numerous testimonies, the three main shocks were accompained by a dull rumble, noticed mainly at Pietra Ligure, Oneglia, Diano Marina, Candeasco, Vado Ligure and Baiardo. Some authors (Issel, 1888; Maineri, 1984; Gatta, 1889) said that the first shock was accompanied by light phenomena («lightning» or «flash»), observed principally at Albissola Marina, Giustenice, and Vado Ligure.
From a wide bibliography, macroseismic data for about a thousand localities have been recognized. These data have been revalued according to the MCS scale. Less reliable data or not completely exhaustive were excluded. The resultant data were drawn and the relevant isoseismal lines were traced. The mesoseismic area is close to the coast and it has an irregular form; it includes Diano Marina, Diano Castello, Diano S. Pietro and Massabovi. The earthquake was felt towards the North to southern Switzerland, towards the South to northern Sardinia, west to Perpignan and east to Venezia.

List of shocked localities:

Locality	Latit.	Long.	I (MCS)
Acqui Terme	44°40'	8°27'	VI-VII
Airole	43°52'	7°33'	VI
Ajaccio	41°55'	8°43'	VI
Alassio	44°00'	8°10'	VII
Albenga	44°02'	8°12'	VI-VII
Albisola Marina	44°19'	8°30'	VIII
Albisola Superiore	44°20'	8°30'	VI
Alessandria	44°54'	8°36'	V
Altare	44°20'	8°20'	VI
Andora	43°57'	8°08'	VIII
Annot	43°58'	6°39'	VI
Antibes	43°33'	7°07'	VI
Antibes	43°33'	7°07'	V
Apricale	43°52'	7°39'	VI-VII
Arenzano	44°24'	8°40'	VII
Arma di Taggia	43°49'	7°51'	VI
Arnasco	44°04'	8°06'	VI-VII
Arzeno	44°00'	7°57'	VIII
Asti	44°53'	8°12'	VI
Auribeau	43°35'	6°55'	VII
Aurigo	43°58'	7°55'	VI-VII
Badalucco	43°54'	7°50'	VII-VIII
Bagnasco	44°18'	8°02'	VI
Baiardo	43°54'	7°43'	VII
Bale	00°00'	0°00'	IV
Balestrino	44°07'	8°10'	VII
Barcelonnette	44°23'	6°39'	VII
Bardineto	44°11'	8°08'	VI
Bardino Nuovo	44°11'	8°15'	VII
Bardino Vecchio	44°11'	8°16'	VII
Bastia	42°41'	9°27'	VI
Bendejun	43°50'	7°17'	VI-VII
Bergeggi	44°14'	8°26'	VI
Berre	43°49'	7°19'	VII
Bezaudun-Les-Alpes	43°48'	7°05'	VIII
Bistagno	44°39'	8°22'	VII
Bogliasco	44°22'	9°04'	V-VI
Boissano	44°08'	8°13'	VI-VII
Bollene Vesubie	43°59'	7°20'	VII
Bolzaneto	44°27'	8°54'	VI
Bonson	43°51'	7°11'	VII
Bordighera	43°46'	7°39'	VI-VII
Borghetto d'Arrosci	44°04'	7°58'	VII
Borghetto S. Nicola	43°47'	7°40'	VI-VII
Borghetto Santo Spt	44°06'	8°14'	VI-VII
Borgio	44°09'	8°18'	VII
Borgomaro	43°58'	7°56'	VII-VIII
Borgo San Dalmazzo	44°19'	7°29'	VI
Borgo Sant'Agata	43°54'	8°00'	VI-VII
Bormida	44°16'	8°14'	V-VI
Borzonasca	44°25'	9°23'	V
Bossolasco	44°31'	8°03'	VI
Bouyon	43°49'	7°07'	VII
Boves	44°19'	7°33'	V-VI
Braux	43°59'	6°41'	VI
Broc	46°36'	7°06'	VII
Busalla	44°34'	8°56'	IV
Bussana	43°49'	7°50'	VIII
Cadibona	44°30'	8°21'	VI
Cagnes Sur Mer	43°39'	7°08'	VII
Cairo Montenotte	44°23'	8°16'	V-VI
Calamandrana	44°44'	8°20'	VI
Calenzana	42°30'	8°51'	V
Calice Ligure	44°12'	8°17'	VII
Calizzano	44°14'	8°06'	VI
Camogli	44°21'	9°09'	V
Campochiesa	44°04'	8°11'	VI
Campo Ligure	44°32'	8°41'	VI
Camporosso	43°48'	7°37'	VI-VII
Canale	44°47'	7°59'	VI
Candeasco	43°58'	7°58'	VII
Cannes	43°33'	7°01'	VI
Capo Mele	43°56'	8°10'	VII
Caramagna Ligure	43°53'	7°58'	IX
Caravonica	43°59'	7°57'	VIII
Carcare	44°21'	8°17'	VI
Carpasio	43°57'	7°51'	VI-VII
Carros	43°47'	7°11'	VII
Carrù	44°28'	7°52'	VI
Cartignano	44°28'	7°17'	V
Casanova Lerrone	44°01'	8°02'	VI
Cassine	44°45'	8°31'	VII
Castagniers	43°47'	7°13'	VII
Castelbianco	44°06'	8°04'	VI
Castellaro	43°51'	7°52'	VII
Castelvecchio di Ro	44°07'	8°06'	V-VI
Castel Vecchio S.ma	43°54'	8°02'	VI-VII
Castel Vittorio	43°55'	7°40'	VII-VIII
Castiglione	43°49'	7°28'	VII
Celle Ligure	44°20'	8°32'	VI-VII
Cenesi	44°04'	8°09'	VI-VII
Cengio	44°23'	8°12'	VI
Cenova	44°02'	7°54'	VII
Ceriale	44°05'	8°13'	VII
Ceriana	43°52'	7°46'	VIII
Cervo	43°55'	8°06'	VII
Cesio	44°00'	7°58'	VII-VIII
Ceva	44°23'	8°01'	VI
Champiercier	44°05'	6°10'	VII
Chateauneuf	43°40'	6°58'	VII
Chaudon	43°58'	6°19'	VI
Chiavari	44°19'	9°19'	V-VI
Chieri	45°00'	7°49'	VI
Chiusanico	43°58'	7°59'	VII
Chiusavecchia	43°58'	7°58'	VII
Cicagna	00°00'	0°00'	IV
Cisano sul Neva	44°05'	8°08'	VII
Civezza	43°52'	7°56'	VI-VII
Clans	43°59'	7°50'	VII
Clos Martel	00°00'	0°00'	VII
Coaraze	43°51'	7°17'	VI-VII
Cogoleto	44°23'	8°38'	VI-VII
Coldirodi	43°49'	7°46'	VII
Conio	43°56'	7°52'	VII-VIII
Contes	43°48'	7°19'	VI-VII
Cornigliano	44°24'	8°52'	VI
Corte	43°59'	7°46'	VII
Corte (Corsica)	42°18'	9°09'	V
Cosio d'Arroscia	44°04'	7°49'	VII-VIII
Cosseria	44°22'	8°14'	VI-VII
Costa d'Oneglia	43°51'	7°56'	VI-VII
Costarainera	43°51'	7°56'	VII
Coursegoules	44°47'	7°02'	VI
Cuneo	44°22'	7°32'	VI
Dego	44°26'	8°18'	V
Diano Arentino	43°57'	8°02'	VIII
Diano Castello	43°55'	8°03'	IX-X
Diano Marina	43°54'	8°03'	X
Diano San Pietro	43°55'	8°04'	VIII
Digne	44°05'	6°15'	V
Dolceacqua	43°51'	7°37'	VI
Dolcedo	43°54'	7°56'	VI-VII
Dronero	44°27'	7°21'	V
Duranus	43°53'	7°43'	VI
Ellera	44°21'	8°28'	VI
Embrun	44°34'	6°33'	V
Entraunes	44°11'	6°45'	VI
Entreveaux	43°57'	6°48'	VI
Erbalunga	43°46'	9°28'	V
Erli	44°08'	8°06'	VI
Farigliano	44°30'	7°54'	VI
Final Borgo	44°10'	8°20'	VII
Finale Ligure	44°10'	8°20'	VII
Final Pia	44°10'	8°22'	VII
Fossano	44°33'	7°43'	VII
Fours	44°19'	6°42'	VII
Gap	44°33'	6°05'	IV
Garessio	44°12'	8°01'	VI
Garlenda	44°02'	8°05'	VI
Genova	44°25'	8°53'	VI-VII
Gilette	43°50'	7°10'	VI
Giustenice	44°10'	8°14'	VII
Giusvalla	44°26'	8°23'	IV
Glori	43°57'	7°49'	VII
Golfe Juan	43°33'	7°04'	VI
Grasse	43°39'	6°56'	V-VI
Greolieres	44°12'	6°56'	VII
Isolabona	43°52'	7°38'	VI
Isola del Cantone	44°38'	8°57'	IV
Jausters	44°25'	6°43'	VII
La Colle sur Loup	43°40'	7°06'	VII
Laigueglia	43°58'	8°09'	VI-VII
Lantosque	43°58'	7°18'	VI
Larche	44°27'	6°51'	VII
La Rochette	43°55'	6°53'	VII
La Spezia	44°06'	9°49'	IV
Lavagna	44°18'	9°20'	V-VI
Lavina	44°01'	7°54'	VII
Le Bar	43°41'	6°59'	VIII
Lerici	44°04'	9°54'	IV-V
Le Rouret	43°40'	7°00'	VII
L'escarene	43°49'	7°22'	VI
Levanto	44°10'	9°36'	V
Levens	43°51'	7°13'	VI
Linguelietta	43°51'	7°55'	VII
Loano	44°07'	8°15'	VI-VII
Lolle	00°00'	0°00'	V
Losanna	46°03'	6°36'	IV
Luceram	43°52'	7°22'	VI
Lucinasco	43°58'	7°57'	VII
Lurs	43°58'	5°52'	VII
Magliolo	44°11'	8°14'	VII
Mallare	44°17'	8°17'	V
Manosque	43°49'	5°34'	VI
Marie	44°01'	7°08'	VI
Maro Castello	43°58'	7°56'	VIII
Marsiglia	43°17'	5°23'	V
Martina Olba	44°30'	8°36'	V
Massaboni	43°52'	8°00'	IX
Massimino	44°17'	8°04'	VI
Mendatica	44°04'	7°48'	VI-VII
Mentone	43°46'	7°30'	VII-VIII
Miella Tanaro	44°24'	7°55'	VI
Mignanego	44°31'	8°54'	VI
Milano	45°27'	9°11'	V

Molini di Triora	43°59'	7°40'	VII
Moltedo	43°55'	7°58'	VIII
Monaco	43°43'	7°25'	VI-VII
Mondovì	44°23'	7°49'	VI-VII
Montalto Ligure	43°55'	7°50'	VII
Monte Carlo di Mona	43°45'	7°27'	VI-VII
Monte Grazie	43°55'	7°58'	VIII
Montezemolo	44°22'	8°08'	V-VI
Nasino	44°06'	8°01'	VI
Nebbio	42°40'	9°19'	IV
Nervi	44°22'	9°03'	V-VI
Niella Belbo	44°30'	8°04'	VII
Nizza	43°41'	7°16'	VIII
Noli	44°12'	8°24'	VII
Novi Ligure	44°45'	8°47'	V
Olivastri	43°57'	7°59'	VII
Oliveto	43°53'	8°02'	VII
Olmi-Cappella	42°32'	9°01'	VI
Oneglia	43°53'	8°03'	IX
Onzo	44°04'	8°02'	VI
Orco Feglino	44°13'	8°19'	VII-VIII
Ormea	44°09'	7°54'	VI
Ortovero	44°03'	8°05'	VI
Osiglia	44°16'	8°11'	VI
Ospedaletti	43°48'	7°43'	VI-VII
Pantasina	43°56'	7°55'	VII
Pegli	44°25'	8°48'	V-VI
Perinaldo	43°52'	7°40'	VI-VII
Peyruis	44°01'	5°56'	VII
Piana Crixia	44°29'	8°18'	VI
Pianavia	43°56'	7°56'	VIII
Piani	43°52'	7°56'	VIII
Piena	43°54'	7°30'	VI
Pietrabruna	43°53'	7°54'	VI-VII
Pietra Ligure	44°08'	8°16'	VI
Pieve di Teco	44°02'	7°54'	VI-VII
Pigna	43°55'	7°39'	VI-VII
Plodio	44°20'	8°15'	VI
Pompeiana	43°51'	7°53'	VI-VII
Pontedassio	43°56'	8°00'	VI-VII
Pontedecimo	44°29'	8°54'	VI
Pontinvrea	44°26'	8°26'	VI
Pornassio	44°04'	7°52'	VII
Porto Maurizio	43°52'	8°00'	VII
Portovenere	44°03'	9°50'	IV
Prà	44°25'	8°47'	V-VI
Prelà	43°55'	7°56'	VII
Priero	44°22'	8°05'	VI
Priola	44°15'	8°01'	VI
Privas	44°44'	4°37'	V
Quarto	44°23'	9°00'	V
Quiliano	44°17'	8°25'	VI-VII
Quinto	44°23'	9°00'	V
Ranzi Pietra	44°09'	8°15'	IV
Ranzo	44°03'	8°00'	VII
Rapallo	44°20'	9°13'	VI
Recco	44°21'	9°08'	VI
Reillanne	43°52'	5°40'	VII
Rezzo	44°01'	7°52'	VII
Rialto	44°13'	8°15'	VII
Riva Ligure	43°50'	7°52'	VI-VII
Rivarolo	44°26'	8°54'	VI-VII
Robilante	44°17'	7°30'	VI
Roccavione	44°18'	7°28'	V-VI
Rocchetta di Cengio	44°23'	8°13'	VI
Rocchetta Nervina	43°53'	7°36'	VI
Rogliano	42°57'	9°25'	V
Ronco Scrivia	44°36'	8°57'	IV
Saint Dalmas le Sel	44°17'	6°52'	VI
Saint Etienne de Ti	44°15'	6°55'	VI
Saint Florent	42°40'	9°18'	IV
Saint Jean la Rivie	43°54'	7°16'	VI
Saint Laurent du Va	43°40'	7°10'	VII
Saint Martin du Var	43°49'	7°11'	VI
Saint Martin Lantos	00°00'	0°00'	VI
Saint-Pierre	45°42'	7°13'	VII
Saint Sauveur sur T	44°04'	7°06'	VI
Salea	44°04'	8°10'	VI-VII
San Bartolomeo	43°55'	8°06'	VIII
San Benedetto Belbo	44°29'	8°03'	VI
San Damiano Macra	44°29'	7°15'	VI
San Lorenzo al Mare	43°51'	7°57'	VI-VII
Sampierdarena	44°24'	8°53'	V-VI
Sanremo	43°49'	7°46'	VII-VIII
San Salvatore Monfe	44°59'	8°33'	VI
S. Lucia di Tallano	41°40'	9°04'	VI
Santa Margherita Li	44°20'	9°12'	VI
Santa Reparata	42°36'	8°58'	V
Santo Stefano al Ma	43°50'	7°53'	VI-VII
Sassello	44°28'	8°29'	VI
Savona	44°18'	8°28'	VI
Segno	44°15'	8°22'	V-VI
Serra Riccò	44°30'	8°56'	V
Sesta Godano	44°17'	9°40'	IV
Sestri Levante	44°16'	9°23'	V
Sestri Ponente	44°25'	8°50'	VI
Sisteron	44°11'	5°57'	V
Sospello	43°52'	7°27'	VI
Spotorno	44°13'	8°25'	VII
Stellanello	44°00'	8°03'	VI-VII
Taggia	43°50'	7°51'	VII
Tavole	43°55'	7°54'	VII
Terme Valdieri	44°12'	7°16'	IV-V
Terzorio	43°51'	7°53'	VII
Testico	44°00'	8°01'	VI-VII
Thoard	44°09'	6°09'	VI
Tiglieto	44°31'	8°37'	V
Toirano	44°07'	8°12'	VII
Tolone	43°08'	5°56'	VI
Torino	45°04'	7°40'	VI
Torrazza	43°53'	7°57'	VII
Torria	43°58'	7°58'	VII
Torriglia	44°31'	9°09'	V
Touet de l'Escarene	43°50'	7°22'	VI-VII
Tournon	45°04'	4°49'	V
Tourrettes-Levens	43°46'	7°16'	VII
Tovo San Giacomo	44°10'	8°16'	VII
Trinità-Vittorio	43°44'	7°18'	VI-VII
Triora	43°59'	7°45'	VII
Vacheres	43°55'	5°37'	VII
Vado Ligure	44°16'	8°26'	VI
Valbonne	43°39'	7°00'	VII
Valdieri	44°16'	7°23'	VI
Valence	44°56'	4°53'	V
Vallauris	43°34'	7°03'	VI
Vallecrosia	43°47'	7°38'	VII-VIII
Varazze	44°21'	8°34'	VI
Varese Ligure	44°22'	9°35'	IV
Vasia	43°55'	7°57'	VIII
Vellego	44°01'	7°53'	VI-VII
Vendone	44°04'	8°05'	VII
Ventimiglia	43°47'	7°36'	VI-VII
Vezzi Portio	44°14'	8°21'	VII
Villafranca	43°41'	7°19'	VI-VII
Villa Guardia	45°46'	9°01'	VII
Villanova d'Albenga	44°02'	8°09'	VI
Villa Talla	43°56'	7°54'	VIII
Ville Vielle	44°45'	6°49'	VI-VII
Vivario la Foce	42°10'	9°10'	V
Voiron	45°22'	5°34'	IV
Voltri	44°25'	8°45'	VI
Zoagli	44°20'	9°16'	V
Zuccarello	44°06'	8°06'	VI-VII
Zurigo	47°22'	8°33'	V

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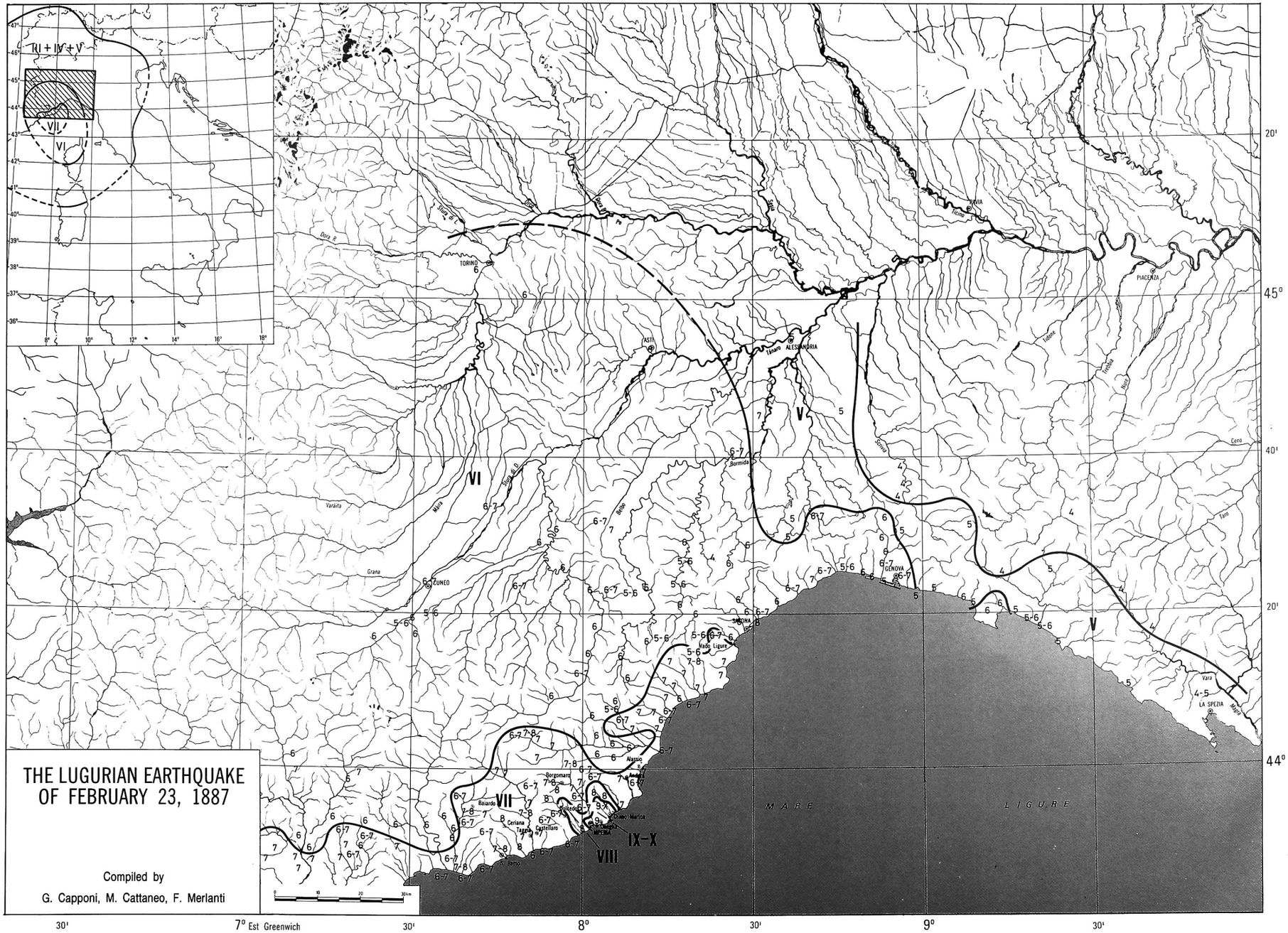

The drainage network of this map – scale 1:500.000 – is the same as the "Structural Model of Italy."

G.T.M - Via Marco Marulo 47a - 00143 ROMA

The Bisignano earthquake of December 3, 1887.

A. Bottari, B. Federico, E. Lo Giudice, C. Pandolfo

This earthquake in southern Calabria (Cosenza province) in the Crati river valley on the north-western edge of the Sila mountains is important for the effects it produced, even if in a relatively restricted area.

It is difficult to evaluate damages because the seismic event was followed by another shock after less than two hours, though the second was less intense and of a shorter duration. Therefore the damage found by contemporary observers was probably the result of both earthquakes. The ninth grade given to the meizoseismal area is correct if it refers to the cumulative damages, but it is to be considered overestimated if it refers to the first earthquake, since the greater damage was caused by the second earthquake.

The essential parameters which characterize the event are:
macroseismic epicentre 39° 32' N; 16° 16' E
epicentral locality: Bisignano (39° 31' N; 16° 18' E)
epicentral intensity: IX
hypocentral normal depth: (4.3 ± 0.6) km
spread coefficient: 4.1 ± 0.1
origin time: 0.3^h 45^m on December 3, 1887

The extension of the areas delimited by isoseismal lines are reported in the following table.

The field appears to be regular. The first 2 isoseismal lines are distinctly lengthened in a WNW-ESE direction, whereas the third one is influenced by an abnormal area (VI up to the VII area) and shows a moving isotropic shape in an E-W direction.

The IV grade isoseismal line shows two anomalies respectively at the NW and SE edges. Its general direction is NE-SW.

The successive isoseismal lines are incomplete because they mostly concern sea areas and they lack quoted points.

The maximum distances of macroseismic perceptibility, on the basis of certain information, are respectively 180 km in a NW direction (Salerno) and 170 km in a SSW direction (Reggio Calabria).

Bibliographical references are scarce

Agamennone G., 1888 (N. 1 and N. 2); Cortese E., 1888 (N. 5); Baratta M., 1895 (N. 4); Mercalli G., 1897 (N. 6); Baratta M., 1901 (N. 3); the journal «L'avanguardia di Cosenza», 1887.

The authors have utilized all the above references for this study except «L'avanguardia di Cosenza», which is quoted in the Agamennone ref., for the description of effects in the most important localities. Whereas Agamennone and Cortese carried out direct research on the earthquake field, the other researchers elaborated the data found by the first two authors. The macroseismic fields proposed by Agamennone, Cortese and Baratta are also reported, and they differ greatly from the field proposed in this study.

In the following table the essential elements that characterize the geometry of the isoseismal lines are reported. In particular they are the maximum (r_{max}) and minimum (r_{min}) radii, the relative azimuthal directions (ϑ_2) measured with respect to E_L for the first two isoseismal lines and with respect to E_N for the other isoseismal lines.

List of shocked localities:

Locality	Latit.	Long.	I (MCS)
Acquaformosa	39°43'	16°05'	≤V
Acri	39°29'	16°23'	VI
Albano di Lucania	40°35'	16°02'	NF
Altomonte	39°42'	16°08'	VI
Amantea	39°08'	16°05'	V
Amendolara	39°57'	16°35'	NF
Balvano	40°39'	15°31'	NF
Battipaglia	40°36'	14°59'	≤II
Bella	40°46'	15°32'	NF
Bella-Muro, Stazione	40°42'	15°32'	NF
Benevento	41°08'	14°47'	NF
Bernalda	40°24'	16°41'	III
Bisignano	39°31'	16°17'	VIII-IX
Bisignano-Arci, Stazione (Luzzi)	39°26'	16°15'	≥V
Bocchigliero	39°25'	16°45'	≥IV
Brindisi Montagna	40°37'	15°56'	NF
Calciano	40°35'	16°12'	NF
Campomaggiore	40°34'	16°04'	NF
Canna	40°06'	16°30'	III
Cariati	39°30'	16°57'	III
Carpanzano	39°09'	16°18'	IV-V
Cassano all'Ionio	39°47'	16°19'	V
Cassano all'Ionio, Stazione	39°43'	16°21'	≥V
Castelfranci	40°56'	15°03'	≤II
Castiglione Cosentino	39°21'	16°17'	V
Castiglione Scalo	39°21'	16°16'	V
Castrovillari	39°49'	16°12'	V
Catanzaro	38°55'	16°35'	III
Cervicati	39°32'	16°08'	≥VI
Cerzeto	39°30'	16°07'	≥VI
Cetraro	39°31'	15°56'	≥IV
Chiaromonte	40°07'	16°13'	III
Contursi	40°39'	15°14'	II
Contursi Stazione	40°39'	15°14'	II
Corigliano Calabro	39°36'	16°31'	V
Cosenza, Centro	39°18'	16°15'	V
Cosenza E., Stazione FS	39°18'	16°16'	V
Crotone (Cotrone)	39°05'	17°08'	NF
Ferrandina	40°30'	16°27'	III
Fiumefreddo Bruzio	39°14'	16°04'	V
Fuscaldo	39°25'	16°02'	VI
Gerace	38°16'	16°13'	NF
Grassano-Garaguso-Tricarico, Staz.	40°36'	16°15'	NF
Ioggi	39°35'	16°05'	VI
Lattarico-Torano, Stazione	39°30'	16°13'	VII-VIII
Lecce	40°21'	18°10'	NF
Lipari, Centro	38°28'	14°44'	NF
Lungro	39°44'	16°07'	V
Luzzi	39°27'	16°17'	VI
Malvito	39°36'	16°03'	VI
Mandatoriccio	39°28'	16°50'	IV
Marconia, Stazione	40°22'	16°41'	NF
Marina di Amendolara	39°56'	16°36'	II|
Messina, Centro	38°11'	15°33'	III
Metaponto	40°22'	16°49'	NF
Mongrassano	39°32'	16°07'	VI
Mongrassano, Stazione	39°32'	16°13'	VIII-IX
Montalto Uffugo	39°24'	16°09'	VI
Montalto Uffugo, Stazione	39°24'	16°14'	≥V
Montecorvino, Stazione (Bellizzi)	40°42'	14°59'	NF
Montemurro	40°18'	15°59'	III
Mottafollone	39°39'	16°04'	VI
Muro Lucano	40°45'	15°29'	NF
Napoli	40°51'	14°16'	NF
Novasiri, Stazione	40°08'	16°39'	NF
Oriolo	40°03'	16°27'	III
Panarea, San Pietro	38°38'	14°51'	II-III
Paola	39°22'	16°02'	VII
Picerno	40°38'	15°38'	NF
Pisticci, Stazione	40°25'	16°33'	III
Policastrello	39°41'	16°03'	≤VI
Policoro	40°13'	16°41'	NF
Pomarico	40°31'	16°33'	≥II
Potenza	40°38'	15°48'	II
Potenza, Stazione	40°38'	15°47'	NF
Reggio Calabria, Centro	38°06'	15°39'	III
Rende, Centro	39°20'	16°11'	VI
Rocca Imperiale Marina	40°06'	16°37'	NF
Rocca S. Felice	40°57'	15°10'	≤II
Roggiano Gravina	39°37'	16°09'	VIII
Rogliano	39°11'	16°19'	V
Romagnano, Stazione	40°38'	15°27'	NF
Rose	39°24'	16°17'	≥V
Roseto, Stazione (Capo Spulico)	39°58'	16°36'	NF
Roseto Capo Spulico	39°59'	16°36'	NF
Rossano	39°34'	16°38'	V
Salandra-Grottole, Stazione	40°35'	16°21'	≥II
Salerno	40°41'	10°46'	≤III
S. Cosmo Albanese (San Cosimo)	39°35'	16°25'	VI
S. Demetrio	39°34'	16°22'	VI
S. Donato di Ninea	39°43'	16°03'	VI
S. Marco Roggiano, Stazione	39°36'	16°11'	≥VII
S. Marco Argentano	39°33'	16°07'	VII
S. Sosti	39°40'	16°02'	VI
S. Caterina Albanese	39°35'	16°04'	VI
S. Agata di Esaro	39°37'	15°59'	≥VI
S. Marina	40°06'	15°32'	≥III
S. Sofia D'Epiro	39°33'	16°20'	≤VIII
Scanziano Ionico	40°15'	16°42'	NF
Scigliano	39°08'	16°18'	≤V
Senise	40°09'	16°17'	III
Serra S. Bruno	38°35'	16°20'	≤III
Sibari, Stazione	39°45'	16°27'	IV-V
Sicignano, Stazione	40°33'	15°19'	NF
Spezzano, Stazione Terme	39°43'	16°17'	V-VI
Spezzano	39°40'	16°19'	≤VI
Spezzano della Sila	39°14'	16°20'	V
Stromboli, San Vincenzo	38°49'	15°01'	III
Taranto	40°28'	17°15'	NF
Tarsia	39°37'	16°16'	VI
Tarsia, Stazione (S. Lorenzo del Vallo)	39°40'	16°13'	VI
Tiriolo	38°57'	16°31'	III
Torano	39°30'	16°09'	≥VI
Trebisacce	39°52'	16°32'	NF
Trivigno	40°35'	15°59'	III
Tropea	38°40'	15°54'	III
Vaglio, Stazione (SS 407 b. Vaglio)	40°39'	15°53'	NF
Verbicaro	39°45'	15°55'	≥IV
Vibo Valentia (Monteleone Cal.)	38°40'	16°06'	III
Vietri	40°36'	15°31'	III

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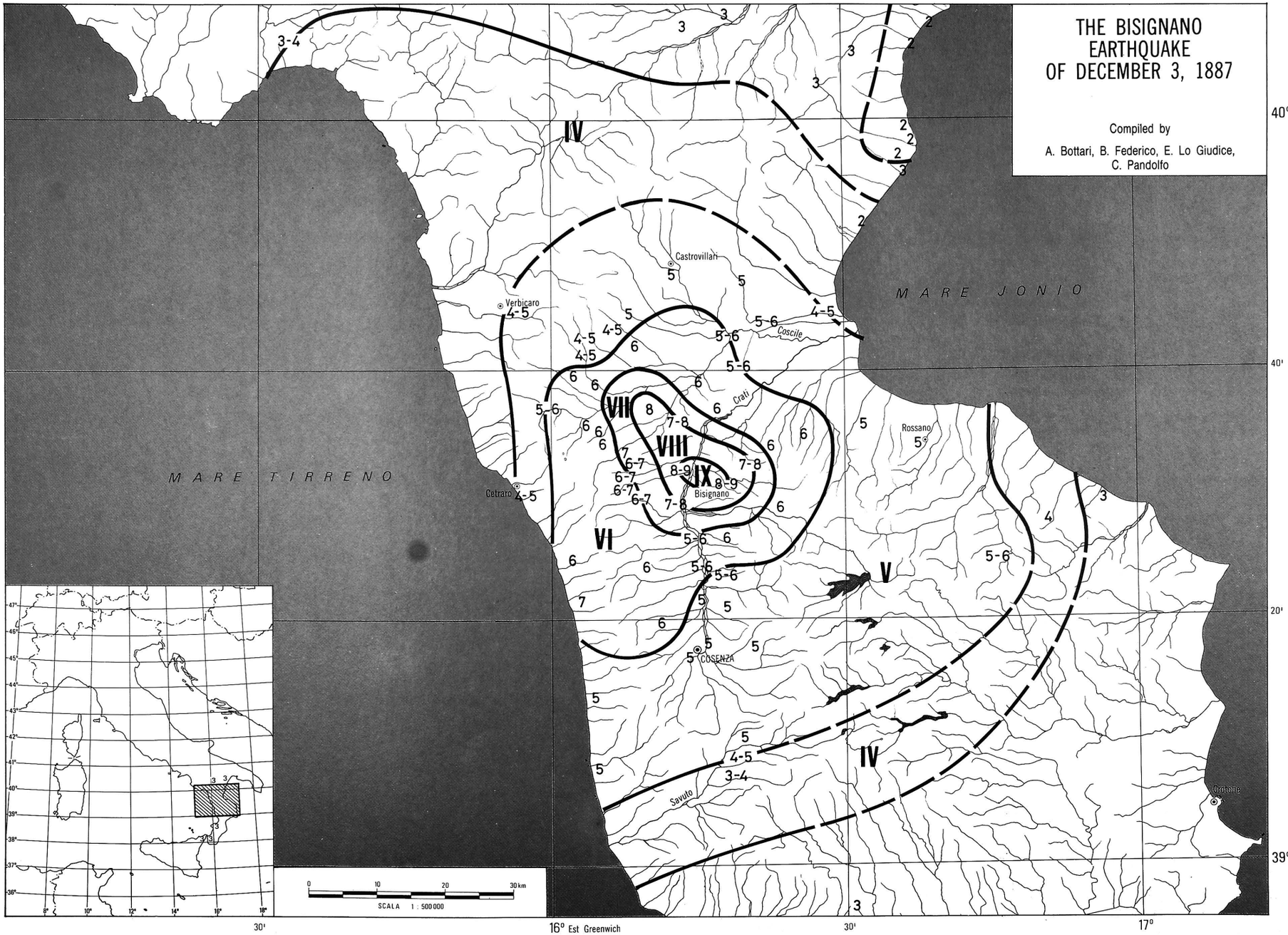
THE BISIGNANO EARTHQUAKE OF DECEMBER 3, 1887

Compiled by

A. Bottari, B. Federico, E. Lo Giudice, C. Pandolfo



The drainage network of this map – scale 1:500.000 – is the same as the "Structural Model of Italy."

G.T.M - Via Marco Marulo 47a - 00143 ROMA

The Mattinata earthquake of August 10, 1893.

D. Molin

This earthquake, in its maximum intensity, concerned a very limited area long the southeast coast of the Gargano, corresponding to Punta Rossa. The only town to be considerably damaged was Mattinata; several farmhouses collapsed, and three people were killed. The very limited number of victims is due to the great number of fairly strong shocks that preceded the major one of 10 August.

No tsunami was observed; however, several boats about 5 kilometres offshore from Punta Rossa noticed a slight movement of the sea.

In the epicentral area, several slight landslides took place as did very slight variations in the flow of underground waters.

A fairly good literature exists on the subject of this earthquake, consisting above all of the works by M. Baratta (6) and G. Grablovitz (14), distinguished seismologists, who visited the site after the main event in order to demonstrate the effects. Information was also given in several seismic bulletins; among these, that of the Central Office of Meteorology and Geodynamics (17) was the most important.

The time of the main event (21. 52 TMEC) should be considered accurate since it was registered by more than one Geophysical Observatory.

The earthquake was characterized by a very noticeable seismic sequence (almost consecutive with another which took place the year before, concerning almost the same area), which probably began with slight shocks at the end of June, 1893, and finished in January, 1894. After this date, other shocks took place in the same area of the Gargano but with different epicentres. Altogether, 350-400 shocks were recorded, their highest frequencies generally occurring together with the highest degrees of intensity. These shocks took place on 1 July, 27 July and 18 December, as well as on 10 August, at about the VII degree. The majority of the shocks had their epicentres in the Mattinata - Punta Rossa area.

The maximum intensity was observed in the area immediately SSE of Mattinata, where it reached the IX degree on the Mercalli scale, demonstrated by the collapse of several farm-houses, towers and other buildings. Among these, were the Torre del Porto, Punta Rossa lighthouse, the signal-station at Monte Saraceno and the road-worker's house at Cavola. All of these buldings, or groups of buildings, were probably well-constructed. The intensity in the town of Mattinata, where some buildings collapsed, was not higher than the VIII degree of the M.C.S. scale.

The epicentre, considering the general pattern of the isoseismal lines, may be placed approximately around Punta Rossa; the most serious damage took place near here (41°42' Lat. N., 16°04' Long. E).

The assembled information, including the numerous negative reports (the black triangle in the diagram), has allowed us to draw a fairly clear isoseismal map, except for the southern part. From this map, the following observations can be made:

- the affected area is sharply drawn, including all of the Gargano, part of the Capitanata, and – further towards the South – part of the Terra di Bari;
- there is some local increase of intensity, particularly near Lavello; and
- there are three major lines of propagation, one in an E-W direction along the «Carbonata Fault», another in a NW-SE direction towards the Terra di Bari, and the last along the lower valley of the Ofanto River, determined by the above-mentioned local increase of intensity at Lavello.

List of shocked localities:

Locality	Latit.	Long.	I (MCS)
Accadia	41°10'	15°20'	III
Alberona	41°26'	15°08'	NF
Amendola (staz. FFSS)	41°32'	15°46'	IV
Anzano di Puglia	41°07'	15°18'	NF
Bari	41°07'	16°52'	NF
Benevento	41°08'	14°46'	NF
Bisceglie	41°15'	16°30'	III
Bovino	41°15'	15°21'	III
Cagnano Varano	41°39'	15°47'	IV
Castel Baronia	41°03'	15°12'	NF
Castellana Grotte	40°53'	17°10'	NF
Castelluccio dei Sauri	41°18'	15°29'	III
Castelluccio Valmaggiore	41°20'	15°13'	NF
Castelnuovo della Daunia	41°35'	15°08'	NF
Celenza Valfortore	41°34'	14°59'	NF
Celle San Vito	41°20'	15°11'	NF
Corato	41°09'	16°25'	IV
Deliceto	41°13'	15°23'	NF
Fasano	40°50'	17°22'	NF
Foggia	41°28'	15°33'	II
Genzano di Lucania	40°51'	16°02'	NF
Giovinazzo	41°11'	16°40'	II-III
Grumo Appula	41°01'	16°43'	III
Ischitella	41°54'	15°54'	IV
Lavello	41°03'	15°48'	V
Manfredonia	41°38'	15°55'	VI
Margherita di Savoia	41°22'	16°09'	V
Mattinata	41°43'	16°03'	VIII
Faro di Mattinata	41°42'	16°04'	IX
Marina di Mattinata	41°42'	16°04'	VIII-IX
Piana di Mattinata	41°42'	16°03'	VIII-IX
Monte Saraceno	41°41'	16°03'	IX-X
Mattinatella	41°44'	16°06'	VIII
Mola di Bari	41°04'	17°05'	NF
Monte Milone	41°02'	15°58'	III
Monte Sant'Angelo	41°42'	15°57'	VII
Orsara di Puglia	41°17'	15°16'	NF
Orta Nova	41°20'	15°43'	NF
Palazzo San Gervasio	40°56'	16°00'	NF
Panni	41°14'	15°17'	NF
Peschici	41°57'	16°01'	NF
Poggio Imperiale	41°47'	15°22'	NF
Polignano a Mare	41°00'	17°13'	NF
Rignano Garganico	41°40'	15°35'	III
Rionero in Vulture	40°56'	15°41'	NF
Rodi Garganico	41°56'	15°53'	III
Roseto Valfortore	41°22'	15°06'	NF
Rutigliano	41°01'	17°00'	II
Ruvo di Puglia	41°07'	16°29'	III
San Giovanni Rotondo	41°43'	15°54'	V
San Marco in Lamis	41°43'	15°38'	V
San Marco la Catola	41°31'	15°01'	NF
San Nicola (Isole Tremiti)	42°07'	15°30'	II
San Paolo di Civitate	41°44'	15°25'	III
San Severo	41°41'	15°23'	III
Serra Capriola	41°48'	15°10'	NF
Spinazzola	40°58'	16°05'	II
Stornarella	41°16'	15°44'	NF
Trani	41°17'	16°25'	IV
Vico Garganico	41°54'	15°57'	IV
Vieste	41°53'	16°11'	V

We know that the earthquake has been felt also abroad in Senebico, Spalato and Montenegro.

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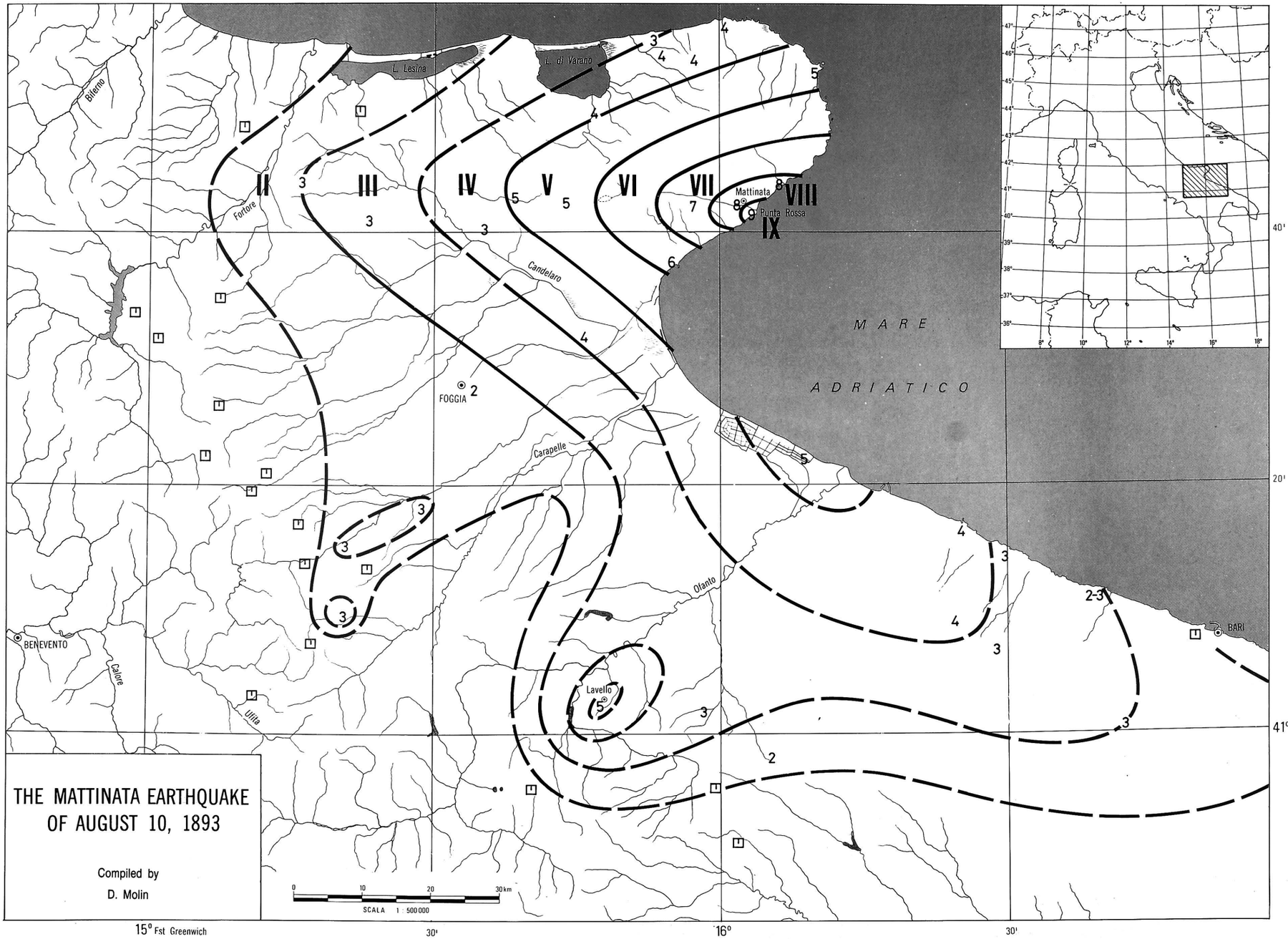

THE MATTINATA EARTHQUAKE OF AUGUST 10, 1893

Compiled by
D. Molin

The drainage network of this map – scale 1:500.000 – is the same as the "Structural Model of Italy."

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The Santa Maria di Licodia earthquake of May 14, 1898.

G. Lombardo

The earthquake of S.M. di Licodia is a typical shock of the Etnean area, characterized by a strong intensity concentrated in a very narrow area. The shock took place in an historical period quite favourable for seismological studies on Mount Etna. In particular, the instrumental surveillance of the volcano and macroseismic surveies of areas affected by earthquake, were usually carried out by volcanologists of that period. Thus it has been possible to find out very detailed information gathered with scientific purposes by contemporary volcanologists studying the geodynamic phenomena of the volcano (Ricco, Arcidiacono).
The quality of descriptions allows better detail in the interpretation of intensity values compared to that which would be possible considering only the descriptions given by Baratta, who in this case is a contemporary author as well. Especially good accuracy in the determination of the mesoseismal area was obtained.
The earthquake took place at 4.46 (G.M.T.) on May 14, 1898 Mt. Etna was in a relatively quiet period since the end of the eruption of 1892 and only little shocks of modest magnitude occurred in that period, mostly in the eastern flank of the volcano (2). The studied earthquake, instead, involved the south-western part of Mount Etna, the villages of S.M. di Licodia, Ragalna, Biancavilla and Paternò, which were heavily struck and several houses damaged. In particular, S.M. di Licodia and the countryside Sparadrappo suffered heavy damage, though there were no victims. In the former village, twenty houses were destroyed and the rest of the houses were more or less damaged.
The shock was also felt without heavy damage in several Etnean villages located mainly on the southern flank of the volcano, while in the north and in the eastern part of Mt. Etna the intensity of the shock was rather reduced. In Mascali and Giarre, located about 30 km away from the epicentral area, the shock seems to have not been felt at all (1). The area where the shock was felt was greatly expanded to the south, and the majority of the inhabitants of Mineo and Augusta, villages located in the northernmost part of hyblaean foreland, felt the earthquake as a strong shock (3).
Moreover, it seems that aftershocks took place in the same area at 6.3 (G.M.T.) of the same day and the 22nd of the same month.
The good quality of information gathered allowed the drawing of a isoseismal map (see figure), in which localities where the shock was not felt are indicated as well.
The earthquake attained intensity VIII in the epicentral area. The mesoseismal area stretched in a NE-SW direction according to the trend of the tectonic structures existing in the area. The mesoseismal area is very narrow (7 km^2) which indicates the shallowness of the event whose focal depth, macroseismically calculated, is about 6 km.
The trend of isoseismals of lower degrees brings into evidence the sharp intensity decrease mainly towards the east and west from the epicentral area, while in the north-south direction the effects of the shock are distributed in a wider area. It is remarkable to note that effects of intensity IV are detectable towards the south till Mineo and Augusta. This further confirms the great energy propagation in the hyblaean foreland, as already observed for other shocks of northern Sicily and southern Calabria.

List of shocked localities:

Locality	Latit.	Long.	I (MCS)
Acireale	37°37'	15°10'	III
Adrano	37°40'	14°50'	VI
Agira	37°40'	14°32'	NF
Augusta	37°13'	15°13'	IV
Belpasso	37°35'	14°49'	VI
Biancavilla	37°38'	14°53'	VII
Bronte	37°47'	14°51'	IV
Capizzi	37°50'	14°29'	NF
Castiglione di Sicilia	37°52'	15°07'	NF
Catania	37°31'	15°05'	IV
Centuripe	37°39'	14°45'	II
Chiaramonte	37°02'	14°42'	NF
Francoforte	37°14'	14°50'	NF
Giarre	37°43'	15°11'	NF
Linguaglossa	37°50'	15°09'	II
Mascali	37°45'	15°12'	NF
Mineo	37°16'	14°41'	IV
Mirabella Imbaccari	37°19'	14°27'	NF
Moio Alcantara	37°56'	14°56'	NF
Nicolosi	37°36'	15°02'	IV-V
Nicosia	37°45'	14°24'	NF
Niscemi	37°09'	14°24'	NF
Novara di Sicilia	38°01'	15°08'	NF
Paternò	37°34'	14°54'	VII
Ragalna	37°38'	14°56'	VII
Randazzo	37°53'	14°57'	IV
Riposto	37°44'	15°12'	II
Roccella Valdemone	37°56'	15°01'	NF
S. Teodoro	37°52'	14°42'	NF
S.M. Licodia	37°37'	14°54'	VIII
S. Venerina	37°41'	15°08'	III-IV
Sparadrappo	37°39'	14°54'	VIII
Trecastagni	37°37'	15°06'	III
Valguarnera	37°46'	14°25'	NF
Viagrande	37°36'	15°06'	IV-V
Zafferana Etnea	37°41'	15°07'	III

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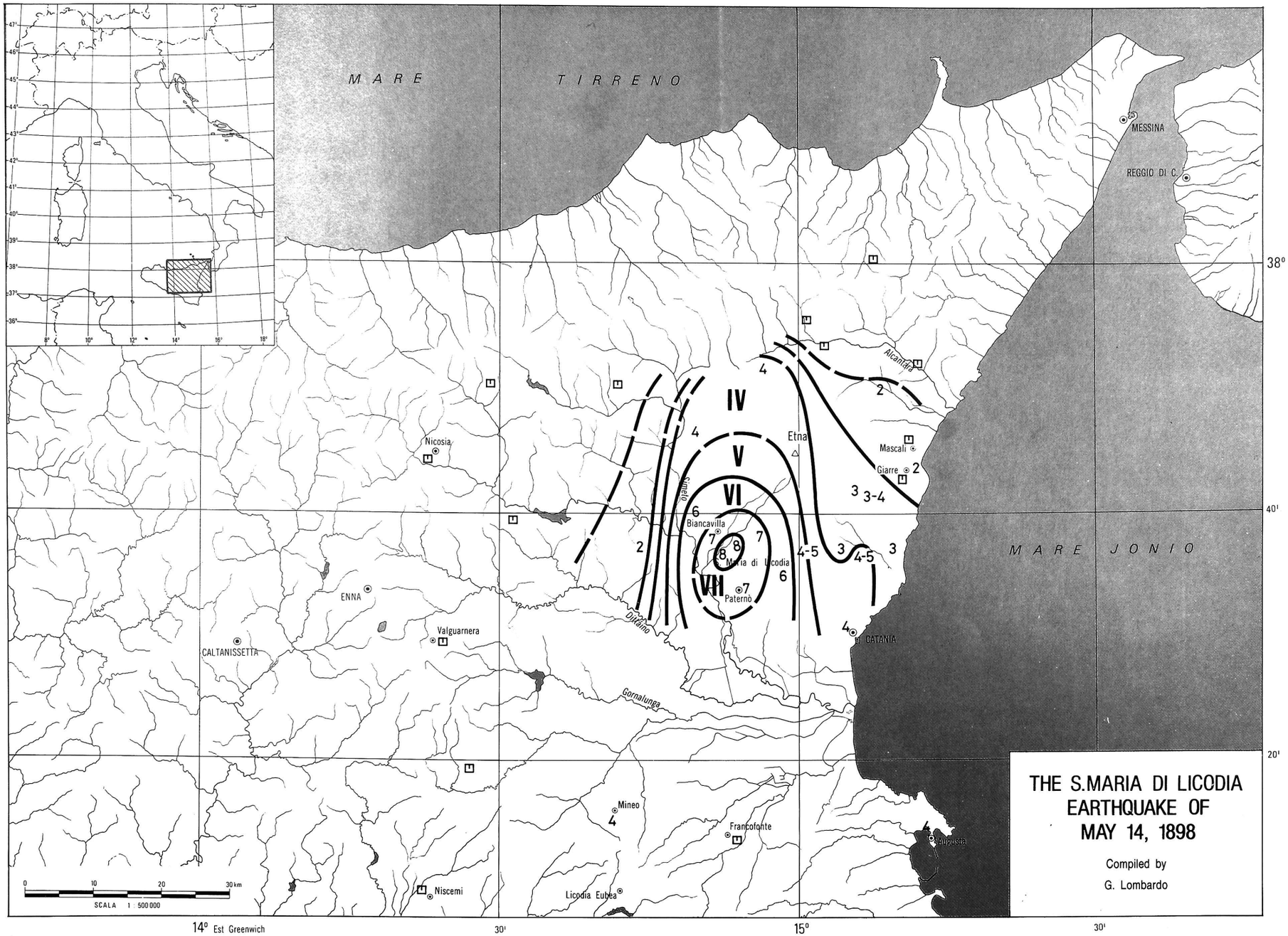

THE S.MARIA DI LICODIA EARTHQUAKE OF MAY 14, 1898

Compiled by

G. Lombardo

The drainage network of this map – scale 1:500.000 – is the same as the "Structural Model of Italy."

G.T.M - Via Marco Marulo 47a - 00143 ROMA

The Rieti earthquake of June 28, 1898.

M.C. Spadea, M. Vecchi, P. Gardellini, S. Del Mese

Preceded by several tremors (the first of which occurred in February, 1898), the event which seriously hit the localities of Rieti, Coppaeli and Santa Rufina on 28 June (00^h38^m) attained an MCS intensity of VIII. This shock was followed by numerous aftershocks, two of which were particularly strongly felt (MCS intensity VI) one in Rieti and surroundings on 30 August (17^h30^m) and the other on 9 September (20^h13^m).
The earthquake was felt over a large part of Central Italy, from the province of Ancona to that of Caserta. The most severely hit provinces were Rieti, Terni, Roma, Viterbo, L'Aquila and Perugia. The seismic period in question was classified as follows in the *CNEN General Catalogue of Earthquakes from Beginning of Christian Age to 1971*, published 1973:

Year	Mo	Da	Ho	Mi	Lat	Long	I_o	Mk
1898	6	27	23	38	42°24'	12°52'	IX	5.2
1898	6	28	00	00	42°24'	12°52'	III	

and in the *ENEL File of Italian Earthquakes from 1000 up to 1975*, unpublished 1977:

Year	Mo	Da	Ho	Mi	Lat	Long	I_o	Mk	Mp	Epic. area
1898	6	27	23	38	42°24'	12°54'	IX	5.1	4.9	Rieti
1898	6	28	00	00	42°24'	12°54'	III	2.5	2.8	Rieti

Huge damage was done in the epicentral zone. Lower Coppaeli (a small hamlet near Rieti) was completely destroyed.
Four people died at Santa Rufina when a farmhouse collapsed. Walls caved in and other serious damage occurred in other buildings.
In Rieti ceilings fell and balconies and chimney pots collapsed. There was considerable damage to many buildings, some of which were subsequently demolished.
The damage caused by the earthquake would certainly have been less serious if better construction techniques had been used.
The numerous bibliographic sources referring to this event afforded a satisfactory determination of the macroseismic field, which comprises very well-defined isoseisms ranging from VIII-V in intensity. Despite the numerous data available, it still has not been possible to assign a univocal MCS intensity to some localities, which are marked on the map using the two intensity values which best fit the effects for which we have any information.
Two negative anomalies (Monte San Giovanni and Poggio San Lorenzo), probably due to the local geological structure, are situated on the VI isoseism. Furthermore, this isoseism is irregular in shape and is characterized by a spur extending several kilometers to the NW. The main orientation of the curves is N-S, i.e. along the Apennines, while maximum attenuation is observed East of the epicentre.
The documents used to study this event were (1, 2, 3, 4, 5, 6, 7, 8).
The bibliographic sources refer to boulder slides, seismic flashes and rumbling.

The following parameters were obtained from macroseismic field analysis:

$$I_o = \text{VIII MCS}$$

$$\varphi_m = 42°,40 \qquad \lambda_m = 12°,90$$

List of shocked localities:

Locality	Latit.	Long.	I (MCS)
Accumoli	42°42'	13°15'	IV
Acquapendente	42°45'	11°52'	NF
Acquasparta	42°41'	12°33'	V
Albano Laziale	41°44'	12°40'	IV
Allumiere	42°09'	11°54'	NF
Alviano	42°35'	12°18'	III
Ancarano	42°50'	13°45'	II
Antrodoco	42°25'	13°05'	V
Apoleggia	42°30'	12°51'	VI
Ariccia	41°43'	12°40'	IV
Arsoli	41°02'	13°01'	IV
Ascoli Piceno	42°51'	13°35'	IV
Assisi	43°04'	12°37'	IV
Atina	41°37'	13°48'	NF
Atri	42°35'	13°59'	III
Avezzano	42°02'	13°26'	III
Bagnorea (Bagnoregio)	42°38'	12°06'	IV
Belmonte in Sabina	42°19'	12°54'	VII
Bevagna	42°56'	12°36'	IV
Borgo Velino	42°24'	13°03'	V
Bracciano	42°06'	12°11'	II
Camerino	43°08'	13°04'	III
Caldarola	43°08'	13°14'	IV
Calvi	42°24'	12°34'	IV
Cancello	41°36'	13°48'	NF
Candelara	43°51'	12°53'	NF
Canepina	42°23'	12°14'	IV-V
Cannara	43°00'	12°35'	IV
Cantalice	42°28'	12°54'	VI
Capestrano	42°16'	13°46'	II
Capracotta	41°50'	14°16'	NF
Capriati al Volturno	41°28'	14°09'	NF
Caramanico	42°09'	14°00'	NF
Casaprota	42°15'	12°48'	VI-VII
Cascina Cavalli	Dintorni	di Rieti	VIII
Castelfranco	42°26'	12°54'	VII
Castel Gandolfo	41°45'	12°39'	IV
Castel Ritaldi	42°49'	12°40'	IV
Castel S. Angelo	42°24'	13°01'	V
Castiglione del Lago	43°08'	12°03'	NF
Ceccano	41°34'	13°20'	IV
Cerreto d'Esi	43°19'	12°59'	II
Cerreto di Spoleto	42°49'	12°55'	IV
Cerveteri	42°00'	12°06'	NF
Cesi	42°37'	12°35'	VI
Cittaducale	42°23'	12°57'	VII-VIII
Collatea	42°31'	12°50'	VI
Collescipoli	42°32'	12°37'	VI
Contigliano	42°25'	12°46'	V
Coppaeli Alto	Dintorni	di Rieti	VIII
Coppaeli Basso	Dintorni	di Rieti	VIII
Cupramarittima	43°01'	13°52'	NF
Falconara Marittima	43°38'	13°24'	NF
Farindola	42°26'	13°49'	NF
Ferentino	41°41'	13°15'	?
Fermignano	43°41'	12°39'	NF
Fiano Romano	42°10'	12°35'	V
Ficulle	42°50'	12°04'	III
Filacciano	42°15'	12°36'	V
Foiano della Chiana	43°15'	11°49'	II
Foligno	42°57'	12°42'	V
Fondi	41°21'	13°26'	II
Fossato di Vico	43°18'	12°46'	NF
Frascati	41°48'	12°41'	IV
Gabicce	43°58'	12°45'	NF
Genzano	41°42'	12°41'	IV
Giano dell'Umbria	42°50'	12°35'	IV-V
Giuliano	41°32'	13°07'	IV
Greccio	42°27'	12°45'	VI
Guarcino	41°48'	13°19'	III
Gubbio	43°21'	12°35'	NF
Labro	42°32'	12°48'	VI
L'Aquila	42°21'	13°43'	III
Latera	42°38'	11°50'	IV
Leonessa	42°34'	12°58'	VI-VII
Lisciano	42°27'	12°55'	VI-VII
Lugnano	42°26'	12°56'	VII
Macerata	43°18'	13°27'	III
Manciano	42°35'	11°31'	NF
Manziano	42°08'	12°08'	NF
Marino	41°46'	12°40'	IV
Marmore	42°33'	12°43'	?
Matelica	43°15'	13°01'	II
Micigliano	42°27'	13°03'	IV-V
Mignano	43°41'	12°00'	NF
Minturno	41°16'	13°45'	NF
Montalcino	43°03'	11°29'	NF
Montalto di Castro	42°21'	11°36'	NF
Montasola	42°23'	12°41'	IV
Mondavio	43°40'	12°58'	NF
Mondolfo	43°45'	13°06'	II
Montecarotto	43°32'	13°04'	II
Montecastrilli	42°39'	12°29'	III
Monte Cavo	41°46'	12°45'	IV
Montecompatri	41°48'	12°44'	IV
Monte Corvo	41°27'	13°40'	III
Montefalco	42°54'	12°39'	IV-V
Montegiorgio	43°08'	13°32'	III
Monteporzio Catone	41°49'	12°43'	IV
Montercole	?	?	IV-V
Monterotondo	42°03'	12°37'	IV-V
Monte S. Giovanni	41°38'	13°31'	V
Monte S. Maria	42°13'	12°46'	NF
Montorio al Vomano	42°35'	13°38'	III
Morro Reatino	42°32'	12°50'	VI
Narni	42°31'	12°31'	VI
Nazzano	42°14'	12°36'	IV-V
Nemi	41°43'	12°43'	IV
Nerola	42°10'	12°47'	IV-V
Nettuno	41°28'	12°40'	II
Norcia	42°48'	13°06'	IV-V
Numana	43°31'	13°37'	NF
Orte	42°28'	12°23'	IV
Osimo	43°29'	13°29'	II
Otricoli	42°25'	12°29'	IV-V
Ovindoli	42°08'	13°31'	NF
Palestrina	41°50'	12°53'	IV-V
Palombara	42°04'	12°46'	IV-V
Papigno	42°33'	12°41'	VI
Passignano	43°11'	12°08'	NF
Pergola	43°34'	12°50'	II
Perugia	43°06'	12°23'	IV
Pescina	42°02'	13°39'	NF
Pianella	42°24'	14°03'	II
Piè del Poggio	42°33'	13°00'	VI-VII
Piediluco	42°32'	12°45'	V
Piegaro	42°58'	12°05'	III
Pietramelara	41°16'	14°11'	NF
Piobbico	43°35'	12°31'	NF
Pioraco	43°11'	12°59'	II
Poggio Bustone	42°30'	12°53'	VI
Poggio Catino	42°18'	12°41'	VI
Poggiodomo	42°43'	12°56'	V
Poggio Mirteto	42°16'	12°41'	VI
Poggio Moiano	42°12'	12°53'	VI
Poggio S. Lorenzo	42°17'	12°51'	V
Ponzano	42°15'	12°34'	IV-V
Porto S. Giorgio	43°11'	13°48'	NF
Posta	42°31'	13°06'	IV
Radiocofani	42°54'	11°42'	NF
Rieti	42°24'	12°52'	VIII
Rivodutri	42°31'	12°51'	VI
Rocca di Cambio	42°14'	13°29'	NF
Rocca di Corno	42°22'	13°09'	IV
Rocca di Fondi	42°23'	13°05'	IV
Rocca di Papa	41°46'	12°43'	V
Roccalbegna	42°47'	11°30'	NF
Rocca Priora	41°47'	12°45'	IV
Rocca Sinibalda	42°17'	12°56'	?
Ronciglione	42°17'	12°13'	IV-V
San Benedetto del Tronto	42°56'	13°54'	NF
San Felice Circeo	41°14'	13°05'	NF
San Gemini	42°37'	12°33'	V
San Pietro Infine	41°27'	13°58'	II
San Severino	43°14'	13°11'	III
Sant'Angelo Romano	42°02'	12°43'	IV
Sant'Ambrogio	41°23'	13°52'	NF
Santa Rufina	42°25'	12°56'	V
Sant'Elpidio	42°14'	13°11'	V
S. Vincenzo Valle Roveto	41°50'	13°32'	NF
Sassa	42°21'	13°18'	IV-V
Scanno	41°54'	13°53'	II
Scheggino	42°43'	12°50'	IV
Sella di Corno	42°22'	13°11'	IV-V
Sellano	42°53'	12°56'	IV
Senigallia	43°43'	13°13'	II
Siena	43°47'	11°20'	?
Soriano nel Cimino	42°25'	12°14'	IV
Spoleto	42°44'	12°44'	V
Stroncone	42°30'	12°40'	IV
Subiaco	42°56'	13°06'	IV-V
Teramo	42°40'	13°42'	?
Terni	42°34'	12°39'	VI
Terracina	41°17'	13°14'	II
Tivoli	41°58'	12°48'	IV
Todi	42°47'	12°24'	IV-V
Torreorsina	42°34'	12°44'	V
Torricella in Sabina	42°16'	12°52'	VI
Toscanella	?	?	IV
Trevi	41°52'	13°15'	IV
Valfabbrica	43°09'	12°36'	IV
Velletri	41°41'	12°47'	IV
Venafro	41°29'	14°03'	NF
Vetralla	42°19'	12°03'	IV
Vetriano	43°47'	12°44'	NF
Vigliano	42°21'	13°13'	IV-V
Visso	42°56'	13°05'	III
Viterbo	42°25'	12°07'	V

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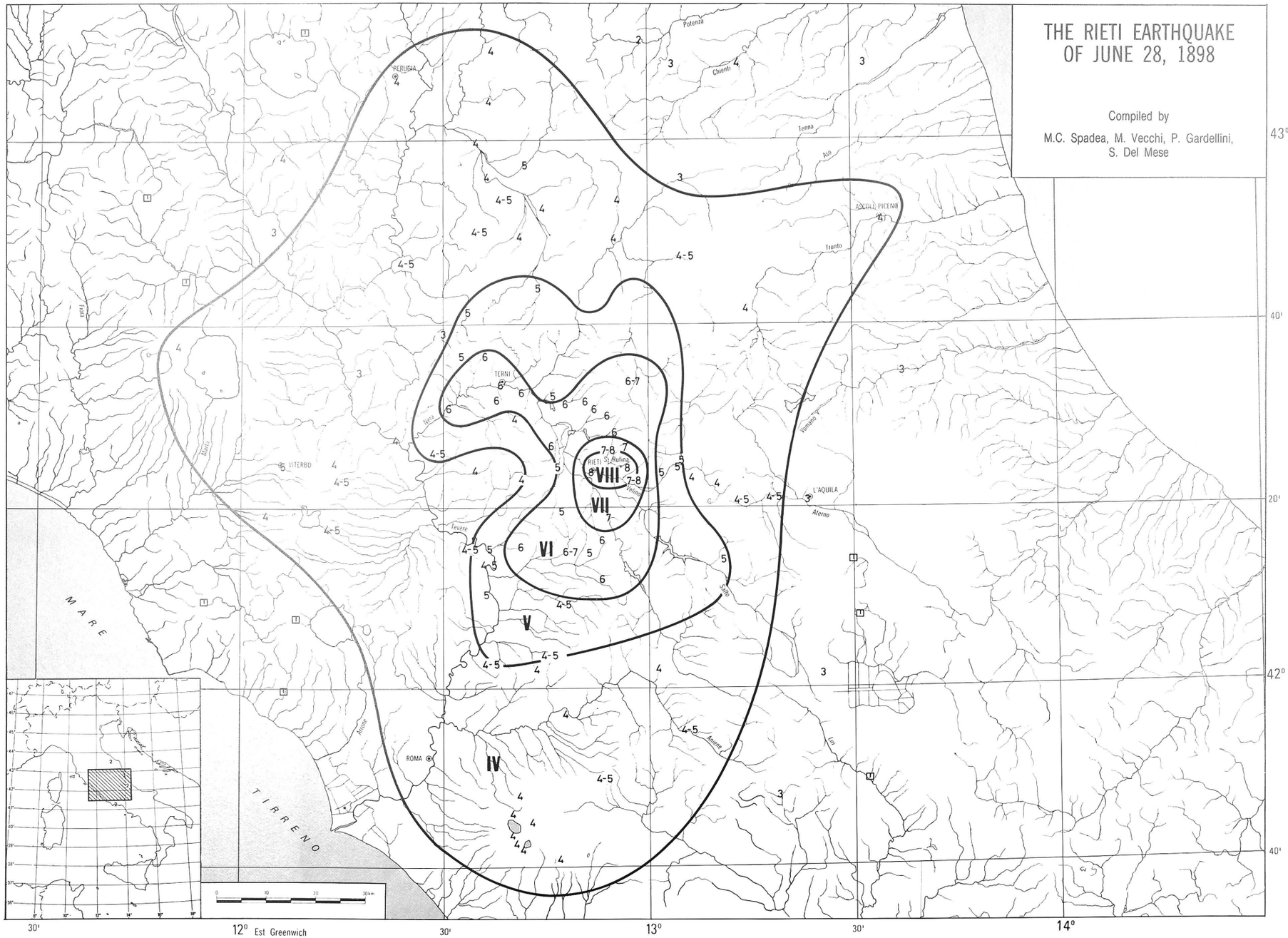

The drainage network of this map - scale 1:500.000 - is the same as the "Structural Model of Italy."

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The Palombara Sabina earthquake of April 24, 1901.

M.C. Spadea, M. Vecchi, P. Gardellini, S. Del Mese

The seismic period of Palombara Sabina began on 21 April with a slight tremor felt at Monterotondo (1, 2, 3). In the days that followed, there were four other comparatively strong events which preceded the main shock that hit the area at the foot of Mt. Gennaro at 15^h20^m.
The worst hit towns were Stazzano, Cretone, Palombara Sabina and Montelibretti.
There were many aftershocks in the days that followed, the largest of which occurred on 7 May at 9^h39^m and caused damage at Cretone.
The seismic period ended on 18 May. The event is classified as follows in the CNEN General Catalogue of Earthquakes from Beginning of Christian Age to 1971. Published 1973:

Year	Mo	Da	Ho	Mi	Lat	Long	I_o	Mk
1901	4	24	08	03	42°06'	12°42'	Felt	
1901	4	24	14	20	42°06'	12°42'	IX	5.0
1901	4	24	14	47	42°06'	12°42'	Felt	

and in the ENEL File of Italian Earthquakes from 1000 up to 1975. Unpublished 1977:

Year	Mo	Da	Ho	Mi	Lat	Long	I_o	Mk	Mp	Epic. area
1901	4	24	11	55	42°05'	12°45'	III	2.5	2.8	Palombara Sabina
1901	4	24	14	20	42°05'	12°45'	VIII	5.1	4.5	Palombara Sabina
1901	4	24	14	30	42°05'	12°45'	IV-V	3.3	3.4	Palombara Sabina

The information referring to the most severely affected area, which comprised two hamlets of Palombara Sabina, may be summarized as follows:
- at Stazzano, a village composed of some thirty buildings, mostly poorly constructed, four or five collapsed completely and the others were damaged;
- at Cretone, seven or eight houses already in a bad state of repair, were declared uninhabitable and many others suffered comparatively severe damage.

A detailed analysis of the data led us to assign a maximum MCS intensity of VIII. The macroseismic field is particularly small, enclosing the three isoseisms of VIII, VII and VI in an area of only 322 sq. Km. The isoseisms themselves are fairly well defined.
The lack of data and the difficulties involved in collecting them make the intensity IV and III areas uncertain. In fact, the areas where an earthquake is barely perceived and there are no objective terms of reference are lost if they are not detected early.
The isoline trend reveals a sharp eastward attenuation, and 40 km away in this direction the tremor was not detected.
This phenomenon can probably be partly explained in terms of geological structure.
Greater attenuation of the effects was observed only 4 km from the epicentre at Moricone, which is situated on compact biassic limestone, than at Montelibretti, located on friable Pliocene rock composed of layers of gravel and sand alternating with sandy clay.
There are references (1, 2) to cracks in the ground, emission of gas, water turbidity, variations in well water levels, agitation of animals and flashes.

Macroseismic parameters

I_o = VIII MCS

$\varphi_m = 42°,09 \qquad \lambda_m = 12°,74$

List of shocked localities:

Locality	Latit.	Long.	I (MCS)
Anzio	41°28'	12°37'	NF
Borgocollefegato (Borgorose)	42°12'	13°14'	NF
Cerveteri	42°00'	12°06'	NF
Collegio di Mondragone	41°49'	12°42'	IV
Cori	41°39'	12°55'	NF
Cretone	42°04'	12°42'	VIII
Fara Sabina	42°13'	12°44'	V
Fiamignano	42°14'	13°08'	NF
Fiumicino	41°46'	12°14'	NF
Formello	42°05'	12°24'	IV-V
Frascati	41°48'	12°41'	III-IV
Labra	42°31'	12°48'	III
Marino	41°46'	12°40'	III
Mentana	42°02'	12°38'	V-VI
Montecelio	42°01'	12°45'	V (?)
Montecompatri	41°48'	12°44'	IV
Monteflavio	42°06'	12°50'	V
Montelibretti Casali	42°08'	12°44'	VII
Montelibretti Castello	42°08'	12°44'	VII
Montemaggiore	42°09'	12°41'	VII (?)
Monteporzio	41°49'	12°43'	III-IV
Monterotondo	42°03'	12°37'	VI
Moricone	42°07'	12°46'	VI
Narni	42°31'	12°31'	III
Nepi	42°14'	12°21'	III
Nettuno	41°28'	12°40'	NF
Orvinio	42°08'	12°56'	III
Oriolo Romano	42°10'	12°08'	NF
Paliano	41°48'	13°03'	III
Palombara Sabina	42°04'	12°46'	VII
Poggio S. Lorenzo	42°15'	12°51'	IV-V
Ponticelli	42°10'	12°49'	V
Rieti	42°24'	12°52'	III
Rocca di Papa	41°46'	12°43'	III
Rocca Priora	41°47'	12°45'	III
Roma	41°54'	12°29'	IV
Ronciglione	42°17'	12°31'	NF
Scoppito	42°22'	13°15'	NF
Soriano nel Cimino	42°25'	12°14'	NF
Stazzano	42°05'	12°46'	VIII
Tagliacozzo	42°04'	13°15'	NF
Tivoli	41°58'	12°48'	IV-V
Vallepietra	41°41'	12°47'	NF
Velletri	41°41'	12°47'	NF

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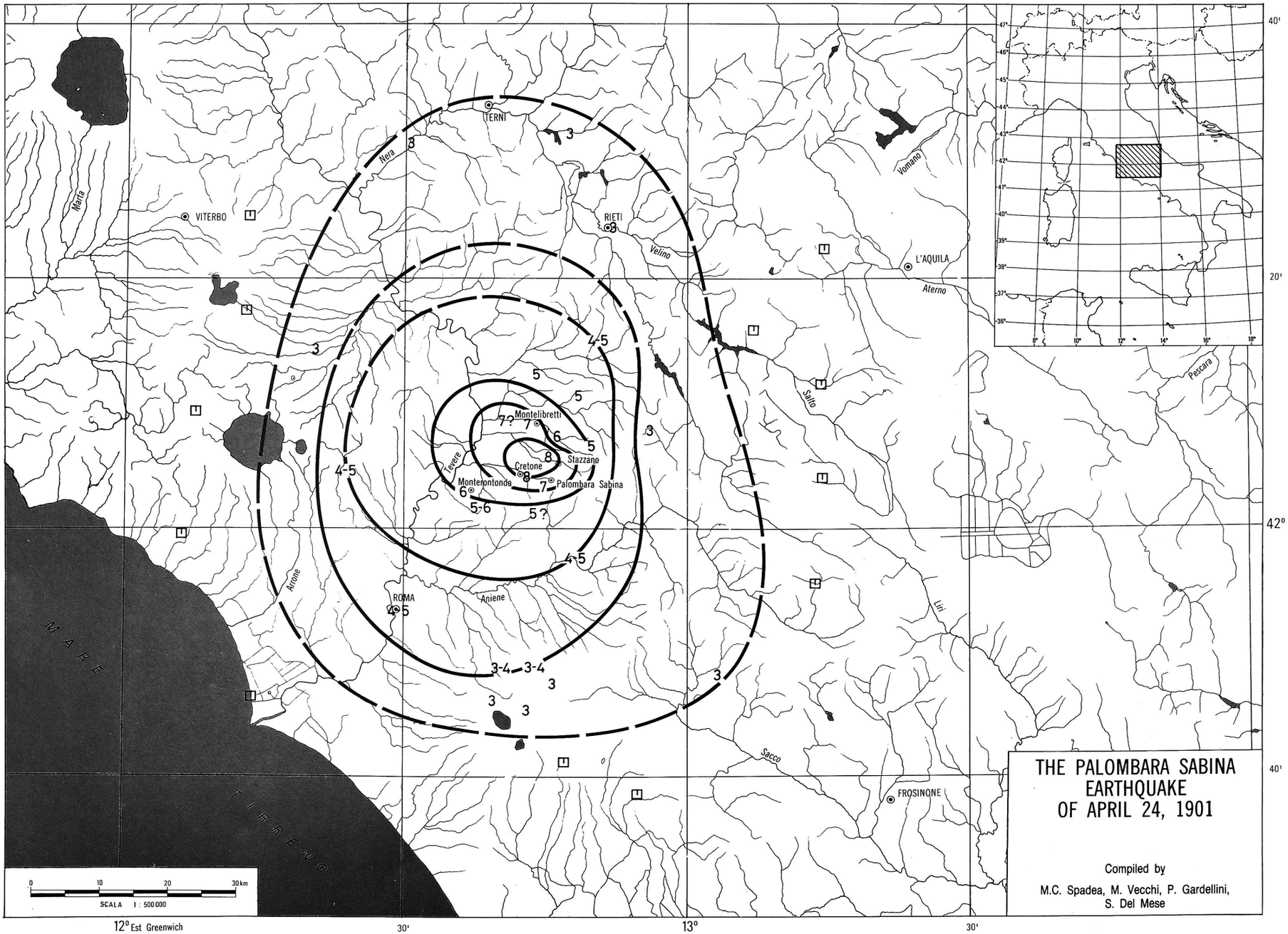

THE PALOMBARA SABINA EARTHQUAKE OF APRIL 24, 1901

Compiled by

M.C. Spadea, M. Vecchi, P. Gardellini, S. Del Mese

The drainage network of this map – scale 1:500.000 – is the same as the "Structural Model of Italy."

G.T.M - Via Marco Marulo 47a - 00143 ROMA

The Marsica earthquake of February 24, 1904.

M.C. Spadea, M. Vecchi, P. Gardellini, S. Del Mese

At 14^h30^m on 24 February, a slight tremor felt at Tagliacozzo marked the beginning of an important seismic period which reached its peak two hours later (16^h53^m), with an MCS intensity of IX.
There were numerous aftershocks, the most powerful of which were:

25 February 01^h29^m VII-VIII
felt in the same area as the main one;

3 March 19^h56^m VI
felt at Magliano dei Marsi, Scurcola, Tagliacozzo, Borgorose, Avezzano, Rocca di Papa;

10 March early morning VII
felt at Magliano dei Marsi;

10 March 05^h22^m VII
felt at Magliano dei Marsi, Massa d'Albe, Scurcola, Avezzano;

11 March 14^h25^m VI
felt at Magliano dei Marsi;

20 March 06^h50^m VI
felt at Magliano dei Marsi and Scurcola;

20 March 08^h50^m VI
felt at Magliano dei Marsi and Scurcola;

25 March 09^h00^m VI-VII
felt at Magliano dei Marsi;

7 April 20^h00^m VI
felt at Magliano dei Marsi;

13 April 06^h57^m VI
felt at Scurcola and Scanzano;

20 April 23^h53^m V-VI
felt at Scanzano;

The long series of aftershocks can be considered as ending only on 23 July.
In the epicentral zone, limited to Magliano dei Marsi and one of its hamlets (Rosciolo), the damage was very extensive.
A very large number of houses were left uninhabitable, and many collapsed either completely or partially. Rosciolo (MCS intensity IX) was "literally reduced to a pile of rubble": none of its 500 dwellings remained inhabitable.
The damage was also very severe at Magliano dei Marsi (about 600 houses were left uninhabitable), although the descriptions available do not allow a definite intensity to be assigned to this locality and it fluctuates between MCS VIII and IX. It must be stressed, however, that as in the surrounding municipalities, the seriousness of the damage was due not only to the violence of the earthquake but also to the age of the buildings and the unsatisfactory construction techniques used. Furthermore, the numerous strong aftershocks repeatedly shaking the disaster area certainly contributed to the ruin of the two townships.
The data resulting from the Civil Engineering Department inspections differ from that obtained from the macroseismic questionnaires by the up to first the MCS degree. This is not surprising since the number of strong and closely successive aftershocks certainly affected the experts' judgment and led them to overestimate the seriousness of the damage caused by the earthquake. The analysis made of this event is the same as that of Cavasino, who described this seismic period with a great wealth of detail. The bibliography is 1, 2, 3, 4, 5.
The macroseismic field is characterized by an intensity of IX to IV. The direction of maximum propagation is parallel to the Apennines. The IX and VIII isoseisms are well-defined and nearly circular in shape. Starting from the VII area and for all the other curves plotted, the available data have not allowed an accurate determination to be made and the curves have been obtained by interpolation of data referring to comparatively distant localities. However, the trends of the isoseisms obtained in this way do not differ substantially from the true ones since the macroseismically shaken area appears to be quite small.

Macroseismic parameters

I_o = IX° MCS

φ_m = 42°,11 λ_m = 13°,34

List of shocked localities:

Locality	Latit.	Long.	I (MCS)
Alvito	41°41'	13°45'	NF
Antrodoco	42°25'	13°05'	IV
Avezzano	42°02'	13°26'	VI
Barisciano	42°19'	13°36'	NF
Borgorose	42°12'	13°14'	VII
Capestrano	42°16'	13°46'	IV
Cappadocia	42°00'	13°17'	VI
Cappelle	42°04'	13°23'	VIII
Carsoli	42°06'	13°05'	V
Celano	42°05'	13°33'	V
Cervara di Roma	41°59'	13°04'	IV
Cerveteri	42°00'	12°06'	NF
Città Ducale	42°23'	12°57'	NF
Civitella Roveto	41°55'	13°25'	V
Frascati	41°48'	12°41'	III
Gallo	41°36'	13°56'	VIII
Grottaferrata	41°47'	12°41'	NF
Introdacqua	42°00'	13°54'	NF
Isola del Liri	41°41'	13°35'	IV
L'Aquila	42°21'	13°24'	IV
Magliano dei Marsi	42°06'	13°22'	VIII-IX
Marano	42°13'	13°56'	VIII
Massa D'Albe	42°06'	13°24'	VII
Montecompatri	41°48'	12°44'	NF
Monteporzio	41°49'	12°43'	NF
Monterotondo	42°03'	12°37'	IV
Paliano	41°48'	13°03'	IV
Pescocostanzo	41°53'	14°04'	NF
Pescorocchiano	42°12'	13°09'	VI
Pico	41°27'	13°34'	NF
Poggio Filippo	42°05'	13°18'	VIII
Poggio Nativo	42°13'	12°48'	IV
Poggio San Lorenzo	42°15'	12°51'	IV
Rocca di Papa	41°46'	12°43'	III
Rocca Priora	41°47'	12°45'	III
Roma	41°54'	12°29'	III
Rosciolo	42°07'	13°20'	IX
Rieti	42°24'	12°52'	IV
San Donato	42°06'	13°17'	VIII
Sant'Anatolia	42°08'	13°17'	VIII
Sant'Elpidio	42°14'	13°11'	VI
Sante Marie	42°06'	13°12'	VII
Scanzano	42°06'	13°15'	VIII
Scurcola	42°04'	13°20'	VIII
Sora	41°43'	13°37'	IV
Sorbo	42°04'	13°19'	VIII
Squarciarelli	41°47'	12°41'	NF
Subiaco	41°55'	13°06'	IV-V
Tagliacozzo	42°04'	13°15'	VII
Terni	42°34'	12°39'	III
Torano	42°49'	13°47'	VII
Tivoli	41°58'	12°48'	IV
Urbino	43°44'	12°38'	III
Valle Corsa	41°27'	13°24'	NF
Vallepietra	41°54'	13°14'	IV-V
Velletri	41°41'	12°47'	III
Veroli	41°41'	13°25'	IV

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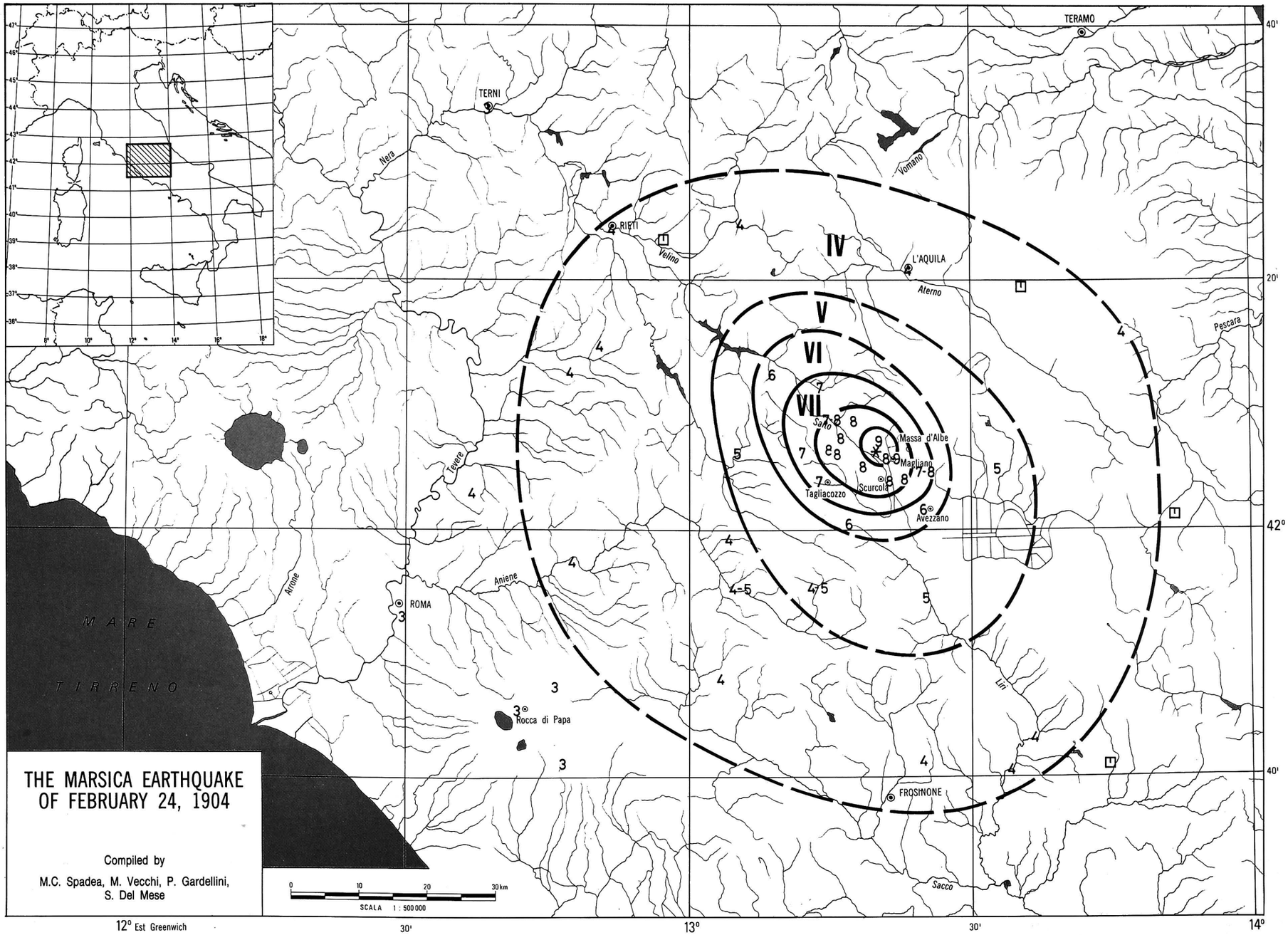

THE MARSICA EARTHQUAKE OF FEBRUARY 24, 1904

Compiled by

M.C. Spadea, M. Vecchi, P. Gardellini, S. Del Mese

The drainage network of this map – scale 1:500.000 – is the same as the "Structural Model of Italy."

G.T.M - Via Marco Marulo 47a - 00143 ROMA

The Fondo Macchia earthquake of October 15, 1911.

S. Imposa, G. Patané

The particular location of this event and its unusual violence allowed a detailed study of the seismic phenomenon by various contemporary scholars. In fact, the area where the effects of the earthquake were most severe, is at the margins of urban centers of primary importance (Giarre and Acireale), the economy of which was based mainly on agriculture and commerce. The area underwent a temporary crisis because of the damage done by the earthquake to buildings and main roads.
The mezoseismic area has a surface of about 3.25 km², a length of 6.5 km, and an average width of 0.5 km, its major axis, oriented in the NNW-SSE direction, at one end corresponds to the urban centers of Fondo Macchia and at the other to Guardia (1, 2, 4).
The urban centers that underwent the most considerable damage were:

- Fondo Macchia
In this center, all of the roads were obstructed by stones from the collapse of dry walls and the houses were either totally or partially destroyed; almost all of the roofs fell in and solid iron gates bent and fell off their hinges. On a farm near the center, a farmer died of asphyxia after having been practically swallowed up by a crevice which then closed.

- Baglio
More or less severe damage was done to the carrying structures of well-constructed buildings. There was total collapse of isolated cottages or villas with main outer retaining walls made of blocks of poorly shaped and cemented lava. The dry boundary walls were usually knocked in an eastern direction.

- Rondinella
In this locality, all of the buildings were razed to the ground by the earthquake.

- Mangano
Only severe cracks in all of the houses of this urban center were observed, though there was also a report of the death of two people who were hit by two slabs of white limestone hurled fifteen meters from their original site.
In the localities of Fau, Badia, Palombaro and Guardia, the effects of the earthquake were equally disastrous and ranged from severe cracks in supporting structures up to complete collapse. In Mangano and Guardia, there were fifteen people injured and two deaths. In all, including deaths and injuries, there were about onehundred victims, and the damage was calculated at about L. 528.750.

Fissures and sinkings of the soil were observed along a narrow six-kilometer-long strip in the NNW-SSE direction, having an average width of 1 km, with one end at Sciara S. Giovanni and the other end at Palombaro. In particular in the roads and fields between Fondo Macchia and Dagala, fissures a few decimeters wide and a few meters deep were observed, prevailing in the N-S direction and extending into the region between Sciara and Rondinella as well. Along provincial road number 114, due south of the locality of S. Leonardello, a fissure with an average width of two decimeters and a sinking of the soil were observed. In S. Venerina, two sinkings of about 15 cm each were reported in the main road. Finally, in Palombaro the soil was disarranged by sinkings and deep fissures, some more than a meter deep.
Table 1 lists all the localities, taken from the bibliography, where the earthquake caused permanent effects on the environment and buildings and temporary effects on the people and objects.
The phenomena accompanying the earthquake included the restlessness of animals and a loud roar, which was even heard in localities far from the epicentral area, e.g. Aci Bonaccorsi and Fiumefreddo.
A special study of the aeral distribution of the ways in which the shock was felt and on its duration was carried out by O. De Fiore (1919). In fact, De Fiore noticed that in the regions and inhabited centers west of the mesoseismic area, the vibrations of the soil were felt for a longer time (an average of 12 seconds) than in those areas east, south and south-west of the mesoseismic area (an average of 5-6 seconds). This phenomenon has been explained by the topographical structure of this region, which would produce effects of reflection resulting in the focalization of the seismic waves on the localities situated against the lower buttresses of the volcano. By utilizing the experimental macroseismic field attributed to the event, the focal depth was determined, and does not seem to be greater than 1 km.
The main seismic event was proceeded by 43 foreshocks which were registered by the seismograph at the Università di Catania and/or felt in various localities (3, 4, 5).
The analysis of the spatiotemporal distribution of the macroseismic epicenters related to these shocks has shown a regular migration of the active centers from NW to SE or, more precisely, from the NW versant of Etna to the opposite SE versant, along a generatrix of the cone of the volcano almost perpendicular to the radial fault that led to its eruption in September 1911.

List of shocked localities:

Locality	Latit.	Long.	I (MCS)
Aci Bonaccorsi	37°35'	15°06'	III-IV
Aci Castello	37°33'	15°09'	II
Aci Catena	37°36'	15°08'	IV
Acireale	37°37'	15°10'	IV
Aci S. Antonio	37°37'	15°06'	III
Badia	37°41'	15°08'	IX
Baglio	37°42'	15°09'	VIII
Calvario	37°42'	15°09'	VIII
Castiglione	37°52'	15°07'	NF
Catania	37°31'	15°05'	II
Cesarò	37°51'	14°43'	NF
Dagala	37°42'	15°09'	VII
Fau	37°41'	15°09'	X
Fiumefreddo	37°47'	15°12'	IV
Fondo Macchia	37°43'	15°12'	X
Giarre	37°43'	15°11'	V
Guardia	37°40'	15°10'	VII-VIII
Linera	37°39'	15°08'	VII
Linguaglossa	37°50'	15°09'	III
Macchia	37°43'	15°10'	VII
Malvagna	37°56'	15°02'	NF
Maniace	37°50'	14°49'	III-IV
Mangano	37°40'	15°10'	VII-VIII
Mascalucia	37°34'	15°02'	II
Misterbianco	37°31'	15°01'	NF
Nunziata	37°45'	15°10'	VI
Palombaro	37°40'	15°09'	IX
Pedara	37°37'	15°04'	III
Riposto	37°44'	15°12'	V
Roccella Valdemone	37°56'	15°01'	NF
Rondinella	37°42'	15°09'	IX
S. Alfio	37°44'	15°09'	VI
S. Giovanni	37°43'	15°09'	X
S.G. la Punta	37°35'	15°06'	III
S. Venerina	37°41'	15°08'	VII
Sorbo	37°39'	15°09'	IX
Stazzo	37°39'	15°12'	V
Taormina	37°51'	15°17'	II
Trecastagni	37°37'	15°06'	IV
Viagrande	37°36'	15°06'	III
Zafferana Etnea	37°41'	15°07'	V

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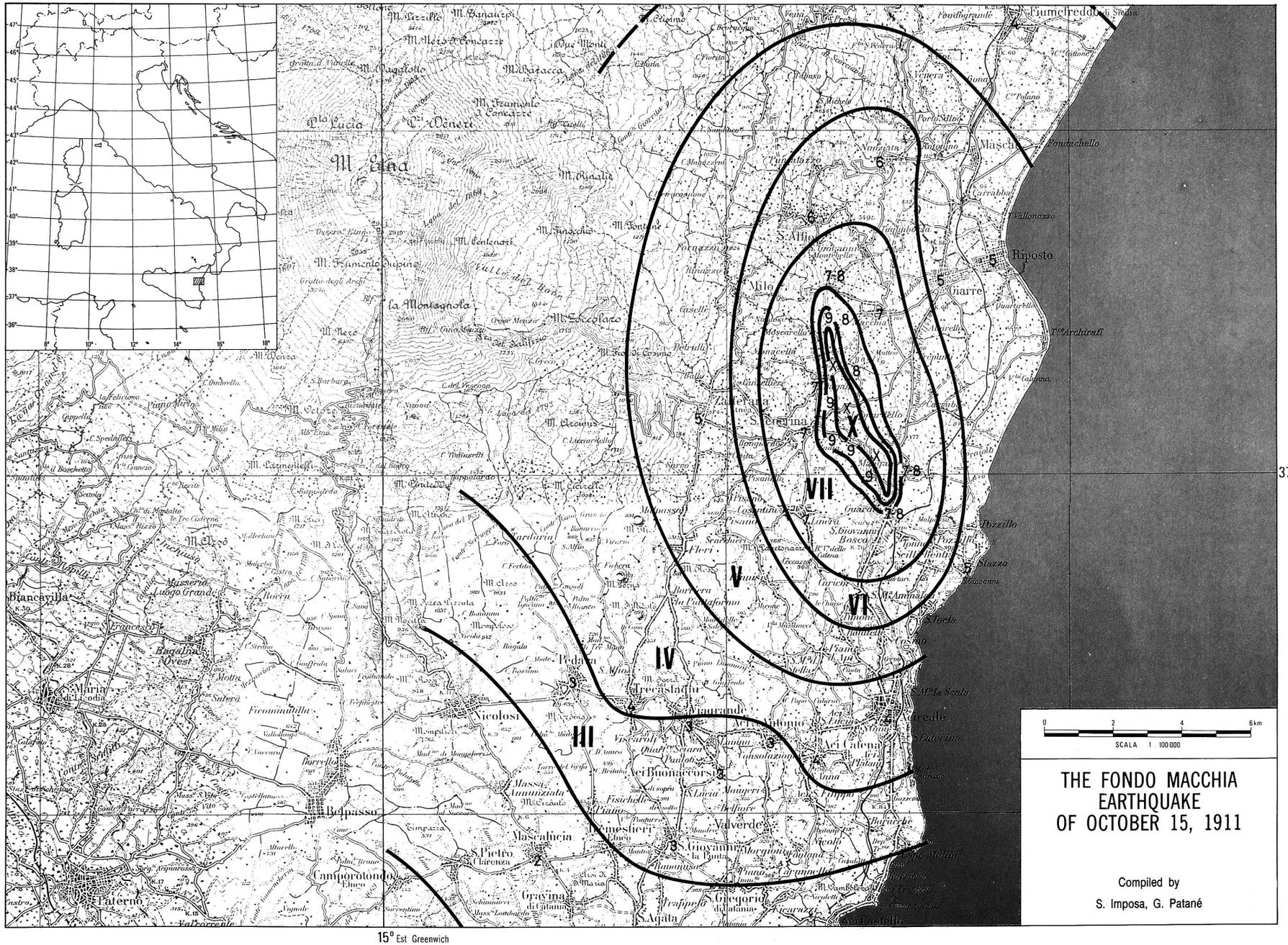

The drainage network of this map – scale 1:100.000 – is taken from the official production of the IGMI – Firenze.

G.T.M - Via Marco Marulo 47a - 00143 ROMA

The Molise earthquake of October 4, 1913.

M.C. Spadea, M. Vecchi, P. Gardellini, S. Del Mese

This event affected the area straddling the Sannio mountains in 1913.
The seismic period began at 19^h26^m on 4 October, without any warning shocks.
The earthquake was accompanied by numerous aftershocks, which lasted until the following month. The largest of these occurred on 25 November (MCS intensity VI at Cercemaggiore) and was strongly felt at Campobasso, Colle Sannita, Santa Croce del Sannio, Gambatesa and Piedimonte Matese.
This event was classified in the CNEN General Catalogue of Earthquakes from Beginning of Christian Age to 1971 - Published 1973, as follows:

Year	Mo	Da	Ho	Mi	Lat	Long	De	I_o	Mk
1913	10	4	18	26	41°30'	14°42'		VIII-IX	5.3
1913	10	4	19	28	41°30'	14°42'		Felt	
1913	10	4	20	47	41°30'	14°42'		Felt	

and in the ENEL File of Italian Earthquakes from 1000 up to 1975 - Unpublished - 1977: Unreported

Year	Mo	Da	Ho	Mi	Lat	Long	De	I_o	Mk	Mp	Epic. area
1913	10	4	18	26	41°30'	14°42'	12	VIII	5.8	4.8	Vinchiaturo
1913	10	4	19	28	41°30'	14°51'		IV	3.0	3.2	Colle Sannita
1913	10	4	20	47	41°30'	14°42'					Vinchiaturo

This event was studied using the following main sources of information 1, 2, 3, 4, 5.
Only slight damage was found in solidly constructed buildings in the worst hit area, while larger cracks and other damage were found in badly built constructions.
The worst hit towns inside this area were reportedly Ielsi and Vinchiaturo. Serious damage and several collapses were reported at Vinchiaturo, and serious damage, many collapses and 30 persons injured at Ielsi.
Consequently, an MCS intensity of VIII has been assigned to the above two localities, which appear on the map as two isolated points in an area of intensity VII.
On the other hand, no specific reference is made in further data collected around 1920 to particular damage or extensive reconstruction after the 1913 earthquake. Vinchiaturo is known to have been completely destroyed in the 1805 earthquake and subsequently reconstructed «in modern style, with wide streets and large squares». Ielsi, which lies in a small hollow at the end of a hill that projects like a spur into Fiumara Carapelle, is described as a large township composed of «farm cottages, wretched little churches and several buildings of importance mingling with small houses along a large street running uphill». (Italian Touring Club Guidebook, volume I, Southern Italy, 1926).
From these descriptions, the reports of partial collapses occurring at Vinchiaturo would seem to be exaggerated, unless they were old buildings still in a bad state of repair after reconstruction. The reports of damage to the structures at Ielsi, i.e. partial collapse and multiple cracks, would appear to be more reliable, in view of the state of the buildings at the time of the earthquake.
This is all the information that it has been possible to gather so far from macroseismic questionnaires, historical references, etc.
Even after detailed analysis of these data several points remain to be clarified.
In an intensity VII area that is clearly delimited by the relative isoseism, two intensity VIII areas restricted to Vinchiaturo and Ielsi emerge a considerable distance apart.
The problem is whether a maximum intensity of VIII can be assigned to the earthquake when possibly the number of aftershocks, the different geological structure of the sites of the two townships, and the difficulties involved in collecting data in an extremely poor and comparatively uninhabited area have perhaps led to the data being overestimated?
It is beyond our present scope to carry out such a verification, and the material available is unlikely to help us more than it already has to solve the problem.
The epicentral coordinates refer to the barycentre of the intensity VII area.

Macroseismic parameters

$\varphi_m = 41°,49$ $\quad I_o = $ VII MCS $\quad \lambda_m = 14°,64$

List of shocked localities:

Locality	Latit.	Long.	I (MCS)
Acerenza	40°48'	15°56'	NF
Agnone	40°13'	14°60'	IV
Alberona	41°26'	15°04'	III
Altamura	40°50'	16°33'	NF
Amalfi	40°38'	14°36'	III
Apice	41°07'	14°56'	IV-V
Apricena	41°47'	15°27'	IV
Aquilonia	40°59'	15°29'	III
Aquino	41°30'	13°42'	IV
Ariano di Puglia	41°09'	15°05'	III
Arpino	41°39'	13°37'	NF
Ascoli Satriano	41°12'	15°34'	III
Atessa	42°04'	14°27'	III
Avellino	40°55'	14°47'	IV
Avezzano	42°02'	13°26'	NF
Balsorano	41°48'	13°34'	NF
Baranello	41°32'	14°33'	VII
Barisciano	42°20'	13°36'	NF
Barletta	41°19'	16°17'	III
Benevento	41°08'	14°47'	V
Biccari	41°24'	15°12'	V
Boiano	41°29'	14°28'	VII
Bonefro	41°42'	14°56'	V
Cagnano Varano	41°50'	15°47'	III
Caiazzo	41°11'	14°22'	V
Campagna	40°40'	15°06'	NF
Campobasso	41°33'	14°40'	VI
Cantalupo nel Sannio	41°31'	14°24'	VI?
Capracotta	41°50'	14°16'	III
Carovilli	41°43'	14°18'	V
Carpineto	41°36'	13°05'	NF
Carpino	41°51'	15°51'	V
Carpinone	41°36'	14°20'	IV
Casalbore	41°14'	15°01'	V
Casalciprano	41°35'	14°32'	VI
Caserta	41°04'	14°20'	V
Cassino	41°29'	13°50'	IV
Castelbaronia	41°03'	15°11'	IV
Castel di Sangro	44°47'	14°06'	III
Castellamare di Stabia	40°42'	14°29'	IV
Castropignano	41°37'	14°34'	IV
Cava dei Tirreni	40°42'	14°42'	IV
Ceccano	41°34'	13°20'	NF
Celenza Valfortoree	41°34'	14°59'	V
Ceppaloni	41°03'	14°46'	VI?
Ceprano	41°33'	13°31'	IV
Cercemaggiore	41°28'	14°43'	VII
Cerreto Sannita	41°17'	14°34'	V
Cervaro	41°29'	13°54'	IV
Chieti	42°21'	14°10'	III
Civitella Roveto	41°55'	13°25'	NF
Colle Sannita	41°22'	14°60'	VI-VII
Cusano Mutri	41°20'	14°30'	V
Foggia	41°28'	15°33'	IV
Foglianise	41°10'	14°40'	V-VI
Fondi	41°21'	13°26'	III
Frascati	41°48'	12°41'	NF
Gambatesa	41°31'	14°55'	VI
Gamberale	41°54'	14°13'	IV
Gildone	41°31'	14°44'	VII
Guarcino	41°48'	13°19'	?
Guardiaregia	41°26'	14°33'	VII
Jelsi	41°31'	14°48'	VIII
Ischitella	41°54'	15°54'	V
Isernia	41°36'	14°14'	V
Isola d'Ischia	40°45'	13°57'	IV
Lanciano	42°14'	14°23'	III?
Larino	41°48'	14°55'	IV
Lucera	41°30'	15°20'	IV
Maddaloni	41°02'	14°23'	IV
Manfredonia	41°37'	15°54'	NF
Margherita di Savoia	41°22'	16°09'	III
Mercato S. Severino	40°47'	14°46'	III
Mignano	41°24'	13°59'	IV
Minervino Murge	41°05'	16°05'	III
Moiano	41°05'	14°33'	V
Montagano	41°39'	14°40'	V
Montecalvo Irpino	41°12'	15°02'	IV
Montecassino	41°29'	13°49'	VI
Montefalcone nel Sannio	41°50'	14°38'	IV
Montemiletto	41°01'	14°55'	NF
Monte Sant'Angelo	41°42'	15°58'	IV
Monte Sarchio	41°04'	14°38'	IV
Morcone	41°20'	14°40'	III
Motta M. Corvino	41°30'	15°07'	?
Napoli	40°51'	14°16'	IV-V
Nocera Inferiore	40°45'	14°28'	IV
Nola	40°56'	14°32'	III
Oratino	41°35'	14°35'	V
Ortanova	41°20'	15°42'	IV
Pescara	42°28'	14°13'	III
Pescocostanzo	41°53'	14°04'	III
Peschici	41°57'	16°01'	III
Piedimonte d'Alipe	41°21'	14°22'	V
Pietracatella	41°35'	14°52'	V
Pietramelara	41°16'	14°11'	IV
Pietraroia	41°21'	14°33'	V
Pozzuoli	40°49'	14°07'	III
Pratica	41°40'	12°29'	NF
Procida	40°45'	14°01'	IV
Rocca d'Evandro	41°23'	13°54'	IV
Rocca di Papa	41°46'	12°43'	III
Rodi Garganico	41°56'	15°53'	III
Riccia	41°29'	14°50'	VII
Roseto	41°22'	15°06'	III
San Bartolomeo in Galdo	41°25'	15°01'	IV-V
San Ferdinando di Puglia	41°18'	16°04'	III
San Giorgio a Cremano	40°50'	14°20'	V
San Giovanni Rotondo	41°42'	15°44'	V
S. Giuliano del Sannio	41°27'	14°38'	VII
San Leucio	41°06'	14°19'	V
San Marco in Lamis	41°43'	15°38'	IV?
San Marco la Catola	41°31'	15°00'	?
S. Martino in Pensilis	41°52'	10°01'	IV
S. Nicandro Garganico	41°50'	15°34'	IV
S. Paolo in Civitate	41°44'	15°16'	?
S. Pietro Avellana	41°47'	14°11'	V
S. Pietro Infine	41°27'	13°58'	IV
S. Severo	41°41'	15°23'	IV
S. Angelo dei Lombardi	40°56'	15°11'	NF
S. Croce del Sannio	41°23''	14°44'	VI
S. Maria Capua Vetere	41°05'	14°15'	?
Serracapriola	41°48'	15°10'	V
Sora	41°43'	13°37'	III
Sorrento	40°37'	14°23'	IV
Spinete	41°33'	14°29'	VII
Stornara	41°17'	16°46'	?
Stornarella	41°15'	15°54'	NF
Subiaco	41°55'	13°06'	NF
Teano	41°15'	14°04'	IV
Terlizzi	41°08'	16°33'	NF
Torremaggiore	41°41'	15°18'	IV
Trani	41°17'	16°25'	III
Treia	43°19'	13°19'	NF
Tricarico	40°37'	16°09'	NF
Trinitapoli	41°21'	16°05'	III
Trivento	41°47'	14°43'	IV
Tufara	41°29'	14°57'	VI
Vallerotonda	41°33'	13°55'	IV
Valmontone	41°47'	12°55'	NF
Venafro	41°29'	14°03'	IV
Venosa	40°58'	15°49'	NF
Vesuvio	40°50'	14°27'	III
Vieste	41°53'	16°11'	III
Villa S. Lucia	41°31'	13°46'	III
Vinchiaturo	41°30'	14°35'	VIII
Vitulano	41°10'	14°39'	?
Volturara Appula	41°30'	15°03'	V
Volturino	41°29'	15°07'	III

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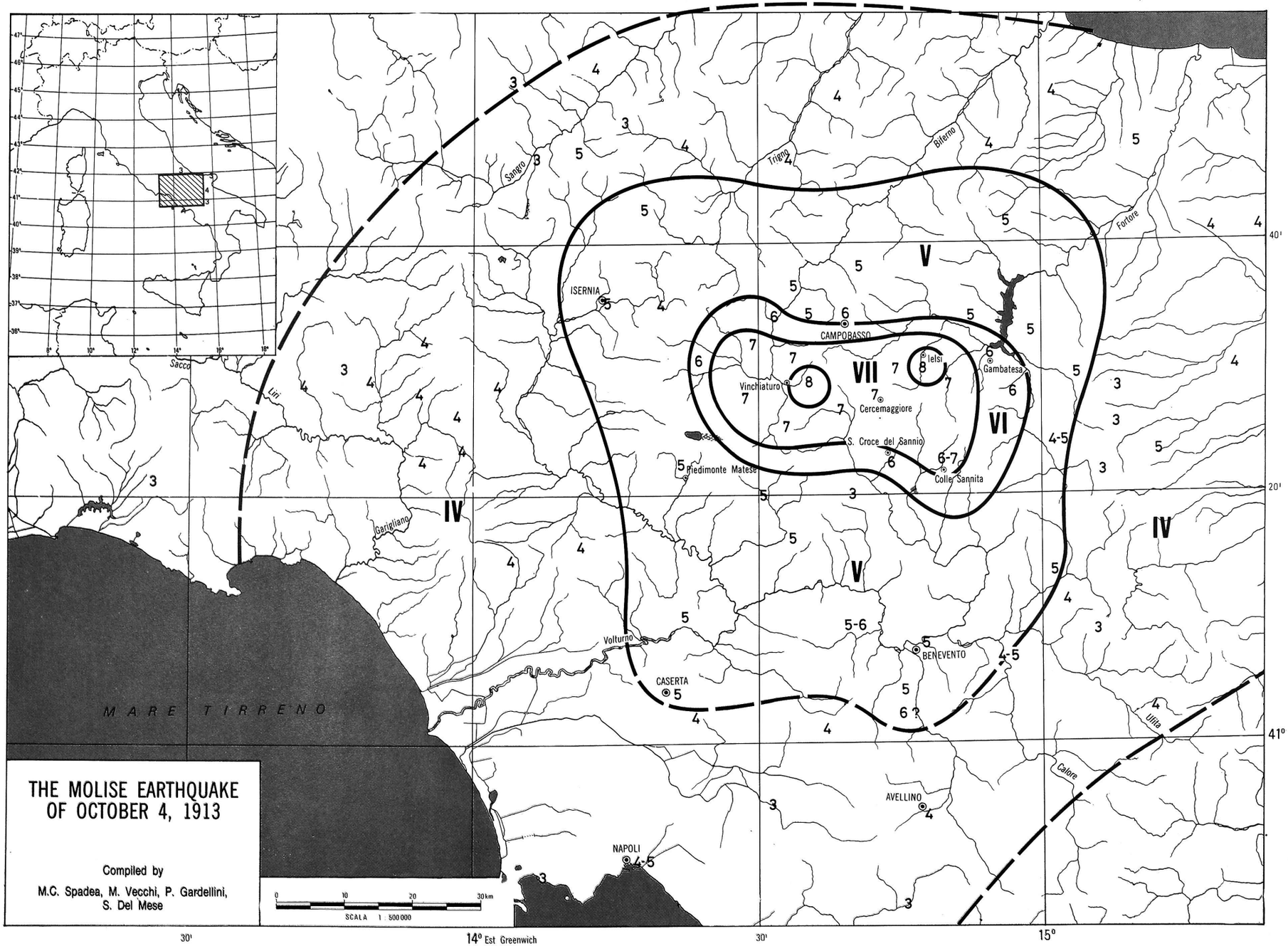

The drainage network of this map – scale 1:500.000 – is the same as the "Structural Model of Italy."

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The Linera earthquake of May 8, 1914.

G. Patané, S. Imposa

The earthquake of May 8, 1914, was one of the macroseismic events of Etna studied in major detail by scholars contemporary to the event (1, 2).
According to the various authors of the period, the mesoseismic area has approximately an elliptical shape, with its major axis approximately 8 km long, oriented NW-SE, and its minor axis approximately 3 km long. Subsequent revisions carried out on original bibliographic data (3) have allowed us to distinguish two isoseismal lines in the zone where major damage occurred. These lines delimit the VIII and IX degree areas of intensity.
The localities where major damage occurred were:

- Pennisi and Sciare di Pennisi
The rural houses of Pennisi underwent a great deal of irregular collapsing of poorly-constructed dry walls.
Wide fissures (an average of 5 cm) were found in many of the less-damaged buildings. Various objects inside and outside of the houses were hurled from south to north.

- Rocca d'Api
Numerous observations were made in the (Rocca d'Alpi area) where the cemetery of Zafferana is located. All of the vaults lined up in the NW-SE direction had fallen, and the partitions between one vault and another were broken at the keystone point. On the contrary, boundary walls constructed in such a way as to form a single, linked structure did not undergo severe damage.
Moreover, various phenomena of rotation of headstones and columns were noticed in both the clockwise and counterclockwise directions. In fact, G. Platania and Sabatini carefully described the phenomena of rotation and projection observed for numerous tombs in order to obtain indications regarding the acceleration and the direction of movement of the soil.

- Passopomo
The rural houses of this locality were, for the most part, completely destroyed. Only a very small percentage were partially destroyed or severely damaged. All of the boundary walls were razed to the ground and, after the aftershocks, the stone bridge completely collapsed. Large lavic blocks broke away from the banks and fell to the bed of the torrent near Passopomo. Six fissures were observed in the road northeast of the bridge.

- Ardichetto
In the region of Ardichetto, all of the houses were razed to the ground, even the well-constructed ones. The twenty-two-meter-high distillery smokestack broke at a height of fourteen meters and shifted from north to south.

- Bongiardo
In this locality, the houses generally poorly-constructed, were in part completely destroyed while others underwent only partial collapse. Objects were found to have fallen in both the SE and NW directions. In the well-constructed buildings and the church, fissures horizontal to the foundations were observed.

- Linera
Some of the buildings in the village of Linera were razed to the ground, and some were so severely damaged that they were later demolished. One reinforced-concrete building with an irrational and poorly-made reinforcement was damaged to the point of rendering it uninhabitable though neither walls nor floors collapsed. In all of the houses, the following damage could be observed: V - form, X - form and horizontal cracks cutting across doors and windows; damage to outside mains walls or total collapse of dry walls; systematic collapse of trellis ceilings; the breakthrough of walls by beams shifting out of their support recesses; the falling of all decorations or architectonic projections.

- Cosentini
The few houses of this village for the most part collapsed with only the outside walls of some of the better-constructed houses remaining intact. Objects fell in the S, N, E and W directions. Trellis and stuccoed ceilings completely collapsed.

- Ceccazzo
In this locality the greatest damage was done to the rural houses constructed in poorly-squared and poorly-cemented stones, while the other buildings were only severely cracked.
All of the dry boundary walls completely collapsed or showed swellings due to lateral pressure exerted on them by the embankments.

- Carico
The damage was similar to that observed in Ceccazzo.

- S. Maria degli Ammalati
In this village, most of the houses were destroyed and, contrary to what happened in other localities, the church almost collapsed as well. Phenomena of rotation and translation of even heavy objects were frequentely observed; the movements were generally from NNW to SSE and from N to S, or more rarely towards east or west.

- Timone, Castelluccio and S. Cosimo
The damage caused to the buildings in Timone, Castelluccio and S. Cosimo by the earthquake on May 8 was in some cases noteworthy because the structures had already been weakened by the damage of previous events. The typology of the damage is similar to that observed in the preceding localities, though the number of houses that collapsed is smaller.

- Guzzi
The number of structures that collapsed was small, though rather severe cracks in retaining and internal walls were frequent. The disconnection of heavy ornamental objects from the walls, and the falling of chimney-tops statues and merlons from well-constructed palaces was common. Inside the houses, most of the objects fell to the east or west.

- Mortara
This locality is also in the zone of maximun destruction. In fact, the number of buildings that completely collapsed was much greater than the number of those that partially collapsed. All of the boundary walls were razed to the ground. The railway line inspector's house, constructed in concrete mix and having an internal wooden foundation, showed only slight cracks. The railway tracks buckled in various points and the corresponding ballast was considerably dissarranged.

- Dagala
The damage done to Dagala was essentially the following:
V-form and horizontal fissures in walls, and the falling of plaster and partial collapse of internal walls; phenomena of translation, in the NE, NW and NS directions; and rotation of objects.

- Zafferana Etnea
Severe damage was done only to the church, i.e. the disconnection of the facade from the main body of the building. Inside the houses, objects fell in the NW, SE and N directions. In the localities of Fleri, Pisano, Aci S. Antonio, Acireale, Guardia, Mangano, Palombaro, Fau, S. Venerina and Cancelliere, only slight cracks were observed in both the internal and external walls of the buildings and only buildings in poor condition underwent severe damage such as cracks in bearing structures or the disconnection of walls. Table 1 gives a list of all of the localities where the earthquake was felt and where it caused slight damage, partial collapse, or complete building collapse. Specifically, 223 houses were totally destroyed, 248 partially collapsed, 619 buildings were severely damaged, and 1.060 were slightly damaged.
In the mesoseismic area, an opened fissure was observed. Its edges showed a difference in height and its total length was 7 km in the NW-SE direction, from the locality of S. Tecla to Passopomo. Along this fissure, which in some parts was more than a meter deep, slow movements lasting a few days were observed. The focal depth of the event has been evaluated as being not greater than 2 km, and the considerable superficiality of the phenomenon accounts for the limited extension of the badly-hit areas. The main event was preceded by 38 foreshocks, which were felt by the people of the area. Some foreshocks reached an intensity of VIII degrees. There were about 83 aftershocks which were felt for 6 months and, in some cases, reached an intensity of VII degrees.

List of shocked localities:

Locality	Latit.	Long.	I (MCS)
Acireale	37°37'	15°10'	V
Aci S. Antonio	37°37'	15°06'	VI
Acitrezza	37°33'	15°09'	VI
Ardichetto	37°41'	15°08'	IX
Balatelle	37°38'	15°09'	VII
Belpasso	37°35'	14°49'	IV
Biancavilla	37°38'	14°53'	II
B.V. della Catena	37°39'	15°09'	IX
Bongiardo	37°41'	15°08'	VIII
Cancelliere	37°42'	15°06'	VI
Carico	37°38'	15°09'	VIII-IX
Castrovillari	37°49'	16°12'	VII-VIII
Catania	37°31'	15°05'	V
Ceccuzzo	37°37'	15°08'	VIII-IX
Civita	37°40'	15°07'	VIII-IX
Cosentini	37°40'	15°08'	IX
Dagala	37°42'	15°09'	VII-VIII
Faggio	37°41'	15°09'	VII
Fleri	37°40'	15°06'	VI
Giarre	37°43'	15°11'	VI
Guzzi	37°40'	15°10'	VIII
Linera	37°39'	15°08'	IX
Linguaglossa	37°50'	15°09'	V
Maletto	37°49'	14°52'	V
Maniace	37°50'	14°49'	III
Milo	37°44'	15°08'	VI
Mortari	37°38'	15°09'	IX
Nicolosi	37°36'	15°02'	V
Passopomo	37°41'	15°07'	IX
Pennisi	37°39'	15°07'	VII-VIII
Piano d'Api	37°38'	15°07'	VII-VIII
Pisano	37°40'	15°07'	VII
Randazzo	37°53'	14°57'	V
Riposto	37°44'	15°12'	V
Rocca d'Api	37°38'	15°07'	VIII-IX
San Leonardello	37°42'	15°10'	VI
S. Maria Ammalati	37°39'	15°09'	VIII-IX
S. Venerina	37°41'	15°08'	VII-VIII
Santa Tecla	37°38'	15°10'	VII-VIII
Sarro	37°41'	15°07'	VII-VIII
Scacchiere	37°40'	15°07'	VI-VII
Sorbello C. da	37°40'	15°06'	IX
Sorbo	37°39'	15°09'	VII-VIII
Stazzo	37°39'	15°12'	VII-VIII
Taormina	37°51'	15°17'	III
Timone	37°38'	15°10'	VII-VIII
Trecastagni	37°37'	15°06'	V
Val Calanna	37°43'	15°04'	V
Viagrande	37°36'	15°06'	VI
Zafferana Etnea	37°41'	15°07'	VI

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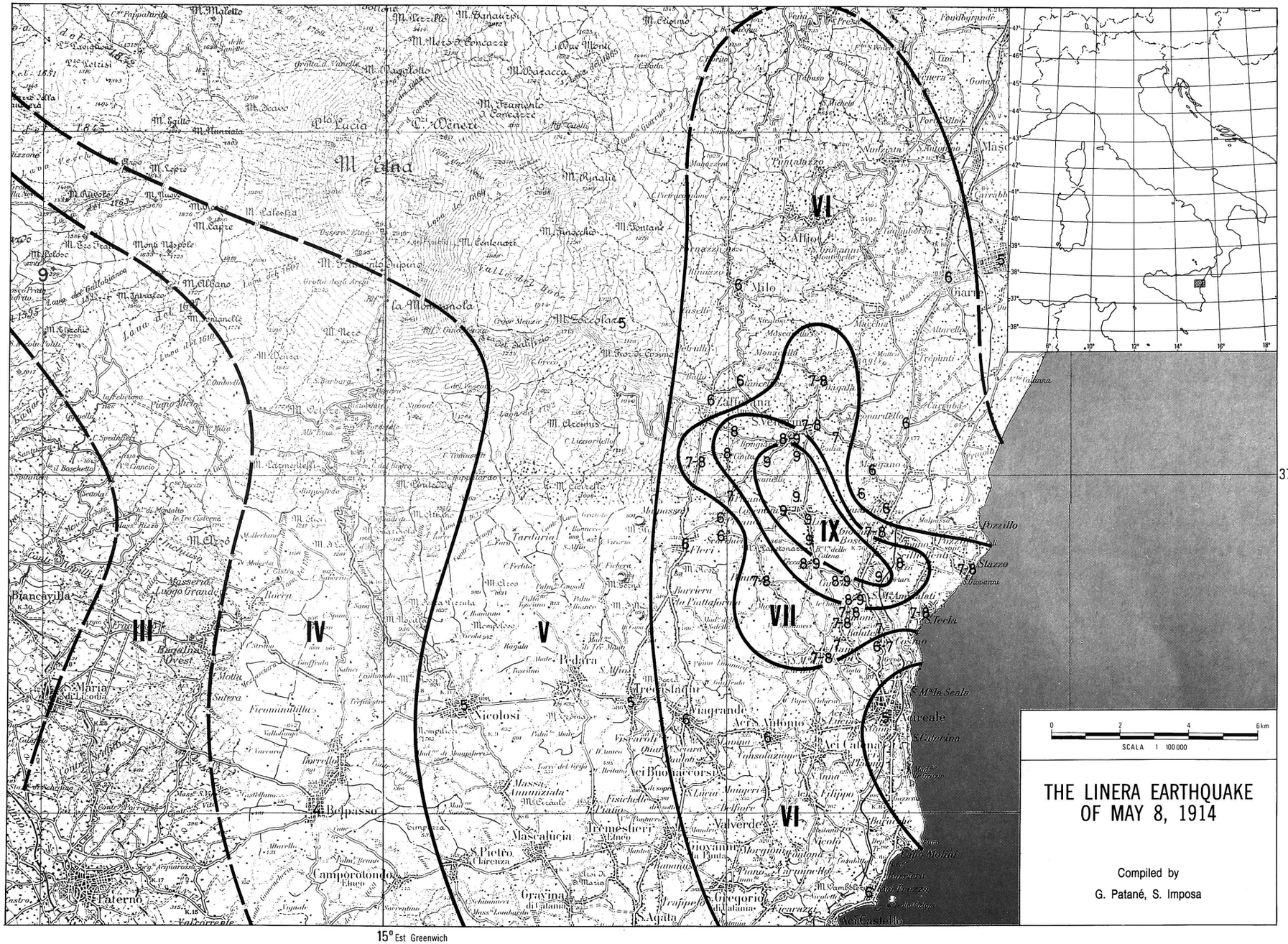
M. Etna
la Montagnola
Mt. Zoccolaro
M. Acuminà
M. Ilice
M. Serrette
M. Cerasello
M. Calanna
M. Rinalia
M. Fontane
M. Centenari
M. Finocchio
M. Capre
M. Calcarazzo
M. Fontanelle
M. Finocchi
M. Nocca
M. Denza
M. Rosa di Cosimo
M. Cerasello
M. Cerretto
M. Elceo
M. Scena
M. Scala
M. Cipolla
M. Cipolla
M. Cipolla

The Avezzano earthquake of January 13, 1915.

M.C. Spadea, M. Vecchi, P. Gardellini, S. Del Mese

This powerful seismic event shook the whole area originally forming the bed of lake Fucino and completely destroyed the towns and villages surrounding it.
The main destructive tremor struck without warning at $07^h\ 52^m$ on 13 January and, in the 6 months that followed, there were 1280 aftershocks, many of which exceeded intensity VI.
The few houses left standing in Avezzano were seriously damaged, and the remainder was transformed into such an enormous heap of rubble and ruins that every trace of the streets was obliterated at certain points. Out of a population of 11,279, 10,700 (95%) were killed, and many other villages had 80% casualties.
For 4 days Ortucchio was flooded by the water from a lake which subsequently dried up. A fault (or perimetral groove) formed in the epicentral zone, which was characterized by a vast network of cracks in the ground. This groove ran for about 70 km, varying from 30 cm to one metre in width. The inner lip (i.e. towards the Fucino) was 30 to 90 cm lower than the other.
In the neighbourhood of Paternò there were 5 or 6 large, deep, natural pools. The largest of these, which covered an area of 2 hectares, had a small island in the centre. The day of the earthquake this island disappeared and, in May the water was still muddy, the lake itself only a few metres deep.
These pools were interesting from the hydrogeographic standpoint as every 3 years they were the site of strong emissions of gas.
Again in the epicentral zone numerous craterlets up to 5-6 metres in depth were formed, some of which emitted water and gas.
Two small mud volcanoes formed near Sora.
In addition to the bibliographic sources here following, a number of newspapers and magazines, have been consulted.
The isoseismal map attached to the text reproduces the curves plotted by M. De Panfilis and was used in the preliminary survey, which was intended to provide a basis for further detailed macroseismic analysis.
The irregularity of the isoseisms makes it difficult to analyse the macroseismic field. However, the epicentral zone (of which many authors have made a detailed study) has been found to be extremely reliable and it is unlikely that any further studies will modify it even marginally.
The results emerging from the analysis of the data utilized so far allow us to assign a maximum MCS intensity of XI to the epicentre.
It is worth noting that, inside the zone of intensity IX, there is a vast area (coinciding with the Le Liri valley) displaying positive anomalies. These anomalies, which may be observed objectively in the data referring to the localities affected, are not easy to quantify, and so a further curve with an MCS intensity estimated between IX and X has been plotted.
It is difficult to comment on the lower intensity isoseisms since data still to be analysed could require changes in areas already plotted on the map.
In the case of this earthquake, it was possible to make an analytical determination of the magnitude, using data referring to the amplitude of the various wave trains and their duration. For this event the magnitude (ML) was found to be 6.8 and the depth 8 km.

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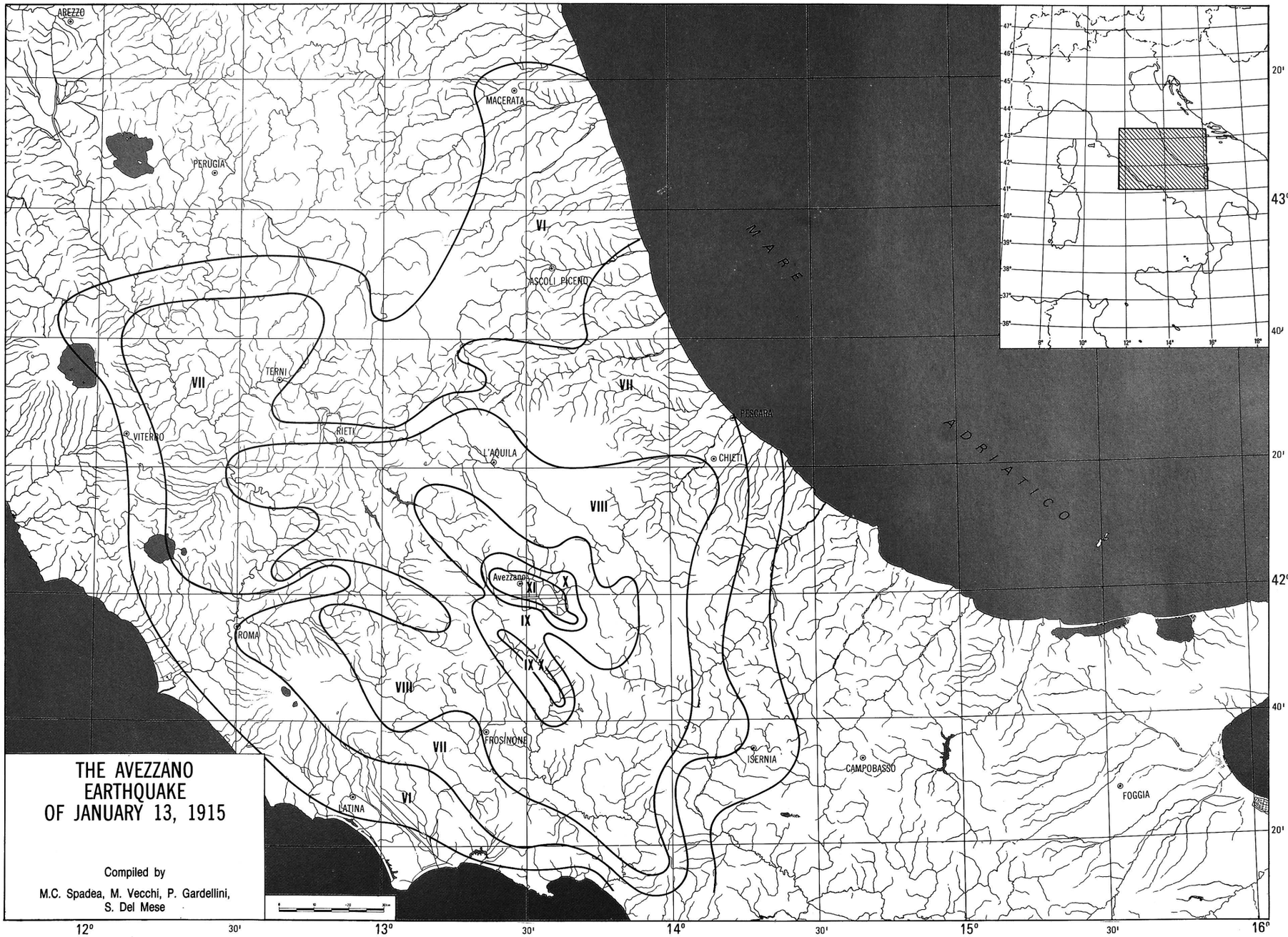

THE AVEZZANO EARTHQUAKE OF JANUARY 13, 1915

Compiled by

M.C. Spadea, M. Vecchi, P. Gardellini, S. Del Mese

The drainage network of this map – scale 1:500.000 – is the same as the "Structural Model of Italy."

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The Mugello earthquake of June 29, 1919

G. Ferrari, D. Postpischl.

At 4:05 p.m. GMT on June 29, 1919, a very strong earthquake led to the destruction of a vast area of Mugello, particularly numerous communities and hamlets of the Sieve Valley.
In the ENEL and Carrozzo et al. Catalogues, this earthquake is classified with an epicentral intensity of the X degree MCS, situated about 25 km NE of Florence.
The sources utilized for the reconstruction of the effects of this earthquake include macroseismic questionnaires and the relative Bulletin of the Central Office of Metereology and Geodynamics, as well as numerous national and local newspapers.
For this earthquake, literary sources (newspapers) and specialized sources (questionnaires and bulletins) were preferred to public surveys. This preference was due to the progressive specialization of the surveys with a consequent loss of descriptive character.
The macroseismic questionnaires, through which the Reale Ufficio Centrale di Meteorologia e Geodinamica (Central Office of Metereology and Geodynamics) organized its gathering of information for the communities regarding single effects of the earthquake, are generally of noteworthy importance for the macroseismic reconstruction of the earthquakes of the first half of the twentieth century.
It is sometimes necessary to take certain precautions because of the heterogeneity of opinions of those who filled out the questionnaires. In many cases, the information received from the communities was already given in terms of intensity.
The comparison made between numerous dailies and the questionnaires has allowed the construction of a sufficiently verified scheme of the distribution of the effects of this earthquake. Such a comparison has also allowed an increase of the number of damaged localities from 26 to 58, and the reduction of the maximum intensity value from X to IX degree MCS.
The strongest effects, IX degrees MCS, took place in Vicchio and in its communal territory, particularly in the localities of Rupecanina, Uliveta, Rostolena, and Mirandola.
It is interesting to note that an intensity between IX and X degree MCS had been attributed to Vicchio, while, from the correspondence of a journalist who visited Vicchio the day of the earthquake, one learns that «exteriorly» (referring to Vicchio) «its characteristic overlapping of houses appears intact. But internally, the ruin is vast and profound...». This precise testimony regarding the external aspect of Vicchio, together with information deducible from other sources, have suggested an intensity evaluation not higher than IX MCS.
In support of this, it must also be said that the macroseismic questionnaires which served as a basis for all the evaluations made for this earthquake, in some cases, as in Vicchio, were filled out at a much later date, when new tremors or human intervention had contributed, at times significantly, in rendering the representation of damage more dramatic.
Some pictures taken from «Il Nuovo Giornale» have contributed to the operation of calibrating the classes of damage in terms of MCS intensity.
The evaluated local intensity and the isoseismal lines of this earthquake are shown in the enclosed map.
The higher degree isoseismal lines (IX, VIII) show a marked lengthening in the NE-SW direction, with an accentuation of propagation in the SE direction for the VII degree area.
This propagation is also present in the isoseismal lines of a lower degree (V and VI degrees MCS), but in this case, the prevalent direction of propagation is approximately in the N-S direction.
The VI degree MCS area shows a four-lobed form and seems to be the limit of the two directions of propagation.
One must recall that in November 1918, an earthquake with a maximum intensity of at least VIII MCS (the earthquake is still the object of study) hit the high valley of the Montone and Rabbi Rivers and part of the Mugello basin.
Therefore, since the constructions in this area had already been damaged or weakened, the extension of the VIII and VII degree MCS areas in the N-E direction for the June 29, 1919 earthquake could be justified.
The macroseismic equivalent of magnitude, according to the Galanopoulus formula, is ME = 5.6, in agreement with the macroseismic magnitude estimated by the Karnik formula.
The following is a comparison of the values of some parameters of this earthquake, reported respectively in the ENEL and Carozzo et al. Catalogues, and in the present study.

Year	Mo	Da	Ho	Mi	Lat	Long	De	I	Me	Mk	Mp	Epic. area
1919	06	29	15	06	43°57'	11°28'	5	X		6.1	6.1	Vicchio
1919	06	29	15	06	43°54'	11°30'		IX-X		6.0		
1919	06	29	15	06	43°56'	11°27'		IX	5.6			Vicchio

List of shocked localities:

Locality	Latit.	Long.	I (MCS)
Adria	45°03'	12°03'	IV
Alfonsine	44°30'	12°03'	II
Arezzo	43°28'	11°53'	IV
Ariano nel Polesine	44°57'	12°07'	IV-V
Badia Tedalda	43°42'	12°11'	VI
Barberino al Mugello	44°00'	11°14'	VI
Belforte	43°14'	11°04'	III
Bibbiena	43°42'	11°49'	VII
Bivigliano	43°54'	11°19'	VI
Bologna	44°30'	11°20'	V
Borgo Pace	43°39'	12°18'	IV-V
Borgo S. Lorenzo	43°57'	11°23'	VIII
Bucigna	43°50'	11°35'	VII
Calenzano	43°52'	11°10'	V-VI
Campi Bisenzio	43°49'	11°08'	VI
Cannara	43°00'	12°35'	IV-V
Cantagallo	44°01'	11°05'	V
Caprona	43°42'	10°30'	IV
Carmignano	43°49'	11°01'	V
Carpi	44°47'	10°53'	IV
Casaglia	44°02'	11°30'	VIII
Casalmaggiore	44°59'	10°25'	IV
Casole	43°58'	11°30'	IX
Castagno	43°54'	11°39'	VII-VIII
Castello	43°49'	11°14'	V
Castiglion Fiorentino	43°20'	11°55'	IV
Cavarzere	45°08'	12°05'	III-IV
Cesena	44°08'	12°15'	VI
Cesenatico	44°12'	12°24'	IV
Chiusi	43°01'	11°57'	V
Codigoro	44°50'	12°06'	V
Collagna	44°21'	10°17'	III
Cologna	45°19'	11°23'	III
Colonnata	43°51'	11°13'	V
Conselve	45°14'	11°53'	IV
Comacchio	44°42'	12°11'	III
Contea	43°52'	11°32'	VII
Corella	43°56'	11°37'	VIII
Correggio	44°46'	10°47'	IV
Crevalcore	44°43'	11°09'	IV
Dicomano	43°53'	11°31'	VII
Doccia	43°49'	11°26'	VII
Empoli	43°43'	10°57'	V
Este	45°14'	11°39'	III
Faenza	44°17'	11°53'	V
Ferrara	44°50'	11°37'	III-IV
Ficulle	42°50'	12°04'	III
Fiesole	43°48'	11°18'	V
Figline	43°55'	11°05'	VI
Figline Valdarno	43°37'	11°28'	V-VI
Finale Emilia	44°50'	11°18'	IV-V
Firenze	43°47'	11°15'	VI
Firenzuola	44°07'	11°23'	VII-VIII
Fiumalbo	44°11'	10°39'	III-IV
Fivizzano	44°14'	10°07'	III
Foiano della Chiana	43°15'	11°49'	IV
Foligno	42°57'	12°42'	II-III
Forlì	44°13'	12°03'	VI
Forlimpopoli	44°11'	12°08'	IV-V
Fornace	43°51'	11°37'	VII
Fornazzano	44°09'	11°37'	VI
Fucecchio	43°44'	10°49'	IV-V
Galluzzo	43°44'	11°14'	V
Gonzaga	44°57'	10°49'	IV
Greve	43°35'	11°19'	V-VI
Gualtieri	44°54'	10°38'	III
Guastalla	44°55'	10°39'	IV
Gubbio	43°21'	12°35'	III
Guiglia	44°26'	10°58'	III
Lastra a Signa	43°46'	11°07'	VI
Legnago	45°12'	11°19'	IV
Lendinara	45°05'	11°36'	IV
Livorno	43°33'	10°19'	III
Lizzano in Belvedere	44°10'	10°54'	IV
Londa	43°52'	11°34'	VII
Lucca	43°51'	10°30'	V
Lugo	44°25'	11°55'	IV
Mantova	45°09'	10°46'	III
Marradi	44°05'	11°37'	VIII
Mercato Saraceno	43°58'	12°12'	VII
Mirandola	44°53'	11°04'	IV
Modena	44°39'	10°56'	V
Montale	43°56'	11°01'	IV
Montecatini Terme	43°53'	10°46'	IV
Monte S. Savino	43°20'	11°43'	IV
Montefalco	42°54'	12°39'	II-III
Montevarchi	43°31'	11°34'	V-VI
Monzuno	44°17'	11°16'	V
Mucciano	43°59'	11°25'	VIII
Novafeltria	43°54'	12°17'	IV-V
Novellara	44°51'	10°44'	III
Ostiglia	45°04'	11°08'	III
Panigaglia	43°59'	11°24'	VIII
Passignano sul Trasimeno	43°11'	12°08'	IV
Pavullo nel Frignano	44°20'	10°50'	III-IV
Peccioli	43°33'	10°43'	V
Pergola	43°34'	12°50'	IV
Perugia	43°06'	12°23'	IV
Pesaro	43°54'	12°54'	IV
Pieve a Nievole	43°53'	10°48'	IV-V
Pievepelago	44°12'	10°37'	II
Pieve S. Stefano	43°40'	12°02'	VI
Pilarciano	43°56'	11°27'	IX
Pisa	43°43'	10°24'	V
Poggibonsi	43°28'	11°08'	V
Pontassieve	43°46'	11°26'	V-VI
Pontedera	43°40'	10°38'	V-VI
Poppi	43°43'	11°46'	VII
Porgano	43°48'	11°42'	VII-VIII
Portico	44°02'	11°47'	VII
Poviglio	44°51'	10°32'	III
Prato	43°53'	11°06'	VI
Pratovecchio	43°57'	11°43'	VI
Predappio	44°06'	11°59'	VI
Rata	43°51'	11°33'	VII
Reggio Emilia	44°42'	10°38'	III-IV
Rostolena	43°57'	11°30'	IX
Rufina	43°49'	11°29'	VIII
Rupecanina	43°57'	11°29'	IX
S. Benedetto Po	45°02'	10°56'	IV
S. Godenzo	43°56'	11°37'	VIII
Sanguinetto	45°11'	11°09'	IV
S. Miniato	43°41'	10°51'	IV
S. Piero a Sieve	43°58'	11°19'	VII
S. Sepolcro	43°34'	12°08'	V-VI
Sant'Agata	44°01'	11°20'	VII
Sant'Arcangelo di Romagna	44°04'	12°27'	IV-V
Sassuolo	44°32'	10°47'	II-III
Scarperia	44°00'	11°21'	VIII
Sestola	44°14'	10°46'	IV
Siena	43°19'	11°20'	IV-V
Signa	43°47'	11°06'	IV-V
Sinalunga	43°13'	11°44'	V
Spoleto	42°44'	12°44'	III
Stia	43°48'	11°42'	VII
Todi	42°47'	12°24'	IV
Urbino	43°44'	12°38'	II
Vallombrosa	43°44'	11°33'	V-VI
Venezia	45°26'	12°20'	III
Vergato	44°17'	11°07'	IV
Vernio	44°03'	11°09'	V
Vespignano	43°57'	11°26'	VII
Vicchio	43°56'	11°28'	IX
Vierie	43°50'	11°34'	VII
Villa Minozzo	44°22'	10°28'	III
Vitigliano	43°58'	11°30'	IX
Volterra	43°24'	10°52'	V
Vorno	43°47'	10°31'	III-IV
Zola Predosa	44°29'	11°13'	V

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THE MUGELLO EARTHQUAKE OF JUNE 29, 1919

Compiled by

G. Ferrari, D. Postpischl

The drainage network of this map – scale 1:500.000 – is the same as the "Structural Model of Italy."

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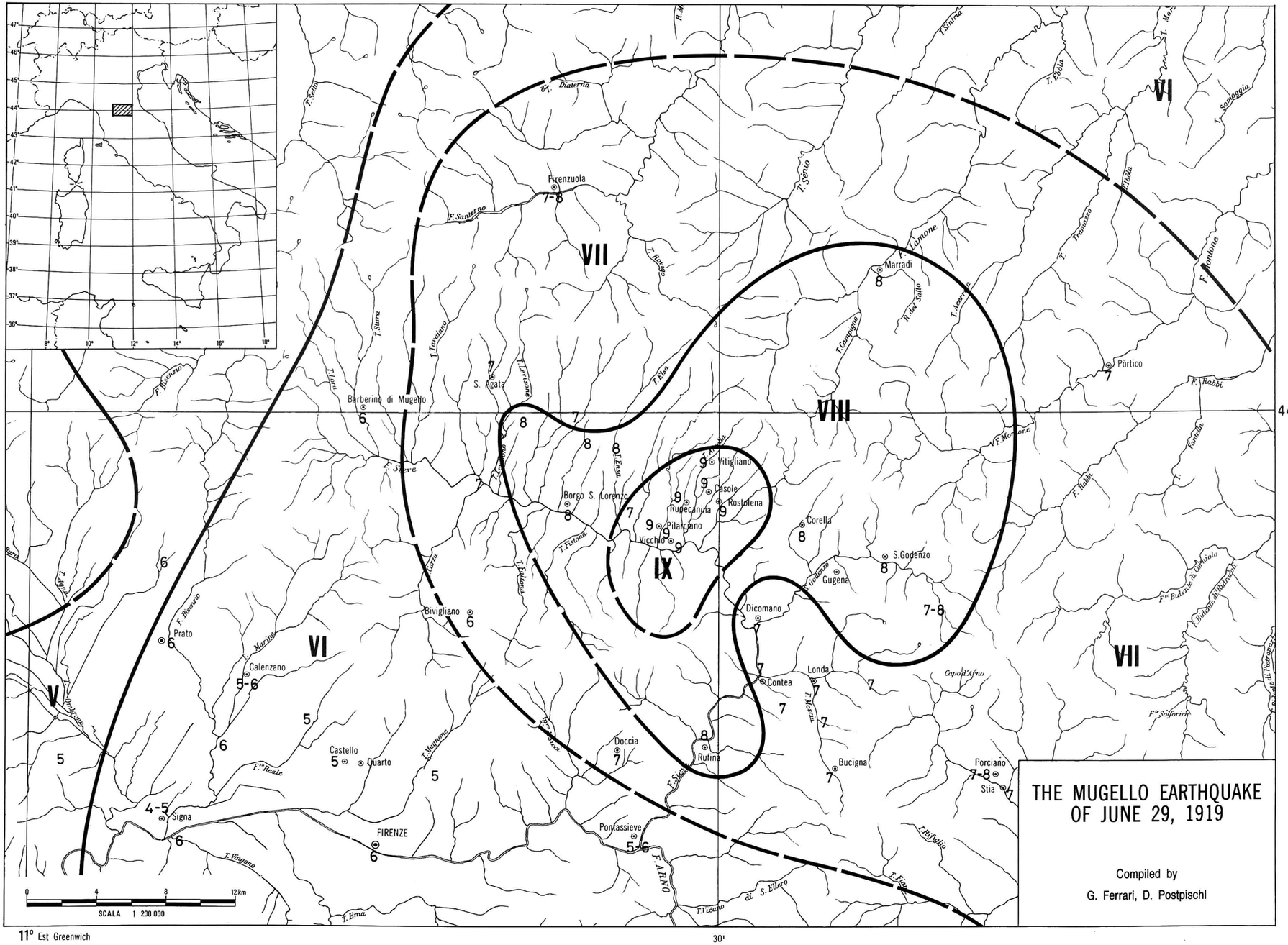

The drainage network of this map – scale 1:200.000 – is taken from the official production of the IGMI – Firenze.

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The Piancastagnaio earthquake of September 10, 1919.

M.C. Spadea, M. Vecchi, P. Gardellini, S. Del Mese

On 10 September at 16h57m the area of Piancastagnaio, Castell'Azzara and Proceno was shaken by a very strong tremor. On the same day and during the following night, there were numerous aftershocks, while there are no reports of warning events.

In the epicentral zone there were reports (1, 2, 3) and eyewitness accounts of:

— considerable ground cracking;
— detachment of boulders from rock cliffs;
— muddying and heating of watercourses and variations in water level;
— agitation of animals
— rumbling and seismic flashes.

The above are all characteristic effects of high-intensity earthquakes which, when checked, are very significant and useful in studying warning signs.

Many houses in Piancastagnaio were destroyed by the quake. However, most of the damage occurred in the surrounding countryside, where all the farmhouses and one church were razed to the ground. The lower part of the township was left completely uninhabitable.

At Proceno three churches and seven houses collapsed, and 51 buildings were seriously damaged, 28 of which had to be demolished, subsequently. The lower part of the village was also badly damaged.

The area hit by the quake includes the valley of the upper Paglia River and its tributaries, and is characterized by a very small number of villages and a large number of farmhouses scattered over the countryside. The data collected seem to indicate that the earthquake caused the greatest damage to both structures and the environment in this particular area.

An MCS intensity of IX was assigned to the epicentral zone, which takes in the towns of Piancastagnaio, Proceno and Castell'azzara.

It must be pointed out, however, that it was not possible to map all the isoseismal lines with the same accuracy. Both the VII and the IV isoseismals were obtained by interpolating intensity values at many points. In fact, it has already been mentioned that there are no villages in the areas included in the two isoseisms, and those few inhabited centres that do exist are either far apart or comparatively isolated. On the other hand, there are numerous farmhouses scattered over the countryside. As a result, there are gaps in the data, though they were sufficient to allow the isoseism to be mapped. On the whole, the field is regular, the direction of maximum propagation is NE-SW, and that of minimum propagation SE-NW. Despite the gaps, the survey may be considered as complete at the present state of our knowledge, and further detailed data would probably not lead to any substantial change or improvement.

The earthquake in question has been defined as follows in the ENEL File of Italian Earthquakes from 1000 up to 1975 — Unpublished — 1977:

Year	Mo	Da	Ho	Mi	Lat	Long	De	I_o	Mk	Mp	Epic. area
1919	10	9	16	57	42°53'	11°41'	3	VIII	5.1	4.6	Piancastagnaio
1919	10	9	17	26	42°39'	11°41'		III	2.5	2.2	Pitignano

and in the CNEN General Catalogue of Earthquakes from Beginning of Christian Age to 1971 - Published 1973

Year	Mo	Da	Ho	Mi	Lat	Long	I_o	Mk	Mp	Epic. area
1919	9	10	16	57	42°51'	11°45'	IX	5.6		
1919	9	10	17	10	42°51'	11°45'	IV			
1919	9	10	17	26	42°51'	11°45'	V			

List of shocked localities:

Locality	Latit.	Long.	I (MCS)
Abbadia S. Salvatore	42°53'	11°41'	VIII
Acquapendente	42°45'	11°52'	VII
Alviano	42°35'	12°18'	IV
Arezzo	43°28'	11°53'	NF
Arsoli	42°02'	13°01'	NF
Assisi	43°04'	12°37'	NF
Bolsena	42°39'	11°59'	V
Castel del Piano	43°04'	12°18'	V
Castellazzara	42°06'	11°42'	VIII-X
Castiglion del Lago	43°07'	12°03'	III-IV
Celle sul Rigo	42°52'	11°49'	VIII
Cetona	42°58'	11°54'	V-VI?
Chiusi	43°01'	11°57'	V-VI?
Città della Pieve	42°57'	12°00'	VI
Colle (Fraz. S. Casc. Bagni)	42°53'	11°53'	VIII
Cortona	43°16'	11°59'	NF
Ficulle	42°50'	12°04'	V
Genzano	41°42'	12°41'	NF
Gradoli	42°39'	11°51'	V
Guardea	42°37'	12°18'	IV
Ischia di Castro	42°33'	11°45'	V
Latera	43°58'	11°14'	VI
leonessa	42°34'	12°58'	NF
Lisciano Niccone	43°15'	12°09'	III
Manciano	42°35'	11°31'	V
marino	41°46'	12°40'	NF
Montefiascone	42°32'	12°02'	IV-V
Montorio	42°44'	11°46'	VII-VIII
Onano	42°42'	11°49'	VII
Orbetello	42°26'	11°13'	III
Perugia	43°06'	12°23'	III-IV
Piancastagnaio	42°51'	11°41'	VIII-IX
Pienza	43°05'	11°41'	V
Pitigliano	42°38'	11°40'	VI
Poggibonsi	43°28'	11°09'	IV
Portoferrario	42°49'	10°19'	NF
Prato	43°27'	12°07'	NF
Proceno	42°45'	11°50'	VIII-IX
Radiocofani	42°54'	11°46'	VIII
Rocca di Papa	41°46'	12°43'	II
Roccalbegna	42°47'	11°30'	VI
Roccastrada	43°01'	11°10'	IV
S. Casciano dei Bagni	42°52'	11°53'	VIII
Santa Fiora	42°49'	11°35'	VI
Sant'Oreste	42°14'	12°31'	NF
Sarteano	42°59'	11°52'	?
Scansano	42°41'	11°20'	IV
Serravalle di Chienti	43°04'	12°57'	NF
Sinalunga	43°13'	11°44'	IV
Spoleto	42°44'	12°44'	III
Subiaco	41°56'	13°09'	II-III
Todi	42°47'	12°24'	III-IV
Valentano	42°34'	11°49'	V
Vallombrosa	43°44'	11°33'	NF

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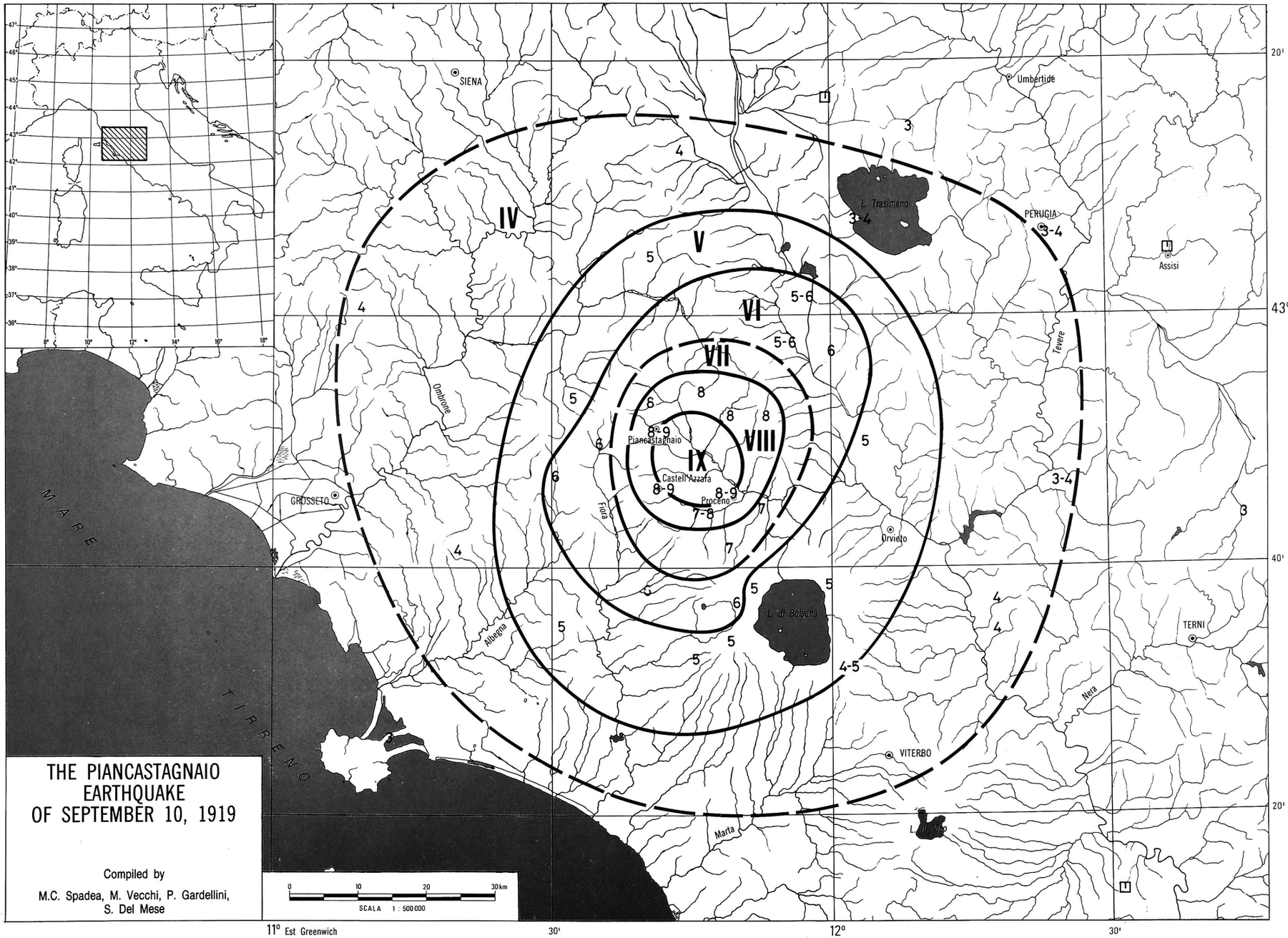

THE PIANCASTAGNAIO EARTHQUAKE OF SEPTEMBER 10, 1919

Compiled by

M.C. Spadea, M. Vecchi, P. Gardellini, S. Del Mese

The drainage network of this map – scale 1:500.000 – is the same as the "Structural Model of Italy."

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The Garfagnana earthquake of September 7, 1920.

G. Ferrari, E. Patacca, V. Petrini, P. Scandone

On September 7, 1920 at 5:55 a.m. GMT., a very strong earthquake destroyed a vast area of the Garfagnana and Lunigiana regions and the high valleys of the Secchia, Enza, Parma and Taro Rivers.

In the ENEL and Carrozzo et al. Catalogues, this event is respectively reported with an epicentral intensity of X and IX-X degrees MCS.

It was not particularly difficult to find information for the reconstruction of the effects of this earthquake, since this historical period is certainly among the best for historical seismologic research in Italy.

On the contrary, difficulties were encountered in: defining homogeneous areas from the point of view of the effects, and therefore, of the intensity; verifying the maximum epicentral intensity; and individuating both punctual and areal anomalies in the territorial seismic response.

The strategy of the research was based on two types of operations: one carried out on the sources of information, and another consisting of the verification and integration of this information in the localities hit by the phenomenon.

Three principal types of sources were utilized: technical and scientific reports on the macroscopic effects of the earthquake; macroseismic questionnaires and the Bollettino Sismico (Seismic Bullettin); and newspapers. The data available on the area that underwent destructive effects derive mainly from the first type of source, particularly from a report by De Stefani, a detailed description of the damage in a small area located at the eastern margin of the epicentral zone by G. Tasatti, and from a note made by A. Raddi.

This information was compared to the one given in the Bollettino Sismico del Reale Ufficio di Meteorologia e Geodinamica (UMG) (The Seismic Bulletin of the Royal Bureau of Meteorology and Geodynamics), derived from the macroseismic questionnaires. The description by De Stefani is the most complete and reliable one, since its author was in the epicentral area (Pieve Fosciana) when the earthquake hit. By transforming the description into numerical parameters, a preliminary map indicanding the severity of the effects with isolines was drawn. Afterwards, field work in the region was carried out in order to:

— test the reliability of the distribution of the damage by checking the building typologies and the degree of repair, reinforcement, or rebuilding after 1920 within the ancient inhabited centers (in addition to direct observations, oral testimonies from on-site questioning of the inhabitants proved useful);

— assign the corresponding degrees of the MCS scale to the preliminary numerical parameters; and

— verify and interpret some relevant anomalies.

The information deduced from the macroseismic questionnaires has contributed principally to the delimitation of the areas with an intensity equal to or less than the VI degree MCS. The questionnaires allowed us to carry out some important verifications regarding the quality and quantity of the information in the macroseimsic bulletins. It was especially useful to check, and in some cases to correct, the attributions of intensity; in other cases it was necessary to regard these attributions with caution, since the compilers of the questionnaires had not provided them with the descriptions of the effects.

The information that reached the UMG from localities where the earthquake was not felt (and which do not appear in the Seismic Bulletin) integrates usefully into the scheme of the distribution of effects indicated in the enclosed map.

Finally, consulting local newspapers has allowed a verification of much of the information related to the epicentral areas, especially in those zones where evident propagation anomalies or local seismic response anomalies were present.

Some photographs, taken from private collections or from periodicals, have contributed further to the calibration of the description of effects reported in the different sources utilized.

The resulting macroseismic field, seen in figure shows a preferential propagation of energy in the NNW-SSE direction.

In the mesoseismal zone, one can distinguish two areas with an intensity higher than VII MCS, separated by a narrow strip characterized by pronunced attenuation. A stronger degree of attenuation has also been individuated from the epicentral area to Reggio Emilia, approximately corresponding to the valley of the Enza River.

Finally, one can see two extensive anomalies: one at the inside of the VI degree isoseismal area, centered NW of Ferrara, with an increment of the values of intensity; and the other at the inside of the V degree isoseismal area, lying between Genoa, Piacenza and Alessandria, with an attenuation of intensity.

On the map, some punctual anomalies can also be seen, the description of which lies beyond the scope of this study.

According to Eva et al. the seismicity of the Garfagnana region is due to a tensional fault system parallel to the axis of the Apennines, which was the cause of the foundering along the Tyrrhenian side of the range.

The shape of the VII-VIII isoseismal area with a NW-SE trend is consistent with effects greater than VII MCS outside of this trend, and especially, the existence of a transverse attenuated area directed towards Reggio Emilia, cannot be easily interpreted, assuming that there exists only one fracture with dip slip motion striking NW-SE.

We believe that a contribution to a better understanding of the 1920 earthquake in the Garfagnana region will come, perhaps in the near future, from the analysis of the original seismograms and from the solution of the focal mechanism.

The Blake formula are Km. 6 for the more superficial part of the seismic source and Km. 16 for the deeper part. Application of the Shebalin model leads to a fault surface of breakage of about Kmq. 250, which corresponds to a macroseismic equivalent of magnitude (ME) of 6.0, agreeing with the value calculated by the Galanopoulos formula for the affected area.

The following is a comparison of the values of some of the parameters of this earthquake, reported respectively in the ENEL and Carrozzo et al. Catalogues, and in the present study.

Year	Mo	Da	Ho	Mi	Lat	Long	De	I	Me	Mk	Mp	Epic. area
1920	09	07	05	55	44°15'	10°17'	18	X		6.2	6.1	Garfagnana
1920	09	07	05	55	44°15'	10°17'	10	IX-X		6.1		
1920	09	07	05	55	44°15'	10°17'		IX	6.0	6.2		Garfagnana

List of shocked localities:

Locality	Latit.	Long.	I (MCS)
Abano	45°22'	11°47'	V
Abbiategrasso	45°24'	08°55'	IV
Acqui Terme	44°41'	08°28'	II
Adria	45°03'	12°03'	IV
Agliano	44°10'	10°15'	IX
Aiola	44°10'	10°08'	VII
Alassio	44°00'	08°10'	III
Albareto di Borgotaro	44°27'	09°42'	VI
Albenga	44°03'	08°13'	III
Albiano (LU)	44°11'	10°13'	VII-VIII
Albiano (MS)	44°11'	10°13'	IX
Alfonsine	44°30'	12°03'	III
Ameglia	44°04'	09°52'	VI
Antisciana	44°07'	10°23'	VIII
Antognano	44°12'	10°12'	VIII-IX
Aosta	45°44'	07°19'	II
Arezzo	45°44'	07°19'	II
Arcigliano	44°11'	10°11'	IX
Assisi	43°04'	12°37'	III-IV
Asola	45°13'	10°15'	VI-VII
Asolo	45°48'	11°55'	III
Aulla	44°13'	09°58'	VIII
Bagni di Lucca	44°01'	10°35'	VII
Bagni di Montecatini	43°53'	10°46'	VI-VII
Bagno di Romagna	43°50'	11°58'	III
Bagnolo Mella	45°26'	10°11'	V
Bagnone	44°19'	10°00'	VIII
Bardolino	45°33'	10°44'	II
Barga	44°04'	10°29'	VII-VIII
Bargecchia	44°07'	10°26'	VIII-IX
Bastia	44°16'	10°03'	VIII
Belgioioso	45°10'	09°19'	V
Benabbio	44°00'	10°36'	VII
Berceto	44°31'	09°59'	VI-VII
Bettola	44°33'	10°32'	IV
Bibbiano	44°40'	10°28'	V
Bibola	44°11'	09°59'	VIII
Bientina (PI)	43°43'	10°37'	VI-VII
Bologna	44°30'	11°20'	V
Bondeno	44°53'	11°25'	V
Bordighera	43°47'	07°40'	III
Borghetto Lodigiano	45°13'	09°30'	IV-V
Borgo a Mozzano	43°59'	10°36'	VII
Borgo S. Lorenzo	43°57'	11°23'	V
Borsigliana	44°13'	10°18'	VIII
Bozzano	43°51'	10°21'	VI-VII
Brescia	45°33'	10°13'	II
Brisighella	44°13'	11°46'	IV
Busana	44°22'	10°19'	VII
Busto Arsizio	45°37'	08°51'	III
Buti	43°44'	10°35'	VI
Calavorno	44°01'	10°32'	VI
Calci	43°44'	10°31'	V
Calcinaia	43°41'	10°37'	VII
Calice al Cornoviglio	44°15'	09°50'	VI
Calizzano	44°14'	08°07'	IV
Camaiore	43°56'	10°18'	VI-VII
Campiano	44°18'	12°12'	VI-VII
Campi Bisenzio	43°49'	11°08'	V
Camporaghena	44°18'	10°10'	VIII-IX
Camporgiano	44°09'	10°20'	VIII-IX
Campori	44°08'	10°25'	VIII-IX
Canigiano	44°11'	10°23'	VIII-IX
Cannara	43°00'	12°35'	III
Canevare	44°12'	10°46'	VI-VII
Capannoli	43°35'	10°41'	VI
Capannori	43°50'	10°34'	VII
Capoli	44°12'	10°15'	IX
Capraia	44°09'	10°28'	IX
Careggine	44°07'	10°19'	VII-VIII
Camagnola	44°51'	07°53'	III
Carmignano	44°58'	11°55'	IV-V
Carpaneto Piacentino	44°55'	09°47'	V-VI
Carpi	44°47'	10°53'	V-VI
Carpineta (LU)	44°05'	10°02'	IX
Carpineti (RE)	44°27'	10°31'	VII
Carrara	44°03'	10°04'	VII
Carrodano	44°14'	09°39'	VI
Casalbuttano	45°15'	09°58'	V
Casalmaggiore	44°59'	10°25'	V
Casatico	44°09'	10°19'	VIII-IX
Casciana (LU)	44°11'	10°09'	VIII-IX
Casciana Terme	43°31'	10°37'	V
Cascianella (LU)	44°10'	10°18'	VIII-IX
Cascina	43°41'	10°33'	VI
Cascine di Buti	43°44'	10°37'	V
Casola	44°12'	10°10'	VIII-IX
Castagneto	44°24'	10°14'	VII
Castagnola	44°10'	10°15'	VIII-IX
Calstelfiorentino	43°36'	10°58'	VI
Castelfranco di Sotto	43°42'	10°45'	V-VI
Casteggio	45°01'	09°07'	V
Castelletto	44°13'	10°16'	IX
Castelnovo ne' Monti	44°26'	10°24'	VI
Castelnuovo Garfagnana	44°07'	10°25'	VI-VII
Castelnuovo Misericordia	43°27'	10°27'	V
Castel S. Pietro	44°24'	11°35'	V
Castelvecchio Pascoli	44°05'	10°28'	VII
Castiglioncello	44°13'	10°11'	VII
Castiglione di Garfagnana	44°09'	10°25'	VIII-IX
Castaglione de' Pepoli	44°08'	11°10'	VI-VII
Castiglione delle Stiviere	45°23'	10°30'	IV
Cavola	44°24'	10°32'	VIII
Cavriago	44°42'	10°32'	V
Cecina	43°19'	10°31'	IV
Cecciola	44°23'	10°11'	VII-VIII
Carageto	44°10'	10°24'	VIII
Cerreto Alpi	44°19'	10°15'	VII
Cerretoli	44°07'	10°23'	VIII
Certaldo	43°33'	11°02'	V
Cervia	44°16'	12°21'	III
Cesena	44°08'	12°15'	IV
Ceserano	44°11'	10°03'	VII-VIII
Cevoli	44°01'	10°38'	VI-VII
Chiappa	44°06'	09°49'	VI
Chiavari	44°19'	09°19'	VI
Chiesina Uzzanese	43°50'	10°43'	V
Chiozza	44°09'	10°26'	VIII-IX
Cingoli	43°22'	13°13'	II
Cinquecerri	44°21'	10°20'	VII
Città di Castello	43°27'	12°14'	IV
Civago	44°15'	10°29'	VIII
Cocciglia	44°02'	10°40'	VI-VII
Codigoro	44°50'	12°06'	IV
Codiponte	44°11'	10°09'	VII
Codogno	44°10'	09°42'	IV-V
Collagna	44°21'	10°17'	VII
Colle	44°07'	10°22'	VIII
Collegnago	44°14'	10°09'	VIII-IX
Colle Val d'Elsa	43°25'	11°08'	V
Colognola	44°12'	10°17'	VIII
Comacchio	44°42'	12°11'	IV
Compiano	44°32'	10°21'	VI-VII
Compione	44°20'	10°03'	VIII
Conti	44°05'	10°27'	VII
Copparo	44°54'	11°50'	IV
Corazzano	43°37'	10°52'	VI
Coreglia Antelminelli	44°04'	10°31'	VI-VII
Corfino	44°11'	10°23'	VIII
Coriano	44°20'	10°26'	VIII
Corniglio	44°28'	10°05'	VI-VII
Correggio	44°46'	10°47'	V
Corsanico	43°55'	10°18'	VI-VII
Cremona	45°08'	10°01'	V
Crevalcore	44°43'	10°09'	IV
Crodo	46°13'	08°19'	III
Cutigliano	44°06'	10°45'	VI
Dalli	44°14'	10°17'	VIII-IX
Dicomano	43°53'	11°31'	IV-V
Empoli	43°43'	10°57'	VI-VII
Equi Terme	44°10'	10°09'	VII-VIII
Erba	45°49'	09°14'	III
Erbezzo	45°38'	11°00'	IV
Fabriano	43°20'	12°54'	II
Fanano	44°12'	10°48'	VI-VII
Fauglia	43°34'	10°31'	VI
Ferrara	44°50'	11°37'	V
Ferriere	44°39'	09°30'	V-VI
Figline	?	?	IV
Filattiera	43°37'	11°28'	VIII
Filecchio	44°03'	10°30'	VII
Filetto	44°18'	09°58'	VIII
Fiorenzuola	44°56'	09°55'	V
Finale Emilia	44°50'	11°18'	IV
Firenze	43°47'	11°15'	V
Fiumalbo	44°11'	10°39'	VII
Fivizzano	44°14'	10°07'	IX
Fonzaso	46°01'	11°48'	II
Forcoli	43°36'	10°42'	VI-VII
Forlì	44°13'	12°03'	V
Fornaci di Barga	44°03'	10°28'	VII
Forno	44°05'	10°11'	VII
Fornovo	44°41'	10°06'	V

Forte dei Marmi	43°58'	10°10'	VII
Fosciandora	44°07'	10°28'	VIII
Fosdinovo	44°08'	10°01'	VI
Frabosa Soprana	44°17'	07°48'	IV
Frassinoro	44°18'	10°34'	VII
Fucecchio	43°44'	10°49'	VI
Galciana	45°53'	11°03'	VI
Galleno	43°46'	10°43'	VI
Gallicano	44°04'	10°26'	VI
Garlasco	45°12'	08°55'	IV
Gavinana	44°03'	10°49'	VII
Gavirate	45°51'	08°43'	II
Gazoldo degli Ippoliti	45°12'	10°35'	V
Gazzano	44°16'	10°30'	VII
Gazzolo	44°26'	10°18'	VII
Genova	44°25'	08°54'	VI
Ghivizzano	44°02'	10°31'	VI-VII
Giuncheto	43°29'	11°55'	VII-VIII
Giuncugnano	44°13'	10°15'	IX
Gorfigliano	44°09'	10°15'	VIII
Gragna	44°14'	10°16'	IX
Gragnana	44°12'	10°16'	VIII
Gragnanella	44°07'	10°23'	VIII
Gramolazzo	44°10'	10°14'	VIII-IX
Grassina	43°43'	11°18'	V
Grezzano	44°01'	11°24'	III
Guastalla	44°55'	10°39'	IV
Guardistallo	43°19'	10°38'	V
Guiglia	44°26'	10°58'	V-VI
Iesi	43°31'	13°14'	II
Impruneta	43°41'	11°15'	IV-V
Isola	44°10'	10°26'	VIII
Isola della Scala	44°16'	11°00'	V
Laiatico	43°28'	10°44'	V
La Lima	44°04'	10°46'	VI
Lama Mocogno	44°18'	10°44'	VII-VIII
Lamporecchio	43°49'	10°54'	VI
Langhirano	44°37'	10°16'	VII
Lari	43°34'	10°36'	VI
La Spezia	44°06'	09°49'	VI
Lastra a Signa	43°46'	11°07'	IV
Latignano	43°39'	10°33'	V
Levanto	44°10'	09°37'	VI
Licciana Nardi	44°16'	10°02'	VIII
Ligonchio	44°19'	10°21'	VIII
Limano	44°03'	10°41'	VI-VII
Limestre	44°03'	10°49'	VII
Livignano	44°12'	10°19'	VIII-IX
Livorno	43°33'	10°19'	VI
Lizzano	44°05'	10°47'	VI
Loiano	44°16'	11°19'	VI
Lorenzana	43°32'	10°32'	V
Lucca	43°50'	10°30'	VI-VII
Lucchio	44°02'	10°43'	VI-VII
Lugo	44°25'	11°55'	IV
Luscignano	44°12'	10°09'	V-VIII
Macerata	43°18'	13°27'	II
Magenta	45°28'	08°53'	III-V
Magliano	44°13'	10°15'	V-VIII
Mammiano	44°03'	10°47'	VI
Maranello	44°32'	10°52'	V
Marciana Marina	42°48'	10°12'	II
Marina di Carrara	44°03'	10°04'	VII
Marina di Massa	44°01'	10°07'	VI
Marina di Pisa	43°40'	10°17'	VI
Massa	44°01'	10°07'	VII
Massa di Sassorosso	44°10'	10°24'	V-VIII
Massarosa	43°52'	10°20'	V-VI
Massa Superiore	45°00'	11°19'	V-VI
Melegnano	45°21'	09°19'	III-V
Mercato Saraceno	43°58'	12°12'	IV
Merizzo	44°16'	09°59'	IX
Metra	44°12'	10°13'	IX
Mezzana	44°10'	10°08'	VII
Migliarina	44°20'	09°55'	V-VI
Milano	45°28'	09°11'	III
Mineo	37°16'	14°41'	I
Minerbio	44°37'	11°29'	IV
Minucciano	44°10'	10°12'	V-VIII
Mirandola	44°53'	11°04'	IV
Modena	44°33'	10°55'	V
Molazzana	44°04'	10°25'	V-VI
Molina di Quosa	43°48'	10°25'	VI
Mologno	44°04'	10°27'	VII
Mommio (LU)	43°55'	10°17'	VI
Mommio (MS)	44°15'	10°12'	VIII
Moncigoli	44°13'	10°05'	IX
Mondovì	44°23'	07°49'	III
Monselice	45°14'	11°45'	V
Monsummano	43°52'	10°49'	VI
Montecastello	43°38'	10°42'	V-VI
Montecatini	43°53'	10°46'	V
Montecreto	44°15'	10°43'	VII
Montecurto	44°14'	10°04'	X
Montefiore	44°13'	10°12'	V-VII
Montese	44°16'	10°57'	VI
Monti	44°15'	10°01'	IX
Monticiano	43°08'	11°11'	IV
Montigiano	43°54'	10°21'	VI
Monza	45°35'	09°16'	IV
Monzone	44°10'	10°08'	VII
Morrona	43°32'	10°40'	VI-VII
Mortara	45°15'	08°44'	IV
Mulazzo	44°19'	09°53'	VI-VII
Naggio	44°10'	10°20'	VII
Nicciano	44°11'	10°17'	VIII-IX
Nigone	44°25'	10°18'	VII
Novi Ligure	44°46'	08°47'	V
Olivola	44°14'	10°02'	IX
Oneglia	43°53'	08°02'	III
Orzaglia	44°11'	10°19'	VIII-IX
Ospedaletto	43°41'	10°25'	VIII
Ostiano	45°13'	10°15'	IV
Palagnana	44°00'	10°22'	V
Palaia	43°36'	10°46'	VI
Palanzano	44°26'	10°11'	VI-VII
Pallanza	45°56'	08°33'	II
Palleggio	44°02'	10°39'	VI-VII
Palleroso	44°07'	10°27'	VIII
Parma	44°48'	10°20'	VI-VII
Pavia	45°11'	09°10'	V
Pavullo nel Frignano	44°20'	10°50'	VI
Peccioli	43°33'	10°43'	VI
Pellegrino	44°44'	09°56'	VI
Pergola	43°34'	12°50'	III
Perugia	43°06'	12°23'	IV
Pescia	43°54'	10°41'	VI
Petrognano	44°10'	10°19'	VIII-IX
Petrognola	44°12'	10°17'	VIII
Piacenza	45°03'	09°42'	V
Pianacci	44°10'	10°23'	IX
Piazza al Serchio	44°11'	10°17'	IX
Pienza	43°05'	11°41'	III-IV
Pietrasanta	43°57'	10°14'	VII
Pieve a Elici	43°53'	10°20'	VI
Pievefosciana	44°08'	10°25'	VIII
Pieve Pelago	44°12'	10°09'	VII
Pieve S. Lorenzo	44°12'	10°12'	IX
Pieve S. Paolo	43°50'	10°33'	VII-VIII
Pieve S. Vincenzo	44°23'	10°13'	VIII
Pignone	44°11'	09°43'	VI
Pinerolo	44°53'	07°20'	?
Pisa	43°43'	10°24'	VI
Pistoia	43°56'	10°55'	VI
Piteglio	44°02'	10°46'	VI
Po	44°15'	10°10'	VIII-IX
Poggibonsi	43°29'	11°08'	V
Poggio	44°09'	10°21'	VIII-IX
Pognana	44°15'	10°08'	VIII-IX
Polinago	44°21'	10°43'	VI
Pomarance	42°18'	10°52'	V
Ponsacco	43°37'	10°38'	VI
Pontassieve	43°46'	11°26'	IV-V
Ponte a Cappiano	43°45'	10°46'	VI
Ponte all'Ania	44°02'	10°30'	VII
Ponte a Moriano	43°55'	10°32'	VI
Ponteccio	44°14'	10°16'	VIII-IX
Potedera	43°40'	10°38'	VI
Pontone	44°26'	10°29'	VII-VIII
Pontremoli	44°23'	09°53'	VII
Popiglio	44°03'	10°45'	VI
Porcari	43°50'	10°37'	VI-VII
Porciglia	44°05'	10°21'	VII-VIII
Portolongone	42°46'	10°24'	III
Portomaggiore	44°42'	11°48'	IV
Porretta Terme	44°09'	10°59'	V
Portoferraio	42°49'	10°19'	IV-V
Posara	44°14'	10°06'	VII
Poviglio	44°23'	10°14'	V
Prato	43°53'	11°06'	V
Puglianella	44°08'	10°19'	VIII
Pugliano	44°12'	10°12'	VIII-IX
Quarto	43°45'	11°20'	VI
Quercia	44°14'	10°00'	VIII-IX
Quiesa	43°51'	10°21'	VI
Ramiseto	44°25'	10°17'	VII
Reggio Emilia	44°42'	10°38'	V
Regnano	44°13'	10°13'	IX
Renzano	44°12'	10°12'	VIII-IX
Reusa (Rensa)	44°13'	10°10'	IX
Riomarina	42°49'	10°26'	VI
Rimini	44°04'	12°34'	IV
Rio nell'Elba	42°49'	10°24'	III
Rivergaro	44°54'	09°36'	IV
Roccalberti	44°09'	10°20'	VIII-IX
Rocca Pelago	44°12'	10°36'	?
Rocchetta di Vara	44°15'	09°45'	V-VI
Roggio	44°08'	10°18'	VIII
Rontano	44°06'	10°22'	VIII
Salsomaggiore	44°49'	09°59'	V-VI
S. Alessio	43°52'	10°29'	VII
Salò	45°36'	10°31'	IV-V
S. Andrea Pelago	44°13'	10°37'	VII
S. Anna Pelago	44°11'	10°33'	VII-VIII
S. Arcangelo	44°04'	12°27'	II
S. Casciano	43°41'	10°31'	VI
S. Cassiano	44°02'	10°38'	V-VI
S. Donnino	44°11'	10°19'	IX
S. Gimignano	43°28'	11°03'	VI
S. Marcello Pistoiese	44°03'	10°48'	VI
S. Maria a Monte	43°42'	10°42'	VI
S. Martino in Rio	44°44'	10°47'	IV
S. Michele	44°11'	10°17'	VIII-IX
S. Miniato	43°41'	10°51'	VI-VII
S. Pellegrino	44°11'	10°29'	VIII
S. Pietro in Campo	44°05'	10°27'	VII
S. Remo	43°49'	07°46'	IV
S. Romano	44°10'	10°21'	VIII
S. Sepolcro	43°34'	12°08'	III
Sarzana	44°07'	09°58'	VII
Sassalbo	44°17'	10°12'	IX
Sassello	44°29'	08°29'	II
Sassorosso	44°11'	10°24'	VIII
Savona	44°18'	08°29'	V-VI
Scarperia	44°00'	11°21'	V
Scandiano	44°36'	10°41'	V
Senigallia	43°43'	13°13'	II
Seravezza	44°00'	10°14'	VII
Sermezzana	44°12'	10°13'	IX
Sesto Fiorentino	43°50'	11°12'	III-IV
Sestola	44°14'	10°46'	V-VI
Siena	43°19'	11°20'	V
Signa	43°47'	11°06'	IV
Sillano	44°13'	10°18'	VIII-IX
Sillicagnana	44°10'	10°21'	VII
Sillico	44°08'	10°27'	VII-VIII
Soliera	44°44'	10°55'	VIII-IX
Sommocolonia	44°06'	10°29'	VIII
Sondrio	46°10'	09°52'	II
Spezia	44°06'	09°49'	V-VI
Spicciano	44°13'	10°08'	IX
Stazzema	44°00'	10°19'	VII
Stiava	43°54'	10°19'	VI-VII
Succiso	44°22'	10°12'	VIII
Suzzara	44°59'	10°45'	IV
Taggia	43°52'	07°51'	IV
Taranto	40°27'	17°48'	I
Tarcento	46°13'	13°13'	II
Tavernelle	44°18'	10°04'	VIII-IX
Tenerano	44°09'	10°06'	VII-VIII
Terenzano	44°13'	10°09'	VIII
Terrarossa	44°14'	09°58'	VII
Terricciola	43°31'	10°41'	VI
Tivoli	41°58'	12°48'	I
Tirano	46°13'	10°10'	II
Tiglio	44°04'	10°30'	VII-VIII
Toano	44°23'	10°34'	VII
Torriglia	44°31'	09°09'	VI
Tortona	44°54'	08°52'	V
Tramonti	44°09'	02°03'	IX
Tramonte di Brancoli	43°56'	10°33'	?
Trassilico	44°03'	10°24'	VI
Trento	46°04'	11°07'	II
Tresana	44°15'	09°55'	VI
Treviglio	45°31'	09°36'	II
Ugliancaldo	44°10'	10°11'	IX
Vagli di Sopra	44°07'	10°16'	IX
Vagli Sotto	44°07'	10°17'	VIII-IX
Valdagno	45°39'	11°18'	III
Vallombrosa	43°44'	11°33'	IV
Vergato	44°17'	11°07'	VI
Vergemoli	44°03'	10°23'	VI
Vernazza	44°08'	09°41'	VI
Valbona	44°11'	10°27'	VIII
Varliano	44°12'	10°15'	VIII-IX
Ventimiglia	43°47'	07°36'	IV
Vericamo	44°20'	10°54'	VII
Vercelli	45°19'	08°25'	IV
Verona	45°26'	11°00'	III-IV
Verrucolette	44°10'	10°16'	VIII-IX
Viadana	44°56'	10°31'	V-VI
Viareggio	43°52'	10°15'	VI
Vicopisano	43°42'	10°35'	VI
Vicchio	43°56'	11°28'	V
Vico Pancellorum	44°03'	10°42'	VI-VII
Vigneta	44°13'	10°11'	X
Vignola	44°23'	09°51'	VIII-IX
Villa Collemandina	44°10'	10°24'	X
Villafranca in Lunigiana	44°17'	09°57'	VII-VIII
Villa Minozzo	44°22'	10°28'	VIII
Villetta	44°09'	10°22'	VII-VIII
Vinca	44°08'	10°09'	VII
Voghera	45°00'	09°00'	IV-V
Volterra	43°24'	10°52'	V-VI
Volongo	45°13'	10°18'	V
Voltri	44°25'	08°54'	IV
Vorno	43°47'	10°31'	V
Virgoletta	44°18'	09°58'	VIII-IX
Vitoio	44°09'	10°19'	VIII-IX

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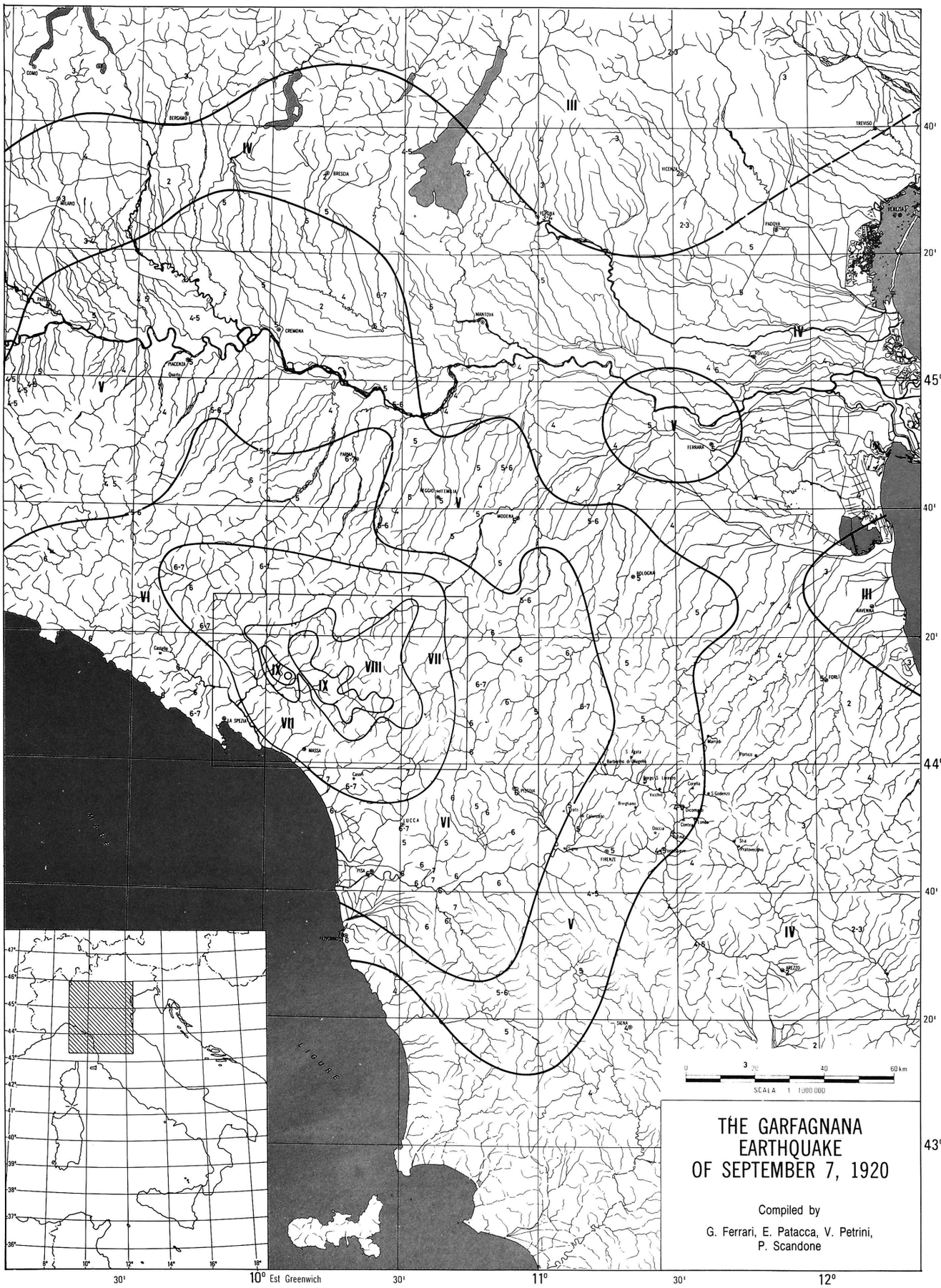

The drainage network of this map - scale 1:1.000.000 - is the same as the "Structural Model of Italy.

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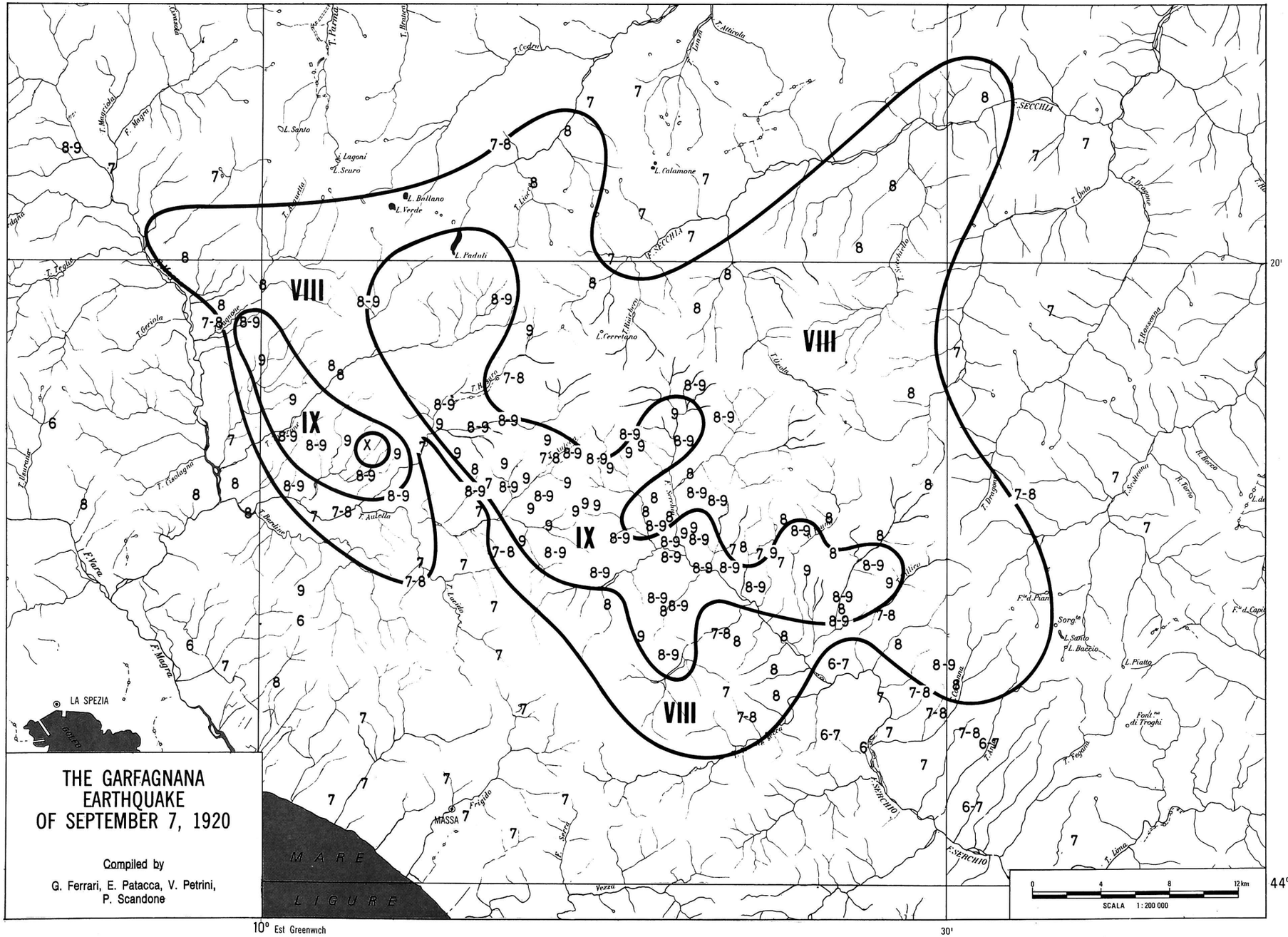

The drainage network of this map – scale 1:200.000 – is taken from the official production of the IGMI – Firenze.

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The Irpinia earthquake of July 23, 1930.

M.C. Spadea, M. Vecchi, P. Gardellini, S. Del Mese

On 23 July 1930 Irpinia was hit by a huge catastrophe: Villanova, Aquilonia, Lacedonia, Scampitella, San Sossio Baronia and Trevico were alost completely destroyed.
The seismic period was characterized by two light warning shocks (of which only vague reports are available) and by a main shock reaching MCS intensity X.
There were a large number of aftershocks, three of which either reached or exceeded intensity VI. The first occurred on 5 August at 00^h23^m and was perceived with varying intensity in the provinces of Avellino, Potenza, Matera and Foggia; the second occurred on 6 November at 21^h56^m, and reached an intensity of VI-VII at Spinazzola, where cracks appeared in numerous buildings; the third, on 10 May 1931 at approximately 10^h49^m, caused damage at Castel Baronia in the form of cracks and falling plaster.
The main shock was particularly destructive, with 1425 dead, about 10,000 injured, 22 villages and houses destroyed and about 40,000 dwellings damaged. In the more seriously affected areas the earthquake caused landslides, partial landslips and ground fractures (e.g. at Ariano Irpino, Villanova, San Giorgio la Molara, Flumeri, Trevico, Andretta, Vallata, Melfi and Aquilonia).
The very serious damage to the built up areas was largely due to the extremely poor quality of the materials used to build the houses, the irrational construction techniques employed and, in some cases, the weakening of the ground caused by the deep and extensive caves dug out beneath the buildings.
The extensive bibliography available (1-13) afforded us access to all the details needed for a full investigation of the earthquake in question, and allowed a complete survey to be made of the macroseismic field from MCS intensity X to VI.
The epicentral zone of MCS intensity X extends over a wide area (180 km^2) and the major axis of 34 km runs virtually parallel to the Apennines (ESE-WNW), a trend characterizing practically the whole field.
Overall analysis of the isoseismal map reveals no relief anomalies, except for two small areas in which positive anomalies are found, i.e. the area of the towns of Airola and Cervinara and that of the Sorrento peninsula.
In virtually all the towns affected the so-called «seismic flash» was observed, which many eye-witnesses described either as a purple tongue of flame, as a dark-red glow in the air or like the flame produced by inflammable gas.

List of shocked localities:

Locality	Latit.	Long.	I (MCS)
Accadia	41°10'	15°25'	IX
Acerenza	40°48'	15°57'	VII-VIII
Acri	39°29'	16°23'	III
Agnone	41°48'	14°22'	IV
Airola	41°04'	14°33'	VIII
Altavilla	41°00'	14°47'	VII
Amalfi	40°38'	14°36'	IV
Ancona	43°36'	13°30'	II
Andretta	40°56'	15°19'	VII
Anzano	41°07'	15°17'	IX
Apice	41°07'	14°56'	VIII
Aquilonia	40°59'	15°29'	X
Aquino	41°30'	13°42'	IV
Ariano	40°39'	15°01'	IX
Arienzo	41°01'	14°30'	VI-VII
Arpaia	41°02'	14°33'	VIII
Arpaise	41°02'	14°45'	VII
Ascoli Satriano	41°12'	15°34'	VIII
Atella	40°53'	15°39'	VIII
Atri	42°35'	13°59'	IV
Atripalda	40°56'	14°50'	VII
Avellino	40°55'	14°47'	VII
Aversa	40°58'	14°12'	VII
Avigliano	40°44'	15°43'	VIII
Bagnoli	41°05'	14°26'	VI
Baiano	40°57'	14°37'	VII
Baranello	41°32'	14°33'	V
Bari	41°06'	16°51'	V
Barile	40°57'	15°40'	VIII-IX
Barletta	41°19'	16°17'	V
Baronissi	40°45'	14°46'	VII
Benevento	41°08'	14°47'	VIII
Bisaccia	41°01'	15°23'	IX
Bisignano	39°31'	16°17'	IV
Bitonto	41°06'	16°41'	V
Bojano	41°29'	14°28'	III-IV
Bonito	41°06'	15°00'	VIII
Bovito	41°15'	15°20'	VIII
Buccino	40°38'	15°23'	VI
Buonalbergo	41°13'	14°59'	VIII-IX
Caggiano	40°34'	15°29'	V
Caivano	40°57'	14°18'	VI
Calabritto	40°47'	15°13'	VI
Calitri	40°54'	15°26'	VIII
Camerota	40°02'	15°22'	IV
Campania	40°40'	15°06'	VI
Campobasso	41°33'	14°40'	V
Cancellara	40°44'	15°55'	VIII
Candela	41°08'	15°31'	VIII
Cantalupo nel Sannio	41°31'	14°24'	V-VI
Capaccio	40°25'	15°05'	VI
Caprarola	42°20'	12°14'	II
Capri	40°33'	14°15'	IV
Capua	41°06'	14°13'	VII
Carife	41°02'	15°13'	IX
Carovilli	41°43'	14°18'	IV-V
Casalbordino	42°09'	14°35'	IV-V
Casamari	41°41'	13°30'	V
Casamicciola	40°45'	13°55'	V
Caserta	41°04'	14°19'	VI
Cassano Ionico	39°47'	16°19'	III
Castelbaronia	41°03'	15°11'	IX
Castel di Sangro	41°47'	14°06'	III
Castelfranco	41°18'	15°05'	VIII
Castellamare di Stabia	40°42'	14°29'	VI
Castelluccio de Sauri	41°18'	15°29'	VII
Castelnuovo di Conza	40°49'	15°19'	VIII
Castelsaraceno	40°10'	16°00'	V
Castrovillari	39°49'	16°12'	III-IV
Cava de' Tirreni	40°42'	14°42'	VII
Ceprano	41°33'	13°31'	V
Cerignola	41°16'	15°54'	VII
Cerisano	39°17'	16°11'	II-III
Cervinara	41°01'	15°05'	VIII
Cetraro	39°31'	15°56'	II
Chieti	42°21'	14°10'	IV-V
Chiusano	40°56'	14°55'	VII
Chiusano di S. Domenico	40°56'	14°55'	VI
Civitanova Marche	43°19'	13°42'	IV
Civitella del Tronto	42°46'	13°40'	V
Colle Sannita	41°22'	14°50'	VII
Contursi	40°39'	15°14'	V
Conza della Campania	40°52'	15°20'	VII-VIII
Cori	41°39'	12°55'	III
Cortona	43°16'	11°59'	II
Cropalati	39°31'	16°44'	II
Cusano Mutri	41°20'	14°30'	VI-VII
Deliceto	41°13'	15°23'	VIII
Eboli	40°37'	15°03'	V
Faenza?			VIII
Fara Sabina	42°12'	12°44'	III
Fermo	43°10'	13°43'	III-IV
Ferrandina	40°30'	16°27'	V
Filottrano	43°26'	13°21'	II
Flumeri	41°05'	15°09'	IX
Foggia	41°28'	15°33'	VI
Fondi	41°21'	13°26'	IV
Frigento	41°01'	15°06'	VIII
Gaeta	41°13'	13°34'	II
Galatina	40°10'	18°10'	IV
Gallipoli	40°03'	17°59'	III
Gambatesa	41°31'	14°55'	V-VI
Genzano di Lucania	40°51'	16°02'	VII
Gesualdo	41°00'	15°04'	VIII
Ginosa	40°35'	16°45'	V
Gioia del Colle	40°48'	16°55'	VI
Giulianova	42°45'	13°57'	IV
Grassano	40°38'	16°17'	VI
Greci	41°15'	15°10'	VIII
Grottaminarda	41°04'	15°03'	VIII
Grottole	40°36'	16°23'	V
Guardia dei Lombardi	40°57'	15°13'	VIII
Ielsi	41°31'	14°48'	V
Irsina	40°45'	16°14'	VI
Ischia	40°45'	13°57'	V
Isola Liri	41°41'	13°35'	IV
Itri	41°17'	13°32'	III
Lacedonia	41°03'	15°25'	X
Lagonegro	40°07'	15°46'	V
Lanciano	42°14'	14°23'	V
Larino	41°48'	14°55'	V
Latiano	40°33'	17°43'	V
Lauria	40°03'	15°50'	V
Lecce	40°21'	18°10'	IV
Locorotondo	40°45'	17°19'	V
Lucera	41°30'	15°20'	VI
Macerata	43°18'	13°27'	III-IV
Maddaloni	41°02'	14°23'	VII
Manfredonia	41°37'	15°54'	V
Maratea	40°00'	15°43'	V
Marigliano	40°55'	14°27'	VII
Matelica	43°15'	13°01'	III
Matera	40°40'	16°36'	V
Materdomini	40°49'	15°14'	VI
Mattinata	41°43'	16°03'	IV
Melfi	41°00'	15°39'	IX
Melito Irpino	41°06'	15°02'	VIII-IX
Mercato San Severino	40°47'	14°46'	VII
Mercogliano	40°55'	14°44'	VII
Mignano Montelungo	41°24'	13°59'	VI
Minervi?			VII
Minturno	41°16'	13°45'	IV
Mirabella	41°03'	15°00'	VIII-IX
Mondragone	41°07'	13°54'	VI
Montaguto	41°15'	15°15'	VIII
Montalbano Ionico	40°17'	16°34'	VI
Montecalvo Irpino	41°12'	15°02'	IX
Montecassino	41°29'	13°50'	V
Montecorvino	40°42'	14°59'	II
Monte Fusco	41°02'	14°51'	VII
Montegiorgio	43°08'	13°32'	IV
Monteleone	41°10'	15°16'	IX
Montella	40°51'	15°01'	VII
Montemarano	40°55'	15°00'	VII
Monte Miletto	41°01'	14°55'	VII
Montemilone	41°02'	15°58'	VII
Monterubbiano	43°05'	13°43'	IV
Monte Sant'Angelo	41°42'	15°58'	V
Monte Sarchio	41°04'	14°38'	VII
Monteverde	41°00'	15°32'	IX
Morigerati	40°08'	15°33'	III-IV
Morrone del Sannio	41°43'	14°47'	V
Mottola	40°38'	17°02'	V
Muro Lucano	40°45'	15°29'	VII
Napoli	40°51'	14°16'	VII
Nardò	40°11'	18°02'	IV
Nicastro	38°58'	16°19'	III
Nocera Inferiore	40°45'	14°38'	VII
Nola	40°56'	14°32'	VII
Nusco	40°53'	15°05'	V
Offida	42°56'	13°41'	IV
Orsara di Puglia	41°17'	15°16'	VII-VIII
Orta Nova	41°20'	15°42'	VII
Ortona a Mare	42°21'	14°24'	IV
Ortona dei Marsi	42°00'	13°44'	III
Paduli	41°10'	14°53'	VIII
Palazzo S. Gervasio	40°56'	15°59'	VII
Palma Campania	40°52'	14°33'	VII
Panni	41°13'	15°16'	VIII
Paola	39°22'	16°02'	IV
Paternopoli	40°58'	15°02'	VII
Pellezzano	40°43'	14°45'	VIII
Pescara	42°28'	14°13'	IV
Pescolamazza?			VIII
Pescopagano	40°50'	15°24'	VIII
Piano di Sorrento	40°38'	14°25'	VII
Picerno	40°38'	15°38'	VI-VII
Piedimonte	41°21'	14°22'	V
Pietraroja	41°21'	14°33'	III-IV
Pietrelcina	41°12'	14°51'	VII
Pignaturo Maggiore	41°11'	14°10'	VII
Pisciotta	40°06'	15°14'	V
Poggio Mirteto	42°16'	12°41'	II
Pollica	40°11'	15°03'	IV
Pontelandolfo	41°17'	14°42'	VII
Potenza	40°38'	15°48'	VI-VII
Pozzuoli	40°49'	14°07'	VI
Pratola Serra	40°59'	14°51'	VII
Procida	40°45'	14°01'	VI
Quindici	40°52'	14°39'	VII
Rapolla	40°59'	15°40'	IX
Recanati	43°24'	13°33'	III-IV
Rieti	42°24'	12°52'	IV
Rionero in Vulture	40°55'	15°40'	IX
Ripacandida	40°55'	15°43'	VIII
Rocca di Papa	41°46'	12°43'	III-IV
Roccamonfina	41°17'	13°59'	VII
Rocchetta Sant'Antonio	41°06'	15°28'	IX
Roma	41°54'	12°29'	III
Rossano	39°34'	16°38'	II
Rotondo	39°57'	16°02'	III
Ruvo del Monte	40°51'	15°32'	VIII
Sala Consilina	40°24'	15°35'	II
Salerno	40°41'	14°46'	VII
Salice Salentino	40°23'	17°58'	IV
Salò	45°36'	10°31'	II-III
San Bartolomeo in Galdo	41°25'	15°01'	VI
San Fele	40°49'	15°32'	VIII-IX
San Ferdinando di Puglia	41°18'	16°04'	VI
San Giorgio la Molara	41°16'	14°55'	VII
San Giovanni in Galdo	41°35'	14°45'	IV
San Giovanni Rotondo	41°42'	15°44'	V
San Giorgio la Molara	41°16'	14°55'	VII
San Marco Argentano	39°33'	16°07'	IV
San Marco in Lamis	41°43'	15°38'	V-VI
San Martino	41°13'	15°43'	VIII
San Nazzaro	41°03'	14°51'	VII
San Nicola Baronia	41°03'	15°12'	IX
San Severo	41°41'	15°23'	VI
San Sossio	40°52'	14°53'	IX
Santa Croce del Sannio	41°23'	14°44'	V
Sant'Agata dei Goti	41°05'	14°30'	VII
Sant'Agata di Puglia	41°09'	15°23'	VIII-IX
Sant'Andrea di Conza	40°51'	15°22'	VII
S. Angelo dei Lombardi	40°56'	15°11'	VII
S. Elia a Pianisi	41°37'	14°52'	III-IV
Sarno	40°49'	14°37'	VII
Sava	40°24'	17°33'	IV
Saviano	40°55'	14°31'	VII
Savignano Irpino	41°14'	15°11'	VIII
Scalea	39°49'	15°48'	V
Scampitella	41°06'	15°18'	X
Scanno	41°54'	13°53'	IV
Semaforo Capo Palinuro	40°02'	15°17'	V

Semaforo del Gargano			V
Serino	40°51'	14°51'	VII
Serracapriola	41°48'	15°10'	VI
Sessa Aurunca	41°14'	13°56'	VI
Sezze	41°30'	13°04'	II
Sicignano	40°33'	15°19'	V
Sirolo	43°31'	13°37'	II
Solofra	40°50'	14°51'	VII
Solopaca	41°11'	14°33'	VIII
Subiaco	41°55'	13°06'	IV
Sulmona	42°03'	13°56'	III
Taranto	40°28'	17°15'	V
Taurasi	41°00'	14°57'	VII
Teana	40°08'	16°09'	V
Teano	41°15'	14°04'	VI
Teggiano	40°23'	15°32'	V
Telese	41°13'	14°32'	VII
Teora	40°51'	15°15'	VII
Teramo	42°40'	13°42'	III-IV
Termoli	42°00'	15°00'	V
Terracina	41°17'	13°14'	IV
Tito	40°35'	15°41'	VI
Tolentino	43°13'	13°17'	IV-V
Tolve	40°42'	16°01'	VII
Torchiara	40°19'	15°03'	V
Torremaggiore	41°41'	15°18'	VI
Trevico	41°03'	15°14'	IX-X
Troia	41°22'	15°19'	VII
Ussita	42°57'	13°08'	III
Vallata	41°02'	15°15'	IX
Valle di Pompei			VII-VIII
Valle L.(?)			V
Venafro	41°29'	14°03'	V
Venosa	40°58'	15°49'	VII-VIII
Ventotene	40°48'	13°30'	IV
Vicenza	45°33'	11°33'	II-III
Vico Equensi	40°40'	14°26'	VII
Vico Garganico	41°54'	15°57'	V
Villa Latina	41°37'	13°50'	III
Villa S. Maria	42°27'	14°07'	IV
Villanova	41°07'	15°10'	X
Vinchiaturo	41°30'	14°35'	III-IV
Visso	42°56'	13°05'	II-III
Volterra	43°24'	10°30'	IV
Volturara Irpina	40°53'	14°55'	VII
Vulturara Appula	41°30'	15°03'	V
Zungoli	41°07'	15°12'	IX

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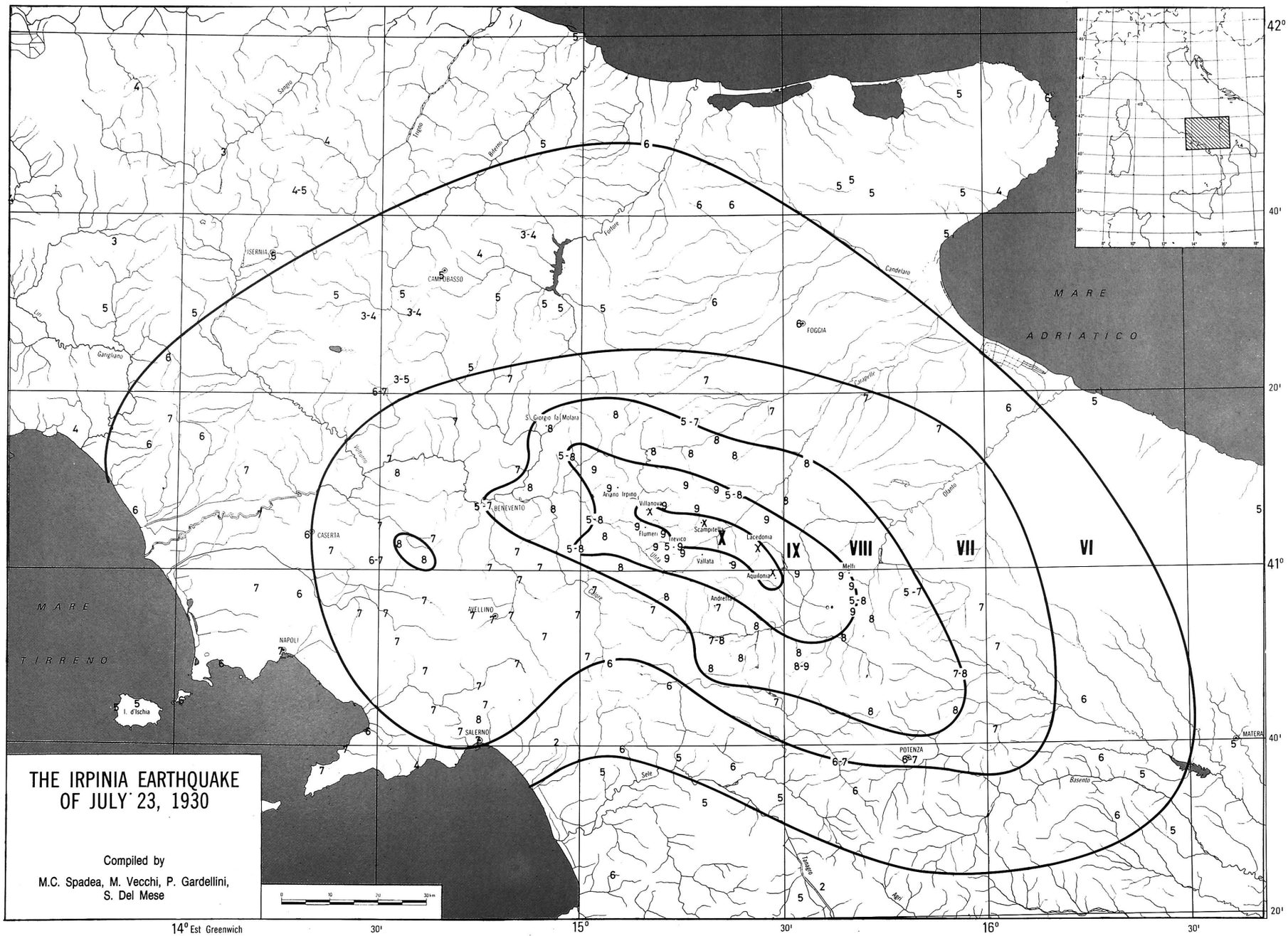

The drainage network of this map – scale 1:500.000 – is the same as the "Structural Model of Italy."

G.T.M - Via Marco Marulo 47a - 00143 ROMA

The Lama dei Peligni earthquake of September 26, 1933.

M.C. Spadea, M. Vecchi, P. Gardellini, S. Del Mese

On 26 September 1933, an extensive seismic period began in southern Abruzzo, with a tremor of MCS intensity IV at 01^h15^m, and one of MCS intensity VI at 03^h11^m. The main shock of IX MCS occurred at 04^h33^m, and principally affected the towns of Lama dei Peligni, Taranta Peligna, Civitella Messer Raimondo and Fara San Martino.

Numerous aftershocks occurred on the same day, although they gradually became more spaced out and attenuated in the days that followed. On 23 November there was a further strong tremor of MCS intensity VII.

There were fortunately only a few casualties (about a dozen) because the two tremors shortly preceding the destructive one, gave the population sufficient warning to leave their houses.

Many dwellings were destroyed: at Lama dei Peligni about 300 houses collapsed and about the same number were damaged; at Taranta Peligna 70 collapsed and some 200 were seriously damaged; at Fara San Martino 10 houses collapsed and 200 were damaged to varying degrees; and at Civitella Messer Raimondo 50 houses collapsed and 100 were seriously damaged.

Analysis of the macroseismic questionnaires shows that a large number of persons in various parts of the epicentral zone observed the so-called «seismic flash», which was described by some as a reddish glow, and by others as a tongue of flame leaving the Maiella in the direction of the sea. In addition to the analysis of the macroseismic questionnaires, which represent the main source of data, other works used in the study of this event were the publications referred to in the bibliography as numbers (3, 4, 5) and contemporary press reports (both local and national) (1, 2).

Some difficulty was encountered in mapping the isoseisms owing to both the irregular distribution of the data and differences in geological structure, as well as to deficiencies in the information contained in maps drawn up by observers.

Nevertheless the macroseismic field may be regarded as well-defined and complete. The general orientation is parallel to the Apennines and the preferential direction of propagation is NNW.

List of shocked localities:

Locality	Latit.	Long.	I (MCS)
Acquasanta	43°32'	13°11'	IV
Aielli	42°05'	13°35'	V
Alanno	42°18'	13°58'	VII
Altino	42°06'	14°20'	VII
Amatrice	42°38'	13°17'	(V)
Anagni	41°45'	13°09'	IV
Ancona	43°36'	13°30'	IV
Antrodoco	42°25'	13°05'	IV
Anversa degli Abruzzi	42°00'	13°48'	VI
Apiro	43°23'	13°08'	IV
Arcevia	43°30'	12°56'	NF
Archi	42°05'	14°23'	VII
Ari	42°17'	14°16'	VI-VII
Arpino	41°39'	13°37'	(V)
Arquata del Tronto	42°46'	13°18'	IV
Arsita	42°30'	13°47'	V
Ascoli Piceno	42°51'	13°35'	V
Atessa	42°04'	14°27'	VIII
Atina	41°37'	13°48'	V
Atri	42°44'	13°00'	V
Avezzano	42°02'	13°26'	IV
Balsorano	41°48'	13°34'	V
Baranello	41°32'	14°33'	IV
Barisciano	42°19'	13°36'	VI
Basciano	43°22'	11°18'	(V)
Benevento	41°08'	14°47'	(III)
Bisegna	41°55'	13°45'	VI
Bisenti	42°32'	13°48'	VI
Bomba	42°02'	14°22'	VII
Bucchianico	42°18'	14°11'	VII
Bussi sul Tirino	42°13'	13°50'	VII
Caldarola	43°08'	13°14'	IV
Camerino	43°08'	13°04'	IV
Campagnano	42°08'	12°23'	(III)
Campo di Giove	42°01'	14°03'	VIII
Canistro	41°56'	13°24'	V
Canosa Sannita	42°18'	14°18'	VI
Cansano	42°00'	14°01'	VIII
Capitignano	42°31'	13°23'	IV
Cappadocia	42°00'	13°17'	IV
Cappelle sul Tavo	42°28'	14°06'	VI
Capracotta	41°50'	14°16'	(VI)
Capranica Prenestina	41°52'	12°57'	IV
Caramanico	42°23'	14°18'	VIII
Carpineto Sinello	42°01'	14°30'	V-VI
Carsoli	42°06'	13°05'	IV
Carunchio	41°55'	14°31'	IV
Casalbordino	42°09'	14°35'	VI
Casale	41°41'	14°28'	VI
Casalincontrada	42°17'	14°08'	VII
Casamicciola	40°45'	13°55'	IV
Casoli	42°07'	14°17'	VIII
Castel di Sangro	41°47'	14°06'	VI-VII
Castel Frentano	42°12'	14°21'	VII
Castelguidone	41°49'	14°31'	VI
Castellaffiume	41°59'	13°20'	IV
Castellalto	42°41'	13°49'	V
Castelli	42°29'	13°43'	VII
Castelvecchio Subequo	42°08'	13°44'	VII
Castiglione Messer Raimondo	42°05'	14°13'	IV
Castignano	42°56'	13°37'	IV
Castilenti	42°32'	13°55'	VI
Catignano	42°21'	13°57'	VI
Ceccano	41°34'	13°20'	IV
Celano	42°05'	13°33'	VI
Celenza sul Trigno	41°52'	14°34'	V
Cellino Attanasio	42°35'	13°52'	V
Cepagatti	42°22'	14°04'	VI
Ceprano	41°33'	13°31'	V
Chieti	42°21'	14°10'	VII
Cingoli	43°22'	13°13'	III
Città Sant'Angelo	42°31'	14°04'	V
Civitaluparella	41°57'	14°18'	VII
Civitanova Marche	43°19'	13°42'	IV
Civitaquana	42°19'	13°54'	(VII)
Civitella Casanova	42°22'	13°53'	VII
Civitella del Tronto	42°46'	13°40'	V
Civitella Messer Raimondo	42°05'	14°13'	IX
Cocullo	42°02'	13°47'	VI
Collecorvino	42°27'	14°01'	VI
Colledara	42°32'	13°40'	VI
Colle di Macine	42°00'	14°12'	VII-VIII
Colledimezzo	41°59'	14°23'	VII
Collurania?			IV
Colonnella	42°52'	13°52'	(III)
Controguerra	42°51'	13°49'	IV
Corridonia	43°15'	13°31'	(IV)
Corropoli	42°50'	13°50'	IV
Corvara	42°16'	13°52'	(VII)
Crecchio	42°18'	14°20'	VI
Crognaleto	42°35'	13°29'	IV
Cupello	42°04'	14°40'	VI
Cugnoli	42°18'	13°56'	VIII
Cupra Marittima	43°01'	13°52'	(III)
Dogliola	41°56'	14°38'	V
Elice	42°31'	13°58'	V
Fagnano Alto	42°14'	13°36'	VI
Falerone	43°06'	13°28'	IV
Fano	43°50'	13°01'	III
Fano Adriano	42°33'	13°32'	VI
Fara Filiorum Petri	42°15'	14°11'	VIII
Fara San Martino	42°05'	14°12'	IX
Farindola	42°26'	13°49'	VI
Fermo	43°10'	13°43'	III-IV
Filetto	42°14'	14°15'	VII
Fogglia	41°28'	15°33'	III
Foligno	42°57'	12°42'	III
Frascati	41°48'	12°41'	IV
Frisa	42°16'	14°22'	VI
Furci	42°00'	14°35'	V
Gagliano Aterno	42°08'	13°42'	VI-VII
Gambatesa	41°31'	14°55'	III
Gamberale	41°54'	14°13'	VII
Gessopalena	42°03'	14°16'	VIII
Gioia dei Marsi	41°57'	13°42'	V
Gissi	42°01'	14°33'	V
Giuliano Teatino	42°18'	14°17'	VII
Giulianova	42°45'	13°57'	IV
Goriano Sicoli	42°05'	13°46'	(VII)
Grottamare	42°59'	13°52'	IV
Guilmi	42°00'	14°29'	VI
Isernia	41°36'	14°14'	IV-V
Isola Liri	41°41'	13°35'	V
Lama dei Peligni	42°02'	14°11'	IX
Lanciano	42°14'	14°23'	VI
L'Aquila	42°21'	13°24'	V
Larino	41°48'	14°55'	IV
Lentella	42°00'	14°41'	(V)
Liscia	41°57'	14°33'	V
Loreto Aprutino	42°26'	13°59'	V-VI
Loro Piceno	43°10'	13°25'	III
Luco dei Marsi	41°58'	13°28'	V
Macerata	43°18'	13°27'	IV
Magliano dei Marsi	42°06'	13°22'	IV
Manoppello	42°15'	14°04'	(VII)
Massa d'Albe	42°06'	13°24'	V
Matelica	43°15'	13°01'	III
Miglianico	42°22'	14°18'	VI
Mogliano	43°11'	12°29'	IV
Mondragone	41°49'	12°42'	IV
Montazzoli	41°57'	14°26'	VI
Montebello di Bertona	42°25'	14°19'	VI-VII
Montecarotto	43°32'	13°04'	III
Montecassiano	43°22'	13°26'	III
Montecassino	41°23'	13°49'	V
Montefano	43°25'	13°26'	IV
Montefino	42°33'	13°49'	V
Montegiorgio	43°08'	13°32'	III
Montegranaro	43°14'	13°38'	(IV)
Montelupone	43°21'	13°34'	IV
Montenerodomo	41°58'	14°15'	VIII
Monteodorisio	42°05'	14°39'	VI
Montereale	42°31'	13°15'	IV
Monterubbiano	43°05'	13°43'	IV
Monte San Pietrangeli	43°11'	13°35'	IV
Montesilvano	42°29'	14°08'	V
Montorio al Vomano	42°35'	13°38'	VI
Morro D'Oro	42°40'	13°55'	V
Mosciano Sant'Angelo	42°45'	13°53'	IV
Moscufo	42°26'	14°03'	(VI)
Mozzagrogna	42°13'	14°27'	VI
Notaresco	42°39'	13°54'	V
Offida	42°56'	13°41'	IV
Opi	41°47'	13°50'	VI
Oricola	42°03'	13°02'	V
Orsogna	42°13'	14°17'	VII
Ortezzano	43°02'	13°37'	IV
Ortona dei Marsi	42°00'	13°44'	VI
Ortucchio	41°57'	13°39'	V
Ovindoli	42°08'	13°31'	V-VI
Paglieta	42°10'	14°30'	VI
Palena	41°59'	14°08'	VIII
Palombaro	42°08'	14°14'	VIII
Penne	42°27'	13°56'	V-VI
Pennadomo	42°00'	14°20'	VII-VIII
Pennapiedimonte	42°09'	14°12'	VIII
Perano	42°06'	14°24'	(VII)
Pescara	42°28'	14°13'	V
Pescocostanzo	41°54'	14°04'	VII
Pescosansonesco	42°14'	13°52'	VIII
Pettorano sul Gizio	41°58'	13°58'	VIII
Petritoli	43°04'	13°39'	IV
Pianella	42°24'	14°03'	VI-VII
Picciano	42°28'	13°59'	VI
Pietranico	42°17'	13°55'	VIII
Pizzoferrato	41°55'	14°14'	VII
Pizzoli	42°26'	13°18'	V
Poggiofiorito	42°15'	14°19'	VI
Poggio Mirteto	42°16'	12°41'	IV
Pollenza	43°16'	13°21'	III
Pollutri	42°08'	14°36'	VI
Ponte Giorgio	43°11'	13°48'	III
Popoli	42°10'	13°50'	VII
Portocivitanova	43°18'	13°44'	III
Pratola Peligna	42°06'	13°52'	VII
Pretoro	42°13'	14°08'	VII
Punta Penna	42°11'	14°43'	V
Quadri	41°55'	14°17'	VII
Rapino	42°13'	14°11'	VII-VIII
Recanati	43°24'	13°33'	(IV)
Rieti	42°24'	12°52'	IV
Ripatransone	43°00'	13°46'	IV
Rocca di Papa	41°46'	12°43'	IV
Rocca Pia	41°56'	13°59'	VII
Roccascalegna	42°04'	14°18'	VII-VIII
Roccacasale	42°07'	13°53'	VI-VII
Roccaspinalveti	41°56'	14°28'	VI
Roio del Sangro	41°55'	14°22'	VI
Roma	41°54'	12°29'	III
Rosciano	42°19'	14°03'	VI
Rosello	41°54'	14°21'	VII
Salle	42°11'	13°58'	VIII
San Buono	41°59'	14°34'	V
San Benedetto del Tronto	42°56'	13°54'	IV
San Demetrio ne Vestini	42°17'	13°33'	VI
San Ginesio	43°06'	13°19'	IV
San Giovanni Lipioni	41°51'	14°34'	IV
San Giovanni Teatino	42°25'	14°12'	VI
San Martino sulla Marrucina	42°13'	14°13'	VIII
San Pietro Avellana	41°47'	14°11'	VI
San Salvo	42°03'	14°44'	V
San Severino Marche	43°14'	13°11'	IV
San Vito Chietino	42°18'	14°27'	VI
Sant'Eufemia a Maiella	42°08'	14°02'	VIII
Sant'Egidio alla Vibrata	42°49'	13°43'	V
S. Maria Imbaro	42°13'	14°27'	V-VI
Sant'Omero	42°47'	13°48'	IV
Santo Stefano di Sessanio	42°21'	13°39'	VI
Sassoferrato	43°27'	12°51'	NF
Sarnano	43°02'	13°18'	III
Serra Monacesca	42°15'	14°06'	VIII
Scanno	41°54'	13°53'	VI
Scerni	42°06'	14°34'	VI
Schiavi d'Abruzzo	41°49'	14°29'	V
Senigallia	43°43'	13°13'	NF
Scurcola Marsicana	42°04'	13°20'	IV
Silvi	42°33'	14°07'	IV
Sulmona	42°03'	13°56'	VIII
Taranta Peligna	42°01'	14°10'	IX
Tagliacozzo	42°04'	13°15'	IV
Teramo	42°40'	13°42'	V
Termoli	42°00'	15°00'	IV
Tocco Casuaria	42°39'	13°38'	VIII?
Tollo	42°20'	14°19'	VI
Tornareccio	42°02'	14°54'	VII
Torino di Sangro	42°11'	14°32'	V
Torre Bruna	41°52'	14°33'	V
Torremaggiore	41°41'	15°18'	IV

Torrevecchia Teatina	42°23'	14°13'	VI
Torricella Sicura	42°39'	13°39'	(V)
Torricella Peligna	42°01'	14°16'	VIII?
Tortoreto	42°48'	13°55'	IV
Tossicia	42°33'	13°57'	VI
Trasacco	41°57'	13°32'	V
Treglio	42°16'	14°25'	VI
Treia	43°19'	13°19'	III
Trivento	41°47'	14°33'	(V)
Tufillo	41°55'	14°38'	V
Turrivalignani	42°16'	14°02'	VII
Vacri	42°18'	14°14'	VI
Vasto	42°07'	14°42'	V-VI
Velletri	41°41'	12°47'	IV
Venafro	41°29'	14°03'	IV
Venarotta	42°53'	13°30'	IV
Veroli	41°42'	13°25'	V
Villetta Barrea	41°47'	13°56'	V
Villa Celiera	42°23'	13°52'	(V)
Villalago	41°56'	13°50'	VI
Villamagna	42°20'	14°14'	VII
Villa Santa Maria	41°57'	14°21'	VII
Villavallelonga	41°52'	13°37'	V

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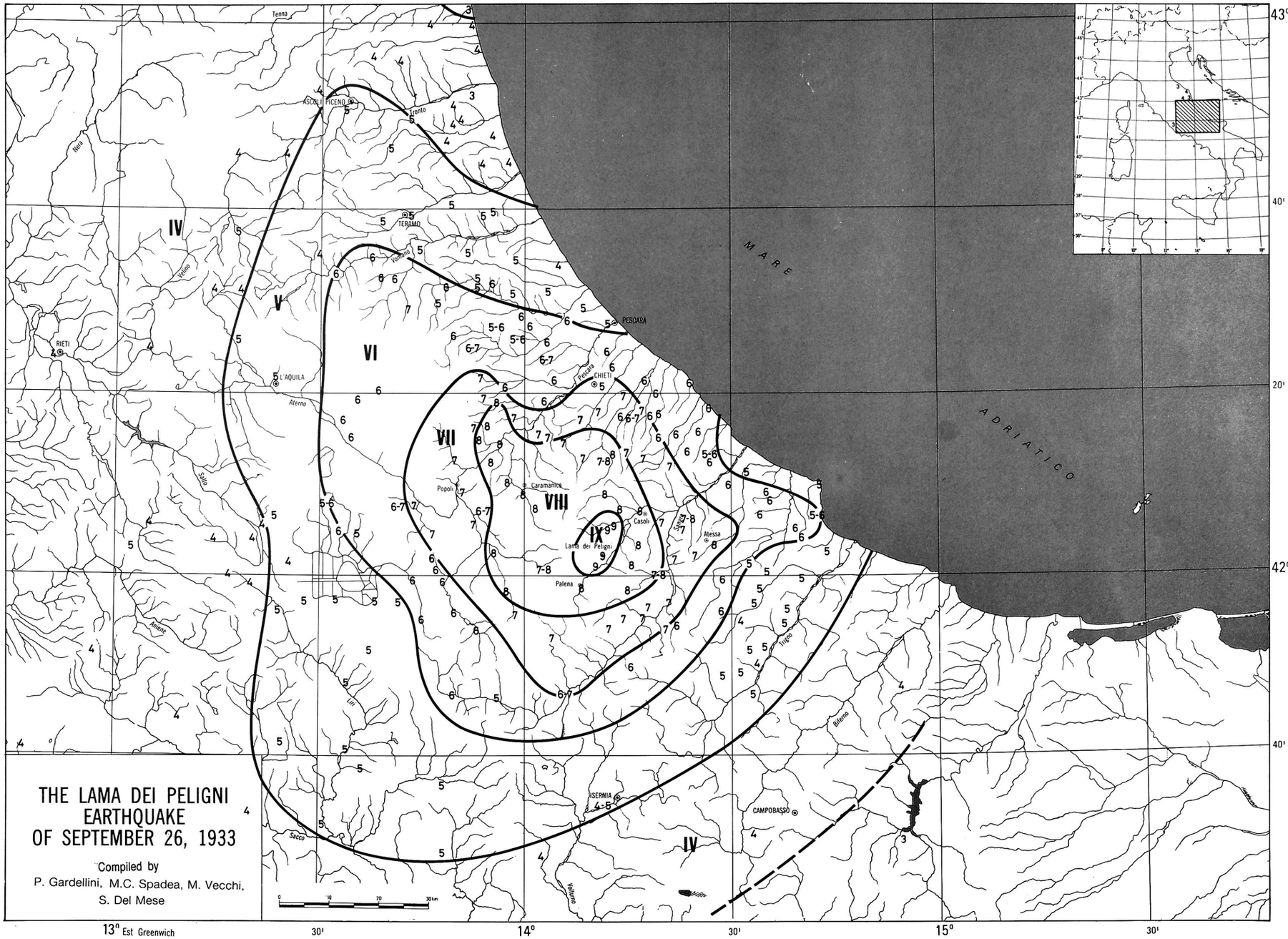

The drainage network of this map – scale 1:500.000 – is the same as the "Structural Model of Italy."

G.T.M - Via Marco Marulo 47a - 00143 ROMA

The Castignano earthquake of October 3, 1943.

S. Raccichini, M. Stucchi, W. Calza

This earthquake is an example of how the knowledge of a nearly contemporary event can be, in some cases, not much greater than in events from past centuries in spite of the widespread growth of instrumental records.
The diversity between macroseismic and instrumental data was relevant at the beginning of the research. Still greater was the diversity between scientific records and social consequence of the event, so that they could actually be interpreted as images of two «different earthquakes».
The earthquake is classified in (1) and (2) as follows:

	Year	Month	Day	Time (GMT)	ep. coord.	Magn.	MCS int.
(1)	1943	Oct.	3	08 28 29	4306 1336	6.0	IX
(2)	1943	Oct.	3	08 28 29	4306 1336	5.0	VIII

Epicentre location is according to instrumental data, and magnitude from macroseismic data.
Initial data included the epicentral location by I.S.S. (43.1, 13.2) based upon 54 stations (3 of which in Italy); and 13 macroseismic cards (reporting data from 22 localities) from which a isoseismal map had been drawn (2).
Another available source was the list of the «Municipalities» which had been classified in 1946 as second category according to the Italian building code. The delay of this statement, due to the war, is probably responsible for poor agreement between the existing isoseismal map and the classified area.
Research on this earthquake is particularly complicated since at the time of the earthquake the area was under military occupation.
No specific reports, newspapers, nor photographic documentation have been found. The only highly relevant source is the report of an official survey carried out by the «Genio Civile» of Ascoli Piceno, which was found in the local Archive (4).
An attempt to carry on searches based on oral sources was made. In this field, the following initiatives were taken:

— interviews performed by junior high school pupils with eyewitnesses of the event in Monte S. Pietrangeli (Ascoli Piceno), accomplished by the filling out of macroseismic forms; a good agreement was found with the «Genio Civile» report – this method can be suggested for those localities where uncertainties lie;
— local radio-talk program, with listeners telephoning in with information on this event;
— distribution of «past-earthquakes» macroseismic forms to the municipalities of a large region surrounding the epicentral area, to obtain direct information or indications for sources;
— «late» macroseismic survey with direct interviews in some ten localities of the epicentral area, generally, it is still possible to see traces of building restorations, fallen buildings, empty spaces or widened places, and so on.

The events listed in (3)

	Year	Month	Day	Time (GMT)	ep. coord.	Magn.	MCS int.
	1943	March	12	21 45	4253 1342	3.0	IV
	1943	March	12	21 47	4253 1342	2.5	III
	1943	March	13	03 15	4253 1342	2.5	III
(2)	1943	March	13	05 15	4253 1342	3.5	V
	1943	March	13	17 40	4253 1342	2.5	III
	1943	June	12	00 25	4300 1340	2.5	III
	1943	Dec.	8	20 35	4254 1340	4.0	VI

which happened prior and subsequent to the October 3, 1943 event, and which are located, presumably on the basis of macroseismic sources, in the Offida, Montalto zone could be related to the «main» event, which on the contrary, is classified as located in Monterubbiano, without aftershocks.

The life-toll is presumed to have been between 20 and 30, most of which was concentrated in S. Venanzo of Castignano. The intensity attributable to this site is IX, though the average intensity for the municipality of Castignano does not reach IX: at the present it is not possible to decide between the VIII and IX degree for the village of Castignano itself.
In spite of the amount of data collected, delimitation of the isoseismal areas is still uncertain.
Two areas need further investigation: the areas of Montegiorgio, and Magliano di Tenna where many localities report intensity up to VII-VIII MCS, though they are substantially distant from the VIII MCS zone; and the region between Ascoli Piceno and Teramo, in order to better delimitate the VIII MCS area.
The trend of this area is elliptical with major axis oriented N 145.

List of shocked localities:

Locality	Latit.	Long.	I (MCS)
Acquasanta Terme	42°46'	13°25'	VIII
Acquaviva Picena	42°57'	13°49'	VII
Alteta (Montegiorgio)	43°10'	13°34'	VIII
Amandola	42°59'	13°21'	VII
Ancarano	42°50'	13°45'	VII-VIII
Appignano del Tronto	42°54'	13°40'	VIII
Arquata del Tronto	42°46'	13°18'	VII
Ascoli Piceno	42°51'	13°35'	VII
Belmonte Piceno	43°05'	13°32'	VII-VIII
Camerino	43°08'	13°04'	V
Carassai	43°02'	13°41'	VII
Castel di Folignano (Folignano)	42°49'	13°38'	VIII
Castel di Lama	42°52'	13°42'	VIII
Castignano	42°56'	13°37'	VIII-IX
Castorano	42°54'	13°44'	VIII
Cerreto (Montegiorgio)	43°10'	13°34'	VII
Civitella del Tronto	42°46'	13°40'	VII-VIII
Colli del Tronto	42°53'	13°45'	VIII
Comunanza	42°58'	13°25'	VII
Cossignano	42°59'	13°41'	VII
Falerone	43°06'	13°28'	VII
Fermo	43°10'	13°43'	VII
Folignano	42°49'	13°38'	VII
Fontespina	43°20'	13°43'	V
Force	42°58'	13°29'	VIII
Francavilla D'Ete	43°11'	13°32'	VII
Grottammare	42°59'	13°52'	VI
Grottazzolina	43°07'	13°36'	VI
Ioannella (Torricella Sicura)	42°40'	13°37'	VII
L'Aquila	42°21'	13°24'	V
Macerata	43°18'	13°27'	VI-VII
Magliano di Tenna	43°08'	13°35'	VII-VIII
Maltignano	42°50'	13°41'	VIII
Massa Fermana	43°09'	13°29'	VII
Massignano	43°03'	13°48'	VII
Monsampolo del Tronto	42°54'	13°48'	VII-VIII
Monsampietro Morico	43°04'	13°33'	VII
Montalto delle Marche	42°59'	13°37'	VIII
Montappone	43°08'	13°28'	VII
Montedinove	42°58'	13°35'	VII
Montegallo	42°50'	13°20'	VII
Monte Giberto	43°05'	13°38'	VII
Montegiorgio	43°08'	13°32'	VII
Monteleone di Fermo	43°03'	13°32'	VII
Montelparo	43°01'	13°32'	VII
Montelupone	43°20'	13°34'	VI-VII
Montemonaco	42°54'	13°20'	VI
Monteprandone	42°55'	13°50'	VII
Montefalcone Appennino	42°59'	13°28'	VII
Monte Rinaldo	43°02'	13°35'	VII
Monte San Pietrangeli	43°11'	13°35'	VII
Monte Urano	43°12'	13°40'	VIII
Monteverde (Montegiorgio)	43°06'	13°31'	VIII
Monte Vidon Combatte	43°03'	13°38'	VII
Monte Vidon Corrado	43°07'	13°29'	VII
Montottone	43°04'	13°35'	VI
Moregnano (Petritoli)	43°05'	13°39'	VII
Offida	42°56'	13°41'	VIII
Osimo	43°29'	13°29'	VI
Palestrina	41°50'	12°53'	III
Patrignone (Montalto delle Marche)	42°59'	13°37'	VIII
Pesaro	43°54'	12°54'	IV
Petritoli	43°04'	13°39'	VII
Poggio San Lorenzo	42°15'	12°51'	III-IV
Ponzano di Fermo	43°06'	13°40'	VII
Porchia (Montalto delle Marche)	43°00'	13°38'	VIII
Porto Recanati	43°26'	13°40'	VI
Rimini	44°04'	12°34'	III
Ripaberarda (Castigliano)	42°55'	13°36'	VIII
Ripatransone	43°00'	13°46'	VII
Roccafluvione	42°52'	13°29'	VII
Roma	41°54'	12°29'	II-III
Roseto degli Abruzzi	42°40'	14°01'	V
Rotella	42°57'	13°34'	VII
Santa Vittoria in Matenano	43°01'	13°30'	VII-VIII
Sant'Egidio alla Vibrata	42°50'	13°43'	VII-VIII
Sant'Elpidio a Mare	43°14'	13°41'	VII
San Venanzo (Castignano)	42°57'	13°39'	IX
Sefro	43°09'	12°57'	IV
Servigliano	43°05'	13°30'	VII
Smerillo	43°00'	13°27'	VII
Spinetoli	42°53'	13°46'	VII
Teramo	42°40'	13°42'	VII-VIII
Tolentino	43°13'	13°17'	VI
Torre San Patrizio	43°11'	13°36'	VII
Venarotta	42°53'	13°30'	VII

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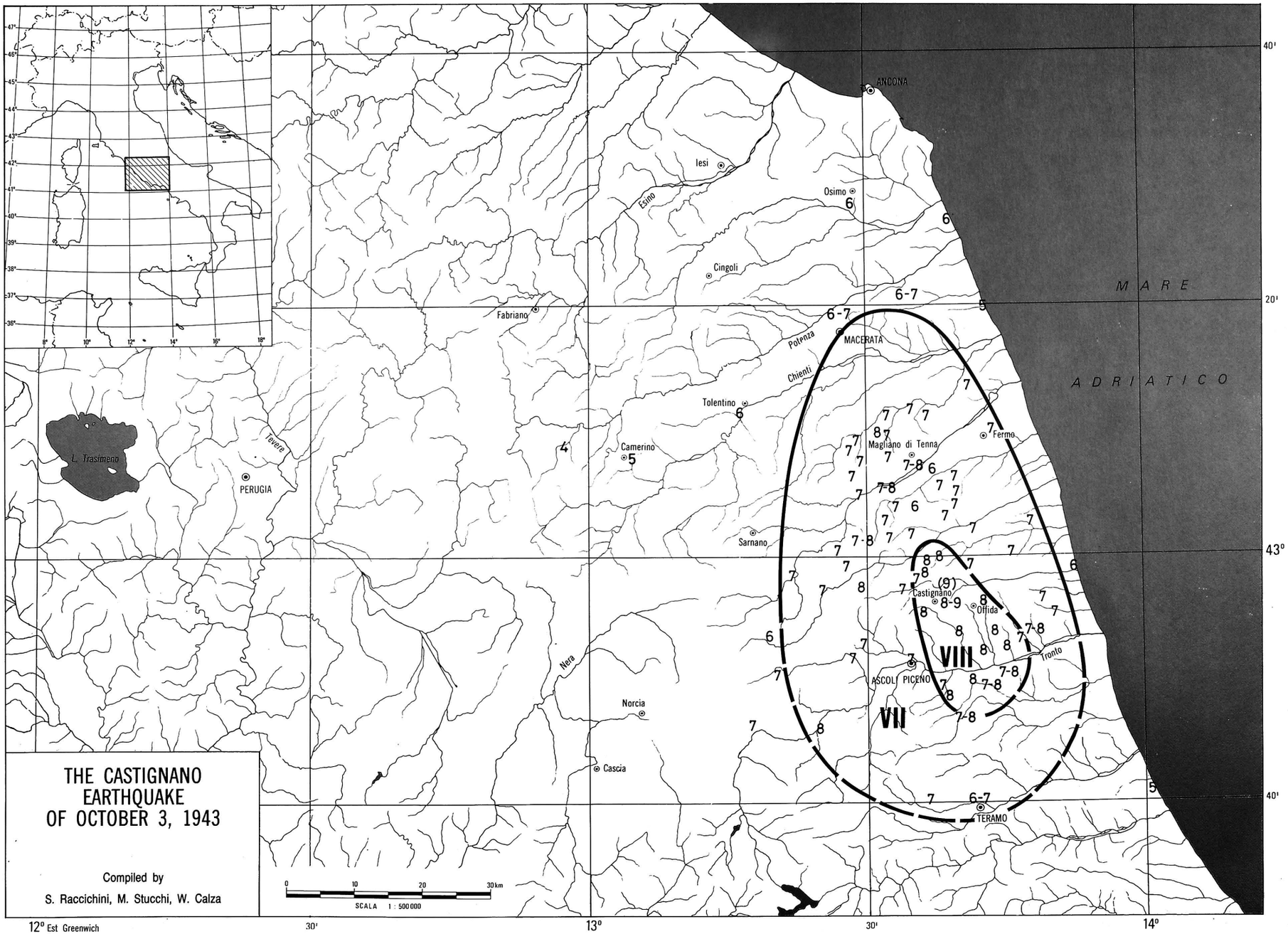

THE CASTIGNANO EARTHQUAKE OF OCTOBER 3, 1943

Compiled by

S. Raccichini, M. Stucchi, W. Calza

The drainage network of this map – scale 1:500.000 – is the same as the "Structural Model of Italy."

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The Gulf of Squillace earthquake of May 11, 1947.

A. Bottari, B. Federico, E. Lo Giudice, C. Pandolfo

Since this is a fairly recent earthquake, instrumental data are available and have been studied by various authors. In 1948, Valle (5), utilizing the seismograms recorded in nine European stations in the $500 \leqslant \Delta \leqslant 1100$ km range, gave the following epicentral coordinates:
latitude 38°41' · 4 ± 7' · 6 N
longitude 16°47' · 7 ± 2' · 2 E
origin time $06^h32^m\ 15^s \cdot 4 \pm 1^s \cdot 4$ (G.M.T. May 11, 1947)
and placed the focal depth in the crust.
The numerous aftershocks were investigated by Agamennone (6). About 20 years later, in 1966, on the basis of the arrival times in 15 European stations in the $1.7 \leqslant \Delta° \leqslant 22$ interval, Cameli (1) calculated the focal mechanism and identified a plane at 63° W.
No direct macroseismic survey exists, however; those authors (De Panfilis and Agamennone) who do give a macroseismic field, and particularly De Panfilis (2, 3), have taken as their exclusive source of information the postcard forms handed in to the Royal Department of Metereology and Geophysics (Regio Ufficio di Metereologia e Geofisica). However, there are some substantial differences both between the two macroseismic fields, and between them and certain data reported by Cameli (1). De Panfilis' field (3) is more detailed and is the only one supplied with a list (2) of the localities damaged.
In our study the information reported on the Regio Ufficio di Metereologia e Geofisica postcard forms was used prevalently. We have traced almost all the postcard forms that exist, since the number of localities missing from our list that are mentioned by De Panfilis (2) is very small. At the same time some doubts remain in that sometimes the information reported on a postcard form is clearly insufficient for a grade of intensity to be assigned, whereas De Panfilis does give it a grade and reports it on the postcard form. We considered that could be due either to non-reported data in the possession of De Panfilis or merely to his own interpretation. Consequently, during the drawing stage we have relied less on such information and in certain cases have expressed our doubts as to the grade of intensity assigned.
The main area concerned in this earthquake is that of the Catanzaro Graben. Here Calabria stretches less than 30 km between the two seas, the Ionian and the Tyrrhenian; inevitably all the isoseismal lines of the macroseismic field are joined together in the sea. Obviously, that makes the evaluations of some of the macroseismic parameters less realistic as well as making the calculation of others meaningless.
The macroseismic epicenter is more or less the same for all isoseismal areas and is sited not far from the coast in the vicinity of Soverato. Its coordinates:
latitude: 38°42' N; longitude: 16°34' E
are in quite good agreement with the instrumental ones.
Apart from the stretch in the sea, the VIII grade isoseismal line contains a part that is not very clear to the west of Vallefiorita in the area between Girifalco, Polia and Chiaravalle; in fact this area is characterized by the highest points of the Serre (≃ 1000 m asl) and is totally void of built-up areas. The mesoseismic area tends preferentially NW-SE and is in perfect agreement with the structural system characterizing preferentially NW-SE and is in perfect agreement with the structural system characterizing the southeastern part of the Graben of Catanzaro which crops out marked 40°-45° W at Soverato and Punta Staletti.
The most damaged locality, Isca Ionica, is dislocated in the southern part of the mesoseismic area. The phenomenology observed at Isca could even be attributed to the grade IX; however, it is closely surrounded by built up areas where the observed phenomenology was of the VIII grade or less. The incompleteness and imprecision of the information, together with the eccentricity and limited extent of the area, do not justify this grade being assigned to the earthquake itself. On the other hand, the position of Isca on the boundary between the Permo-Carboniferous granites and granatiorites of the Serre and the Lower-Pliocene argillaceous and marly formations could explain this positive-sign anomaly as being due to the typical increase at contact zones between terrains having different competences.

Despite its incompleteness, the external field appears fairly regular. The best defined areas are that of the VII and VI grade, the latter a little less so. These two areas show a fair amount of attenuation northwestwards. In our opinion this is in all likelihood connected to the strong development of sheaves of longitudinal structures in the Calabrian Arc (20° E) which at that point characterizes the upper valley of the Mesima River and the Serra di Vito from Dinami to Iacurso.
The macroseismic field shows two areas with negative-sign anomalies. The first is fairly delimitable and runs NE of Catanzaro showing a decrease of one or two grades inside the grade VII isoseismal line. The second is a «not-flet» area, not clearly delimitable to the east of the Sila massif from Bocchigliero to Cirò. These two areas of decrease are both characterized by vast outcrops of clays, marls («Trubi») and evaporites of the Lower-Pliocene.
Seven foreshocks were reported during the night prior to the earthquake; the main foreshocks reached an intensity of grade V at 1^h33^m and 1^h45^m at San Sostene and 2^h00^m at Squillace. These shocks were felt southwestwards but not outside of the grade VII isoseismal line of the main shock.
The numerous aftershocks reported, both on the day itself and on those following, did not exceed the grade IV or V. Here we list, among those of the day itself, the ones which, knowing their «felt-point» distribution, can most probably be referred to the source itself: 7^h30^m which was of grade IV; 8^h30^m; 9^h33^m; 10^h47^m; 12^h16^m; and 12^h45^m. In the afternoon of the same day some shocks were reported as reaching grade V or VI. However, these were felt only in the localities to the E and NE of the Sila massif, where the main shock was not felt.

List of shocked localities:

Locality	I (MCS)
Aci Castello	NF
Acquaro	VI-VII
Acri	⩾III
Aiello Calabro	V
Albi	VII
Altomonte	NF
Amantea	V
Amato	⩽VII
Andali	⩽VII
Andrea Apostolo dell'Ionio, San	⩽VIII
Argusto	⩽VIII
Belcastro	VI-VII
Badolato	VIII
Barcellona Pozzo di Gotto	NF
Belcastro	VI-VII
Belmonte	V
Belpasso	NF
Biancavilla	NF
Bocchigliero	NF
Bonifati	⩽IV
Borgia	VIII
Brindisi	NF
Buonvicino	III
Calatabiano	NF
Calogero, San	VI
Caltagirone	NF
Campobasso	NF
Capistrano	VII
Cardinale	⩽VII
Carlopoli	⩽VI-VII
Carolei	V
Casabona	IV
Casole Bruzio (Trenta)	IV-V
Castiglione di Sicilia	NF
Castroreale	III
Catanzaro	V
Ceglie Messapico	NF
Cessaniti	V
Chiaravalle Centrale	VII-VIII
Cicala	VII
Cirò Superiore	NF
Cisternino	NF
Conflenti	V-VI
Corigliano Calabro	NF
Cortale	VII
Cosenza	IV
Cosmo Albanese, San	⩾III
Costantino Calabro, San	VI
Crichi	VI
Cropani	VII
Crotone	⩾IV
Curinga	VII
Cutro	VI
Dasà	VI-VII
Davoli	⩽VIII
Decollatura	VI
Dinami	V
Domenica Vittoria, Santa	NF
Feroleto Antico	⩽VII
Filadelfia	⩽VII
Fili, San	IV
Filippo del Mela, San	NF
Fiumfreddo di Sicilia	NF
Floresta	NF
Floro, San	VIII
Fossato Serralta	VII
Francavilla Angitola	VII
Francavilla Fontana	NF
Furci	III
Galati Mamertino	NF
Gasperina	VIII
Gerace	V
Giarre	NF
Gimigliano	VII
Gizzeria	⩾V
Graniti	NF
Girifalco	VII-VIII
Gran Michele	NF
Gregorio d'Ippona, San	VI
Gregorio, San	NF
Guardavalle	VII
Iacurso	VII
Ioppolo	VI
Isca Ionica	⩽IX
Licodia Eubea	NF
Limbadi	VI
Lucia del Mela, Santa	NF
Macisano	VI-VII
Maida	VII
Maierato	⩽VII
Maletto	NF
Manduria	NF
Mango d'Aquino, San	V
Marcedusa	VI
Marcellinara	⩽VII
Maria di Licodia, Santa	NF
Marina di Salina, Santa	NF
Massafra	NF
Mauro Marchesato, San	V
Melissa	NF
Messina	IV
Michele di Ganzaria, San	NF
Michele Salentino, San	NF
Mileto	VI
Mirto	NF
Misterbianco	NF
Mongiana	VII
Montalbano d'Elicona	NF
Montauro	⩽VIII
Monterosso Calabro	VII-VIII
Motta Santa Anastasia	NF
Nardo di pace	VI-VII
Nicastro	⩽VI
Nicola da Crissa, San	VII
Novara di Sicilia	NF
Olivadi	VII-VIII
Oliveri	NF
Onofrio, Santo	V-VI
Ostuni	NF
Palagianello	NF
Pallagorio	NF
Patti	NF
Pedara	NF
Pentone	VI
Petronà	VI-VII
Piano di Sorrento	III
Pianopoli	VII
Piedimonte Etneo	NF
Pietro Apostolo dell'Ionio, San	VII
Pietro in Maida, San	⩽VII
Pietro Venatico, San	NF
Pizzo Calabro	VII
Pizzoni	VII
Platania	VI
Polia	VII
Ramacca	NF
Randazzo	NF
Reggio Calabria	NF
Rende	IV
Ricadi	V
Riposto	NF
Rocca di Neto	V
Roccabernarda	V
Roccella Valdemone	NF
Rose	IV
Sambiase	VI
Sangineto	⩽IV
Sava	NF
Savelli	IV
Scandale	VI
Scordia	NF
Sellia	VI
Serra San Bruno	⩾VI
Sersale	⩾VI
Simbario	VII
Simeri	VI
Someria Simeri	VI
Soriano Calabro	VII
Sostene, San	VIII
Soverato	VIII
Soveria Mannelli	VI
Spadola	VII
Spezzano della Sila	V
Spilinga	VI
Squillace	VIII
Staletti	VIII
Stefanaconi	VI
Taranto	NF
Taverna	VI-VII
Tiriolo	VII
Torano Castello	IV
Torciarolo	NF
Trecastagni	NF
Tremestieri Etneo	NF
Tropea	V
Umbriatico	NF
Vallefiorita	⩽VIII
Vallelonga	VII
Viagrande	NF
Vibo Valentia	VI
Villafranca Tirrena	III
Zafferana Etnea	NF

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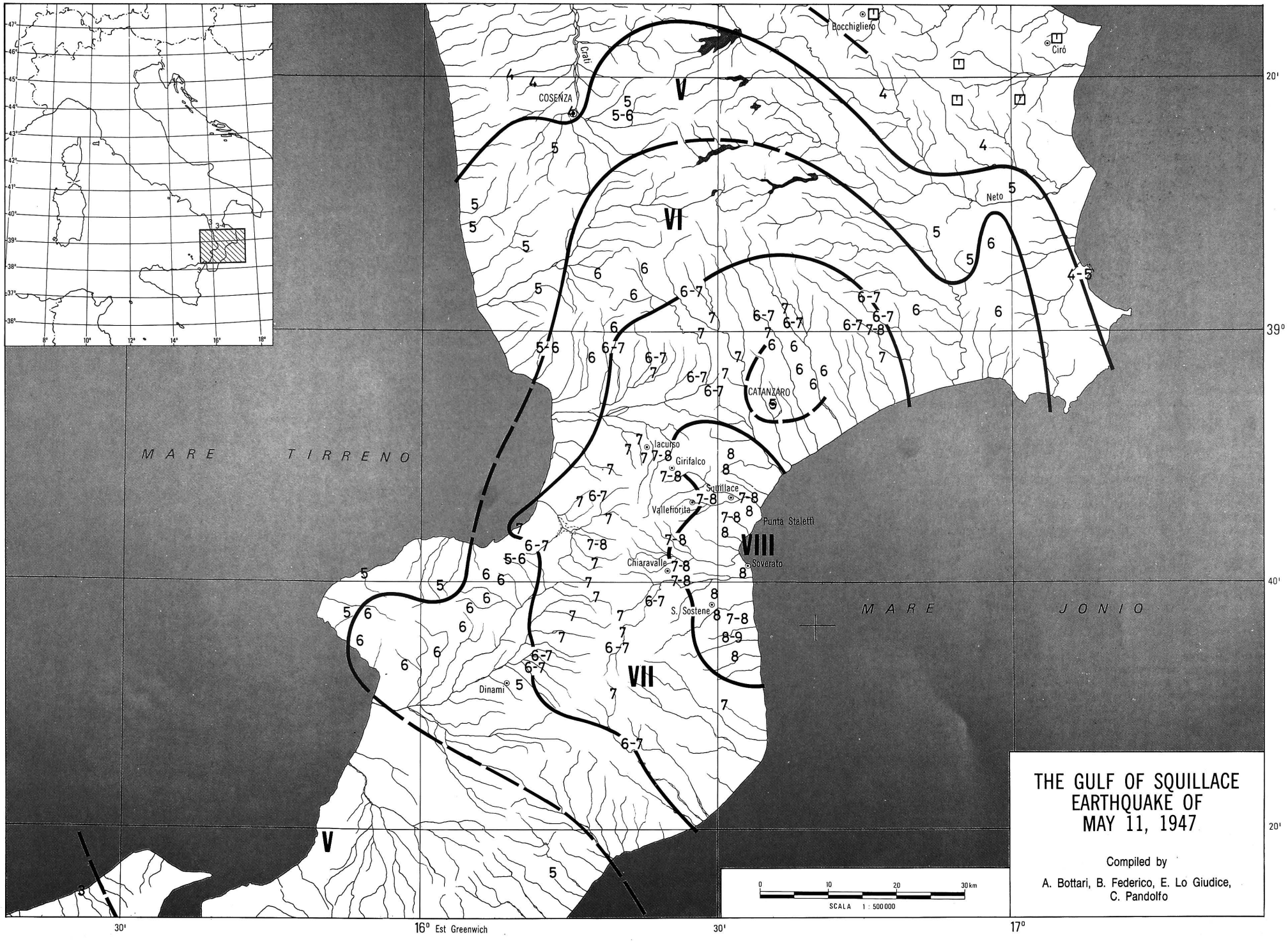

THE GULF OF SQUILLACE EARTHQUAKE OF MAY 11, 1947

Compiled by

A. Bottari, B. Federico, E. Lo Giudice, C. Pandolfo

The drainage network of this map – scale 1:500.000 – is the same as the "Structural Model of Italy."

G.T.M - Via Marco Marulo 47a - 00143 ROMA

The Irpinia earthquake of August 21, 1962.

M.C. Spadea, M. Vecchi, P. Gardellini, S. Del Mese

The seismic events affecting the Irpinia region in 1962 gave rise to one of the most extensive seismic periods of the past few decades. The worst hit provinces on this occasion were: Avellino, Benevento, Naples, Salerno, Caserta, Potenza, Campobasso and Foggia.

The seismic period in question was characterized by two warning shocks of an estimated MCS intensity of VI, and by two main shocks, respectively of MCS intensity VIII-IX (18^h09^m) and IX (18^h19^m).

On the same day there were numerous aftershocks with a maximum MCS intensity of VI-VII. The aftershocks lasted several days.

The number of victims was fairly low as a result of the two warning events, which enabled most of the population to leave their dwellings before they were destroyed.

The fact that the main shocks occurred 10 minutes apart makes it impossible to make a clearcut distinction between their individual effects. This again raises the problem, common to other seismic events, of the available data referring essentially to cumulative effects.

Although the sources from which the energy was released are to be assumed as separated in space, the macroseismic questionnaire data is shown in combined form and no distinction is made between the effects of the respective sources.

This event was studied using the following main sources of information.

1) the macroseismic questionnaires collected by the U.C.M.G.;
2) news items appearing in the newspapers of the time (both local and national);
3) the publication referred to as n. 3 in the bibliography of Di Filippo-Peronaci, 1963.

As far as we know, the isoseisms of this seismic event had not been previously mapped.

In the macroseismic data analysis, the MCS intensity of IX has been assigned to the towns of Molinara, San Giorgio la Molara and Sant'Angelo Trimonte. In numerous localities insufficient data was available for the univocal assignment of an MCS intensity of VIII or IX. In this case an intermediate intensity value was marked on the map and the corresponding curve drawn through these data. A similar procedure was also used in evaluating lower intensities.

The isoseismal map indicates a preferential propagation whose direction is in good agreement with the geological structure of the subsoil. Tectonic and other surveys have revealed a series of deep faults running at right angles to the Apennine range. One of these faults lies very close to the epicentral zone. The possible, and probable, vicinity of another deep fault parallel to the first could constitute the plane of fracture causing the seismic event under investigation.

In conclusion, despite some uncertainty over assigning intensities to a few localities, the data used allowed a satisfactory determination of the macroseismic field, for which the following parameters were found.

List of shocked localities:

Locality	Latit.	Long.	I (MCS)
Accadia	41°10'	15°25'	(VII-VIII)
Acerra	40°57'	14°22'	VI
Alife	41°20'	14°20'	VI
Andria	41°14'	16°18'	V
Apice	41°07'	14°56'	VIII-IX
Ariano Irpino	40°39'	15°01'	VIII-IX
Arielli	42°16'	14°18'	III-IV
Armento	40°18'	16°04'	III
Ascoli Satriano	41°12'	15°34'	VII
Avellino	40°55'	14°47'	VIII
Avezzano	42°02'	13°26'	IV
Avigliano	40°44'	15°43'	V-VI
Bari	41°06'	16°31'	V
Bella	40°46'	15°32'	V
Benevento	41°08'	14°47'	VI-VII
Bisaccia	41°01'	15°23'	VII
Bonito	41°06'	15°00'	VIII-IX
Bovino	41°15'	15°20'	VII
Brienza	40°29'	15°38'	III
Buonalbergo	41°13'	14°59'	VIII
Caivano	40°57'	14°18'	VI
Calabritto	40°47'	15°13'	VI
Calvello	40°29'	15°51'	III
Calvizzano	40°54'	14°12'	VI?
Campobasso	41°33'	14°40'	VI
Cancello	41°04'	14°02'	VII
Candela	41°08'	15°31'	V
Canosa di Puglia	41°13'	16°04'	VI
Capri	40°33'	14°15'	IV
Carife	41°02'	15°13'	VIII
Carpino	41°51'	15°51'	V
Carpinone	41°36'	14°20'	V
Casalbore	41°14'	15°01'	VIII
Casapulla	41°05'	14°17'	V-VI
Caserta	41°04'	14°20'	VI-VII
Casoria	40°54'	14°17'	VI-VII
Castel Baronia	41°03'	15°11'	VIII
Castelfranco in Miscano	41°18'	15°05'	VIII-IX
Castelpagano	41°24'	14°48'	VIII
Castelpoto	41°08'	14°42'	VIII
Cerignola	41°16'	15°54'	VI-VII
Cerreto Sannita	41°17'	14°34'	?
Chiaiano	40°53'	14°13'	VI?
Chieti	42°21'	14°10'	IV
Civitella Casanova	42°22'	13°53'	III
Colle Sannita	41°22'	14°50'	(VIII)
Contrada	40°52'	14°46'	V-VI
Corato	41°09'	16°25'	IV
Cupello	42°04'	14°40'	V
Domicella	40°53'	14°35'	(VII-VIII)
Faeto	41°19'	15°10'	VII-VIII
Filignano	41°32'	14°03'	IV
Flumeri	41°05'	15°09'	VIII
Foggia	41°28'	15°33'	V?
Fondi	41°21'	13°26'	IV
Fontanarosa	41°01'	15°01'	VII-VIII
Forenza	40°52'	15°51'	III
Formia	41°16'	13°37'	IV
Fragneto	41°15'	14°46'	VIII
Francavilla al Mare	42°25'	14°18'	IV
Frigento	41°01'	15°06'	VIII
Frosolone	41°36'	14°27'	IV
Gaeta	41°13'	13°34'	IV
Genzano di Lucania	40°51'	16°02'	IV
Gesualdo	41°00'	15°04'	VII-VIII
Ginestra degli Schiavoni	41°17'	15°02'	VIII
Gioi	40°17'	15°13'	IV
Giugliano in Campania	40°56'	14°12'	?
Giuliano Teatino	42°18'	14°17'	III
Grottaminarda	41°04'	15°03'	VIII-IX
Grottolella	40°58'	14°47'	VI
Guardia Sanframondi	41°15'	14°36'	VI
Guglionesi	41°55'	14°55'	V
Isernia	41°36'	14°14'	V
Lanciano	42°14'	14°23'	III
Laurenzana	40°28'	15°58'	III
Laviano	40°47'	15°18'	V-VI
Liberi	41°53'	14°19'	VI
Longano	41°31'	14°15'	III-IV
Loreto Aprutino	42°26'	13°59'	III
Lucera	41°30'	15°20'	VI
Macchia d'Isernia	41°34'	14°10'	IV
Manfredonia	41°37'	15°54'	V
Marano	40°54'	14°11'	VI
Marzano Appio	41°19'	14°02'	V
Materdomini	40°49'	15°14'	V
Melfi	41°00'	15°39'	V-VI
Melito	41°06'	15°02'	VIII-IX
Melito di Napoli	40°55'	14°14'	VI
Mercato S. Severino	40°47'	14°46'	VII
Mercogliano	40°55'	14°44'	VIII
Miglianico	42°22'	14°18'	III
Minervino	41°05'	16°05'	IV
Minturno	41°16'	13°45'	IV
Mirabello Eclano	41°03'	15°00'	VIII-IX
Molinara	41°18'	14°55'	IX
Montaguto	41°15'	15°15'	VII-VIII
Montaquila	41°34'	14°07'	III
Montecalvo	41°12'	15°02'	VIII-IX
Montefalcone di V.	41°20'	15°01'	VIII
Monteforte	40°54'	14°43'	VII-VIII
Monterocchetta	41°03'	14°49'	VIII
Monteroduni	41°31'	14°11'	IV
Monte S. Angelo	41°42'	15°58'	V
Mugnano	40°54'	14°12'	VI
Muro Lucano	40°45'	15°29'	IV
Napoli	40°51'	14°16'	VII
Nocera Inferiore	40°45'	14°38'	VII
Nola	40°56'	14°32'	VI
Olevano sul Tusciano	40°39'	15°01'	VI
Orria	40°18'	15°10'	IV
Orsogna	42°13'	14°17'	IV
Paduli	41°10'	14°53'	VIII
Pagani	40°45'	14°37'	VII
Pago Vejano	41°15'	14°52'	VIII
Panni	41°13'	15°16'	?
Pastorano	41°05'	14°34'	VII
Paternopoli	40°58'	15°02'	VII
Pescara	42°28'	14°13'	III-IV
Pesco Sannita	41°14'	14°49'	VIII
Pianella	42°24'	14°03'	III
Picerno	40°38'	15°38'	III
Pietranico	42°17'	13°55'	III
Pietrelcina	41°12'	14°51'	VIII
Pimonte	40°40'	14°31'	VII-VIII
Poggiofiorito	42°15'	14°19'	III
Pontelandolfo	41°17'	14°42'	VII
Pontelatone	41°12'	14°14'	VI
Pozzilli	41°31'	14°04'	IV
Pozzuoli	40°49'	14°07'	VI
Pratula Serra	40°59'	14°51'	VII-VIII
Putignano	40°51'	17°07'	V
Quarto	40°53'	14°09'	IV
Rapolla	40°59'	15°40'	VI
Ravello	40°39''	14°37'	V
Reino	41°17'	14°49'	VIII
Rignano Garganico	41°41'	15°35'	IV
Rionero	40°55'	15°40'	VI
Ripa Teatina	42°21'	14°14'	IV
Roccamonfina	41°17'	13°59'	V
Roseto Valforte	41°22'	15°06'	VI
Salerno	40°41'	14°46'	VII
S. Agato dei Goti	41°05'	14°30'	VII
S. Arcangelo	40°15'	16°16'	III
S. Arcangelo Trimonto	41°10'	14°56'	IX
S. Bartolomeo in Galdo	41°25'	15°01'	VII
S. Giorgio la Molara	41°16'	14°55'	IX
S. Giovanni di Puglia	41°41'	14°58'	VI
S. Giovanni Rotondo	41°42'	15°44'	V
S. Giovanni Teatino	42°25'	14°12'	III
S. Leucio	41°04'	14°45'	VIII
S. Lorenzo Maggiore	41°15'	14°38'	VII
San Marco la Catola	41°31'	15°00'	VI-VII
Sannicandro Garganico	41°50'	15°34'	IV
S. Nicola Baronia	41°03'	15°12'	VIII
S. Nicola Manfredi	41°04'	14°49'	VII
S. Pietro Avellana	41°47'	14°11'	III-IV
S. Severo	41°41'	15°23'	VI
S. Sossio Baronia	41°04'	15°12'	VIII
Sant'Agapito	41°33'	14°13'	V
Sarno	40°49'	14°37'	(VII-VIII)
Savignano	41°14'	15°11'	VI?
Scampitello	41°06'	15°18'	VII-VIII
Scauri	41°15'	13°42'	IV
Scontrone	41°45'	14°02'	IV
Serra Capriola	41°48'	15°10'	VI
Sessano	41°38'	14°20'	V
Solopaca	41°11'	14°33'	VI
Sora	41°43'	13°37'	V-VI
Sperlonga	41°15'	13°26'	IV
Spinazzola	40°58'	16°05'	IV
Stella Cilento	40°14'	15°06'	III
Sturno	41°01'	15°07'	VIII
Taurasi	41°00'	14°57'	VII
Teano	41°15'	14°04'	VI
Teramo	42°40'	13°42'	IV
Terlizzi	41°08'	16°33'	III-IV
Torremaggiore	41°41'	15°18'	VI
Tito	40°35'	15°41'	IV
Tocco Caudio	41°07'	14°38'	VIII
Tollo	42°20'	14°19'	III
Torella dei Lombardi	40°56'	15°07'	VII
Torrecuso	41°11'	14°41'	VI
Trani	41°17'	16°25'	VI-VII?
Trevico	41°03'	15°14'	VII-VIII
Troia	41°22'	15°19'	VI
Turrivalignani	42°15'	14°03'	III
Vallata	41°02'	15°15'	VIII
Vallesaccarda	41°04'	15°15'	VIII
Vasto	42°07'	14°42'	V
Venosa	40°58'	15°49'	VI
Venticano	41°03'	14°55'	VIII
Vico del Gargano	41°54'	15°57'	IV
Vicoli	42°20'	13°54'	?
Vieste	41°53'	16°11'	IV
Villanova D. Battista	41°07'	15°10'	VII-VIII
Villaricca	40°55'	14°12'	(VI)
Vinchiaturo	41°30'	14°35'	IV-V
Volturara Irpina	40°53'	14°55'	VII
Zungoli	41°07'	15°12'	(VIII)

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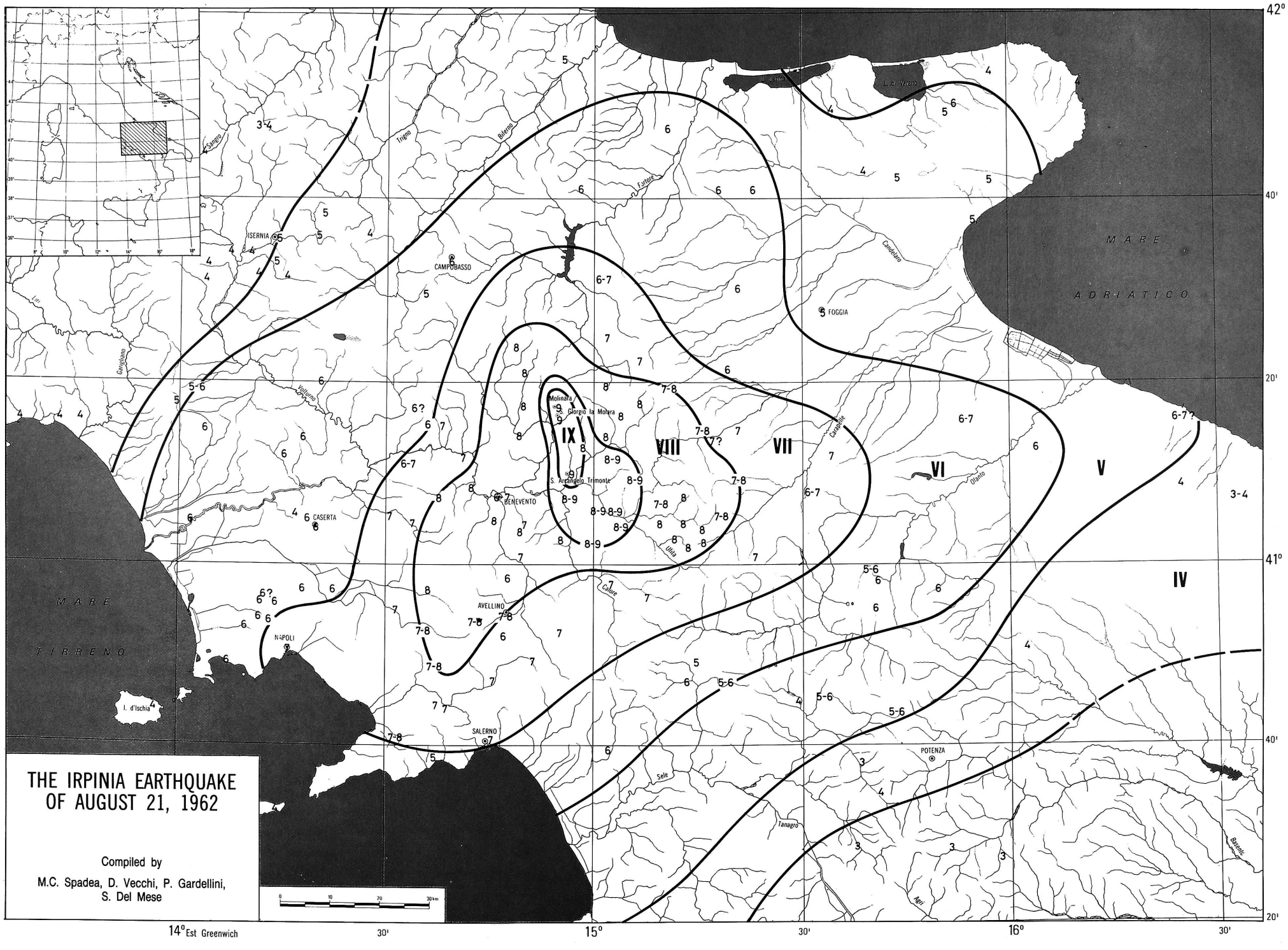

The drainage network of this map – scale 1:500.000 – is the same as the "Structural Model of Italy."

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The Belice earthquake of January 15, 1968.

P. Cosentino, A. Mulone

The seismic period began abruptly on January 14, 1968 and continued with lower grade until the summer of the same year. The main shocks occurred on January 15, 1968 at 01:33:02 (MK = 5.6) and 02:01:09 (MK = 5.6), on January 16, 1968 at 16:42:45 (MK = 5.6) and on January 25, 1968 at 09:56:47 (MK = 5.3). The time is expressed as G.M.T..

The epicentral area was located in the Belice Valley along the Belice River, which crosses the southern part of the western Sicilian chain from northeast to southwest.

Since very strong shocks followed one another over a period of a few days, it was not possible to distinguish the effects of single shocks. As a result, a preliminary attempt to distinguish the effects with respect to the three main shocks (the first one on January 15 was a double shock) has produced three isoseismal maps which separately are incomplete and together are very similar.

This study constructs a single isoseismal map referring to the effects of the whole seismic period. The information utilized consists mainly of news reports published during the seismic period (Giornale di Sicilia, l'Ora). These reports have provided us with a detailed sketch of the destructive effects of the event as well as an insight into the human and social climate during the seismic period, which in turn permits us to determine the necessary epistemological code.

In addition, an interview survey has been carried out in the Belice Valley area in order to confirm some of the reports made by the above mentioned sources.

With reference to the official local, regional and national sources of data, our attitude is characterized by prudence and distrust; as a matter of fact, many discrepancies and conflicting reports have penetrated the official documents, probably due to hopes of indemnity.

In summary, the following cumulative data have been obtained for the entire seismic period: 296 persons killed in the macroseismic area (15 due to subordinate causes); damages in the whole area have been calculated to be 320,000,000 U.S. dollars.

The approximate evaluation of the percent damage in the macroseismic area is the following (the official reported estimate in brackets): Salaparuta, 100% (100%); Gibellina, 100% (100%); Montevago, 98% (100%); Santa Margherita Belice, 80% (80%); S. Ninfa, 70% (43%); Salemi, 25% (25%); Poggioreale, 80% (100%); and Partanna, 25% (30%).

Typical buildings in the area were rural structures (about 90%) with irregular and disconnected stones, lean mortar with poor binding power; and several edifices constructed with various materials, very few with reinforced concrete frames. With respect to the latter structures, some were significantly damaged due to defective construction.

The macroseismic intensity ratings have been made using the Mercalli Cancani Sieberg scale (MCS).

Intermediate ratings have been assigned where the effects recognized were greater than those associated with the lower degree and less than those associated with the next higher degree.

These intermediate ratings have been reported using both the higher and lower degrees (e.g. 6-7). In the mesoseismic area the ratings have been assigned mostly on the basis of permanent effects and the intermediate values should represent a refining of the macroseismic estimates.

In the periseismic area where the evaluations have been reached on the basis of more or less well remembered transient effects, the intermediate values correspond to indetermination limits.

The assigned intensity values have been subdivided into two classes corresponding to high confidence (1) and lower confidence (2), based on the number and quality of available supporting data.

The mapped intensity values range from 10 in the macroseismic epicentral area to 4-5 in the eastern area (Enna). Unfortunately, the closeness of the epicentral area to the sea has allowed us to enclose only the areas of IX and X degrees.

Due to the difficulties of assigning lower degrees of intensities, it has not been possible to draw the eastern part of the area in which the earthquake was felt; nevertheless intensities of 1-2 can be estimated for the area from Messina to Catania and 2-3 for Milazzo (on the eastern north coast).

It can be observed that the behaviour of the isoseismal lines is not regular; in particular two main directions of maximum attenuation are evident, from Mazara del Vallo to Roccamena (west-southwest to east-northeast) and from Alcamo to Sambuca di Sicilia (north-northweast to south-southeast). A direction of minimum attenuation is present from east to west following the main fault system of the area.

In conclusion it should be pointed out that although the earthquake studied is very recent, the evaluation of the macroseismic intensities and the macroseismic field presents many doubts and probably some inaccuracies due to the lack of a well organized macroseismic survey immediately following the earthquake.

List of shocked localities:

Locality	Latit.	Long.	I (MCS)
Agrigento	37°18'	13°35'	V
Alcamo	37°58'	12°58'	VII
Alessandria della Rocca	37°34'	13°27'	VI
Alia	37°46'	13°43'	VI
Alimena	37°41'	14°07'	V
Aliminusa	37°51'	13°47'	V-VI
Altavilla Milicia	38°02'	13°33'	VI
Altofonte	38°02'	13°18'	VI
Aragona	37°24'	13°37'	V-VI
Bagheria	38°05'	13°31'	VI
Balata di Baida	38°01'	12°47'	VI
Balestrate	38°03'	13°00'	VI
Baucina	37°55'	13°32'	VI-VII
Belmonte Mezzagno	38°03'	13°22'	VI
Bisacquino	37°42'	13°15'	VI-VII
Bivona	37°37'	13°26'	VI
Bolognetta	37°58'	13°27'	VI
Bompietro	37°45'	14°06'	V
Borgetto	38°02'	13°02'	VI
Burgio	37°36'	13°17'	VII
Buseto Palizzolo	38°01'	12°43'	VI
Caccamo	37°55'	13°40'	VI
Calamonaci	37°31'	13°17'	VII
Calatafimi	37°54'	12°52'	VI
Caltabellotta	37°34'	13°13'	VII
Caltanissetta	37°29'	14°04'	V
Caltavuturo	37°49'	13°53'	V-VI
Cammarata	37°38'	13°38'	V-VI
Campobello di Licata	37°15'	13°55'	V
Campobello di Mazara	37°38'	12°45'	VIII
Campofelice di Fitalia	37°49'	13°29'	VII
Campofelice di Roccella	37°59'	13°53'	V
Campofiorito	37°45'	13°16'	VII
Campofranco	37°30'	13°43'	V
Camporeale	37°53'	13°06'	VIII
Canicatti	37°21'	13°51'	V
Capaci	38°10'	13°14'	VI-VII
Carini	38°08'	13°11'	VI
Castelbuono	37°55'	14°05'	V-VI
Casteldaccia	38°03'	13°32'	VI
Castellamare del Golfo	38°01'	12°53'	VI-VII
Castellana Sicula	37°47'	14°03'	V
Casteltermini	37°32'	13°39'	V-VI
Castelvetrano	37°41'	12°47'	VII
Castronuovo di Sicilia	37°40'	13°36'	VI
Catania	37°30'	15°05'	I-II
Cattolica Eraclea	37°26'	13°23'	VI-VII
Cefalà Diana	37°55'	13°28'	VI-VII
Cefalù	38°02'	14°01'	V
Cerda	37°54'	13°49'	V-VI
Chiusa Sclafani	37°40'	13°16'	VII
Cianciana	37°31'	13°26'	VI-VII
Ciminna	37°53'	13°34'	VI-VII
Cinisi	38°09'	13°07'	VI
Collesano	37°55'	13°56'	V-VI
Contessa Entellina	37°43'	13°11'	VII-VIII
Corleone	37°49'	13°18'	VII
Custonaci	38°05'	12°41'	VI-VII
Enna	37°34'	14°17'	IV-V
Erice	38°02'	12°35'	VI
Favara	37°19'	13°40'	V
Favignana	37°56'	12°20'	VI-VII
Ficarazzi	38°06'	13°28'	VI
Gangi	37°48'	14°12'	V
Geraci Siculo	37°51'	14°08'	V
Giardinello	38°05'	13°10'	VI
Gibellina	37°47'	12°58'	X
Giuliana	37°40'	13°14'	VI-VII
Godrano	37°53'	13°24'	VII
Gratteri	37°58'	13°59'	V-VI
Grotte	37°24'	13°42'	V
Isnello	37°56'	14°00'	V-VI
Isola delle Femmine	38°12'	13°14'	V-VI
Joppolo Giancaxio	37°23'	13°33'	V
Lascari	38°00'	13°56'	V
Lercara Friddi	37°45'	13°36'	VI-VII
Licata	37°06'	13°58'	V
Lucca Sicula	37°34'	13°18'	VII
Macari	38°08'	12°44'	VI
Marineo	37°57'	13°25'	VI-VII
Marsala	37°48'	12°26'	VI
Mazara del Vallo	37°39'	12°36'	VI
Menfi	37°36'	12°58'	VIII-IX
Messina	38°10'	15°34'	I-II
Mezzojuso	37°51'	13°28'	VI-VII
Milazzo	38°13'	15°14'	II-III
Misilmeri	38°02'	13°27'	VI
Monreale	38°05'	13°17'	VI
Montallegro	37°23'	13°21'	VI-VII
Montelepre	38°05'	13°10'	VI-VII
Montemaggiore Belsito	37°51'	13°46'	VI
Montevago	37°42'	12°58'	X
Mussomeli	37°34'	13°45'	V
Naro	37°17'	13°47'	V
Paceco	37°59'	12°33'	VI
Palazzo Adriano	37°41'	13°23'	VI-VII
Palermo	38°07'	13°22'	VI
Palma di Montechiaro	37°11'	13°46'	V
Partanna	37°43'	12°53'	VIII-IX
Partinico	38°03'	13°07'	VI
Petralia Soprana	37°47'	14°06'	V-VI
Petralia Sottana	37°48'	14°05'	V
Piana degli Albanesi	37°59'	13°17'	VI-VII
Pietraperzia	37°25'	14°08'	V
Poggioreale	37°47'	13°02'	IX
Polizzi Generosa	37°48'	14°00'	V
Pollina	37°59'	14°09'	V
Porto Empedocle	37°17'	13°32'	V
Prizzi	37°43'	13°26'	VI
Racalmuto	37°24'	13°44'	V
Raffadali	37°24'	13°32'	VI
Ravanusa	37°16'	13°58'	V
Realmonte	37°18'	13°28'	V-VI
Resuttano	37°41'	14°02'	V
Ribera	37°30'	13°16'	VII
Riesi	37°17'	14°05'	V
Roccamena	37°50'	13°09'	VI
Roccapalumba	37°48'	13°38'	VI
Salaparuta	37°46'	12°59'	X
Salemi	37°49'	12°48'	IX
Sambuca di Sicilia	37°38'	13°06'	VII-VIII
San Biagio Platani	37°30'	13°32'	VI
San Cataldo	37°29'	13°59'	V
San Cipirello	37°57'	13°11'	VII
San Giovanni Gemini	37°37'	13°39'	V
San Giuseppe Jato	37°58'	13°11'	VII
San Mauro Castelverde	37°55'	14°11'	V
Santa Caterina Villarmosa	37°35'	14°02'	V
Santa Cristina Gela	37°59'	13°19'	VI-VII
Santa Flavia	38°05'	13°32'	VI
Santa Margherita di Belice	37°41'	13°01'	X
Santa Ninfa	37°46'	12°53'	X
Santo Stefano Quisquina	37°37'	13°29'	VI
San Vito Lo Capo	38°10'	12°44'	VI
Sciacca	37°30'	13°05'	VII
Sciara	37°55'	13°46'	VI
Scillato	37°51'	13°55'	VI
Sclafani Bagni	37°49'	13°51'	V-VI
Serradifalco	37°27'	13°53'	V
Siculiana	37°20'	13°25'	VI
Sommatino	37°20'	14°00'	V
Termini Imerese	37°59'	13°42'	VI
Terrasini	38°09'	13°05'	VI
Torretta	38°07'	13°14'	VI-VII
Trabia	37°59'	13°39'	VI
Trapani	38°01'	12°31'	VI
Trappeto	38°04'	13°03'	VI
Ustica	38°42'	13°10'	V
Valderice	38°02'	12°37'	VI
Valledolmo	37°44'	13°50'	VI
Vallelunga Pratameno	37°41'	13°50'	V-VI
Ventimiglia di Sicilia	37°55'	12°34'	VI-VII
Vicari	37°49'	13°34'	VI
Villabate	38°04'	13°26'	VI
Villafranca Sicula	37°35'	13°17'	VII
Villafrati	37°54'	13°29'	VI-VII
Villalba	37°39'	13°50'	V-VI
Villarosa	37°35'	14°10'	V
Vita	37°52'	12°49'	VIII-IX

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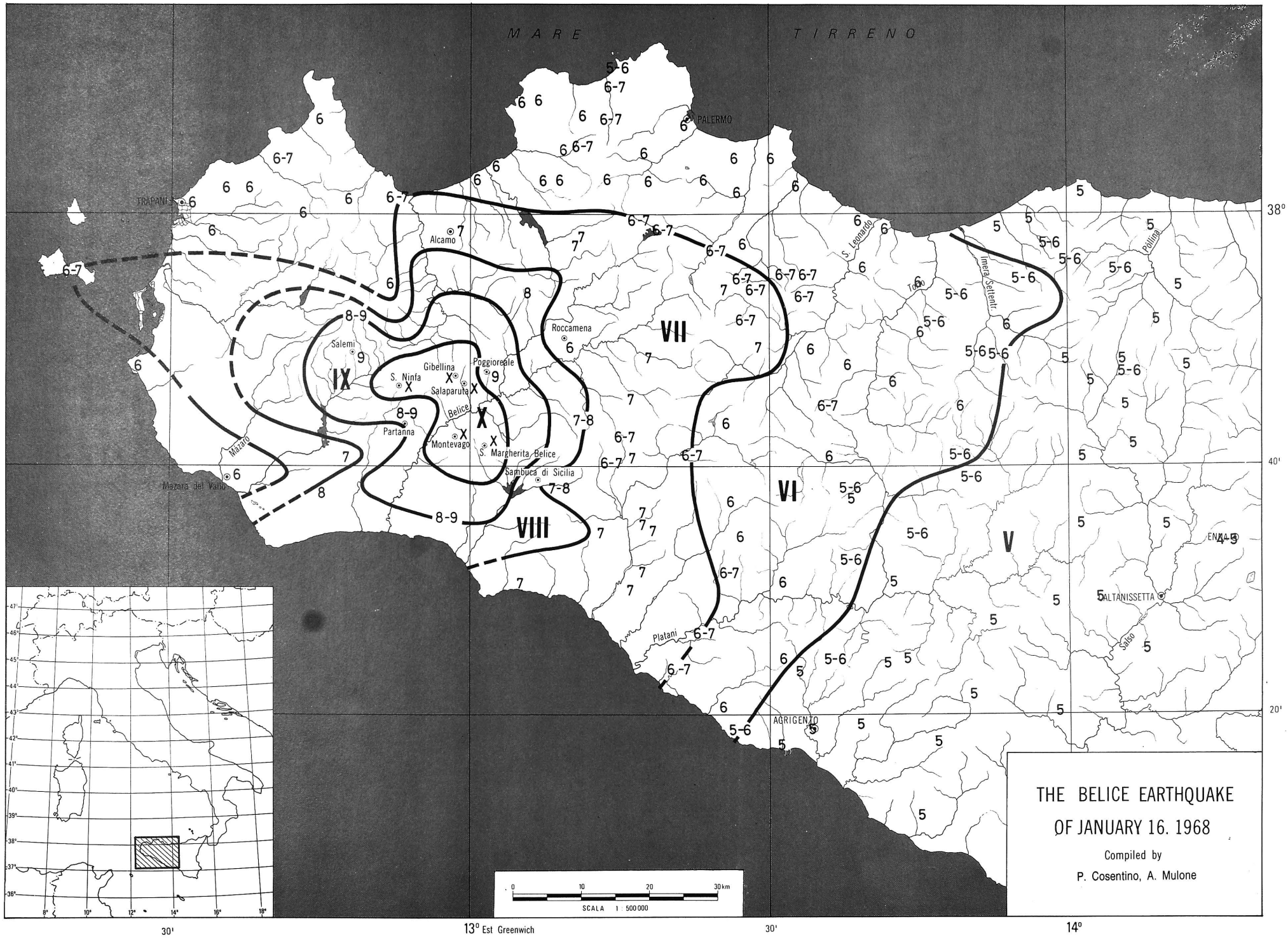
THE BELICE EARTHQUAKE OF JANUARY 16. 1968

Compiled by

P. Cosentino, A. Mulone



The drainage network of this map – scale 1:500.000 – is the same as the "Structural Model of Italy."

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The Irpinia earthquake of November 23, 1980.

D. Postpischl, A. Branno, E.G.I. Esposito, G. Ferrari, A. Marturano, S. Porfido, V. Rinaldis, M. Stucchi

The intervention of the macroseismic section of the Progetto Finalizzato Geodinamica (P.F.G.) charged with the study of the earthquake in Soutern Italy on November 23, 1980, began two days after the event and developed in two phases directed respectively towards the macroseismic classification of the area hit by the disastrous effects and towards the classification of the effects produced in areas further away from the epicentre.

Forty researchers (seismologists, geologists and engineers) were employed in the first phase of the project (Postpischl, 1981). They were divided into eight groups and operated in the area where the effects were more severe than those corresponding to the VII degree of the MSK scale.

Four groups were charged with the identification of the area where the effects were not inferior to the VIII degree of the MSK scale. Three other groups carried out the same research in the area hit by effects not inferior to the VI degree of the MSK scale. The last group was charged with carrying out a survey of the mesoseismal areas. This phase lasted 16 days, during which 306 villages were visited.

To guarantee the homogeneity of the survey carried on by so many researchers, their work was monitored by a questionnaire and the replies, after having been put in order, classified according to a general scale of effects severity and then evaluated on macroseismic basis by setting the questionnaire to some «sample localities».

The «sample localities» are places for which an agreement in attributing values of intensity was reached among the teams that had participated in the survey. The second phase of the survey was aimed at the gathering of information in the areas hit by effects inferior to the VI degree of the MCS scale.

Two different questionnaires were used, the first one of which prepared by the P.F.G. was sent to the science teachers of the junior high and high schools and the other one distributed by I.N.G. (Istituto Nazionale di Geofisica) to the gendarmeries.

In total, the effects in 1,285 different localities were classified and 306 of these were object of survey on the terrain by the teams of the P.F.G..

The distribution of the intensity is illustrated in the enclosed tables.

In the epicentral area map two zones of elevated attenuation can be observed: zone (A) corresponds to the Vesuvian area; instead, zone (B) shows values of attenuation even up to two degrees of intensity and apparently does not correspond to any structural causes which can justify its existence.

The attenuation towards Cilento is still evident, an element, like the attenuation in the eastern direction, seen in all the historical earthquakes and especially in the earthquakes of 1694 and 1857.

Other elements confirmed by historical data are the good propagations towards the Sorrentine peninsula and towards the Gargano.

In the wole area, effects of local amplification were also observed, being bound to particular geomorphological situations.

In order to complete the macroseismic study of the earthquake in exam, a tentative at modelling the surface of rupture was made according to the method proposed by Shebalin (1972, 1973).

The surface of rupture can be estimated around 400 Km^2 corresponding to macroseismic equivalent of magnitude Me=5.3, which fully complies with the value obtained instrumentally of Me=6.5. This same value of 6.5 is also obtained by considering the felt area as well as the Galanoupolus formula (1962).

List of shocked localities:

Locality	Latit.	Long.	I (MCS)
Abriola	40°29'	15°47'	VI-VII
Accadia	41°09'	15°18'	VII
Acerenza	40°47'	15°56'	VI
Acerno	40°43'	15°03'	VIII
Acerra	40°57'	14°21'	VII
Acireale	37°36'	15°09'	III
Acquafondata	41°32'	13°56'	IV
Acquapendente (VT)	43°43'	11°51'	NF
Acquasparta	42°40'	12°32'	NF
Acquaviva d. Fonti	40°53'	16°50'	V
Acquaviva Picena	42°56'	13°48'	IV
Acri	39°28'	16°23'	V
Adelfia	41°00'	16°51'	V-VI
Affile	41°52'	13°05'	NF
Afragola	40°55'	14°17'	VII
Agerola	40°37'	14°31'	V
Agira	37°38'	14°31'	II
Agnone	41°47'	14°21'	V
Agosta	41°58'	13°01'	NF
Agropoli	40°20'	14°58'	VI
Agugliano	43°32'	13°22'	IV
Aiello	40°46'	14°42'	VI
Aiello del Sabato	40°52'	14°48'	VI
Ailano	41°22'	14°11'	V
Airola (BN)	41°03'	14°32'	VII
Alanno	42°17'	13°58'	V
Alatri (FR)	41°42'	13°19'	IV
Alba Adriatica	42°50'	13°54'	IV
Albano	41°43'	12°39'	IV
Alberobello	40°46'	17°13'	V
Alberona	41°25'	15°06'	VI
Albinia	42°29'	11°13'	NF
Alcamo	37°57'	12°56'	NF
Alife	41°19'	14°19'	VI
Aliterme	38°00'	15°25'	III
Allerona	42°48'	11°58'	NF
Alliste	39°56'	18°04'	NF
Altamura	40°50'	16°33'	V
Altavilla Irpina (AV)	41°00'	14°46'	VIII
Altavilla Silentina	40°31'	15°07'	VI
Altino	42°05'	14°19'	V
Alvignano	41°14'	14°19'	VI
Amalfi	40°37'	14°35'	VI
Amelia	42°32'	12°25'	NF
Amendolara	39°56'	16°34'	V
Amorosi	41°11'	14°26'	VI
Ancona Pinocchio	43°34'	13°29'	III
Andretta (AV)	40°55'	15°19'	VII
Andria	41°13'	16°16'	V
Antillo	37°57'	15°14'	III
Antonimina	38°16'	16°08'	III
Anversa D. Abruzzi	42°00'	13°47'	NF
Anzano in Puglia	41°06'	15°16'	VII
Anzi (PZ)	40°30'	15°55'	VI
Anzio	41°27'	12°36'	IV
Anzio (Lavinio)	41°29'	12°34'	IV
Apice Nuova (BN)	41°06'	14°55'	VII
Apiro	43°25'	13°07'	NF
Apollosa (BN)	41°04'	14°41'	VII
Appignano (MC)	43°21'	13°19'	IV
Apricena	41°46'	15°25'	V
Aquilonia (AV)	40°58'	15°28'	V
Aquino	41°28'	13°40'	IV
Aradeo	40°07'	18°07'	III-IV
Arasi	38°07'	15°44'	III
Arce	41°34'	13°33'	III-IV
Arcidosso	42°51'	11°31'	NF
Arena	38°33'	16°13'	IV
Arezzo	43°27'	11°52'	II-III
Ariano Irpino	41°08'	15°04'	VII
Arielli	42°15'	14°18'	IV
Arienzo	41°01'	14°29'	VII
Arlena di Castro (VT)	42°27'	11°50'	III
Armento	40°17'	16°03'	VI
Arnesano	40°19'	18°04'	IV
Arpaia (BN)	41°03'	14°32'	VII
Arpaise	41°03'	14°43'	VIII
Arrone	42°34'	12°45'	NF
Arsoli	42°01'	13°00'	IV
Ascea (SA)	40°07'	15°10'	VI
Ascoli Satriano	41°11'	15°33'	VI
Assisi	43°03'	12°36'	NF
Ateleta	41°50'	14°11'	V
Atella (PZ)	40°52'	15°38'	VII
Atena Lucano (SA)	40°26'	15°32'	VIII
Atessa	42°03'	13°56'	V
Atina	41°36'	13°47'	IV
Atri (TE)	42°34'	13°58'	IV
Atripalda (AV)	40°54'	14°50'	VIII
Auletta (SA)	40°32'	15°25'	VIII
Aulla	44°12'	09°58'	NF
Ausonia	41°21'	13°44'	IV
Avellino	40°54'	14°47'	VIII
Aversa (CE)	40°57'	14°12'	VI
Avetrana	40°20'	17°43'	IV
Avezzano	42°01'	13°25'	IV
Avigliano (PZ)	40°43'	15°42'	VI
Bacoli-Baia	40°47'	14°04'	VI
Badolato	38°33'	16°31'	IV
Bagaladi	38°01'	15°48'	III
Bagnacavallo	44°25'	12°04'	III
Bagnara	38°16'	15°48'	III
Bagnoli del Trigno	41°42'	14°27'	V
Bagnoli Irpino (AV)	40°50'	15°04'	VI
Bagnolo del Salento	40°08'	18°20'	NF
Baiano (AV)	40°56'	14°36'	VII
Balvano (PZ)	40°38'	15°30'	VIII
Baragiano (PZ)	40°40'	15°35'	VII
Baranello	41°30'	14°32'	VI
Barcellona	38°07'	15°12'	III
Bari	41°06'	16°51'	VI
Barletta (BA)	41°18'	16°15'	V
Baronissi (SA)	40°44'	14°45'	VIII
Baschi	42°39'	12°12'	NF
Baselice	41°23'	14°58'	VI
Bastia Umbra	43°03'	12°32'	III
Belforte sul Chienti	43°09'	13°13'	NF
Bella (PZ)	40°45'	15°31'	VIII
Bellante	42°43'	13°47'	IV
Bellegra	41°52'	13°01'	IV-V
Bellosguardo (SA)	40°25'	15°18'	VI
Benevento	41°06'	14°45'	VI
Bettona	43°00'	12°28'	NF
Bevagna	42°55'	12°35'	NF
Biancavilla	37°37'	14°51'	II-III
Bianco	38°04'	16°08'	IV
Biccari	41°23'	15°11'	VI
Bisaccia (AV)	41°00'	15°22'	VII
Bisceglie	41°14'	16°29'	V
Bisignano	39°30'	16°17'	V
Bitetto	41°02'	16°44'	V
Bitonto	41°05'	16°41'	V
Bobbio	44°45'	09°22'	NF
Boiano	41°28'	14°28'	VI
Bologna	44°29'	11°19'	III
Bolsena (VT)	42°37'	12°00'	III
Bomarzo	42°29'	12°14'	IV
Bonefro	41°41'	14°55'	VI
Bonito (AV)	41°05'	15°00'	VIII
Borgo Piave (LT)	41°37'	12°51'	IV
Borgo Podgora	41°30'	12°50'	IV
Borgo Val Tidone	45°01'	09°26'	NF
Boscotrecase	40°46'	14°27'	VII
Botricello	38°55'	16°51'	III-IV
Botrugno	40°03'	18°18'	NF
Bovino	41°14'	15°19'	VII
Bracigliano	40°48'	14°41'	VII
Brienza (PZ)	40°28'	15°35'	VII
Brindisi	40°36'	17°57'	V
Bronte	37°46'	14°50'	III-IV
Brusciano (NA)	40°53'	14°25'	VI
Bucchianico	42°17'	14°10'	V
Buccino Borgo (SA)	40°37'	15°21'	VIII
Buonalbergo	41°13'	14°58'	VII
Caggiano (SA)	40°33'	15°29'	VII
Cagnano Varano	41°48'	15°46'	V
Caiazzo	41°10'	14°21'	VI
Cairano (AV)	40°53'	15°21'	VIII
Calabritto (AV)	40°46'	15°12'	IX
Calimera	40°15'	18°15'	NF
Calitri (AV)	40°53'	15°25'	VIII
Caloveto	39°30'	16°44'	V
Calvello (PZ)	40°27'	15°50'	VI
Calvi	42°23'	12°33'	NF
Calvi Risorta	41°12'	14°08'	VI
Camaldoli	40°38'	15°10'	VII
Camastra	37°14'	13°46'	III
Camerano	43°31'	13°32'	IV
Camerata Nuova	42°00'	13°05'	IV
Camerino	43°07'	13°03'	V
Cammarata	37°37'	13°37'	NF
Campagna (SA)	40°39'	15°05'	VII
Campana	39°23'	16°50'	IV
Campello S. Clitunno	42°48'	12°45'	NF
Campi Salentina	40°22'	18°00'	IV
Campli	42°42'	13°40'	IV
Campo di Giove	42°00'	14°02'	IV
Campobasso	41°33'	14°39'	VI
Campofranco	37°30'	13°42'	III
Campoli	41°06'	14°38'	VI-VII
Campolieto	41°37'	14°45'	V
Campomarino	41°56'	15°01'	V
Campora (SA)	40°17'	15°17'	V
Camporotondo di F.	43°07'	13°17'	NF
Campoverde Aprilia	41°31'	12°43'	III
Cancello-Arnone	41°00'	14°25'	VI
Candela	41°07'	15°29'	VII
Cannara	43°00'	12°34'	III
Cannole	40°09'	18°21'	NF
Canosa	41°12'	16°03'	VI
Canosa Sannita	42°16'	14°19'	IV
Cantalice	42°26'	12°53'	III
Capaccio	40°23'	15°04'	VI
Capalbio	42°26'	11°25'	NF
Capena	42°07'	12°32'	IV
Capestrano	42°15'	13°45'	IV
Capistrello	41°57'	13°22'	IV
Capolona	43°33'	11°50'	NF
Caposele (AV)	40°48'	15°12'	IX
Cappadocia	42°00'	13°16'	NF
Capracotta	41°50'	14°15'	V
Capranica di Lecce	40°15'	18°14'	NF
Caprarola (VT)	42°18'	12°13'	III
Capri	40°32'	14°12'	IV-V
Capriati al Volturno	41°27'	14°08'	V-VI
Capurso	41°02'	16°55'	V
Carapelle	41°22'	15°41'	V
Carassai	43°01'	13°40'	IV
Cariati	39°29'	16°55'	IV-V
Carife (AV)	41°01'	15°11'	VIII
Carinola	41°11'	13°58'	VI
Carlantino	41°35'	14°58'	VI
Carovigno	40°42'	17°38'	IV
Carpignano Salentino	40°11'	18°19'	NF
Carpineti	44°26'	10°29'	NF
Carpino	41°50'	15°51'	V
Carpinone	41°35'	14°18'	V
Carrara	44°04'	10°05'	NF
Casabona	39°14'	16°57'	IV

Casacalenda	41°43'	14°50'	VI	Catona	38°10'	15°38'	IV	Corigliano Otranto	40°09'	18°14'	III	Fornaci di Barga	44°03'	10°27'	NF
Casacanditella	42°14'	14°11'	IV	Cautano	41°08'	14°37'	VI-VII	Corinaldo	43°38'	13°02'	III-IV	Forte dei Marmi	43°54'	10°09'	NF
Casalanguida	42°01'	14°29'	V	Cava dei Tirreni	40°41'	14°38'	VII	Corleto Monforte (SA)	40°25'	15°22'	VI	Fossacesia	42°14'	14°28'	IV-V
Casalbordino	42°08'	14°34'	V	Cegie Messapico	40°38'	17°30'	IV	Corleto Perticara	40°22'	16°02'	VII	Fossato di Vico	43°17'	12°45'	NF
Casalfiumanese	44°17'	11°36'	NF	Celano	42°04'	13°33'	IV	Corridonia	43°14'	13°29'	IV	Fosso Castalda	40°28'	15°40'	VI-VII
Casalincontrada	42°16'	14°07'	IV-V	Celenza sul Trigno	41°51'	14°34'	IV	Corropoli	42°50'	13°50'	IV	Fragagnano	40°25'	17°28'	IV
Casalnuovo	38°02'	16°00'	III	Celenza Valfortore	41°33'	14°58'	VI	Cortona	43°14'	11°57'	III	Fragneto l'Abate	41°15'	14°46'	VII
Casalnuovo di Napoli	40°54'	14°19'	VII	Celleno	42°36'	12°07'	III	Cosenza	39°17'	16°14'	IV-V	Fragneto Monforte	41°14'	14°44'	VII
Casalnuovo M.	41°36'	15°06'	VI	Cellino Attanasio	42°34'	13°51'	IV	Cossignano	42°57'	13°41'	IV	Francavilla al Mare	42°25'	14°16'	V
Casalvecchio Puglia	41°35'	15°06'	VI	Cellino S. Marco	40°27'	17°57'	IV	Crispiano	40°36'	17°13'	V	Francolise	41°11'	14°02'	VI-VII
Casalvieri	41°37'	13°42'	IV	Cellole	41°12'	13°50'	VI	Cropani	38°57'	16°47'	III-IV	Frattamaggiore	40°56'	14°15'	VII
Casamassima	40°56'	16°54'	V	Celzi (AV)	40°51'	14°15'	VIII	Crotone	39°04'	17°07'	IV	Frattaminore	40°55'	14°14'	VII
Casapesenna (CE)	41°00'	14°09'	VI	Cento (FE)	44°42'	11°16'	III-IV	Cupello	42°03'	14°39'	V	Frattocchie (Roma)	41°45'	12°35'	IV
Casarano	40°00'	18°09'	IV	Centola (SA)	40°04'	15°18'	V	Cupra Marittima	43°00'	13°50'	IV	Fresagrandinaria	41°58'	14°39'	IV-V
Cascia	42°42'	13°00'	NF	Cepagatti	42°21'	14°01'	IV-V	Cursi	40°08'	18°18'	III-IV	Frigento (AV)	41°00'	15°05'	VI
Casenuove	43°27'	13°23'	NF	Ceppaloni (BN)	41°02'	14°44'	VIII	Cutrofiano	40°06'	18°10'	IV	Frosinone	41°37'	13°20'	IV
Caserta	41°04'	14°19'	VI-VII	Ceprano	41°32'	13°30'	V	Decollatura	39°02'	16°20'	V	Frosolone	41°35'	14°26'	V
Casola di Napoli	40°40'	14°31'	VII	Cerchiara	39°50'	16°22'	V	Delianuova	38°13'	15°56'	III	Furci	42°00'	14°34'	IV-V
Casoli	42°06'	14°17'	V	Cerchio-Aielli	42°03'	13°34'	IV	Deliceto	41°13'	15°22'	VII	Furnari	38°05'	15°06'	III
Cassano allo Jonio	39°47'	16°19'	VI	Cercola (NA)	40°50'	14°20'	V	Deruta	42°58'	12°25'	NF	Futani (SA)	40°08'	15°18'	V
Cassano Irpino	40°51'	15°01'	VII	Cerignola	41°15'	15°53'	VI	Dinami	38°31'	16°08'	IV	Gaeta	41°14'	13°36'	IV
Cassano Murge	40°53'	16°45'	V	Cerreto di Spoleto	42°48'	12°54'	NF	Domicella	40°52'	14°34'	VII	Galatina	40°10'	18°09'	IV
Cassino	41°28'	13°50'	V	Cerreto Sannita (BN)	41°16'	14°33'	V	Doria	39°43'	16°21'	V	Galatone	40°08'	18°08'	IV
Castel del Piano U.	43°03'	12°17'	NF	Cervaro	41°28'	13°53'	IV	Dugenta	41°07'	14°26'	VI	Galdo (Sicig. Alburni)	40°33'	15°18'	VI
Castel di Judica	37°29'	14°38'	III	Cervinara	41°01'	14°36'	VII	Durazzano	41°03'	14°25'	VI	Gallicano	41°52'	12°47'	IV
Castel di Lama (AP)	42°52'	13°41'	IV	Cerzeto	39°31'	16°05'	IV	Eboli (SA)	40°36'	15°02'	VII	Gallipoli	40°03'	18°00'	III
Castel di Sangro	41°46'	14°06'	IV	Cesinali (AV)	40°53'	14°50'	VII	Empoli	43°44'	10°55'	III	Gambatesa	41°29'	14°54'	VI
Castel Giorgio	42°42'	11°58'	NF	Cetraro	39°30'	15°57'	V	Enna	37°33'	14°16'	II-III	Gamberale	41°53'	14°11'	IV
Castel Morrone	41°07'	14°21'	VI	Chiaromonte	40°06'	16°17'	VI	Episcopia	40°03'	16°05'	VI	Gatteo	44°09'	12°25'	III
Castel Ritaldi	42°50'	12°37'	NF	Chieti	42°20'	14°09'	V	Ercolano	40°47'	14°20'	VI	Geraci Siculo	37°51'	14°08'	NF
Castel S. Elia	42°14'	12°21'	IV	Chiusano S.D. (AV)	40°55'	14°54'	VII	Esperia	41°22'	13°40'	IV	Gerano	41°55'	12°58'	IV
Castel S. Giorgio	40°46'	14°41'	VI	Ciampino	41°47'	12°35'	IV	Fabriano (AN)	43°19'	12°53'	III	Gerocarne	38°34'	16°14'	V
Castel S. Lorenzo	40°25'	15°13'	VI	Cicala	39°01'	16°28'	IV	Fabrica di Roma	42°19'	12°16'	IV	Gessopalena	42°04'	14°15'	V
Castel S. Pietro	44°23'	11°34'	NF	Ciciliano	41°56'	12°56'	IV	Fabro	42°51'	12°00'	IV	Gesualdo (AV)	41°00'	15°03'	VI
Castel S. Vincenzo	41°38'	14°03'	V	Cimitile	40°56'	14°31'	VI	Faenza	44°15'	11°51'	III-IV	Giano dell'Umbria	42°47'	12°31'	NF
Castelbaronia (AV)	41°02'	15°10'	VII	Cingoli	43°21'	13°12'	III-IV	Faeto-Celle S. Vito	41°19'	15°09'	VI	Giardini	37°50'	15°16'	III
Castelcampagnano	41°10'	14°25'	VI	Ciro Marina	39°22'	17°06'	V	Faleria	42°12'	12°25'	IV	Giarre	37°42'	15°07'	III
Castelcivita (SA)	40°29'	15°13'	VI	Cisterna di Latina	41°35'	12°48'	IV	Falerna	39°00'	16°10'	III	Giffoni Vallepiana	40°42'	14°56'	VIII
Castelcolonna	43°40'	13°06'	IV	Cisternino	40°44'	17°25'	IV	Fallo	41°55'	14°18'	IV	Ginestra d. Schiavoni	41°16'	15°02'	VI-VII
Castelfidardo	43°27'	13°32'	IV	Citerna	43°28'	12°05'	NF	Fara F. Petri	42°15'	14°09'	IV	Ginosa	40°34'	16°44'	V-VI
Castelforte	41°17'	13°48'	V	Città di Castello	43°27'	12°12'	IV	Fara S. Martino	42°04'	14°11'	V	Ginosa Marina	40°25'	16°52'	V
Castelfranci (AV)	40°55'	15°02'	VII	Città S. Angelo (PE)	42°30'	14°02'	V	Farindola	42°26'	13°48'	IV	Gioia dei Marsi	41°56'	13°40'	IV
Castelfranco Miscano	41°17'	15°05'	VII	Cittadella del Capo	39°32'	15°53'	IV	Farini d'Olmo	44°44'	09°34'	NF	Gioia del Colle	40°47'	16°55'	V
Castelfrentano	42°11'	14°21'	V	Civita	39°50'	16°19'	IV	Fasano	40°50'	17°20'	V	Gioia Tauro	38°25'	15°55'	IV
Castelgandolfo	41°44'	12°38'	IV	Civitacampomarano	41°46'	14°40'	VI	Ferentillo	42°36'	12°46'	NF	Giove	42°30'	12°18'	NF
Castelgrande (PZ)	40°46'	15°25'	VIII	Civitaluparella	41°56'	14°17'	IV	Fermignano (PS)	43°39'	12°38'	III	Giovinazzo (BA)	41°10'	16°39'	V
Castellamare (NA)	40°41'	14°28'	VIII	Civitanova Marche	43°18'	13°43'	IV	Fermo (AP)	43°09'	13°41'	IV	Girifalco	38°47'	16°25'	IV
Castellana Grotte	40°53'	17°09'	IV-V	Civitaquana	42°19'	13°54'	IV	Ferrara	44°50'	11°34'	III	Gissi	42°00'	14°32'	V
Castellaneta	40°37'	16°55'	V	Civitella Casanova	42°21'	13°52'	IV	Ferrazzano	41°31'	14°39'	VI	Giuggianello	40°05'	18°21'	III
Castelluccio d. Sauri	41°17'	15°28'	VII	Civitella d. Tronto	42°46'	13°39'	IV	Fiano Romano	42°09'	12°34'	IV	Giurdignano	40°07'	18°25'	IV
Castelluccio Valmag.	41°20'	15°11'	VI	Civitella M. Raimondo	42°04'	14°12'	V	Ficulle	42°50'	12°03'	NF	Goriano Sicoli	42°04'	13°45'	V
Castelmadama	41°57'	12°51'	III	Civitella Roveto	41°54'	13°25'	IV	Fidenza (PR)	44°51'	10°03'	IV	Graffignano	42°33'	12°11'	IV
Castelmauro	41°50'	14°41'	V	Cocullo	42°01'	13°45'	NF	Filadelfia	38°46'	16°17'	IV	Gragnano	40°40'	14°30'	VII
Castelmezzano (PZ)	40°31'	16°02'	V	Collarmele	42°02'	13°36'	IV	Filiano	40°47'	15°41'	VII	Grassano (MT)	40°37'	16°16'	VII
Castelnuovo d. Daunia	41°34'	15°06'	VI	Collazzone	42°53'	12°25'	NF	Filicudi	38°37'	14°34'	II	Gravina di Puglia	40°48'	16°25'	VI
Castelnuovo De Monti	44°25'	10°25'	NF	Colle di Macina	42°00'	14°11'	IV	Filignano	41°32'	14°02'	V	Grottaglie	40°32'	17°25'	IV
Castelnuovo Di Conza	40°48'	15°18'	X	Collecorvino-Picc.	42°26'	14°00'	IV	Filottrano	43°25'	13°19'	IV	Grottaminarda (AV)	41°03'	15°03'	VI
Castelnuovo Rangone	44°31'	10°56'	NF	Collepasso	40°03'	18°09'	III	Firenze	43°45'	11°14'	III	Grottammare	43°00'	13°51'	IV
Castelvecchio Sub.	42°06'	13°43'	IV	Collescipoli (Terni)	42°31'	12°35'	NF	Firmo	39°42'	16°10'	IV-V	Grotte	37°23'	13°42'	NF
Castelvetere in V.F.	41°26'	14°55'	VI	Collestatte	42°33'	12°43'	NF	Flumeri (AV)	41°04'	15°08'	VI	Grotte S. Stefano	42°30'	12°09'	III
Castelviscardo	42°44'	12°00'	III	Colletorto	41°39'	14°48'	VI	Foggia	41°27'	15°32'	V-VI	Grottole (MT)	40°35'	16°22'	VI
Castiglion Fioren.	43°19'	11°54'	III	Colli al Volturno	41°35'	14°05'	V	Foglianise (BN)	41°09'	14°39'	VI	Grottolella (AV)	40°57'	14°46'	VII
Castiglione M.M.	41°51'	14°26'	V	Colliano	40°42'	15°16'	VIII	Foiano di Valfortore	41°20'	14°58'	VI	Grumento Nova	40°15'	15°53'	VI
Castorano	42°53'	13°43'	III-IV	Colmurano	43°09'	13°20'	IV	Foligno (PG)	42°57'	12°41'	IV	Grumo Appula	41°00'	16°41'	VI
Castri di Lecce	40°16'	18°15'	NF	Colonella	42°52'	13°51'	IV	Fondi	41°21'	13°25'	IV	Grumo Nevano	40°55'	14°14'	VII
Castrignano d. Greci	40°10'	18°16'	NF	Comacchio	44°41'	12°11'	IV	Fontana Liri	41°35'	13°32'	IV	Guagnano-Villa Bald.	40°23'	17°56'	IV
Castropignano	41°36'	14°33'	V	Conca dei Marini	40°37'	14°32'	VI	Fontanarosa (BN)	41°00'	15°00'	VI	Gualdo Cattaneo	42°53'	12°33'	IV
Castroreale	38°05'	15°12'	III	Conselice	44°29'	11°48'	III	Fontecchio	42°13'	13°35'	IV	Gualdo Tadino (PG)	43°12'	12°46'	NF
Castroregio	40°00'	16°28'	V	Controne (SA)	40°30'	15°11'	VII	Forchia-Arpaia	41°01'	14°31'	VII	Guardea	42°36'	12°16'	NF
Castrovillari	39°47'	16°12'	V	Contursi Terme (SA)	40°38'	15°13'	VI	Forenza (PZ)	40°50'	15°50'	V-VI	Guardia dei Lombardi	40°56'	15°12'	IX
Casumaro	44°50'	11°19'	NF	Conversano	40°57'	17°05'	V	Forino (AV)	40°51'	14°43'	VII	Guardiagrele	42°10'	14°12'	V
Catanzaro	38°52'	16°34'	IV	Conza (AV)	40°51'	15°19'	X	Forlì	44°10'	12°03'	III	Guardialfiera	41°47'	14°46'	V
Catignano	42°20'	13°56'	V	Copertino	40°16'	18°02'	IV	Formia	41°15'	13°35'	IV	Guardiaregia	41°25'	14°31'	VI
				Corato	41°08'	16°25'	V	Formicola	41°12'	14°13'	VI	Gubbio (PG)	43°20'	12°33'	III

Guglionesi	41°54'	14°54'	V	Marcellina	42°01'	12°47'	IV	Montecilfone	41°53'	14°50'	V	Novoli	40°21'	18°02'	IV
Ielsi	41°30'	14°47'	IV	Margherita di Savoia	41°21'	16°08'	V	Montecorsaro	43°18'	13°37'	IV	Numana	43°30'	13°36'	IV
Ienni	41°52'	13°09'	NF	Marigliano (NA)	40°54'	14°26'	VII	Montecorvino Puglia	40°40'	14°56'	VII	Nusco (AV)	40°52'	15°02'	VII
Imola	44°20'	11°41'	III	Marina di Schiavonea	39°38'	16°32'	V	Montecorvino Rovella	40°41'	14°57'	VI	Offagna	43°30'	13°22'	IV
Introdacqua	42°00'	13°53'	IV	Marino	41°46'	12°39'	IV	Montedinove	42°57'	13°34'	III	Offida	42°55'	13°40'	III
Iolanda di Savoia	44°51'	11°58'	III	Marsciano (PG)	42°53'	12°16'	III	Montefalco	42°52'	12°38'	IV	Ogliastro Cilento	40°20'	15°02'	VI
Irsina (MT)	40°43'	16°13'	VI	Marsico Nuovo	40°25'	15°41'	VII	Montefalcone Sannio	41°51'	14°37'	IV	Oliveto Citra (SA)	40°40'	15°13'	VII
Ischia	40°42'	13°55'	V	Martano	40°11'	18°17'	NF	Montefalcone Valfor.	41°18'	15°00'	VI	Oppidi (SA)	40°37'	15°08'	VI
Ischitella	41°53'	15°53'	V	Martignano	40°14'	18°14'	NF	Montefano	43°23'	13°25'	IV	Ordona	41°18'	15°37'	V
Isernia	41°34'	14°14'	V	Martina Franca	40°41'	17°20'	IV-V	Montefiascone (VT)	42°31'	12°01'	NF	Oria (BR)	40°29'	17°38'	V
Isola del Ciglio	42°19'	10°51'	NF	Martinsicuro	42°52'	13°54'	IV	Montefino (TE)	42°31'	13°42'	IV	Oriolo	40°02'	16°26'	VI
Isola del Liri	41°40'	13°33'	V	Martirano (CZ)	16°12'	39°05'	IV	Monteforte Irpino	40°52'	14°42'	VIII	Orsara di Puglia	41°16'	15°15'	VII
Isola del Piano (PS)	43°43'	12°45'	III	Maruggio	40°18'	17°34'	IV	Montegabbione	42°54'	12°04'	NF	Orsogna	42°12'	14°16'	V
Itri	41°16'	13°31'	IV	Marzocca	43°39'	13°17'	III-IV	Montegiordano	40°04'	16°31'	V	Orsomarso	39°47'	15°51'	V
Jesi	43°30'	13°13'	III	Massa Lubrense	40°36'	14°20'	VI	Montegranaro (AP)	43°13'	13°37'	III-IV	Orta Nova	41°19'	15°42'	V
L'Aquila	42°20'	13°23'	IV	Massa Martana	42°46'	12°31'	NF	Monteleone d'Orvieto	42°54'	12°02'	IV	Orte	42°26'	12°22'	IV
Lacedonia (AV)	41°02'	15°25'	VII	Massafra	40°35'	17°06'	V	Monteleone d. Spoleto	42°38'	12°55'	NF	Ortelle	40°01'	18°25'	NF
Laceno	40°47'	15°05'	VIII	Massignano	43°02'	13°47'	IV	Monteleone di Puglia	41°09'	15°13'	VII	Ortocchio	41°56'	13°37'	V
Lagonegro	40°06'	15°44'	VI	Matera	40°39'	16°35'	V	Montelibretti	42°08'	12°43'	IV	Ortona	42°20'	14°23'	IV-V
Laino Castello	39°56'	15°53'	V	Materdomini (AV)	40°48'	15°13'	VIII	Montella (AV)	40°50'	15°00'	VII	Ortona dei Marsi	42°00'	13°43'	IV
Lama dei Peligni	42°01'	14°10'	V	Matino	40°01'	18°07'	III	Montelongo	41°43'	14°56'	VI	Orvieto	42°42'	12°05'	IV
Lama Mocogno	44°18'	10°42'	NF	Matrice	41°36'	14°41'	VI	Montelupone	43°20'	13°33'	III-IV	Osimo	43°28'	13°28'	IV
Lamezia Terme	38°52'	16°15'	IV	Mattinata	41°42'	16°02'	IV	Montemurro	40°17'	16°00'	VII	Ostia Lido	41°43'	12°16'	IV
Lanciano	42°13'	14°22'	V	Melendugno	40°16'	18°19'	NF	Montenero d. Bisaccia	41°56'	14°45'	V	Ostra Vetere (AN)	43°35'	13°02'	III-IV
Lanuvio	41°40'	12°42'	IV	Melfi (PZ)	40°58'	15°38'	VI	Montenerodomo	41°58'	14°14'	V	Ostuni	40°43'	17°34'	V
Larino	41°50'	14°54'	V	Melissano	39°56'	18°06'	III	Monteprandone	42°54'	13°50'	IV	Otranto	40°08'	18°28'	IV
Laterza	40°36'	16°46'	VI	Melpignano	40°09'	18°16'	NF	Montepulciano	43°04'	11°50'	III	Otricoli	42°25'	12°27'	NF
Latina	41°27'	12°54'	V	Mercato S. Severino	40°46'	14°45'	VII	Monterado	43°41'	13°05'	IV	Ottati (SA)	40°27'	15°18'	VII
Laurenzana	40°27'	15°58'	VI	Mercogliano (AV)	40°54'	14°43'	VIII	Monteroduni	41°30'	14°10'	IV	Ottaviano	40°51'	14°28'	VI
Laurino (SA)	40°19'	15°19'	VI	Mesagne	40°33'	17°48'	IV	Monteroni di Lecce	40°18'	18°04'	IV	Ottone	44°34'	09°19'	NF
Lauro	40°51'	14°37'	VII	Messina	38°10'	15°34'	III-IV	Monterosi	42°10'	12°17'	IV	Ovindoli	42°07'	13°30'	IV
Lauro di Sessa	41°15'	13°52'	VI	Meta di Sorrento	40°38'	14°25'	VII	Monterubbiano (AP)	43°04'	13°41'	IV	Pacentro	42°02'	14°00'	IV
Lavezzola	44°34'	11°50'	III	Miggiano	39°57'	18°18'	III	Montesano S.	39°57'	18°19'	NF	Padula (SA)	40°19'	15°38'	VII
Laviano (SA)	40°46'	15°17'	X	Miglianico	42°21'	14°17'	IV	Montesano S. Marcell.	40°15'	15°41'	VI	Paestum	40°23'	15°01'	VI
Lecce	40°20'	18°10'	IV	Mignano Monte Lungo	41°23'	13°57'	V	Montesarchio (BN)	41°03'	14°37'	VII	Pagani	40°43'	14°36'	VI-VII
Lenola	41°25'	13°27'	IV	Milazzo	38°13'	15°14'	III-IV	Monticelli d'Ongina	45°07'	09°54'	NF	Paglieta	42°09'	14°29'	V
Lentini	37°16'	15°00'	II	Militello Rosmarino	38°02'	14°40'	II-III	Montieri	43°06'	11°02'	NF	Pago del Vallo di L.	40°51'	14°35'	VI
Lequile	40°17'	18°08'	IV	Minervino di Lecce	40°05'	18°25'	III	Montorio Vomano (TE)	42°34'	13°37'	IV	Pago Veiano	41°14'	14°51'	VII
Lesina	41°51'	15°20'	V-VI	Minervino Murge	41°04'	16°04'	V	Montoro Inf. (AV)	40°48'	14°45'	VI	Palagianello	40°34'	17°01'	V
Lettopalena	42°00'	14°09'	V	Minori (SA)	40°38'	14°37'	VI	Montoro Sup. (AV)	40°48'	14°47'	VIII	Palagiano	40°36'	16°58'	V
Licenza	42°03'	12°53'	III	Minturno	41°15'	13°44'	IV	Morala	41°37'	13°11'	IV	Palata	41°53'	14°46'	V
Limatola	41°08'	14°23'	VI	Mirabella Eclano	41°02'	15°00'	VIII	Morano Calabro	39°50'	16°06'	V	Palazzo S. Gervasio	40°55'	16°00'	VII
Lioni (AV)	40°52'	15°10'	X	Mirabello Sannitico	41°30'	14°39'	V	Morciano	39°50'	18°18'	NF	Palena	41°58'	14°07'	IV-V
Lipari	38°29'	14°56'	II-III	Misterbianco	37°29'	15°00'	II-III	Morra de Sanctis (AV)	40°55'	15°14'	VIII	Palermo	38°06'	13°21'	NF
Liveri	40°53'	14°33'	VI	Modena	44°37'	10°55'	NF	Morrovalle	43°18'	13°34'	NF	Palinuro (SA)	40°02'	15°15'	V
Livorno	43°29'	10°19'	NF	Modugno	41°04'	16°45'	V	Moscufo	42°25'	14°02'	IV	Palizzi Marina	37°57'	15°58'	NF
Lizzanello	40°17'	18°13'	IV	Mogliano	43°10'	13°28'	III	Motta Montecorvino	41°30'	15°06'	VI	Palma Campania (NA)	40°51'	14°33'	V
Lizzano	40°23'	17°26'	IV	Moiano	41°04'	14°31'	VI	Motta S.G.	38°00'	15°42'	III	Palmariggi	40°07'	18°22'	NF
Locorotondo	40°44'	17°19'	IV	Mola di Bari	41°03'	17°04'	V	Mottola	40°37'	17°02'	IV	Palmoli	41°55'	14°33'	V
Loreto	43°25'	13°35'	IV	Molfetta	41°11'	16°34'	V	Mugnano d. Cardinale	40°55'	14°37'	VII	Palo del Colle	41°02'	16°41'	V
Loreto Aprutino	42°25'	13°58'	IV	Molinella	44°36'	11°35'	III	Mugnano di Napoli	40°53'	14°12'	VI-VII	Palombara Sabina	42°03'	12°45'	IV
Loro Piceno	43°09'	13°25'	IV	Moliterno	40°13'	15°52'	VI	Mugnano Fontignano	43°03'	12°13'	NF	Palombaro	42°06'	14°14'	IV
Lucca	43°50'	10°29'	III	Monasterace	38°26'	16°32'	III-IV	Muro Leccese	40°05'	18°19'	III	Palomonte (SA)	40°39'	15°16'	VII
Lucera	41°29'	15°19'	VI	Mongrassano	39°30'	16°06'	V	Muro Lucano (PZ)	40°44'	15°28'	VIII	Panarea	38°37'	15°02'	III
Lucito	41°43'	14°40'	V	Monopoli	40°57'	17°16'	V	Napoli	?	?	VII	Panni	41°13'	15°15'	VII
Luco dei Marsi	41°56'	13°27'	IV	Monsampolo T.	42°53'	13°47'	III	Nardò	40°10'	18°01'	IV	Paola	39°20'	16°02'	V
Lugnano in Teverina	42°34'	12°19'	NF	Montagano	41°38'	14°39'	VI	Narni	42°30'	12°30'	NF	Papasidero	39°51'	15°55'	V
Lungobucco	39°25'	16°35'	IV	Montalto Marche	42°58'	13°36'	III	Navelli	42°13'	13°43'	IV	Parabita (LE)	40°04'	18°07'	III-IV
Lungro	39°43'	16°07'	IV-V	Montano Antilia (SA)	40°09'	15°21'	VII	Nepi	42°13'	12°20'	IV	Parete	40°56'	14°09'	VI-VII
Luzzi	39°26'	16°17'	IV-V	Montaquila	41°33'	14°06'	V	Nereto Torano Nuovo	42°48'	13°48'	IV	Parma	44°50'	10°19'	II
Macchia Valforte	41°35'	14°54'	V	Montazzoli	41°56'	14°25'	V	Nettuno	41°27'	12°39'	IV	Parolise (AV)	40°55'	14°52'	VII
Macchiagodena	41°34'	14°25'	V	Monte di Procida	40°46'	14°02'	VI	Nicastro	38°58'	16°20'	IV-V	Parrano	42°51'	12°05'	IV
Macerata (MC)	43°17'	13°26'	IV-V	Monte Giorgio (AP)	43°09'	13°28'	IV	Nicosia	37°44'	14°23'	II	Passignano S. Trasim.	43°10'	12°07'	NF
Maddaloni	41°02'	14°23'	VII	Monte Marano	40°54'	15°00'	VII	Nocera Inferiore	40°44'	14°38'	VII	Passo Corese (RI)	42°07'	12°38'	IV
Madonna dell'Arco	40°51'	14°22'	VI	Monte S. Giusto	43°13'	13°34'	IV	Nocera Superiore	40°44'	14°40'	VII	Pastena	41°28'	13°29'	IV
Maenza	41°31'	13°10'	NF	Monte S. Martino	43°01'	13°25'	III-IV	Nocera Umbra	43°06'	12°46'	NF	Paternò	37°33'	14°53'	III
Mafalda	41°56'	14°42'	V	Monte S. Angelo	41°41'	15°56'	V	Noci	40°47'	17°06'	V	Paternopoli (AV)	40°57'	15°01'	VII
Magliano dei Marsi	42°04'	13°21'	IV	Monte S.M. Tiberina	43°25'	12°09'	NF	Nociglia	40°01'	18°18'	NF	Patti	38°07'	14°57'	III
Maglie	40°06'	18°17'	III	Montebello Bertona	42°25'	13°51'	IV	Noicattaro	41°01'	17°00'	V	Penna S. Giovanni	43°03'	13°25'	IV
Maiori (SA)	40°39'	14°37'	VI	Montecalvo Irpino	41°09'	15°01'	VII	Nola (NA)	40°54'	14°31'	VI	Pennadomo	42°00'	14°18'	V
Mandanici	38°00'	15°19'	II-III	Montecassiano	43°21'	13°25'	IV	Norcia	42°46'	13°05'	IV	Penne	42°27'	13°56'	IV
Mandatoriccio	39°27'	16°50'	III	Montecastello Vibio	42°50'	12°20'	III	Normanno	39°52'	16°00'	V-VI	Percile	42°04'	12°54'	III
Manduria	40°23'	17°37'	IV	Montecastrilli	42°38'	12°28'	NF	Nova Siri	40°08'	16°32'	V	Pergola (PS)	43°33'	12°50'	III
Manfredonia	41°39'	15°54'	V	Montecchio	43°08'	12°42'	NF	Novara Sicilia	38°00'	15°06'	III-IV	Persano (SA)	40°32'	15°02'	V

Perugia	43°05'	12°23'	III	Porto Recanati	43°25'	13°39'	IV	Roseto Valforte	41°21'	15°05'	VI	S. Leucio del Sannio	41°04'	14°44'	VII	
Pesaro	43°54'	12°53'	III	Porto San Giorgio	43°10'	13°46'	III-IV	Rosignano Solvay	43°25'	10°27'	III	S. Lorenzo Bellizzi	39°52'	16°19'	IV	
Pescara	42°27'	14°11'	V	Portocannone	41°54'	15°00'	V	Rossano	39°33'	16°38'	V	S. Lucia del Mela	38°07'	15°16'	III	
Pescasseroli	41°48'	13°46'	III	Positano (SA)	40°36'	14°28'	V	Rotello	41°44'	15°00'	V	S. Lucia di Serino	40°51'	14°51'	VIII	
Peschici	41°56'	16°00'	V	Postiglione (SA)	40°33'	15°13'	VII	Rotondella	40°09'	16°31'	VI	S. Mango sul Calore	40°57'	14°58'	IX	
Pescina	42°01'	13°39'	IV	Potenza	40°37'	15°47'	VII	Rotondi	41°01'	14°35'	VII	S. Marco in Lamis (FG)	41°44'	15°37'	V	
Pescocostanzo	41°52'	14°03'	IV-V	Potenza Picena (MC)	43°21'	13°36'	IV	Rovereto (MO)	44°50'	10°57'	III-IV	S. Marco la Catola	41°30'	15°00'	VI	
Pescolanciano	41°40'	14°19'	V	Pozzuoli	40°48'	14°09'	VI	Ruffano	39°58'	18°14'	IV	S. Maria Capua Vetere	41°05'	14°15'	VII	
Pescopagano (PZ)	40°50'	15°23'	IX	Praiano (SA)	40°35'	14°31'	V	Ruoti (PZ)	40°42'	15°40'	VII	S. Maria degli Angeli	43°02'	12°33'	IV	
Pescosannita	41°13'	14°48'	VI	Prata Princ. Ultra	40°57'	14°50'	VIII	Rutigliano	41°00'	17°00'	V	S. Martino Pensilis	41°51'	15°00'	V	
Patacciato	42°00'	14°50'	V	Prato	43°52'	11°04'	NF	Rutino (SA)	40°17'	15°04'	VI	S. Martino v. Gaudina	41°00'	14°39'	VII	
Petilia d. Policastro	39°06'	16°47'	IV	Pratola Peligna	42°05'	13°53'	V	Ruviano	41°11'	14°23'	VI	S. Martino Val d'Agri	40°13'	16°02'	VI	
Petrella Tifernina	41°40'	14°41'	V	Preci	42°52'	13°02'	NF	Ruvo del Monte (PZ)	40°50'	15°31'	VIII	S. Mauro Marchesato	39°05'	16°55'	IV	
Petrignano d'Assisi	43°08'	11°55'	IV	Presenzano	41°22'	14°04'	VI	Ruvo di Puglia	41°05'	16°29'	VI	S. Michele di Serino	40°51'	14°50'	IX	
Petriolo	43°12'	13°27'	III-IV	Presicce	39°53'	18°15'	III	S. Mauro Forte	40°28'	16°15'	V	S. Michele Salentino	40°37'	17°36'	NF	
Pettorano sul Gizio	41°58'	13°56'	IV	Prignano Cilento (SA)	40°20'	15°03'	VI	S. Agata Bolognese	44°39'	11°09'	NF	S. Nicola Arcella	39°47'	15°48'	V	
Pezze di Greco	40°48'	17°25'	IV-V	Priverno	41°27'	13°10'	IV	S. Agata di Puglia	41°08'	15°22'	VII	S. Nicola Baronia (AV)	41°02'	15°11'	VI-VII	
Piacenza	45°01'	09°42'	NF	Procida	40°43'	14°01'	VI	S. Agata Li Battiati	37°33'	15°04'	II-III	S. Nicola la Strada	41°03'	14°19'	VI	
Piana M.V.	41°09'	14°19'	VI	Prossedi	41°30'	13°15'	NF	S. Agnello	40°37'	14°23'	VI-VII	S. Nicolò Atordino	42°40'	13°45'	III	
Piancastagnaio	42°50'	11°37'	II-III	Puglianello	41°13'	14°26'	VI	S. Anastasia	40°51'	14°23'	VII	S. Pancrazio Salent.	40°25'	17°50'	IV	
Piandiscò (AR)	43°38'	11°32'	III	Pulsano	40°22'	17°21'	IV	S. Anatolia di Narco	42°43'	12°39'	NF	S. Paolo Civitate	41°43'	15°15'	IV	
Pianella	42°23'	14°02'	IV-V	Putignano	40°51'	17°07'	V	S. Andrea di Conza	40°50'	15°21'	IX	S. Pier Niceto	38°08'	15°21'	III	
Pianello Vallesino	43°36'	13°06'	III	Quaglietta (AV)	40°44'	15°13'	VIII	S. Angelo d'Alife	41°21'	14°15'	VI	S. Pietro in Guarano	39°19'	16°19'	V	
Piano di Sorrento	40°35'	14°21'	VII	Quindici	40°50'	14°38'	VI	S. Angelo d. Lombardi	40°55'	15°10'	X	S. Pietro in Lama	40°17'	18°06'	IV	
Pianoro (BO)	44°21'	11°18'	NF	Racale	39°54'	18°06'	IV	S. Angelo del Pesco	41°51'	14°14'	V	S. Pietro Vernotico	40°29'	18°00'	IV	
Pianura	40°51'	14°10'	VII	Raiano	42°05'	13°48'	IV	S. Angelo Fasanella	40°26'	15°19'	VIII	S. Potito Ultra (AV)	40°57'	14°51'	VII	
Picinisco	41°37'	13°51'	IV	Randazzo	37°52'	14°56'	III	S. Angelo in Pontano	43°05'	13°23'	IV	S. Prisco	41°05'	14°16'	VII	
Pico	41°26'	13°33'	IV	Rapino-Pretoro	42°12'	14°09'	IV	S. Angelo le Fratte	40°32'	15°33'	VII	S.S. Cosma e Damiano	41°17'	13°50'	IV	
Piediluco di Terni	42°31'	12°44'	NF	Rapone	40°50'	15°29'	VII	S. Antimo	40°57'	14°12'	VI	S. Salvo	42°01'	14°43'	V	
Piedimonte S. Germano	41°29'	13°43'	V	Ravenna	44°26'	12°11'	IV	S. Apollinare	41°22'	13°50'	V	S. Severina	39°08'	16°56'	IV	
Pietra de Fusi (AV)	41°02'	14°52'	VIII	Recanati (MC)	43°23'	13°32'	IV	S. Arcangelo Basilic.	40°14'	16°16'	VI	S. Severino (MC)	43°12'	13°09'	V	
Pietra Montecorvino	41°32'	15°07'	VI	Regalbuto	37°38'	14°37'	III	S. Arcangelo Romagna	44°04'	12°26'	IV	S. Stefano del Sole	40°53'	14°51'	VI	
Pietrabbondante	41°44'	14°22'	V	Reggio Calabria	38°05'	15°38'	III-IV	S. Arsenio	40°27'	15°28'	VIII	S. Venanzo	42°51'	12°15'	III	
Pietragalla (PZ)	40°44'	15°52'	V	Reggio Emilia	44°41'	10°36'	III	S. Bartolomeo in Gal.	41°25'	15°00'	VI	S. Vincenzo V. Roveto	41°50'	13°31'	V	
Pietralunga	43°26'	12°25'	NF	Rende	39°19'	16°10'	V	S. Benedetto d. Marsi	42°00'	13°36'	IV	S. Vitiliano (NA)	40°54'	14°28'	VI	
Pietramellara	41°16'	14°10'	VII	Riccia	41°28'	14°50'	IV	S. Benedetto d. Tronto	42°56'	13°51'	IV	S. Vito Chietino	42°17'	14°26'	IV	
Pietranico	42°15'	13°54'	V	Ricigliano (SA)	40°39'	15°28'	VIII	S. Biagio Saracinisco	41°35'	13°55'	IV	S. Vito dei Normanni	40°39'	17°42'	IV	
Pietrastornina (AV)	40°58'	14°43'	VII	Rieti	42°23'	12°51'	IV	S. Biase (SA)	40°11'	15°16'	VI	S. Vittore D.L.	41°26'	13°55'	IV	
Pietrelcina	41°11'	14°50'	VII	Rignano Garganico	41°39'	15°34'	V	S. Buono	41°57'	14°33'	IV	Sala Consilina (SA)	40°23'	15°35'	VII	
Piglio	41°48'	13°08'	V	Rimini	44°03'	12°34'	III	S. Cassiano	44°08'	11°40'	NF	Salice Salentino	40°22'	17°58'	IV	
Pignataro Maggiore	41°11'	14°10'	VI-VII	Riofreddo	42°03'	13°00'	III	S. Cesarea Terme	40°01'	18°27'	NF	Salve	39°50'	18°17'	NF	
Pignola	40°34'	15°46'	VI	Rionero in Vulture	40°54'	15°39'	VII	S. Cesario di Lecce	40°17'	18°09'	IV	Salvitelle (SA)	40°34'	15°27'	VIII	
Pignola (PZ)	40°33'	15°46'	VII	Ripabottoni	41°40'	14°47'	VI	S. Chirico Nuovo	40°40'	16°04'	VI	Salza Irpina (AV)	40°54'	14°52'	VIII	
Pimonte	40°39'	14°30'	VII	Ripacandida (PZ)	40°53'	15°43'	VI	S. Cosma e Damiano (LT)	41°16'	13°47'	IV	Sammichele di Bari	40°52'	16°57'	V	
Piombino	42°54'	10°31'	NF	Ripalimosani	41°36'	14°38'	V	S. Croce di Magliano	41°42'	15°00'	VI	San Clemente (FO)	43°54'	12°37'	IV	
Pisciotta (SA)	40°05'	15°13'	VI	Ripatransone	43°00'	13°45'	IV	S. Donato di Lecce	40°15'	18°10'	IV	San Donaci	40°26'	17°54'	IV	
Pizzoferrato	41°54'	14°11'	IV	Ripe	43°39'	13°06'	IV	S. Donato Val Comino	41°41'	13°48'	IV	Sal Leucio	41°05'	14°19'	V-VI	
Pofi (FR)	41°33'	13°25'	IV-V	Ripe S. Ginesio	43°09'	13°21'	IV	S. Egidio a. Vibrata	42°50'	13°42'	IV	San Rufo (SA)	40°25'	15°27'	VII	
Poggiardo	40°02'	18°22'	NF	Rizziconi	38°25'	15°57'	IV	S. Elena Sannita	41°33'	14°28'	V	San Severo (FG)	41°41'	15°25'	VI	
Poggio a Caiano (FI)	43°48'	11°03'	NF	Rocca d'Evandro	41°23'	13°54'	V-VI	S. Elia Fiumerapido	41°32'	13°51'	IV-V	Sanarica	40°04'	18°21'	III	
Poggio Imperiale	41°50'	15°20'	V	Rocca di Mezzo	42°11'	13°30'	IV	S. Eufemia	38°54'	16°15'	IV	Sangemini	42°36'	12°32'	NF	
Poggio Mirteto	42°15'	12°40'	IV-V	Rocca Pia	41°55'	13°57'	IV	S. Eusanio d. Sangro	42°09'	14°19'	V	Sannicandro di Bari	41°00'	16°47'	V	
Poggio Sannita	41°45'	14°25'	V	Rocca S. Felice (AV)	40°56'	15°09'	VIII	S. Fele (PZ)	40°48'	15°31'	VIII	Sannicandro Gargan.	41°50'	15°33'	V	
Poggiofiorito	42°15'	14°19'	IV-V	Roccadaspide (SA)	40°25'	15°11'	VI	S. Felice a Cancello	41°00'	14°28'	VII	Sannicola di Lecce	40°04'	18°03'	III	
Poggiorsini	40°54'	16°15'	V	Roccaforte del Greco	38°02'	15°55'	III-IV	S. Felice sul Panaro	44°50'	11°09'	NF	Sant'Agata dei Goti	41°04'	14°29'	VII	
Policorno	40°12'	16°39'	VI	Roccagiovine	42°02'	12°53'	III	S. Ferdinando Puglia	41°16'	16°04'	V	Santeramo in Colle	40°47'	16°44'	V	
Polignano a Mare	41°00'	17°13'	V	Roccagorga	41°31'	13°08'	IV	S. Fili	39°19'	16°08'	V	Santomenna (SA)	40°47'	15°18'	X	
Polistena	38°23'	16°04'	IV	Roccamonfina	41°16'	13°58'	VI	S. Fiora	42°50'	11°34'	NF	Sanza (SA)	40°13'	15°32'	VI	
Polla (SA)	40°30'	15°29'	VIII	Roccarainola (NA)	40°57'	14°33'	VII	S. Giorgio a Liri	41°23'	13°45'	IV-V	Sarno (SA)	40°48'	14°36'	VI	
Pollena Tr.	40°50'	14°22'	VI	Roccaraso	41°50'	14°04'	IV-V	S. Giorgio del Sannio	41°03'	14°50'	VI-VII	Sassano	40°19'	15°33'	VI	
Pollenza	43°15'	13°19'	IV	Roccascalegna	42°03'	14°17'	V	S. Giorgio Ionico	40°26'	17°22'	IV	Sassocorvaro (PS)	43°46'	12°29'	II-III	
Polverigi	43°30'	13°25'	IV	Roccasecca	41°31'	13°39'	V	S. Giorgio la Molara	41°15'	14°53'	VII	Satriano di Lucania	40°31'	15°37'	VI	
Pomigliano d'Arco	40°53'	14°22'	VII	Roccasecca d. Volsci	41°28'	13°12'	NF	S. Giovanni in Fiore	39°14'	16°42'	IV	Sava	40°23'	17°33'	IV	
Pompei	40°44'	14°29'	VII	Roccaspinalveti	41°55'	14°27'	V	S. Giovanni Incarico	41°29'	13°33'	IV	Saviano-Scisciano	40°53'	14°29'	VII	
Ponte S. Giovanni	43°05'	12°26'	NF	Roccastrada	43°00'	11°09'	NF	S. Giovanni Lipioni	41°50'	14°33'	IV	Savoia di Lucania	40°33'	15°32'	VII	
Pontecagnano (SA)	40°38'	14°53'	VII	Roccella Ionica	38°19'	16°23'	IV	S. Giovanni Persiceto	44°37'	11°09'	III	Scafati (SA)	40°44'	14°30'	VI	
Pontecorvo	41°25'	13°39'	V	Rocchetta S. Antonio	41°05'	15°27'	VII	S. Giovanni Rotondo	41°42'	15°43'	V	Scalea	39°47'	15°47'	V	
Pontelandolfo	41°16'	14°41'	VI	Rodi Garganico	41°55'	15°51'	V	S. Giuliano d. Sannio	41°26'	14°37'	V	Scandiano	44°34'	10°41'	III	
Popoli	42°09'	13°50'	V	Rofrano (SA)	40°11'	15°25'	VI	S. Giuliano di Puglia	41°40'	14°58'	VI	Scanno	41°53'	13°51'	IV	
Poppi	43°44'	11°44'	NF	Rogliano	39°10'	16°19'	IV	S. Giuliano Teatino	42°17'	14°17'	IV	Scanzano	42°05'	13°13'	NF	
Porano	42°41'	12°05'	NF	Roma	41°52'	12°29'	IV	S. Giustino	43°32'	12°10'	NF	Scerni	42°06'	14°33'	IV	
Portici	40°48'	14°19'	VI	Rosciano	42°19'	14°02'	V	S. Gregorio Magno (SA)	40°38'	15°23'	VIII	Scheggia	43°23'	12°39'	NF	
Porto Cesareo	40°15'	17°54'	IV	Roscigno (SA)	40°23'	15°20'	V	S. Gregorio Matese	41°22'	14°22'	V	Schiavi di Abruzzo	41°47'	14°28'	V	
Porto Potenza Picena	43°20'	13°40'	IV	Rose	39°23'	16°18'	V	S. Leonardo Treponzio	43°50'	10°34'	III	Scido	38°15'	15°54'	IV	

Scisciano	40°52'	14°29'	VI	Teramo	42°39'	13°41'	III	Valsinni	40°09'	16°26'	VI
Scorrano	40°06'	18°17'	IV	Terlizzi	41°07'	16°32'	VI	Valtopina	43°04'	12°45'	IV
Scorzo	40°33'	15°14'	VI	Termoli	42°00'	15°00'	V	Valva (SA)	40°43'	15°15'	VIII
Scurcola Marsicana	42°04'	13°19'	IV	Terni	42°32'	12°37'	NF	Vasanello	42°25'	12°20'	III-IV
Secinaro	42°08'	13°40'	IV	Terracina	41°16'	13°15'	IV	Vasto	42°06'	14°41'	V
Sellano	42°53'	12°55'	NF	Terzigno (NA)	40°47'	14°29'	VI	Veglie	40°19'	17°58'	IV
Senerchia (AV)	40°43'	15°11'	IX	Thurio	39°40'	16°28'	IV-V	Venafro	41°28'	14°02'	V
Senise	40°07'	16°17'	VI	Tito (PZ)	40°34'	15°40'	VII	Ventotene	40°45'	13°23'	V
Sepino	41°23'	14°36'	V	Tivoli Bagni	41°56'	12°46'	IV	Verbicaro	39°44'	15°55'	V
Serino (AV)	40°51'	14°51'	VIII	Tizzano	44°29'	10°14'	IV	Vernole	40°16'	18°18'	NF
Serra Pedace	39°14'	16°19'	V	Tocco Caudio	41°06'	14°36'	VI-VII	Vezzano	44°34'	10°29'	NF
Serra S. Bruno	38°34'	16°20'	IV	Todi	42°45'	12°23'	IV	Vibo Valenzia	38°40'	16°04'	V
Serracapriola	41°47'	15°09'	VI	Tolentino (MC)	43°11'	13°15'	III	Vico del Gargano	41°53'	15°56'	IV
Serradarce (SA)	40°37'	15°08'	VI	Tollo	42°19'	14°19'	IV	Vico Equense	40°39'	14°25'	VII
Serre (SA)	40°34'	15°10'	VIII	Tolve (PZ)	40°41'	16°00'	VI	Vicovaro	42°00'	12°53'	IV
Sersale	39°00'	16°44'	III-IV	Torchiarolo	40°28'	18°02'	IV	Vieste	51°52'	16°09'	V
Sessa Aurunca	41°13'	13°55'	VI	Torella del Sannio	41°37'	14°30'	V	Vietri di Potenza	40°35'	15°29'	VIII
Siano	40°47'	14°40'	VII	Torgiano	43°01'	12°25'	NF	Viggiano	40°20'	15°53'	VI
Sibari	39°44'	16°27'	IV-V	Torino di Sangro	42°10'	14°31'	IV-V	Vignola	44°29'	10°54'	NF
Sicignano d. Alburni	40°35'	15°16'	VI	Toritto	41°00'	16°40'	V	Villa Castelli	40°34'	17°29'	IV
Siderno	38°15'	16°15'	IV	Toro	41°33'	14°45'	V	Villa d'Agri	40°21'	15°50'	V
Siena	43°19'	11°19'	III	Torre Annunziata	40°44'	14°26'	VII	Villa Minozzo	44°21'	10°27'	III
Sigillo	43°19'	12°44'	NF	Torre del Greco	40°46'	14°21'	VII	Villafranca Lunig.	44°17'	09°54'	NF
Siracusa	37°04'	15°16'	II-III	Torre S. Susanna (BR)	40°27'	17°44'	V	Villalago	41°55'	13°50'	IV
Sirolo	43°30'	13°36'	IV	Torrebruna	41°51'	14°31'	IV	Villamagna	42°19'	14°13'	V
Soleto	40°10'	18°12'	NF	Torrecuso (BN)	41°11'	14°39'	VI	Villamaina (AV)	40°57'	15°04'	VIII
Solofra (AV)	40°50'	14°50'	VIII	Torrecuso-Paupisi	41°11'	14°40'	VI-VIII	Villetta Barrea	41°45'	13°55'	IV
Solopaca	41°11'	14°32'	VI-VII	Torrella d. Lombardi	40°55'	15°06'	VIII	Vinchiaturo	41°28'	14°37'	V
Somma Vesuviana (NA)	40°51'	14°25'	V	Torremaggiore	41°40'	15°16'	V	Visciano	40°55'	14°34'	VI-VII
Sonnino	41°25'	13°14'	III	Torretta	38°06'	13°13'	NF	Viterbo	42°23'	12°06'	III-IV
Sora	41°42'	13°36'	V	Torricella Peligna	42°00'	14°19'	V	Vitulano-Foglianise	41°09'	14°39'	VI-VII
Sorbo Serpico	40°53'	14°52'	VIII	Torricella Sicura	42°38'	13°41'	III	Vitulazio Bellona	41°09'	14°12'	VI
Sorrento	40°36'	14°22'	VI-VII	Tortoreto	42°47'	13°54'	IV	Volterra	43°25'	10°50'	NF
Soverato	38°40'	16°33'	IV	Tramonti (SA)	40°40'	14°37'	VII	Volturara Appula	41°29'	15°03'	VI
Spadafora	38°14'	15°23'	III	Trani	41°16'	16°25'	VI	Volturara Irpina (AV)	40°52'	14°54'	VIII
Sparanise	41°11'	14°05'	VI-VII	Trasacco	41°57'	13°31'	IV	Volturino	41°28'	15°07'	VI
Specchia	39°55'	18°17'	NF	Trebisacce	39°51'	16°29'	V	Zafferana Etnea	37°41'	15°07'	III
Spello	42°58'	12°40'	IV	Trecase (NA)	40°45'	14°25'	VII	Zagarolo	41°50'	12°50'	V
Sperlonga	41°15'	13°25'	IV	Treia	43°18'	13°18'	III-IV	Zapponeta	41°26'	15°56'	V
Spina di Marsciano	42°57'	12°16'	NF	Tremiti Isole	42°06'	15°28'	IV-V	Zollino	40°11'	18°15'	NF
Spinazzola (BA)	40°57'	16°04'	VI	Trenta	39°16'	16°19'	V	Zuppino	40°34'	15°15'	VI
Spinetoli	42°52'	13°45'	III-IV	Trepuzzi	40°23'	18°03'	IV				
Spoleto	42°43'	12°43'	NF	Trestina di C. Cast.	43°21'	12°13'	IV				
Squinzano	40°25'	18°02'	IV	Trevi	42°52'	12°43'	III				
Sternatia	40°12'	18°13'	NF	Trevico	41°02'	15°13'	VII				
Sterpito (PZ)	40°46'	15°40'	VI	Tricarico	40°36'	16°08'	VII				
Stilo	38°28'	16°27'	III	Tricase	39°55'	18°21'	IV				
Stornara	41°16'	15°45'	VI	Triggiano	41°03'	16°54'	VI				
Stornarella	41°14'	15°43'	VI	Trinitapoli	41°20'	16°04'	V-VI				
Strangolagalli	41°35'	13°28'	IV	Trivento	41°46'	14°32'	IV-V				
Strasatti di Marsala	37°42'	12°30'	NF	Trivigno (PZ)	40°34'	15°58'	VII				
Striano	40°47'	14°33'	VII	Troia	41°21'	15°18'	VI				
Strómboli	38°45'	15°11'	III-IV	Tropea	38°40'	15°53'	III				
Stroncone	42°28'	12°38'	NF	Tufo (AV)	41°00'	14°48'	VIII				
Strongoli	39°14'	16°03'	IV	Tuoro S.T.	43°11'	12°03'	NF				
Subbiano	43°34'	11°50'	NF	Turi	40°54'	17°01'	V				
Subiaco	41°55'	13°05'	IV	Tursi	40°14'	16°28'	V				
Sulmona	42°02'	13°54'	IV-V	Tuturano	40°32'	17°56'	IV				
Supersano	40°00'	18°14'	IV	Ugento	39°55'	18°09'	NF				
Surano	40°01'	18°20'	NF	Uggiano la Chiesa	40°05'	18°26'	IV				
Surbo (LE)	40°25'	18°07'	IV	Umbertide	43°17'	12°18'	NF				
Tagliacozzo	42°04'	13°14'	IV	Urbania (PS)	43°39'	12°30'	NF				
Talsano	40°25'	17°16'	V	Urbisaglia	43°11'	13°21'	IV				
Taranta Peligna	42°00'	14°09'	IV-V	Ururi	41°50'	15°00'	V				
Taranto	40°26'	17°13'	V	Vaglio (PZ)	40°39'	15°54'	V				
Tarquinia	42°14'	11°43'	IV	Vairano Patenora	41°19'	14°07'	VI				
Tarsia	39°36'	16°15'	V	Valenzano	41°02'	15°52'	VI				
Taurasi (AV)	41°00'	14°57'	VII	Valfabbrica (PG)	43°08'	12°35'	NF				
Taurisiano	39°56'	18°12'	IV	Vallata (AV)	41°01'	15°14'	VII				
Taverola	41°01'	14°12'	VI	Valle di Maddaloni	41°04'	14°25'	VI-VII				
Taviano	39°58'	18°04'	NF	Vallepietra	41°55'	13°13'	NF				
Teano	41°14'	14°03'	VI	Vallerotonda	41°36'	13°54'	IV-V				
Teggiano (SA)	40°21'	15°31'	VII	Vallo Lucania (SA)	40°13'	15°15'	VI				
Teora (AV)	40°50'	15°14'	IX	Vallo Lucania Scalo	40°13'	15°09'	VI				

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THE IRPINIA EARTHQUAKE OF NOVEMBER 23, 1980

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LEGENDA

Symbol	Intensity MCS
□	Not Felt
△	II
+	III
×	IV
◇	V
▲	VI

MARE ADRIATICO

MARE TIRRENO

MARE IONIO

Scala 1 : 3 000 000

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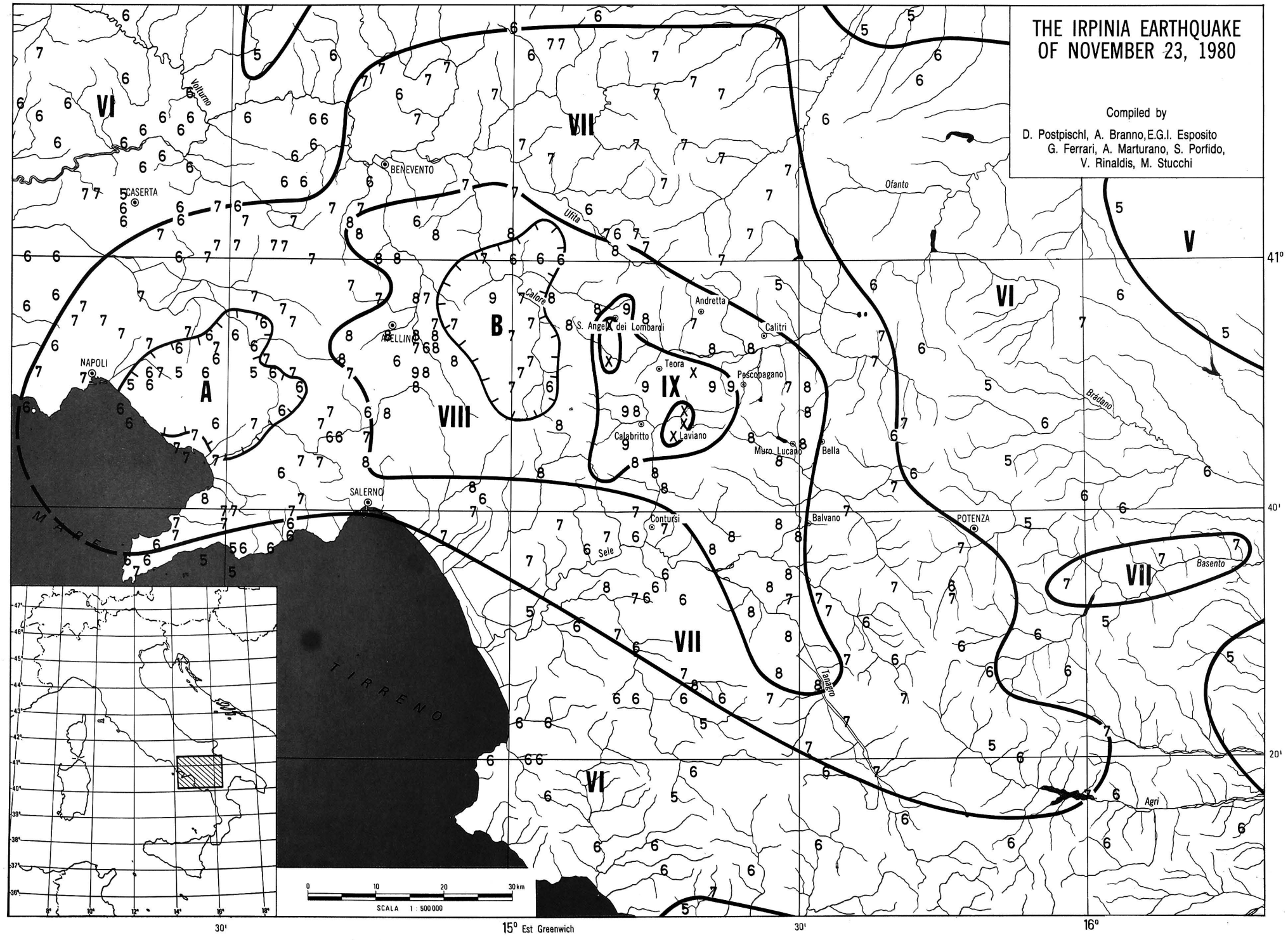

The drainage network of this map – scale 1:500.000 – is the same as the "Structural Model of Italy."

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APPENDIX

The Irpinia earthquake of October 11, 1125.

D. Molin

It appears that this earthquake principally hit the region between Benevento and Ariano Irpino. Numerous sources report it, but macroseismic information is very scarce. In fact, only two authors supply original information: chroniclers F. Beneventano (5) and P. Da Montesarchio (13). The former, an eye witness, describes what occurred in Benevento, while the latter reports on the severe damage in Bonito Irpino.
Pratically all of the successive authors consulted refer to the chronicle of F. Beneventano, often distorting the information given and exaggerating the damage. In particular, by taking advantage of the phrase, «other cities and castles belonging to the county of Benevento were damaged», very severe damage is attributed to localities in Irpinia and in the East Molise. Because of the existing uncertainty, these localities (Ariano Irpino, Cliternia, Larino, Abazia di San Giovanni in Venere, Ortona and Termoli) have not been included in the enclosed list of the territories hit by the earthquake.
The most probable date of the event, the night of October 11, 1125, was taken from the chronicle of F. Beneventano.
The seismic period according to Beneventano, lasted about 15 days, with three shocks occurring that same night a fourth one occurring the next day.
Evaluations of intensity can only be made for Bonito Irpino and Benevento, and even these evaluations are uncertain: IX-X MCS for Bonito Irpino, which was «almost completely razed to the ground», and VIII-IX MCS for Benevento, where the collapse of part of the town wall damaged some houses. It is also reported that Pope Honorius II, who was in Benevento at the time of the earthquake, went to pray in several of the churches and was followed by the entire population.
The epicenter, whose location is obviously very uncertain, might be placed in the zone of Bonito Irpino (41° 06' lat. N, 15° 00' long. E), where the greatest damage seems to have occurred. Isoseismal lines have not been drawn up yet due to the very limited data available.

List of shocked localities:

Locality	Latit.	Long.	I (MCS)
Benevento	41°08'	14°46'	VIII-IX
Bonito Irpino	41°06'	15°01'	IX-X

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The Arezzo earthquake of 1192.

M.C. Spadea, M. Vecchi, P. Gardellini, S. Del Mese

Isolated tremor.
Farulli(1) writes: «great earthquake in Tuscany. Most of Arezzo razed to the ground».
As can be seen, there are no bobliographic references to other localities so that no isoseismal map could be made.
Milne J. in: *A catalogue of destructive earthquakes, Londra 1889*, assigns an intensity of VIII and VIII-IX, while the *ENEL File of Italian Earthquakes from 1000 up to 1975* — Unpublished — 1977, gives IX.
With the degree of accuracy obtained our calculated I. agrees with both.

Year	Mo	Da	Ho	Mi	Lat	Long	I_o
1192	—	—	—	—	43°27'	11°53'	VIII-IX

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The Arezzo earthquake of 1298.

M.C Spadea, M. Vecchi, P. Gardellini, S. Del Mese

Seismic period.
The information gleaned from the authors (1, 2, 3) consulted is uncertain and contradictory.
Farulli (2), who is quoted by Baratta (1), claims that «in that year in Arezzo there was a great earthquake which threw down many buildings and caused many victims».
This is probably the earthquake referred to by Tolomeo Lucense (4), and quoted by Baratta (1), although dated as 1297, when he spoke of strong earthquakes in Tuscany which ruined many houses.
The great uncertainty and confusion of this information makes it hard to assign the epicentre or the epicentral intensity. It is thus virtually impossible to give geographic coordinates or intensity values or to map the macroseismic field.

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The Aquila earthquake of November 27, 1461.

M.C. Spadea, M. Vecchi, P. Gardellini, S. Del Mese

Seismic period.
From a detailed study of this earthquake based on data reported by various authors it was still not possible to map the macroseismic field.
The seismic period began with a foreshock on November 16 and characterized by two IX-X main shocks, the first at 21 hours on 27 and the second about two hours later.
Of the numerous aftershocks that occured until February, the largest took place on December 4 (I_o = VI), December 17 at about 24 hours, I_o = VII-VIII, January 3 1462 at 20.24 hours with I_o = VI, January 4 at 23.30 hours with I_o = VI, and two on March 27, one at about 03 hours and the other during the day. It has been possible to ascertain the day of the first two aftershocks mentioned above, while neither the time nor the intensity of the first or the second aftershock could be ascertained owing to the uncertain and confused data available.
On the other hand, it was mainly Baratta (3) who included among the cities affected by the great 1456 earthquake (Naples area) the other sites listed below, while in our evaluation these cities were also hit by the earthquake examined here.
We believe that the spatial and temporal vicinity of the two seismic events has given rise to confusion and inaccuracy in the historical chronicles.
Furthermore, some uncertainty exists in the case of sites lying such a distance away that it is difficult to decide which of the two affected areas to include them in. Such localities include Castel di Sangro, Pettorano, Caramanico, Carsoli and Corvara. Roccacinquemiglia, Roccaraso, Rocca Valle Oscura (= Roccapia?), Vasto, and Sulmona (localities in which the intensity ranges from VIII° to X°) were included by Baratta (3) in the 1456 (Naples area) earthquake.

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The Reggio Calabria earthquake of February 25, 1509.

A. Bottari, B. Federico, E. Lo Giudice, C. Pandolfo

Samperi (3) and Pacca (2) writing a few decades after the earthquake on February 25 give us the reports which are most contemporary to the event. Their documentation of its effects is limited to the area of Reggio and Messina only, and can be related to Magini's maps (1), which show a considerable density of inhabited zones for that period in the area of the Straits. This indicates that witnesses of the earthquake might be found in a reasonably extensive area. We suggest, therefore, that research into local bibliographical sources nearer in time to the event be carried out in order to obtain further information.

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The Friuli earthquake of March 26, 1511.

F. Gentile, M. Poropat, G. Renner, A.M. Riggio, D. Slejko, M. Zacchigna

Ample documentation is available for the earthquake of March 26, 1511: the shock is described in several published works and particularly in the contemporary chronicles and in some notarial deeds. The consistence of historical Friulan sources during the 15 and the 16 century leads us to believe that additional useful material could be found.
Ribaric (7) considers this phenomenon to have been a double event: the first hit Idrija, in Slovenia at 14 GMT with an intensity of X degrees MSK scale, while the second shook Gemona, in Friuli, at 19 GMT with an intensity of X-XI degrees MSK. Only the isoseismals of the joint effects are drawn, resulting in a large epicentral area (to ⩾ X MSK).
In the Friulan sources, no information about a quake in the early afternoon is reported. The middle Friuli, a thickly populated area, was strongly hit. The towns of Udine, Cividale, Gemona, Venzone and many fortifications suffered in the violence of the earthquake. In the urban centres, where during the 15th century masonry buildings had spread, numerous victims and severe damages were counted. A terrible rumble was heard during the shock and the ground shoock for about a «miserere».
People could rest in the squares and inside the houses of Udine, part of the patriarchal castle and many buildings ruined. The castles of Zucco, Faedis, Moruzzo, Villalta, Fagogna, Colloredo, Pers, Mels and Fontanabona were destroyed or suffered heavy damages and the Pinzano castle, on the right side of the Tagliamento river, cracked though it had resisted the 1348 eartquake.
According to Amaseo (3), tremors were felt till February 15, 1512. Twenty were strong but they did not cause additional damages.

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The Ferrara earthquake of November 24, 1561.

G. Ferrari, E. Guidoboni, D. Postpischl

This earthquake is classified with different values in the current catalogues: VIII MCS in the ENEL Catalogue, and IX MCS in the Carrozzo et al. Catalogue. The area hit by the strongest effects includes the city of Ferrara and its territory.
From the summary contained in the report by Baratta (the only source of information for both catalogues), the limited description of the effects is the cause of the different evaluations.
The discovery of new sources contemporary to the event, especially manuscript diaries written by citizens of Ferrara has allowed the exclusion of effects greater than VIII MCS. There is concordance among the testimonies regarding the collapse of numerous chimneys and a few houses in the city of Ferrara, which appears to be the only inhabited center hit by the earthquake.
The main shock occurred on the night of November 24, at about 1:00 a.m. GMT. Other shocks followed in December, causing the collapse of some vaults of one of the cathedral chapels. In particular, considerable shocks were felt on December 13 and 14, although they were less intense than the main one.
Following this event, which preceded the 1570-1574 seismic period of Ferrara by nine years, many buildings were reinforced with iron braces and chains.
The available information although precise, does not cover a sufficient number of localities to allow the drawing of an isoseismal map. However, the maximum intensity, not greater than VIII degrees MCS, can be associated with the effects on the city of Ferrara.
The following is a comparison of the values of some parameters, reported respectively in the ENEL and Carrozzo et al. Catalogues, and in the present study.

Year	Mo	Da	Ho	Mi	Lat	Long	De	I	Me	Mk	Mp	Epic. area
1561	11	24			44°50'	11°40'		VIII		5.2	5.4	Ferrara
1561	11	24			44°45'	11°30'		IX		6.0		
1561	11	24	01		44°50'	11°41'		< VIII				Ferrara

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The Corleone earthquake of April 24, 1593.

P. Cosentino, P. Fradella

The Corleone earthquake of April 24, 1593 has been described by modern authors (e.g. Baratta, 1936) (1) as an earthquake felt in all of Sicily, although serious damage occurred only in the village of Corleone and there were no deaths or injuries.
The briefness and vagueness of the descriptions as well as the improbable absence of deaths or injuries in an earthquake rated IX MCS (Giorgetti and Iaccarino, 1971 (3); ENEL, 1977) (2) are, at the least, suspiscious.
It has not been possible to retrieve any data about this earthquake from records of nearby villages. All available descriptions are contemporary with those given by Mongitore (4) in the «Cronological History of Sicilian Earthquakes», or even later, giving rise to the suspiscion of more or less transcribed information.
These descriptions report a shock striking all of Sicily, but they mention only the village of Corleone where vast damage was confined to one area (S. Nicolò). This damage caused by the «earth splitting» was the «ruining» of some houses and necessitated the moving of nuns from one convent to another. At the end of this report Mongitore (4) cites a cultured inhabitant of the town (Valerio Rosso Corleonese) (6) who described the event in detail. Unfortunately, in spite of numerous searches, the original manuscript by Corleonese has not been located. However, the event is described in *Various Notable Occurances in Palermo and Sicily from 1587 to 1601* by the same author. In this work the author does not make any mention of an earthquake, but does say that at dawn on April 24, 1593 the «soil split» under the area called S. Nicolò in Corleone causing damage to houses and churches. The mention of the temporary transfer of the nuns from one convent to another convent not menaced by the «splitting and mutation of the soil» is made. There is no mention of victims.
The analysis of the descriptions provides evidence on several points: unlike other earthquakes of that period, this earthquake was felt in all Sicily with no mention of any village other than Corleone and, in particular, with the damage limited to one small area of the village; the authors reporting the earthquake are either later than or contemporaries of Mongitore (4) who describes this event in his catalogue of earthquakes (1743), where he mentions Valerio Rosso Corleonese (6) who lived in the village of Corleone at that time. Corleonese mentions only the «splitting and mutation of the soil» in the area called S. Nicolò. Furthermore, the total absence of casualties, the described damage, the absence of news of the event in villages near Corleone, the absence of data about aftershocks and also the fact that the geomorphologic knowledge of the area suggests a tendency toward large slide movements, allows us to conclude that most likely the event described as the Corleone earthquake of 1593 was a large landslide involving the area called S. Nicolò. Nevertheless, the fact that a small shock served to trigger the land slide must be included, but in this case, this event cannot be classified as an earthquake of IX degree MCS.

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The Amatrice earthquake of October 8, 1639.

M.C. Spadea, M. Vecchi, P. Gardellini, S. Del Mese

The seismic period began at Amatrice on 8 October 1639 and lasted about 10 days (1 ÷ 7).
The exact beginning of the period was 24.00 hours on 7 October, with a V degree warning shock, and a further VI degree one at 00.15 hours. At 00.30 hours the main shock occurred with an intensiity of X.
In addition to Amatrice, numerous other localities were devastated, causing death, injury, collapse and ruin. The worst hit centres were: Campotosto, S. Martino, Collalto, Pinaco, Capricchia, Corva, Forcella, Filetta, Nescaia, Pedarga, Cantone, Colle Raso, Corsenito, Casale, La Rocca, Torretta, Pasciano, S. Jorio and Collemoresco, Accumoli (numerous deaths), Rocca di Salli, Poggio Cancello, and Montereale. The shock was felt and caused panic as far as Recanati and Rieti, although no damage was done.
Numerous aftershocks of intensity IV-VI occurred in the two hours that followed.
There was another violent VII degree shock at 00.30 hours on 14 October, which ruined other houses. On 17 October yet another strong event caused further damage to the buildings.
Owing to the lack of data concerning the epicentral zone it has not been possible to construct the macroseismic field.

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The Badolato earthquake of June 19, 1640.

A. Bottari, B. Federico, E. Lo Giudice, C. Pandolfo

We have an original contemporary source of information on this earthquake, Agatio di Somma, n. 3, to whom all the successive authors quoted in our bibliography (1, 2, 4, 5) refer.
Agatio gives information about the effects of the seism in the town of Badolato only. Here the earthquake of 19th June 1640 caused about 300 victims and the aftershock on the 22 June completed the destruction of the town and caused further casualties among the rescue teams. No information is given about the effect of the earthquake on the surrounding areas, so a complete and precise estimate of the event is impossible. In an effort to deduce these effects, a study had been made of the geographical maps of the period, in particular of the atlas «Italia» compiled by G.A. Magini in 1620 (4). From this it appears that in the area in question there was more intense urban concentration at that time than there is today. This suggests that research should be conducted on the spot to find out to what extent the evacuation and consequent extinction of these centres caused the present lack of information.
Another point to take into consideration is the difficulty in the transmission of information in this period. In fact, Di Somma (3) wrote about the earthquake of Badolato in Naples in 1641, while the other sources listed in the bibliography (1, 2, 4, 5) are of a much later date.
Since the data referring to the epicentre are rather vague, the degree of uncertainty is fairly high. The same may be said of the maximum intensity.
That the earthquake was a violent one is proved by both the number of victims and the destruction it caused, as well as the fact that Mt. Corvo was split in two (1, 5).
There are reports of an unspecified number of aftershocks which lasted until 12.August of the same year.

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The Terra di Lavoro earthquake of July 23, 1654.

M.C. Spadea, M. Vecchi, P. Gardellini, S. Del Mese

Despite the numerous bibliographic sources available (1-6) for macroseismic data, conflicting observations have been recorded for towns that should be at the epicentre or in the epicentral zone.
The reports written by the various authors do not appear to be in good agreement. Although the earthquake affected a wide area, it has not been possible to evaluate the intensity data in such a way as to make a homogeneous and regular plot of the isoseisms.

The Atella (Basilicata) earthquake of September 8, 1654.

D. Molin

This event, classified in some national seismic catalogues with an intensity of IX degrees MCS, probably never occurred.
The reports given in the works of M. Baratta (2), M.T. Carrozzo et al. (3), F. Giorgetti - E. Iaccarino (5) and E.N.E.L. (4) are derive from information supplied by A. Amati (1), according to whom, «On September 8, 1654, Atella was so severly hit by the earthquake that it was destroyed».
Such information, incorrect because of a probable stamping error, refers instead to the earthquake that occurred on September 8, 1694, which in fact did almost destroy Atella.
In order to confirm what has been stated, both national and local seismic catalogues and historical-chronicle sources regarding the zone of Atella were consulted: none of the sources report an earthquake on September 8, 1654, while all of them report on event occurring on September 8, 1694.

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The Modena earthquake of June 20, 1671.

G. Ferrari, E. Manenti, D. Postpischl

Significant information was found for this earthquake referring to the two principal cities hit, the cities of Modena and Reggio Emilia, while, as it is often the case, it was difficult to find information regarding minor centers and the countryside. No verification to this regard could be found in the sources of Sassuolo, Castelvetro and Maranello to ascertain if the area hit could resemble the area indicated for the June 5, 1501 earthquake.
For the city of Modena, various archival documents were located which provide direct and precise evidence of the damage caused by the shock that occurred on the morning of June 20, 1671, and of the measures of restoration carried out the same year and during the following one. The Libro Dei Conservatori della Comunità di Modena (Administration Book of the Comunity of Modena), on June 20, 1671, presents an official report of the «Gran Terremoto» («Great Earthquake»). It includes a description of the most severe damage, where the bell and the small marble tower fell through the roof of the Palazzo della Regione, killing one notary public and injuring another person; pieces of a battlement, which fell from the same palace, caused the death of two people; and a woman was killed when the marble angel located above the facade of the Duomo fell. The same source gives also a general account of the various injuries suffered and the great deal of damage in the city. Judging from the compensation requests presented by the citizens of Modena, it would appear that the damage particulary concerned the collapse of chimneys and cornices.
The public authorities carried out a series of operations, which led, among other things, to the demolition of the tower called «*la mozza*», which, previously damaged by the 1501 earthquake, according to various surveys, manifested a dangerous slant (from 1 m to 1.20 m, depending on the source). In addition, the decision was made to demolish some merlons of the Palazzo della Regione and to restore what was damaged. Detailed information supplied by another survey makes reference to the damage done to the Torre di Sant'Ambro, outside the city.
With regard to Reggio Emilia, all the chronicled sources utilized give a representation of damage similar to that already described for Modena. In fact, in Reggio a large number of chimneys, «pieces» of towers, and some church vaults collapsed.
The delibere del Consiglio (the Council deliberations) provide no information in that period of time regarding the shocks, nor are there any signs of provisions while, amongst the enclosed documents, an expense bill was found for wood utilized to repair the «castello» (mount) of the bells of the clock.
As chronicler Carletti reports, the earthquake in Modena was «worse» than the one in Reggio Emilia because of the number of deaths it caused.
The description of even greater damage in Reggio Emilia, accepted by Baratta in his Appendix, was rejected by us due to a series of gaps and uncertainties in the original source. We believe that this fact does not exclude the possibility that the given data refer to another event or that they are the result of erroneous information. For example, this source mentions three significant shocks, while all the sources of Modena and Reggio agree on only one.
No direct evidence of the effects of the earthquake was found for the territories surrunding the two cities, exept for Nonantola (10 Km E-NE from Modena), where the shock damaged the chimney of a public building.
On the basis of these considerations, an intensity of VII MCS can be attributed to Modena and Reggio Emilia, and VI-VII MCS to the locality of Nonantola.
This earthquake seems to have been to some extent similar to the one that occurred on June 5, 1501, even though the contemporary sources of Castelvetro, Maranello and Sassuolo make no reference to this possibility.
Likewise, the event was not registered in the sources relating to Carpi (MO), Correggio (RE), Guastalla (RE), Parma, Piacenza or Bologna.
Summing up, the following is a comparison of the values of some parametres, reported respectively in the ENEL and Carrozzo et al. Catalogues, and in the present study.

Year	Mo	Da	Ho	Mi	Lat	Long	De	I	Me	Mk	Mp	Epic. area
1671	06	20	14	00	44°40'	10°50'		VIII-IX		5.5	5.7	Soliera
1671	06	20	09	15	44°30'	11°00'		VIII		5		
1671	06	20			44°40'	10°50'		VII		4.7		Soliera

List of shocked localities

Locality	Latit.	Long.	I (MCS)
Bologna	44°30'	11°20'	NF
Brescello	44°54'	10°31'	NF
Carpi	44°47'	10°53'	VI-VII
Fidenza	44°52'	10°04'	NF
Gualtieri	44°54'	10°38'	NF
Guastalla	44°55'	10°39'	NF
Modena	44°39'	10°56'	VII
Nonantola	44°41'	11°02'	V-VI
Parma	44°48'	10°20'	NF
Piacenza	45°03'	09°42'	NF
Reggio Emilia	44°42'	10°38'	VII
Verona	45°26'	11°00'	NF
Villafranca	44°50'	11°04'	NF

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The Travale earthquake of December 1724.

M.C. Spadea, M. Vecchi, P. Gardellini, S. Del Mese

In his «Relazione del terremoto accaduto in Siena il dì 26 maggio 1798» (Report on the earthquake occurring in Siena on 26 May 1798), second letter, Soldani (3) writes:
«The earthquake that occurred in this province towards the end of December 1724 is famous and was communicated to Siena on the opposite side towards the southwest. A description of it is contained in a manuscript possessed by the Nobil Uomo Cav. Perfetti in the following exact terms: «*At about 20.00 hours* (i.e. one hour after noon, which would correspond to the time of our hearty shock) *there was felt in Siena a terrible Earthquake which caused some small damage in the City, such as the fall of a few chimney pots, and the cracking of a few walls, particularly in the Convent of the Barefoot Carmelite Monks: it was later learnt that it had done great damage in the D'Elci county, with the ruin of Churches and Dwellings; that is, in Monte Ingegnoli, Fosini, and much more in Travale, where twenty-six houses collapsed, Pieve, a Company and the few other factories were badly damaged, and by the grace of God no one perished*».
After consulting Soldani, Baratta (1) dates the Travale earthquake as 11 December 1724.
In his book «Della probabile origine dei terremoti ecc.» (On the probable origin of earthquakes, etc.), Fondelli (2), again quoting Soldani, dates the earthquake as 20 December 1724.
In our opinion both have misinterpreted the date of the event. Because there is only one source and very few macroseismic data, it was not possible to plot the isoseisms.

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The Palermo earthquake of September 16, 1726.

P. Cosentino, P. Fradella

Though amply reported both by authors of the period and more modern ones, this event is not very clear.
The descriptions, in fact, refer to more or less emotional aspects of human and religious compassion.
In spite of the number of available reports, the main doubts concern the determination of the epicentral area.
The main shock, which was preceded by a feeble tremor, was felt on September 1, 1726 in all of Western Sicily and in particular in a radius of 60 miles from Palermo including Mazara and Marsala; in Trapani it caused little damage. Palermo suffered the most damage, especially in those areas built on sands, clays and alluvia.
At least four shock waves followed immediately, giving rise to yet more damage. Some phenomena which can be related to a small tsunami were observed.
Among the 120,000 inhabitants of Palermo there were 226 deaths and 138 who sustained injuries.
These reports and other observations suggest the localization of the epicenter in the immediate vicinity of Palermo.
However, the entire picture of this event is confused because of its seismic period, the climax of which continued for about two months.
Another shock occurred on September 16 and a strong aftershock felt on September 26, 1726 caused damage in Trapani where some buildings were «ruined». The internal zone of western Sicily suffered damage due mostly to the effects of this shock. Thus a shifting of the epicenter to an area between Palermo and Trapani can be assumed.
A series of aftershocks was felt in Palermo on October 16 and 19; a stronger shock struck Palermo on October 20, 1726 causing serious damage in the seismic zone of the Madonie chain especially in the villages of Isnello, Gratteri, Tusa, Cefalù, Geraci and Calatabiano.
These scattered pieces of information, as well as the lack of data concerning the minor villages of the area, give rise to various assumptions about the location of the epicenter. In fact, it can be assumed that either a focus migration or a series of events in different areas (in the Tyrrhenian sea close to Palermo, in an internal area of western Sicily near Trapani and in the seismic area of the Madonie chain near the above mentioned villages) occurred.
With respect to the main event of September 1, 1726, the available data seem to confirm the intensity estimate of IX MCS in the epicentral area with a slight correction of the time from 21^h05^m to 20^h55^m GMT.

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The Ponza earthquake of September 1, 1755.

M.C. Spadea, M. Vecchi, P. Gardellini, S. Del Mese

W. Hamilton (4), quoted by Baratta (2) and Mercalli (6), although the only existing source, is not original himself, as he quotes information he received from the governor of the island of Ponza. Here is what he wrote:
«The governor of the castle of Ponza, who has resided there fifty-three years, told me that the island was still subject to earthquakes; that there had been one violent shock there about four years ago; but the most violent one he ever felt was on the very day and hour of the great earthquake which destroyed Lisbon; that two houses out of three, which were then on the island were thrown down. This seems to prove, that the volcanic matter which gave birth to these islands, is not exhausted».
From available bibliographic references to the Lisbon earthquake, it is known to have been felt slightly at: Napoli (E. Capocci) (3); Lodi, where the canopy over the Main Altar and the suspended lamps moved (G. Agnelli) (1); Abbiategrasso, where doors and windows rattled (A. Perrey) (7); Nice; San Remo; Turin; and Milan, where a slight shock was felt (G. Mercalli) (5).
Mercalli also pointed out that, even though the shock was felt in several places in northern Italy, it is inconceivable that it should have shaken the island of Ponza so severely.
We agree entirely with this hypothesis; it is absurd to claim that a shock which caused such great damage on Ponza (collapse of 2 houses out of 3) was not felt on the Italian coast facing the island.
The are no bibliographic references to earthquakes on the same day as that of Lisbon or others affecting neighbouring areas as well as Ponza.
Consequently, the information given by Hamilton does not allow the macroseismic field to be characterized (i.e. intensity, geographic coordinates, etc.), nor do we feel that it is legitimate to call this event the «Ponza earthquake».
Furthermore, the distinguished historian of the Ponza archipelago, G. Tricoli (8), makes no reference in his monography to any seismic events on the island of Ponza.
Mercalli postulates that this does not mean there were no earthquakes, only that if there were, they were comparatively insignificant.
In fact, from the early 16th century until the mid 18th century there are virtually no historical references to Ponza. During this period the islands of the archipelago were almost completely uninhabited and were used for shelter and supplies by the pirates then infesting the Tyrrhenian Sea.

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The Poggio Picense earthquake of October 6, 1762.

M.C. Spadea, M. Vecchi, P. Gardellini, S. Del Mese

In the absence of evidence of any warning tremors or aftershocks, this has been assumed to be an isolated event.
Available bibliographic sources (1, 2, 4, 5, 6) refer to Poggio Picense where only 73 houses were left standing, some in precarious conditions. Ten years after the earthquake the ruins of 58 houses belonging to churchmen or foreigners still remained. Part of the population was forced to live in caves or ruined houses with makeshift roofs (P. Rustici, quoted by Morelli).
There are references to L'Aquila where a number of chimneys collapsed, as well as the main altars of two churches. The tremor was felt faintly in Rome (Malvasia - De Rossi (3)).
Because of the lack of data it was not possible to plot the macroseismic field.

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The Santa Sofia earthquake of October 19, 1768.

G. Ferrari, E. Guidoboni, D. Postpischl

This earthquake is classified with different values in the current catalogues: IX MCS in the ENEL Catalogue and IX-X MCS in the Carrozzo et al. Catalogues. The area hit was approximately the same one hit by the earthquake of March 22, 1661 (in this issue).
By comparing the sources utilized by Baratta to the known manuscript testimonies, the damage in S. Sofia, the hardest hit locality, can be evaluated as VIII MCS.
Although effects greater than IX MCS can be excluded, a complete and detailed description of the effects must still be defined, and could lead to a more severe estimate of maximum intensity.
Summing up, the following is a comparison of the values of some parameters, reported respectively in the ENEL and Carrozzo et al. Catalogues, and in the present study.

Year	Mo	Da	Ho	Mi	Lat	Long	De	I	Me	Mk	Mp	Epic. area
1768	10	19	23	00	43°55'	11°50'	7	IX		5.6	5.4	S. Sofia
1768	10	19	23	00	43°57'	11°54'		IX-X		5.0		
1768	10	19	23	00	43°55'	11°50'		≤IX		5.6		S. Sofia

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The Lagonegro earthquake of November 20, 1836.

M.C. Spadea, M. Vecchi, P. Gardellini, S. Del Mese

Available bibliographic sources indicate Lagonegro (5,000 inhabitants) as the worst hit township (1÷4).
A contemporary, Achille Antonio Rossi (4), relates that many houses in Lagonegro collapsed and all the others were damaged. Ten persons were killed and 40 injured.
The surrounding countryside was devastated by landslides and partial slips.
Other towns and villages in which houses were damaged or partially collapsed were: Nemoli, Rivello, Trecchina, Latronico, Castelfranco, Carbone, Chiaramente, Montenuovo, Corleto, Tramutola, Casalnuovo and Montesano, all of which lay inside the area of maximum effect.
Baratta (1) reports that the shock was felt distinctly in Napoli.
There is no mention in the bibliography of any warning shocks, although reference is made to very violent atmospheric phenomena (rain, wind) occurring some days prior to the earthquake. Twenty-six aftershocks are reported on the same day as the quake and others on 2nd December, although no mention is made of their intensity.
There is some uncertainty as to when the seismic period ceased, even though further tremors were felt after 2nd December.
It has not been possible to define any macroseismic field for this earthquake. The available data refer to Lagonegro, to which an evaluation ranging from I to IX has been assigned, and to a dozen villages in the vicinity, which have been assigned an intensity of I to VIII.

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The Bella (Basilicata) earthquake of August 6, 1858.

G. Magri, D. Molin

This event is reported in various seismic catalogues (1-8). In the E.N.E.L. Catalogue (5), a macroseismic intensity of IX degrees MSK was attributed to it, while in the more recently published catalogue (6) it was classified with an intensity of V degrees MCS.
The noteworthy difference of evaluation is probably due to the different interpretations by all the authors of the report that on August 6, 1858, an earthquake hit Bella with an intensity equal to the first shock that occurred there on December 16, 1857.
In the E.N.E.L. Catalogue, the epicentral intensity of the first shock of December 16, 1857 was evidently attributed to the August 6th shock, while we believe that the intensity that should be attributed to it ***.

On December 16, 1857, two destructive shocks separated by a three-minute pause hit Basilicata with epicentral intensities respectively IX and X degrees (5).
The only original report concerning the shock in Bella is supplied by F. Del Giudice (4) a contemporary author who, in the list of earthquakes occurring in the Kingdom of The Two Sicilies in 1858, reports: «August 6, 11:30 a.m. - Bella -lasting 3 second - innocuous - sussultatory movement from south to north. Its intensity was compared to that of the first shock occurring on December 16, 1857».
There is no direct information regarding the intensity of the first shock that occurred in Bella on December 16, 1857. However, a macroseismic intensity of V degrees MCS can be attributed to the shock occurring of August 6, 1858 at about 11:30 a.m., since according to F. Del Giudice, it was «innocuous» in that it did not cause any damage and lasted only three seconds.

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The Stromboli earthquake of May 22, 1941.

A. Bottari, B. Federico, E. Lo Giudice, C. Pandolfo

The earthquake on May 22, was the cause of extensive damages only in the central quarter of S. Vincenzo in Stromboli; three slightly wounded men were reported. The features, peculiar of the VIII degree, are limited center of the village; on the contrary, for the rest, no damages are reported. Since the event was not perceived elsewhere in Calabria or in Sicily, the focus is thought to have been very superficial. This agrees with the instrumental determination of De Panfilis, who locates the epicentre in Stromboli and estimates the depth h < 5 Km. The same author reports an aftershock of III degree at 10^h35^m of the same day. The references, composed of macroseismic cards and of the I.N.G. (Istituto Nazionale di Geofisica) internal report by De Panfilis, are in partial disagreement. In fact, whereas the compiler of the cards concerning Stromboli attributes an intensity of VIII-IX degree, De Panfilis attributes to the same event a VII-VIII degree. A letter from the Director of the Messina Geophysical Institute to the Royal Central Institute of Meteorology and Geophysics refers to the seismic recording in Messina, attributing a V-VI Mercalli intensity to the earthquake without giving information of seismic perception. In contrast, in the report of De Panfilis, the seismic perception is limited to Messina only.

List of shocked localities:

Calabria	
Polistena	NF
Trenta	NF
Stignano	NF
Sicilia	
Milazzo	NF
Patti	NF
Stromboli, San Vincenzo	VIII
Messina	NF

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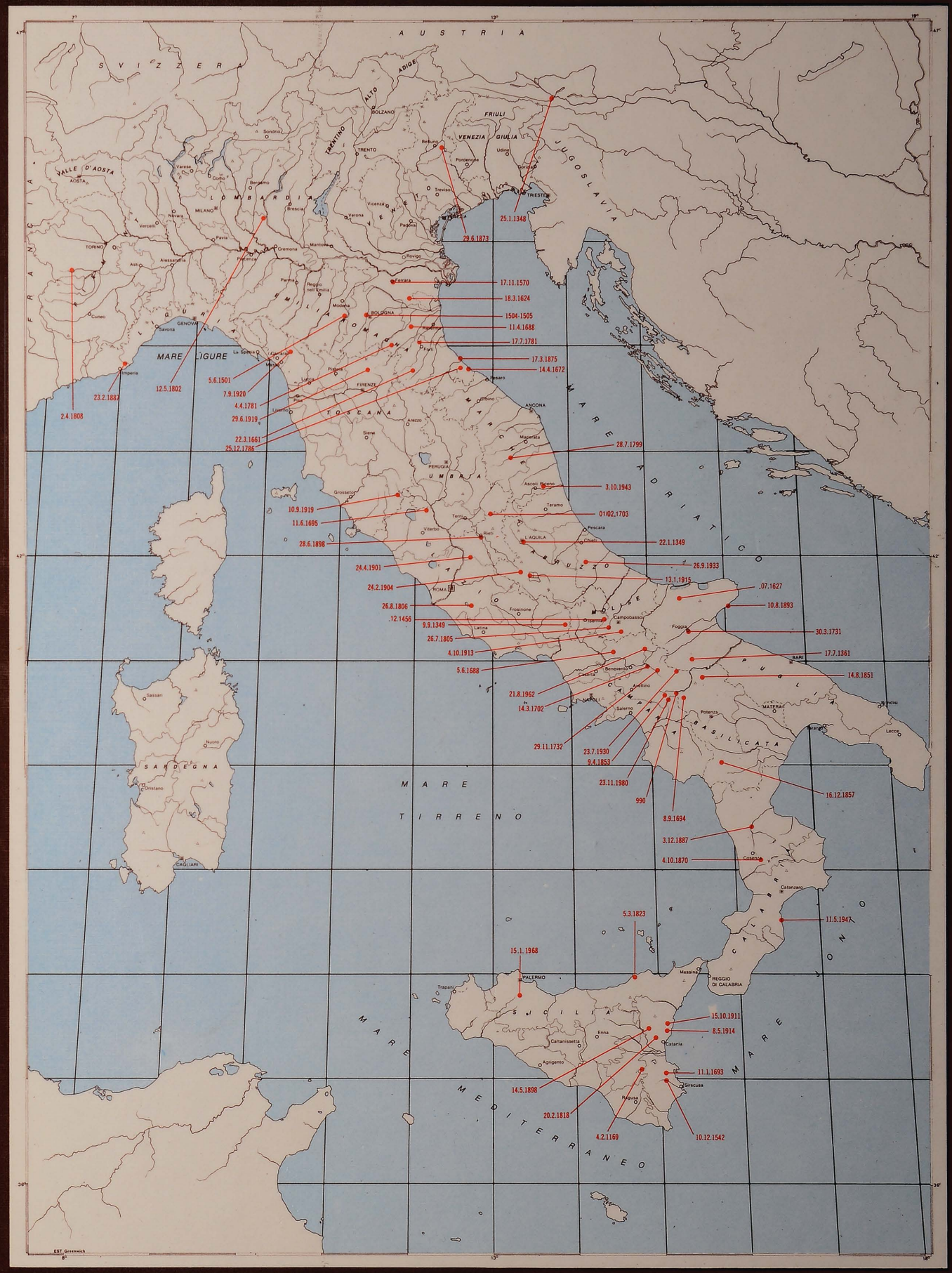
The atlas collects the isoseismal maps of 61 Italian earthquakes located, as shown in this map.



QUADERNI DE «LA RICERCA SCIENTIFICA» N. 114 - VOL. 2A

ISBN (ed. digitale) 978 88 8080 736 0