NEtwork of Research Infrastructures for European Seismology

Deliverable D6
The Comprehensive NA4 Working File 1000-1750

(June 2009)

D6 incorporates and expands D1,
the Comprehensive NA4 Working File 1000-1600

Activity:	Distributed Archive of Historical Earthquake Data
Activity number:	NA4, Task 1
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Sixth Framework Programme
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Note. The NA4 WF is accessible on the NA4 website

http://emidius.mi.ingv.it/neries_NA4/

partner login (user and password to be delivered by the NA4 coordination unit)

D1+D6

1. Introduction

1.1. NA4 and the European Parametric Earthquake Catalogue. One of the most popular tool for seismic hazard assessment is the parametric earthquake catalogue, that is, a list of earthquake parameters - such as time of occurrence, location, magnitude, depth, etc. - that can be used as input for current computer codes. While in the case of instrumentally recorded events the parameters are determined from waveforms, in the case of historical events such parameters are determined either from intensity datapoints or from the effects accounts, in this case according to mostly unreported procedures. Each national or regional earthquake catalogue adopts individual procedures; this is why merging national catalogues into a comprehensive one may be a dangerous and misleading procedure.

One of the goals of the NA4 module is to compile a homogeneous European Parametric Earthquake Catalogue to serve as a tool for understanding the long-term seismicity and a reliable input for seismic hazard assessment.
NA4 intends to avoid current procedures which consist of making corrections to parametric catalogues without consulting the supporting primary data and without following standard and well reported procedures. On the opposite, NA4 intends to re-assess the earthquake parameters according to homogeneous methods from the best possible supporting datasets.

The compilation of a homogeneous European Parametric Earthquake Catalogue is being accomplished in NA4 by first retrieving, evaluating and improving the supporting primary data and then assessing a new set of parameters for as many earthquakes as possible, according to uniform procedures.

1.2. Value of the background information. The access to the information upon which the earthquake parameters of a catalogue are derived is one of the keys for checking their reliability; the second one is the procedure used for deriving them. It is widely known that catalogues of the last part of the 20th century were often compiled in a hurry, on the basis of uncritical earthquake compilations. Starting from the 80's some national institutions and individual investigators started revising the background and went further in search of primary historical sources. This happened in a non homogeneous way throughout Europe, depending on the available resources and the expertise of the investigators. Although most of the results contributed to the current parametric catalogues, some of them remained unexploited. In other regions, the situation did not make substantial progress; the background is not known or it is limited to previous parametric catalogues, the background of which is unknown. This is mostly the case of the Balkans, where a pioneer project lead to an advanced catalogue for that time (Shebalin et al., 1974) well before most of the other European countries; unfortunately, the progress of the historical investigation was sporadic afterwards, and the most recent catalogues are still based on it.

In the following boxes some examples are shown the value of the background information of parametric catalogues and their reliability.

The 13 February 1196 earthquake, located in Vrancea (Romania)

This earthquake is located in Vrancea by all the current catalogues (Costantinescu and Marza, 1980; Kondorskaya and Shebalin, 1982; Oncescu et al., 1999)

Year	MoDaHoMi	Ct	Et	Ax	Nmdp	Ix	Root	RL	CP	Lat	Lon	Io	M		FN	Rn	P
1196	02 1307						Kondorskaya & S., 1982	31	COMA980	45.700	26.600	9	7.30		11010	010	
1196	02 1307			Vrancea deep			Kondorskaya & S., 1982	31	KOSH982	45.700	26.600	8	7.00		11010	020	pl
1196	02 1307						Oncescu et al., 1999	32	ONAL999	45.700	26.600	9	7.50		11010	040	

Figure 1. Records pertaining to the 13 February 1196 earthquake.

The investigation performed by Tatevossian and Albini (2009, submitted), showed that the catalogue by Kondorskaya & Shebalin (1982) relies upon one observation only from Kiev. The primary source is the *Voskresenskaya* Chronicle, a pan-Russian chronicle of the 13th century; the account for the year 6704/1196 reports the earthquake in connection with the latest news on the political allegiances and contrasts in the lands near Kiev:
"The same winter during Great Lent [...] and that time **on Tuesday second week of Lent, exactly during liturgy, earth trembled all over Kiev land; in Kiev itself churches masonry and wooden shook and all the people could not stand on their feet from fear, and afraid fell face down.**" (*Voskresenskaya* chronicle, Kloss ed., 2001).
The information on this earthquake is confirmed by *Ipatevskaya* chronicle (Kloss ed., 1998), so the date is confirmed. However, the date 13 February as in the catalogue by Kondorskaya & Shebalin (1982) should be corrected. In 6704 (March dating) Easter was on the 21st of April. Counting back from Easter, "Tuesday of the second week of the Great Lent" corresponds to Tuesday 12 March 1196. The earthquake was widely felt, all over the land of Kiev (Fig. 2); it was frightening but no damage was reported either to masonry or to wooden constructions. The earthquake is located in Vrancea by the compilers on the basis of considerations widely in use for the events felt in the Russian plane.

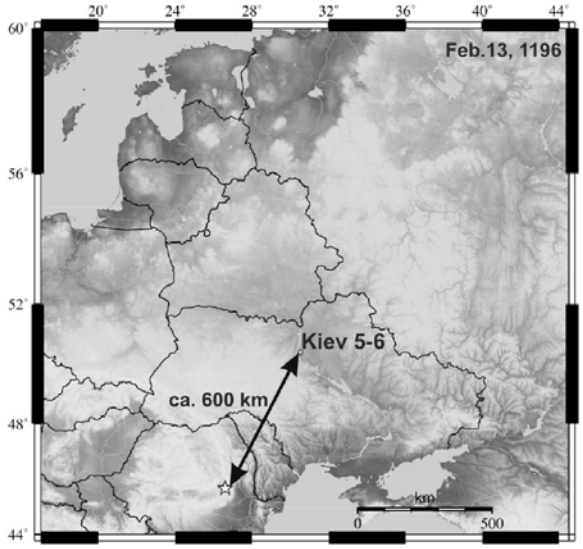

Figure 2. Vrancea (star) and the unique macroseismic information available for the 1196 earthquake.

References

Costantinescu L. and Marza V.I., 1980. A computer-compiled and computer-oriented catalog of Romania's earthquakes during a millennium (984-1979). Revue Roumanie de Geologie Geophysique et Geographie. Ser. Geophysique, v. 24, 171-191.

Ipatevskaya chronicle. In: Kloss B.M. (ed), 1998. PSRL (in Russian). Yazyki Russkoy Kul'tury, II, Moscow.

Kondorskaya N.V. and Shebalin N.V. (eds.), 1982. New Catalogue of strong earthquakes in the USSR from Ancient Times through 1975. 2nd edition, Boulder (Colorado), 608 pp. (1st edition, 1977, Moscow, 536 pp., in Russian).

Oncescu M.C., Marza V.I., Rizescu M. and Popa M., 1999. The Romanian earthquake catalogue between 984-1997. In: F. Wenzel and D. Lungu (eds), Contributions from the First International Workshop on Vrancea Earthquakes, Bucharest, Romania, November 1-4, 1997, Kluwer Academic Publishers, 43-48.

Tatevossian R. and Albini P., 2009. Information background of 11th to 15th centuries earthquakes located by the current catalogues in Vrancea (Romania). *Submitted*.

Voskresenskaya chronicle. In: Kloss B.M. (ed), 2001. PSRL (in Russian). Yazyki Russkoy Kul'tury, VII, Moscow.

The 17 January 1332 earthquake, Istanbul

Year	MoDaHo	Mi	Ct	Et	Ax	Nmdp	Ix	Root	RL	CP	Lat	Lon	Io	M		FN	Rn	P
1332	01 17				Costantinople			Papazachos & P., 2003	14	PAPA003	40.800	28.900	(8)	6.80		13430	040	
1332	01 17	18			45	Istanbul TR		Guidoboni & Com., 2005	11							13430	050	pl

Figure 1. Records pertaining to the 1332 earthquake.

As it can be seen in the excerpt of the NA4 Working File (Figure 1), there are two different published studies available that locate the 17 January 1332 earthquake in the same area (Figure 2).

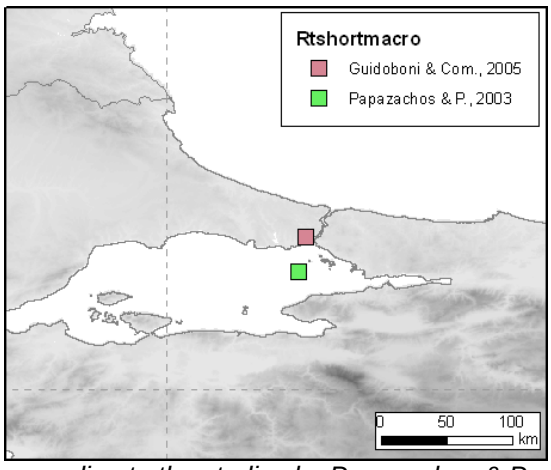

Figure 2. Epicentres according to the studies by Papazachos & Papazachou (2003) and Guidoboni & Comastri (2005).

What strongly differentiate these two studies is the assessment of the size of this earthquake:

i) Papazachos & Papazachou (2003) assessed an epicentral intensity of 8 MSK

ii) Guidoboni & Comastri (2005) assessed an "F" (felt) only at Istanbul.

The following analysis tries to check upon the origin of so different an evaluation, with the aim of understanding if the contradiction might be solved.

The scheme of relationships among the different studies and the sources coeval to the earthquake is shown in Fig. 3.

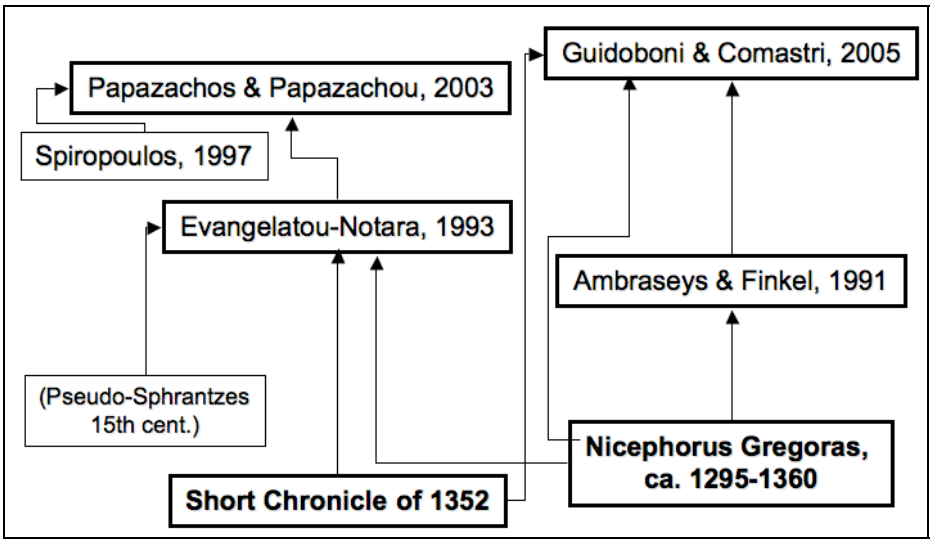

Figure 3. Scheme of relationships among studies and their sources.

What is worth to observe is that both the studies included in NA4 Working File, as well as two more independent studies such as Evangelatou-Notara (1993) and Ambraseys & Finkel (1991), relied upon the same primary, coeval to the event, sources of information: Nicephorus Gregoras and the so called Short Chronicle of 1352. Let's look at their content.

The Short Chronicle reported that "On 17 January, 15th indiction, third hour of the night, there was a great earthquake […]" (text in the translation by Guidoboni & Comastri, 2005). Gregoras wrote that "there was an earthquake in the evening when Christians celebrate the annual feast of his [Emperor Andronicus II Paleologus] namesake Antonius" (text in the translation by Guidoboni & Comastri, 2005). Then he went on recording on 12 February "violent thunderstorms and heavy seas which caused serious damage to buildings and the sea walls" (text in the summary given by Ambraseys & Finkel, 1991). According to Ambraseys & Finkel (1991), "the shock itself caused no damage".

Thus we concluded that:

i) there has been a misinterpretation of the primary sources as to what the actual effects of the earthquake of 17 January 1332 were, mainly because they were mixed up with the effects of the thunderstorms of 12 February

ii) the only way to discriminate about two different, though recent and good-quality studies is to go back to their informative background and compare the original records.

References

Ambraseys N.N. and Finkel C., 1991. Long-term seismicity of Istanbul and of the Marmara Sea region. Terra Nova, 3, 5, 527-539.

Evangelatou-Notara F., 1993. Seismoi sto Bizantio apo ton 13° mechri kai ton 15° aiona. Istoriki exetasi. Athens, 183 pp.

Gregoras N., 14th cent. Byzantina Historia. Corpus scriptorum Historiae Byzantinae, 3 vols.

Guidoboni E. and Comastri A., 2005. Catalogue of earthquakes and tsunamis in the Mediterranean area from the 11th to the 15th century. INGV-SGA, Bologna, 1037 pp.

Papazachos B.C. and Papazachou C., 2003. The earthquakes of Greece. Ziti Publ. Co., Thessaloniki, Greece, 286 pp. (in Greek).

Short Chronicle of 1352, 14th cent. Schreiner P. (ed.), 1977. Die bysantinischen Kleinchroniken, 2 vols, Vienna.

Spiropoulos, I.P., 1997. Chroniko ton seismon tis Ellados. Ekdoseis "Dodoni", Athina-Iannina, 454 pp. (in Greek).

2. The comprehensive NA4 Working File (1000-1750)

2.1. Definition, area and size threshold. The comprehensive NA4 WF is the critical, annotated inventory of European earthquakes and their supporting datasets (from now on, roots: for a better understanding see section 2.2).
The inventory mostly concerns damaging earthquakes (approximately, Io>5, M>4.5), and covers the territories belonging to EU and neighbouring areas, approximately comprised between 13°W to 31°E of longitude and from 35°N to 65°N of latitude (Figure 1).

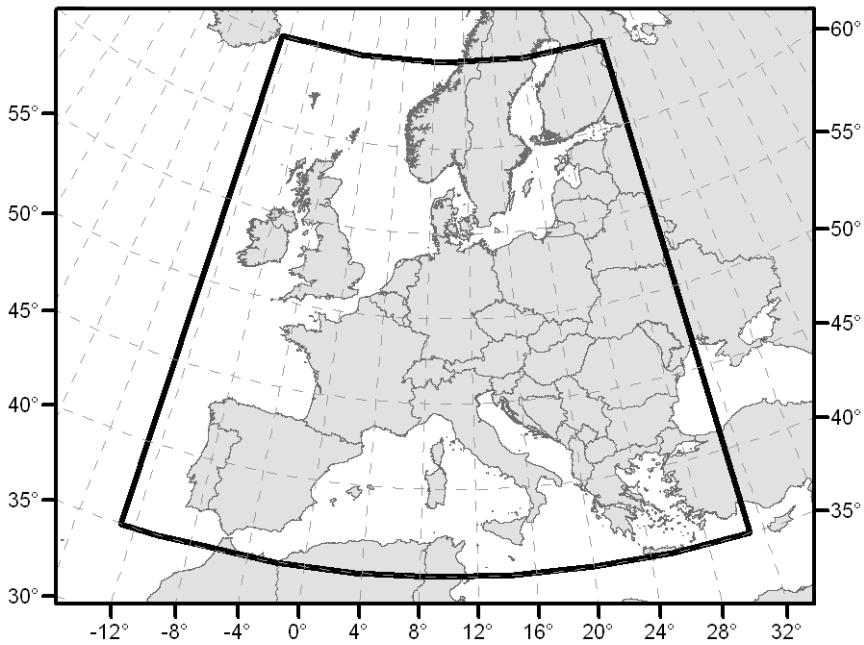

Figure 1. Area approximately covered *by the NA4 Working File.*

2.2. The inventoried material. The historical investigation of an earthquake is usually performed dealing with a number of **historical sources**: the investigator summarizes the information gathered from the **historical sources** in a report in which he/she provides an overview of the investigation and the effect distribution. The historical sources are then quoted at the end of the study as **references**. The output of the investigation, compiled in the view of a seismological use, can assume the form of a report, a study, a map or a list of intensity data points, etc.. This is what we call a **root.**

The scope of the NA4 Working File is to collect and put together the most significant, or at least the most recent, roots supporting the inventoried earthquakes, in order to preserve and make their multiplicity available. The roots inventoried in the NA4 Working File have been retrieved: i) from the recent literature; ii) from the current - and in some case older - parametric catalogues; iii) from the online macroseismic databases, such as ECOS (2002), SisFrance (2009), DBMI (Stucchi et al., 2007).
For a small percentage of earthquakes the root is nothing else than a parametric catalogue itself, without any possibility of tracking the relevant, supporting background.
Each root has been classified according to a two-digit code that represents both its type and quality, according to Table 1.

Table 1. Root classification (RL) according to their type and quality.

Definition	Level
1. Studies with Macroseismic Data Points:	
MDPs + text + references	11
MDPs + references	12
MDPs only	13
text + references + unpublished MDPs	14
2. Studies without usable MDPs:	
Recent (from 1980 on)	21
Old (before 1980)	22
Material	23
3. Parametric Earthquake Catalogues:	
with references	31
without references or not available	32

The roots in full (texts of the studies) have been linked from their original web pages or stored in a dedicated archive accessible through a website (Deliverable 2). The inventory of the roots is not frozen; it is permanently updated according to new findings, releases, etc.

2.3. Compiling the WF

For each root an entry is compiled inserting time, area of larges effects (Ax), number of datapoints and maximum intensity (when available), and root in the fields here described:

Time	original time, as provided by the root (year, month, day, hour, minute)
CT	comment to time, in case the time of the event provided by the root
Et	entry type; used for assessing fake, very doubtful, uncertain or doubtful earthquakes
Ax	area of maximum effects; same wording as provided by the root
Nmdp	number of macroseismic data-points (MDPs), when the root provides them.
Ix	maximum intensity, when the root provides MDPs
Root	short citation of the root
RL	root level (Table 1)

An example of the compilation of some entries of the Working File starting from the raw material is given in Appendix 1. The entries are compiled by the partners and then homogenised and checked by the coordinating unit.

Different roots may refer to the same event; they can provide a set of coinciding or conflicting information. Records coming from different roots but referring to the same earthquake are grouped and the same event identifier, also called “family number” (FN), is given to all of them. Each entry carries a unique identifier composed by the family number and a record number (Rn) which allows one to sort the roots from the oldest to the most recently published one.

As a rule, the grouping of the roots into a family is performed case by case by expert judgment, examining and comparing the content of each root, with special reference to earthquake date, location and size. Automatic clustering, performed on the basis of time and location, may lead to big mistakes, with special reference to medieval times - but not only.

Figure 2 shows the grouping of five roots, all referring in a clear way to the same earthquake, as visible from the identical times and similar areas; also the maximum intensities (Ix) are comparable. In such cases this the family is easily assessed and, therefore, the four records are given the same family number.

Year	Mo	Da	Ho	Mi	Ct	Et	Ax	Nmdp	Ix	Root	RL	FN	Rn
1428	02	02	08				CATALUNIA	45	9-10	Banda & Correig, 1984	11	16580	020
1428	02	02	08				Queralbs (Girona)		9-10	Susagna & Goula, 1999	12	16580	040
1428	02	02	08		@		CATALOGNE (CAMPRODON)	70	9	SisFrance	12	16580	060
1428	02	02	08				Queralbs.GI	44		Martinez S. & M., 2002	13	16580	070
1428	02	02	08				Camprodon	133	9	Olivera et al., 2006	11	16580	090

Figure 2. Example of grouping of different roots referring to the same earthquake.

It has to be stressed that we are referring to families of roots of the same event, and not to families of mainshock, aftershocks, and so on.

Assessing a family is not always easy, particularly if the same earthquake is reported in different roots with different times or areas.
A common case is the use of the Julian Calendar in old studies or catalogues and the Gregorian Calendar in more recent ones. Figure 3a shows an example in which the earthquake dated 2 July 1630 (Gregorian Calendar) is linked with the one dated 22 July 1630 by Shebalin et al. (1974), which uses the Julian Calendar. In this case the date in Shebalin et al. (1974), given as 1630 07 22 is a misprint for 1630 06 22.
Figure 3b shows the example of two roots reporting two earthquakes in December 1420 and on 21 January 1421 respectively in the same area. The text of the study by Papazachos and Papazachou (2003) explains that December 1420 corresponds to the starting date of a sequence, for which it mentions also the shock of 21 January 1421. For this reason we concluded that the two studies refer to the same event and the two records were given the same family number. In order to make the final decision clear, a short comment summarizes the reasons why records that are apparently different, particularly as regards time or area, are in the same family (Figure 3c).
The comment may also contain questions or doubts which cannot be solved with the present knowledge and would require further *ad hoc* research.

a.

Year	Mo	Da	Ho	Mi	Ct	Et	Ax	Nmdp	Ix	Root	RL	FN	Rn
1630	07	22	04							Shebalin et al., 1974	31	35392	010
1630	07	02					Katouna	2	9	Papazachos & P., 2003	14	35392	030

b.

Year	Mo	Da	Ho	Mi	Ct	Et	Ax	Nmdp	Ix	Root	RL	FN	Rn
1420	12						Nafplio	1	8	Papazachos & P., 2003	14	16190	030
1421	01	21					Artokosta GR	2	G4	Guidoboni & Com., 2005	11	16190	040

c.

1420 12 Nafplio (PAPA003)

This is a sequence, for which Papazachos & P. (2003) chooses the starting date of December 1420 and mentions in the text also a shock on 1421 Jan 21. For this reason, this record refers to the same earthquake as the one dated 1421 Jan 21 by Guidoboni & Com (2005).

Figure 3. a) and b) show roots related to the same earthquake and grouped in the same family, though they report different times. c) Comment explaining the family shown in b).

The NA4 Working file 1000-1750 contains today 4561 entries referred to 2859 earthquakes. The 1291 earthquakes with Io>5 and/or M>4.5) are represented in the Working File by 2407 entries.

2.4 Fake earthquakes. The NA4 Working File contains 415 records referring to fake, very doubtful, or doubtful earthquakes, taken from the list of fake earthquakes provided by some catalogues (e.g. ECOS, 2002 or SisFrance, 2009) or from individual studies.
European compilers use the terms “fake”, “doubtful” or “very doubtful” according to non homogeneous definitions. The NA4 Working File classifies fake earthquakes according to Table 2.

Table 2. Classification and description of fake earthquakes in the NA4 Working File.

Code (Et)	Definition	Description
ZZ	fake	Earthquake definitely proven to be fake. They can be either duplications of other seismic events or other natural phenomena (i.e. landslides, storms an so on) reported as earthquakes by historical sources.
ZD	very doubtful	Earthquake likely to be fake, but its supporting information is very poor and the conclusion is not final.
DD	doubtful	Earthquake for which the supporting information is poor but there is no enough evidence to consider it as a fake. These earthquakes are usually compiled in the parametric catalogues, although sometimes they are not used for SHA.

When available, the reasons why the earthquake is considered as a fake are summarized in the comment. In particular, in the case of a root that describes an earthquake listed in a catalogue as the duplication of another one, the comment provides a link to the earthquake with the true date or location respectively.

Out of the 369 records assessing fake or very doubtful earthquakes, 35 derive from the analysis of the available roots and background information performed by the NA4 partners and collaborators in the frame of NA4. Most of the tricky cases of relating different studies to the same earthquake led to the discovery that the earthquake under analysis was a fake or very doubtful one. Some of these results are not published, yet: they are considered as “root in progress” and proposed in form of a short report or simply a comment inserted in the WF.

3. Preferred root(s)

3.1. Definition and criteria. In order to proceed towards the compilation of the European Macroseismic Database and the European Parametric Catalogue, one of the roots of each family had to be selected as the preferred one.
The assessment of the preferred root is agreed among the partners. As a first step it is based on the root level RL (see Table 1); in general the priority is given to roots providing macroseismic data points (first RL = 11, then 12, then 13, than 14).

In case of entries of the same RL, the choice has been performed according to expert judgment.
The example in Figure 4 shows that the preference is given to the most recent root with RL 11 (Musson, 2008). Although providing slightly less MDPs and being less recent, the selected root provides a text.

Year	Mo	Da	Ho	Mi	Ct	Et	Ax	Nmdp	Ix	Root	RL	FN1	Rn	P
1580	04	06	18				DOVER STRAITS			Neilson et al., 1984a	21	24420010		
1580	04	06					Dover-Calais	58	7-8	Melville et al., 1996	11	24420050		
1580	04	06	18				DOVER STRAITS	27	6	Musson et al., 1998	11	24420060		
1580	04	06	18				DOVER STRAITS	91	7-8	Musson, 2008	11	24420080		pl
1580	04	06	16		@		MANCHE (DETROIT DE CALAIS-DOUVRES)	92	7-8	SisFrance, 2009	12	24420110		

Figure 4. Example of how the preferred root was assessed.

A short comment explains the reasons that led to prefer one root instead of an apparently identical one, for example those with the same number of MDPs.
The selected root is marked in the column “p” with codes that also approximately describe the size of the earthquake, based on the initial knowledge (Table 3).
The total number of earthquakes large, medium and small is 1291 (pl+pm+ps).

Table 3. Codes, description and numbers of the preferred roots in the WF.

p code	description	energy thresholds	N. of earthquakes
pl	large	M ≥ 5.8 or I > 8	432
pm	medium	5.0 ≤ M < 5.8 or 7≤ I ≤ 8	468
ps	small	4.5 ≤ M < 5.0 or 5 < I < 7	391
pt	very small	M < 4.5 or I ≤ 5	1147
pu	unknown size	No M or I assessment	164

Figure 5 shows the geographical distribution of the earthquakes in the WF, with reference to the epicentral coordinates from the original root, when available, or from another record of the same family.

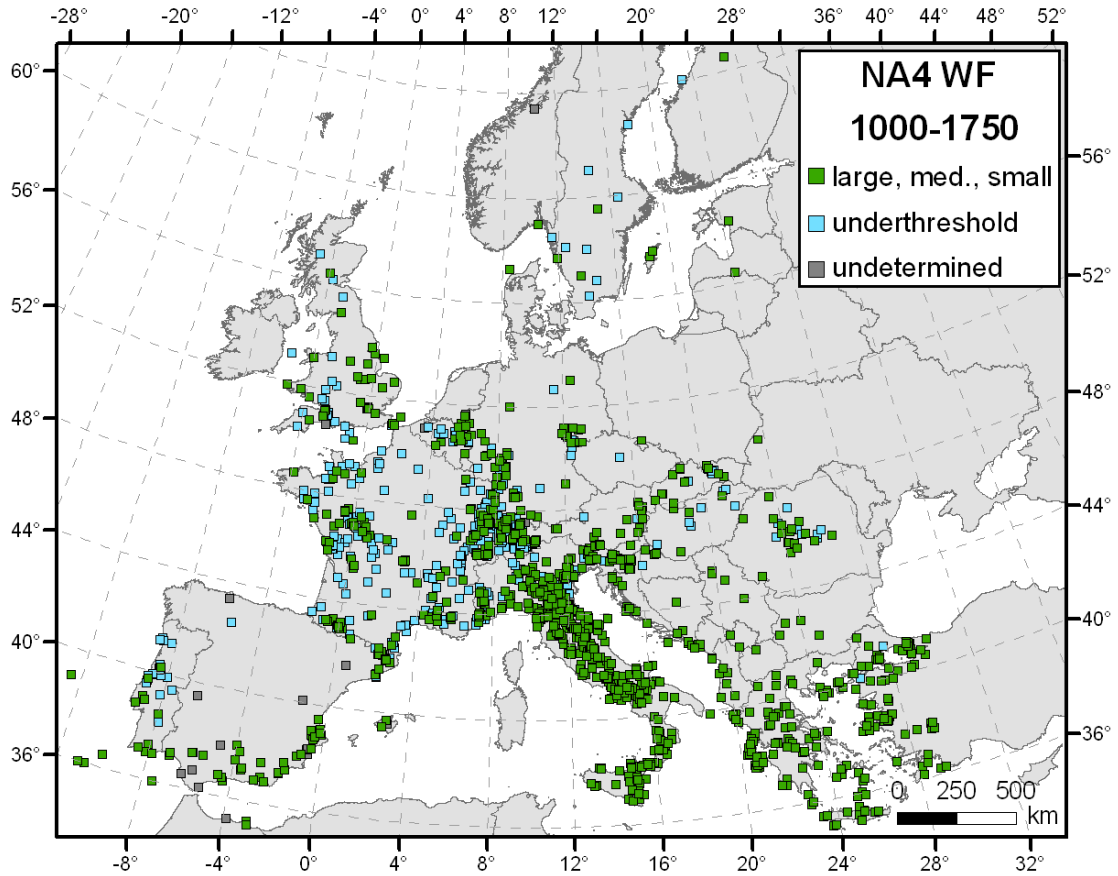

Figure 5. Geographical distribution of the earthquakes in the Working File, according to their size.

The amount and percentage on the total of the preferred roots according to their level is given in Table 4, their geographical distribution in Figure 5.

Table 4. Amount and percentage of the types of the preferred roots.

RL	Total number of p roots		% of p roots	Number of pl, pm and ps roots		% of pl. pm and ps roots
11	700	1828	64	531	933	72
12	809			210		
13	183			56		
14	136			136		
21	218	460	16	23	130	10
22	164			84		
23	78			23		
31	477	571	20	195	228	18
32	94			33		
Tot.	**2859**	**2859**	**100**	**1291**	**1291**	**100**

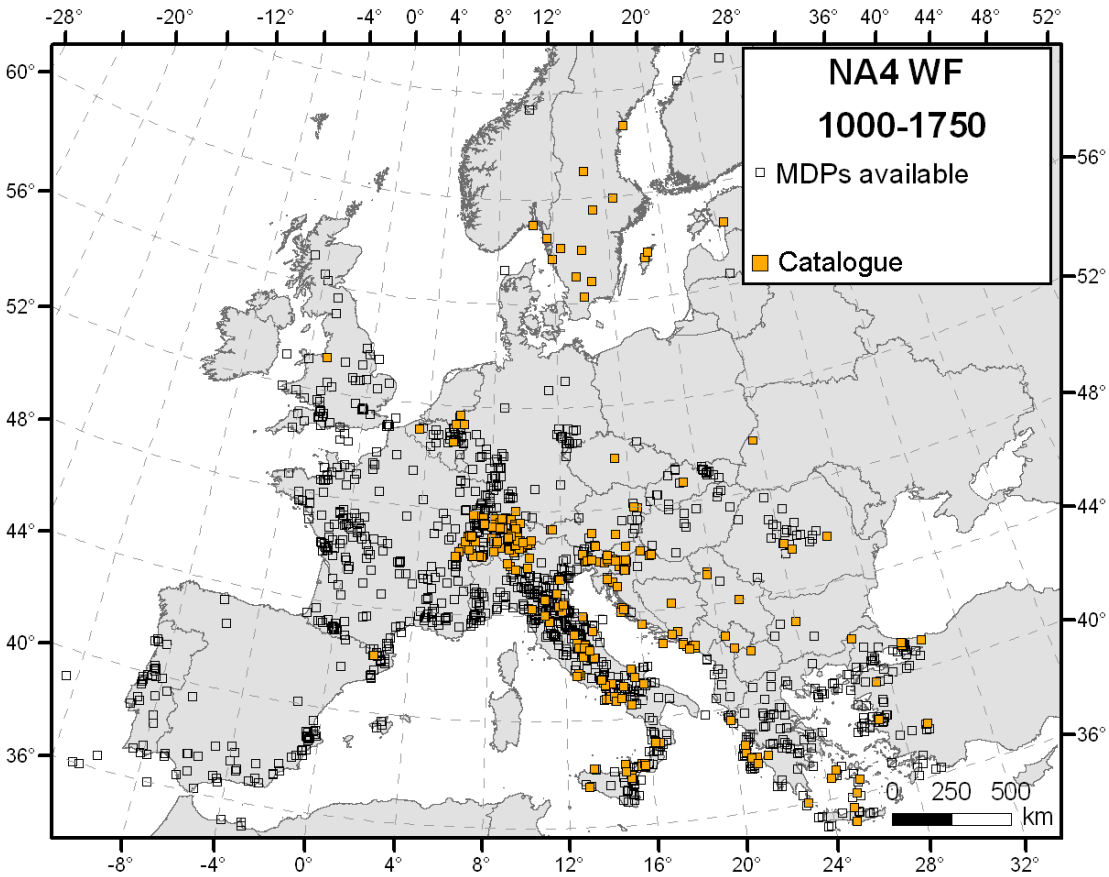

Figure 5 a. Geographical distribution of preferred roots of level 3 (Catalogues).

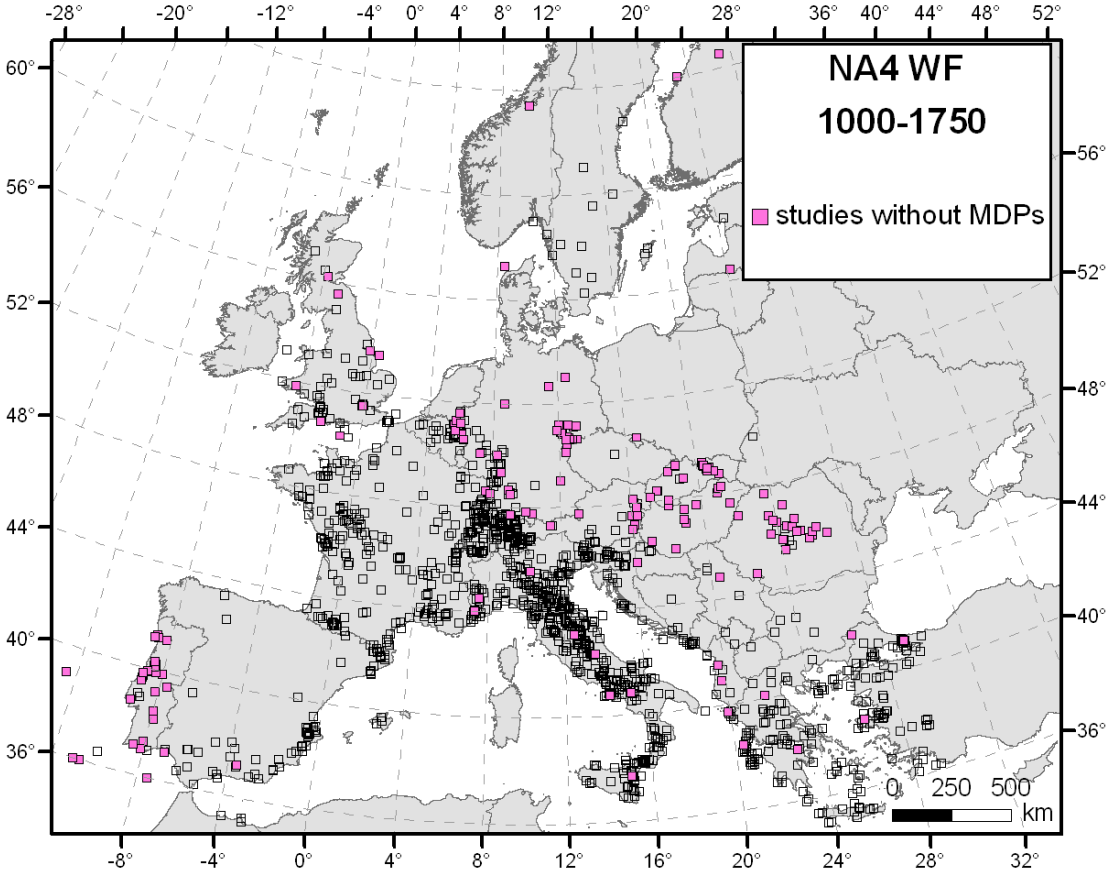

Figure 5 b. Geographical distribution of preferred roots of level 2 (studies without MDPs).

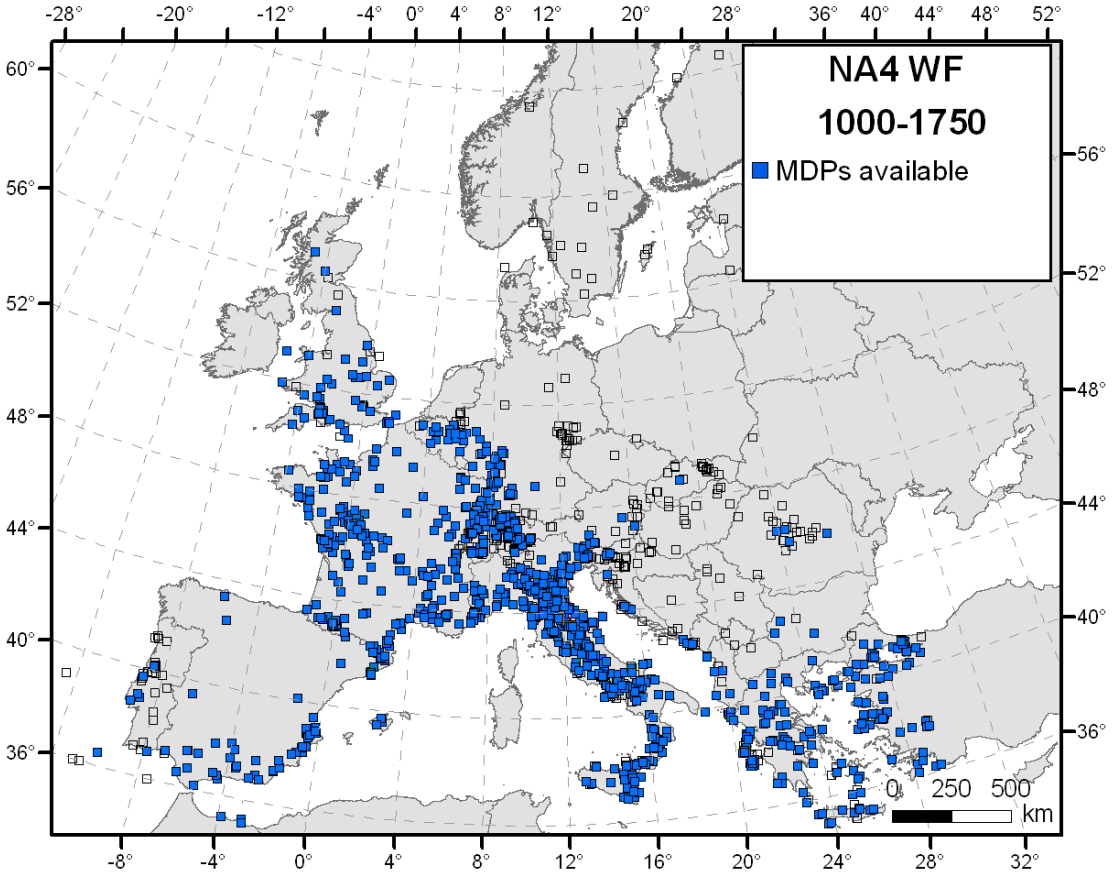

Figure 5 c. Geographical distribution of preferred roots of level 12 (studies with MDPs).

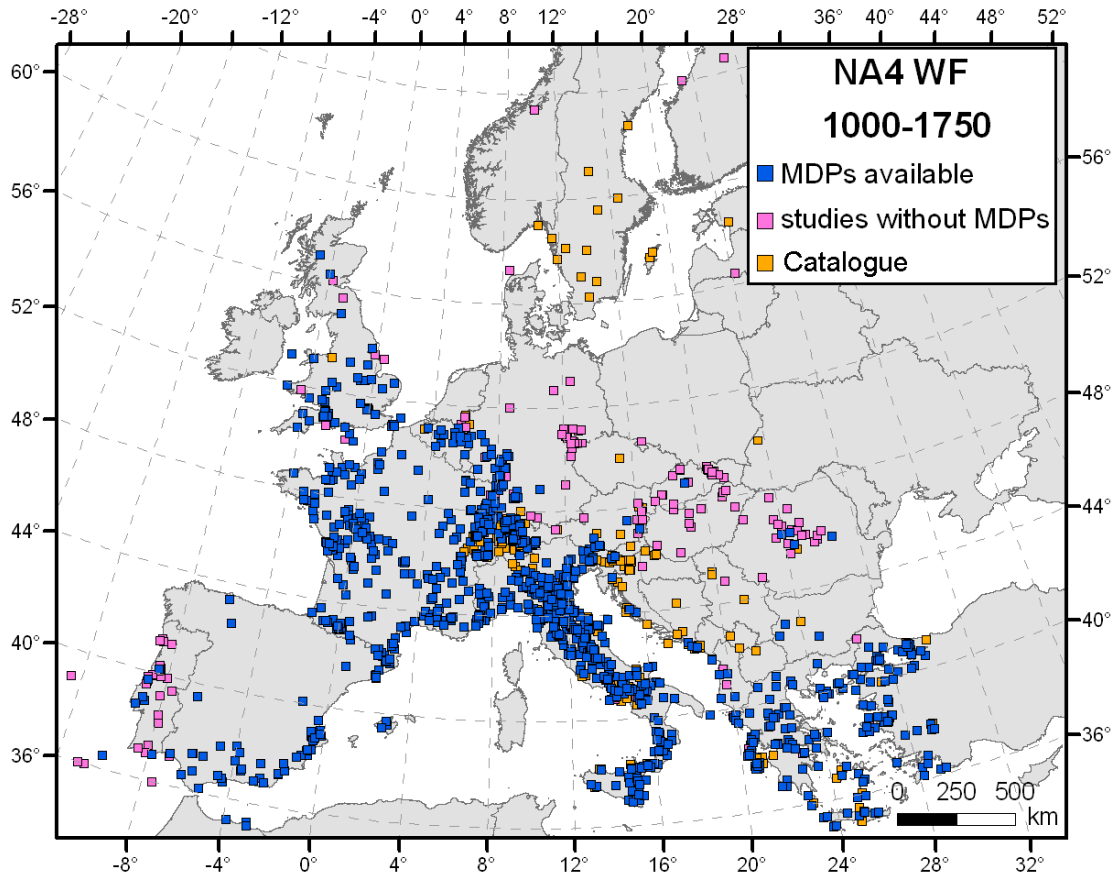

Figure 5. Geographical distribution of preferred roots of level 3, 2 , and 1 together (d). Epicentral coordinates are from the original root when available or from another record of the same family.

3.2 Fake events and preferred root. As a general rule, if a family contains a reliable "Z" entry, this is adopted as preferred root; the corresponding p code is then, respectively, pzz, or pzd. For 15 families only, the Z entry is not the preferred root, as a more recent root demonstrates that the earthquake is not a fake. In the case of more than one "Z" entry, the preference is given to the oldest one, i.e. the study that first declared an earthquake to be a fake.

The total number of families with a preferred "Z" root, i.e. the number of fake earthquakes in the Working File, is 260. The geographical distribution of preferred "Z" earthquakes is given in Figure 6; their number according to the type is given in Table 5.

Table 5. Number of preferred Z roots in the Working File, according to their type

Et	P	N. of earthquakes
ZZ	pzz	203
ZD	pzd	57
Total		**260**

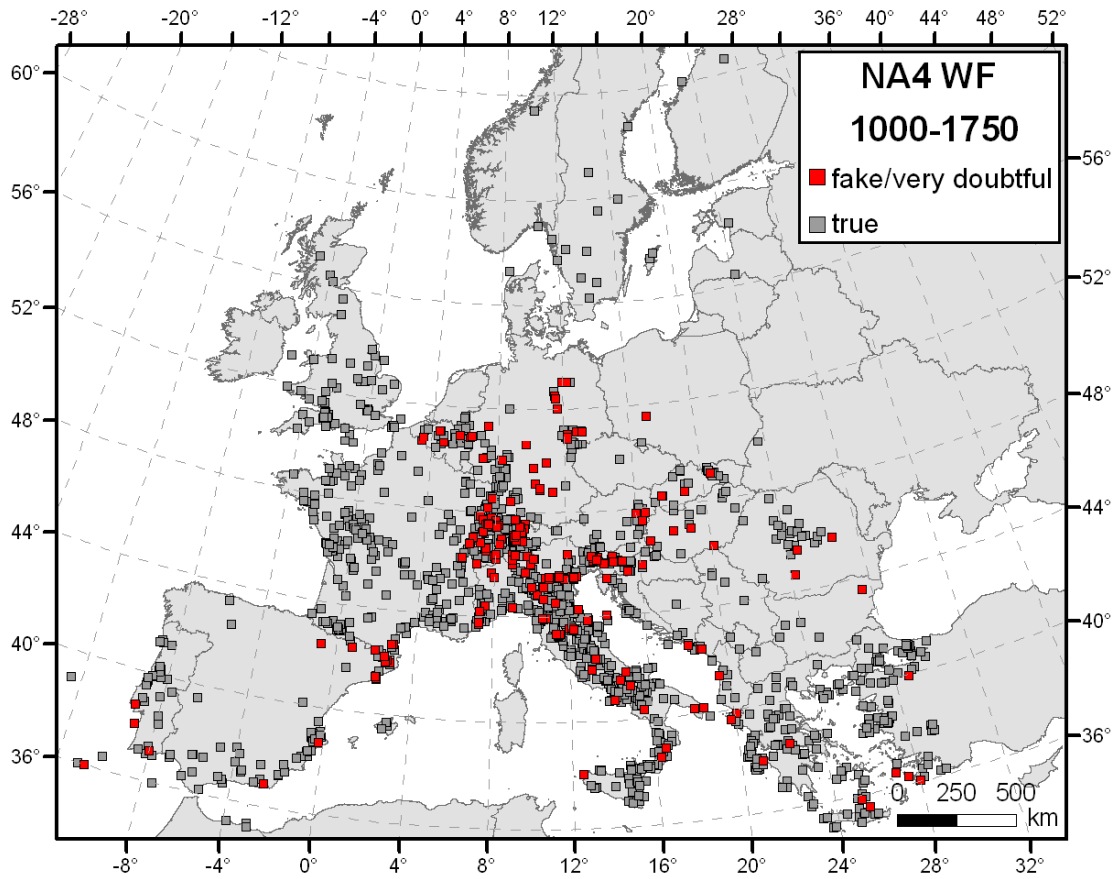

Figure 6. Geographical distribution of fake or very doubtful earthquakes in the NA4 Working File. The epicentral coordinates are those of the earthquake before being proven fake.

4. Accessing to and interacting with the WF

The NA4 WF is accessible on the NA4 website (http://emidius.mi.ingv.it/neries_NA4/) and the access is currently limited to partners and collaborators, under the understanding and the agreement that the content is not to be delivered outside the project.
These restrictions are necessary as part of the content of the Working File is confidential or subject to copyright rules.

The web interface of the Working File has been designed and developed entirely by the INGV coordination unit.

The structure of the Working File is organized in groups of fields, differently coloured in the web interface. These groups are:

Time and location	contains the date (Year, Mo, Da), time (Ho, Mi), the entry type (Et) and area of maximum effects (Ax) of the earthquake as given by the root. The filed Ct contains a flag that opens a pop-up window with additional information on the time (e.g. uncertainties).
Root	contains the number of MDPs provided by the root (Nmdp), if any, the maximum intensity (Ix), the short citation of the root (Root) and its level (RL).

UNID	contains the family number (FN) and the record number (Rn), assessed during the compilation of the WF; FN represents the unique identifier of an earthquake and groups roots referring to the same earthquake; the union of FN and Rn gives the unique identifier of the record of the WF.
Preference	contains the field through which the preference is given to a root in each family (P); the flags in the fields comment (C) and EMD open respectively a pop-up window with the comment to the record or family and the map of the intensity distribution from the NA4 European Macroseismic Database (see D4).
Original eq. parameters	contains, only for records from parametric catalogues (specified in the field CP), the original epicentral intensity (Io), epicentral coordinates (Lat and Lon), magnitude and type of magnitude (M and TM, respectively) as provided by the catalogue itself.

As a default only the “time and location”, “root” and “UNID” part of the WF are visible; the other groups can be shown by ticking the boxes above.

The description of each field is displayed in a pop-up window by clicking on the field name.

Also the records can be browsed in groups or as a whole. These options are selected through the two drop-down lists on top right:

Select area allows one to display the earthquakes located:
- South of 46°N of latitude,
- North of 45°N of latitude,
- with no area selection (“Whole Europe” option);

Select entries: allows one to display the following records:
- all records (to display the entire WF),
- pl + pm (to display only preferred large and medium records),
- pl + pm and families (to display the preferred large and medium records together with the other records in each family),
- pl + pm + ps (to display only preferred large, medium and small records),
- pl + pm + ps and families (to display the preferred large, medium and small records together with the other records in each family),
- pz (to display only fake earthquakes)
- pz and families (to display fake earthquakes together with the other records in each family)

The default option is “pl + pm records” and “South of 46°”.
When the “all records” display option is selected, the WF can be browsed only by the time-windows selectable through the “select time-window” drop-down list. The time-windows are: 1000-1300, 1301-1500, 1501-1600, 1601-1700 and 1701-1750.
Preferred roots are coloured according to the following code:

blue	large and medium earthquakes (P = pl or pm)
orange	small earthquakes (P = ps)
black	very small earthquakes (P = pt)
grey	earthquake with unknown size (P = pu)
red	fake or very doubtful earthquakes (P = pzz or pzd)

All the other records are black.

As a default, records are sorted by families (Fn) and by families and record number (Rn) depending on the selected display option. When all the records of the families are displayed, the families are divided by a grey line.
The records can also be sorted by one of the fields marked with a red triangle on top of them (i.e. Time, Et, Ax, Nmdp, Ix, Root, RL, P, EMD or CP) by clicking on this triangle. The default sort is restored by clicking on the triangle above the FN field.

Independently from the selected display option, clicking on some parts of each records gives access to a series of information. The clickable parameters are:

- date: opens a map that displays the epicentral location(s) of the earthquake as provided by the root(s);
- Ct: opens a pop-up window with additional information on the time (e.g. uncertainties).
- Nmdp: opens a link to the original intensity distribution map if the root has an available on-line macroseismic database, such as SisFrance (2009), Ecos (2002) or DBMI04 (Stucchi et al., 2007).
- Root: opens the bibliographical reference to the root and, if available, an external link to the web-page of the root or a link to the text of the root in .pdf format; a warning is present in case of copyrighted documents
- C opens the comment to the record or to the family
- EMD: opens the map of the intensity distribution from the NA4 European Macroseismic Database (see D4).
- CP: the bibliographical reference of the original parametric catalogue and, if available, an external link to the web-page of the; a warning is present in case of copyrighted documents.

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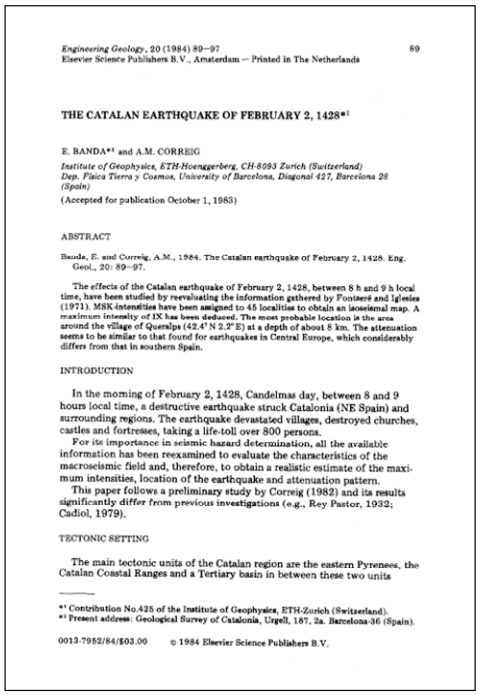
Appendix

Filing of the roots and their grouping

This appendix shows the steps of the compilation of the records of the Working File starting form the information supplied the root. The root can be a printed scientific paper, a book or an electronic (web) database.
The sequence of figures shows also the grouping of records referring to the same earthquake into the same family and end with the selection of the preferred root.



Engineering Geology, 20 (1984) 89–97
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THE CATALAN EARTHQUAKE OF FEBRUARY 2, 1428*[1]

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(Accepted for publication October 1, 1983)

ABSTRACT

Banda, E. and Correig, A.M., 1984. The Catalan earthquake of February 2, 1428. Eng. Geol., 20: 89–97.

The effects of the Catalan earthquake of February 2, 1428, between 8 h and 9 h local time, have been studied by reevaluating the information gathered by Fontseré and Iglesias (1971). MSK-intensities have been assigned to 45 localities to obtain an isoseismal map. A maximum intensity of IX has been deduced. The most probable location is the area around the village of Quesalps (42.4°N 2.2°E) at a depth of about 8 km. The attenuation seems to be similar to that found for earthquakes in Central Europe, which considerably differs from that in southern Spain.

INTRODUCTION

In the morning of February 2, 1428, Candelmas day, between 8 and 9 hours local time, a destructive earthquake struck Catalonia (NE Spain) and surrounding regions. The earthquake devastated villages, destroyed churches, castles and fortresses, taking a life-toll over 800 persons.

For its importance in seismic hazard determination, all the available information has been reexamined to evaluate the characteristics of the macroseismic field and, therefore, to obtain a realistic estimate of the maximum intensities, location of the earthquake and attenuation pattern.

This paper follows a preliminary study by Correig (1982) and its results significantly differ from previous investigations (e.g., Rey Pastor, 1932; Cadiol, 1979).

TECTONIC SETTING

The main tectonic units of the Catalan region are the eastern Pyrenees, the Catalan Coastal Ranges and a Tertiary basin in between these two units

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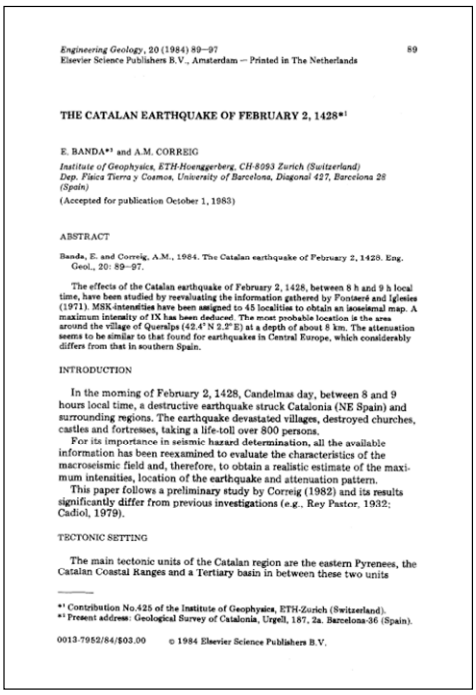
Year	Mo	Da	Ho	Mi	Ct	Et	AxOr	Nmdp	Ixm	Root	RL	FN1	Rn	P1	C	CP1	IoOr	LatOr	LonOr	MOr	TM
										Banda & Correig, 1984	11										



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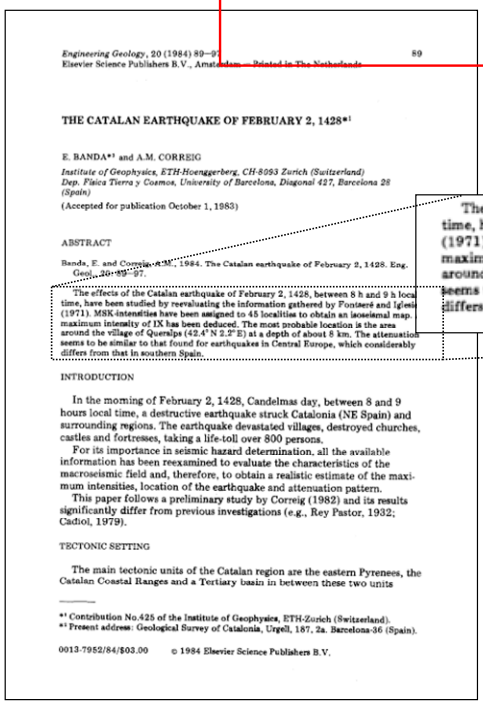
Year	Mo	Da	Ho	Mi	Ct	Et	AxOr	Nmdp	Ixm	Root	RL	FN1	Rn	P1	C	CP1	IoOr	LatOr	LonOr	MOr	TM
1428	02	02	08				CATALUNIA			Banda & Correig, 1984	11										



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1428	02	02	08				CATALUNIA	45	9-10	Banda & Correig, 1984	11										

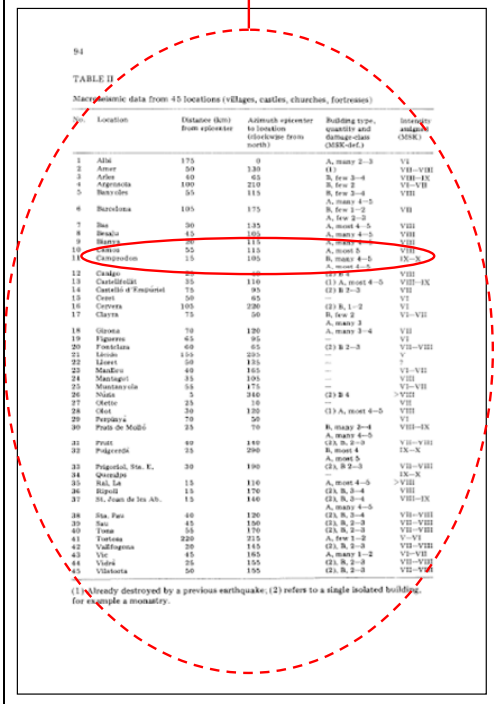

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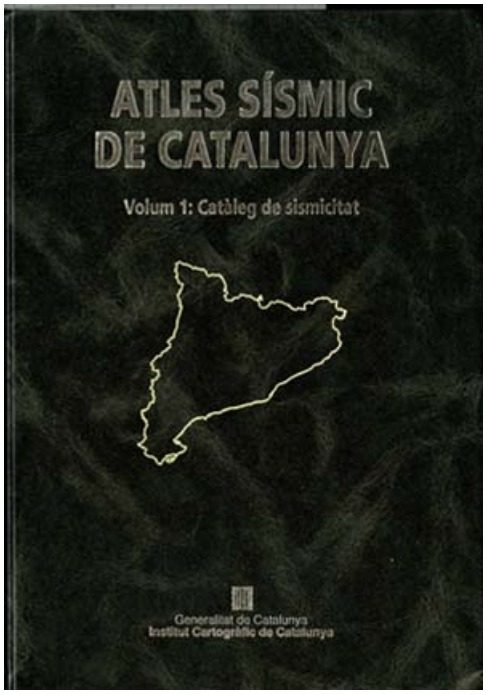
TABLE II

Macroseismic data from 45 locations (villages, castles, churches, fortresses)

No.	Location	Distance (km) from epicenter	Azimuth epicenter to location (clockwise from north)	Building type, quantity and damage-class (MSK-def.)	Intensity assigned (MSK)
1	Alòs	175	0	A, many 2–3	VI
2	Amer	50	130	(1)	VII–VIII
3	Arfes	60	65	B, few 3–4	VIII–IX
4	Argentona	100	210	B, few 2	VI–VII
5	Banyoles	55	115	B, few 3–4	VIII
6	Barcelona	105	175	A, many 4–5 B, few 1–2 A, few 2–3	VII
7	Bas	30	135	A, most 4–5	VIII
8	Besalú	45	105	A, many 4–5	VIII
9	Blanes	80	115	A, many 4–5	VIII
10	Calella	55	115	A, most 5	VIII
11	Campredon	15	195	B, many 4–5 A, most 4–5	IX–X
12	Canigó	20	10	(2) B 4	VIII
13	Castellfullit	35	110	(1) A, most 4–5	VIII–IX
14	Castillo d'Empúriet	75	95	(2) B 2–3	VII
15	Ceret	50	65	—	VI
16	Cervera	105	230	(2) B, 1–2	VI
17	Claver	75	50	B, few 2 A, many 3	VI–VII
18	Girona	70	120	A, many 3–4	VII
19	Figueres	65	95	—	VI
20	Fontclara	60	65	(2) B 2–3	VII–VIII
21	Lérida	155	235	—	V
22	Lloret	50	135	—	V
23	Manlleu	40	165	—	VI–VII
24	Mantagrí	35	105	—	VIII
25	Montserrat	55	175	—	VI–VII
26	Núria	5	340	(2) B 4	>VIII
27	Olette	25	10	—	VII
28	Olot	30	120	(1) A, most 4–5	VIII
29	Perpinyà	70	50	—	VI
30	Prats de Molló	25	70	B, many 2–4 A, many 4–5	VIII–IX
31	Prott	40	140	(2) B, 2–3	VII–VIII
32	Prósperdó	25	290	B, most 4 A, most 5	IX–X
33	Prigorlol, Sta. E.	30	190	(2) B 2–3	VII–VIII
34	Queralbs			—	IX–X
35	Ral, La	15	110	A, most 4–5	>VIII
36	Ripoll	15	170	(2) B, 3–4	VIII
37	St. Joan de les Ab.	15	140	(2) B, 3–4 A, many 4–5	VIII–IX
38	Sta. Pau	40	120	(2) B, 3–4	VII–VIII
39	Sau	45	150	(2) B, 2–3	VII–VIII
40	Tona	55	170	(2) B, 2–3	VII–VIII
41	Tortosa	220	215	A, few 1–2	V–VI
42	Vallfogona	20	145	(2) B, 3–3	VII–VIII
43	Vic	45	185	A, many 1–2	VI–VII
44	Vidrà	25	155	(2) B, 2–3	VII–VIII
45	Vilademuls	50	155	(2) B, 2–3	VII–VIII

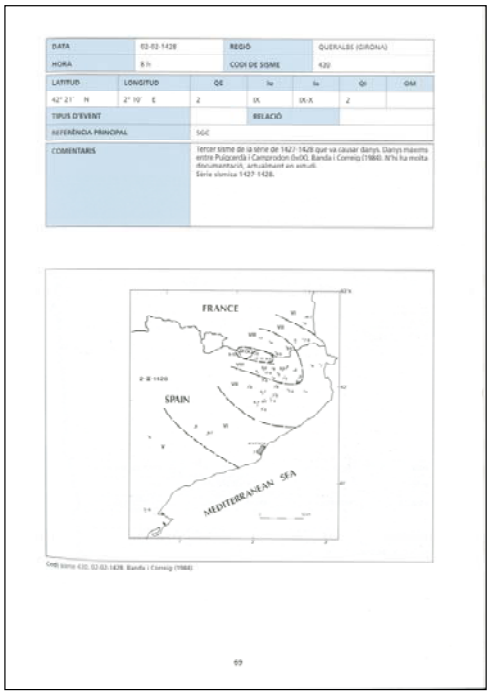
(1) already destroyed by a previous earthquake; (2) refers to a single isolated building, for example a monastery.

Year	Mo	Da	Ho	Mi	Ct	Et	AxOr	Nmdp	Ixm	Root	RL	FN1	Rn	P1	C	CP1	IoOr	LatOr	LonOr	MOr	TM
1428	02	02	08				CATALUNIA	45	9-10	~~Banda & Correig, 1984~~ Susagna & Goula, 1999	~~11~~ 12										

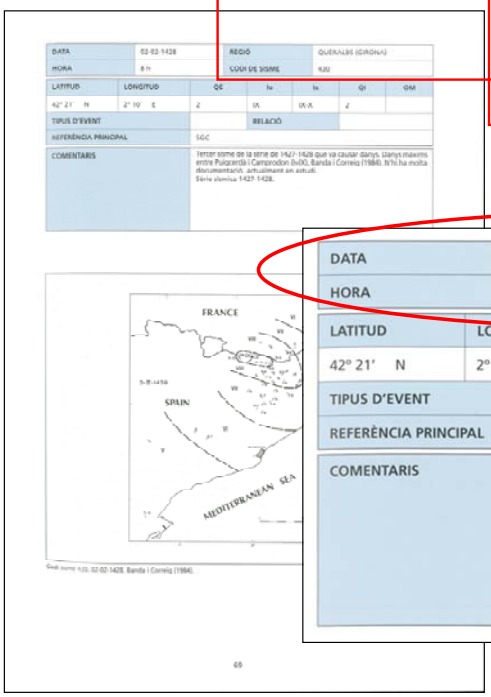


Susagna T. and Goula X., 1999. Catàleg de Sismicitat. Atlas Sísmic de Catalunya, vol. I, Institut Cartogràfic de Catalunya, 436 pp.

Year	Mo	Da	Ho	Mi	Ct	Et	AxOr	Nmdp	Ixm	Root	RL	FN1	Rn	P1	C	CP1	IoOr	LatOr	LonOr	MOr	TM
1428	02	02	08				CATALUNIA	45	9-10	Banda & Correig, 1984	11										
										Susagna & Goula, 1999	12										



Year	Mo	Da	Ho	Mi	Ct	Et	AxOr	Nmdp	Ixm	Root	RL	FN1	Rn	P1	C	CP1	IoOr	LatOr	LonOr	MOr	TM
1428	02	02	08				CATALUNIA	45	9-10	Banda & Correig, 1984	11										
1428	02	02					Queralbs (Girona)		9-10	Susagna & Goula, 1999	12										



DATA	02-02-1428	REGIÓ	QUERALBS (GIRONA)
HORA	8 h	CODI DE SISME	430

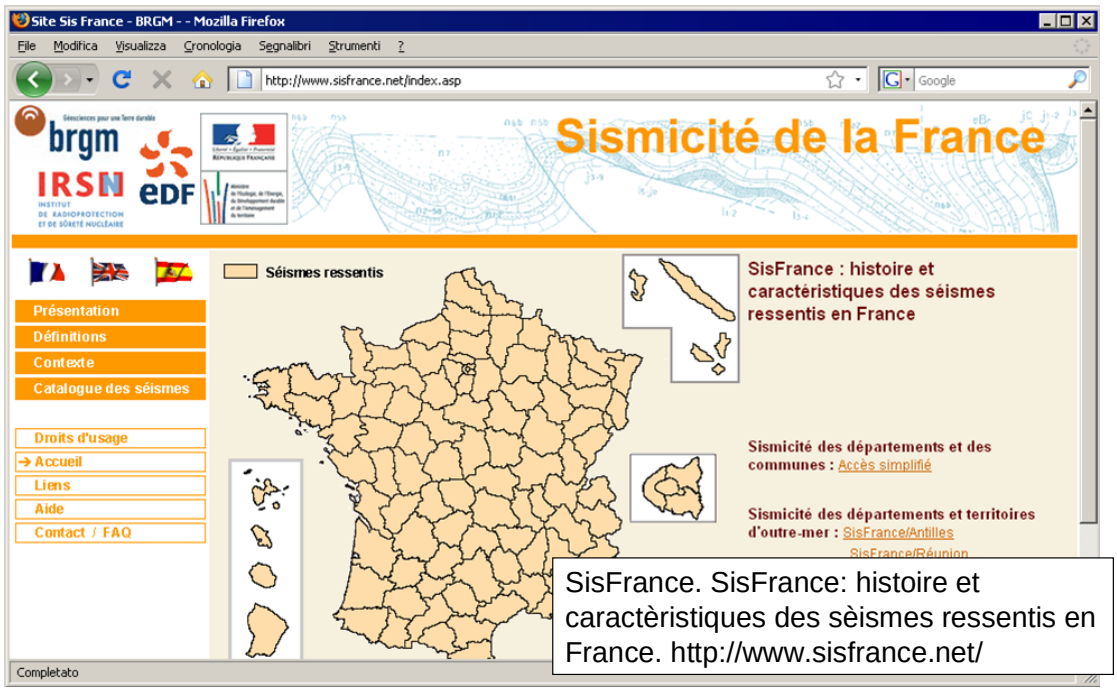
LATITUD	LONGITUD	QE	Io	Ix	QI	OM
42º 21' N	2º 10' E	2	IX	IX-X	2	

TIPUS D'EVENT		RELACIÓ	
REFERÈNCIA PRINCIPAL	SGC		

COMENTARIS	Tercer sisme de la sèrie de 1427-1428 que va causar danys. Danys màxims entre Puigcerdà i Camprodon (I=IX), Banda i Correig (1984). N'hi ha molta documentació, actualment en estudi. Sèrie sísmica 1427-1428.

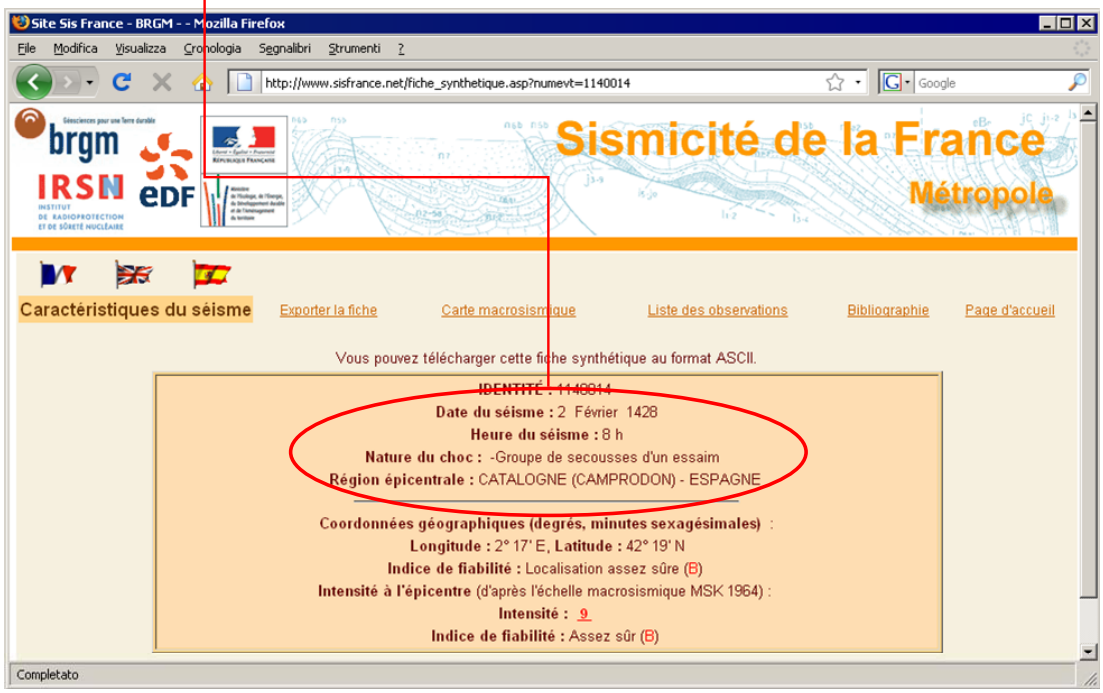
Year	Mo	Da	Ho	Mi	Ct	Et	AxOr	Nmdp	Ixm	Root	RL	FN1	Rn	P1	C	CP1	IoOr	LatOr	LonOr	MOr	TM
1428	02	02	08				CATALUNIA	45	9-10	Banda & Correig, 1984	11	16580	020								
1428	02	02					Queralbs (Girona)		9-10	Susagna & Goula, 1999	12	16580	040								

Year	Mo	Da	Ho	Mi	Ct	Et	AxOr	Nmdp	Ixm	Root	RL	FN1	Rn	P1	C	CP1	IoOr	LatOr	LonOr	MOr	TM
1428	02	02	08				CATALUNIA	45	9-10	Banda & Correig, 1984	11	16580	020								
1428	02	02					Queralbs (Girona)		9-10	~~Susagna & Goula, 1999~~	12	16580	040								
										SisFrance	12										

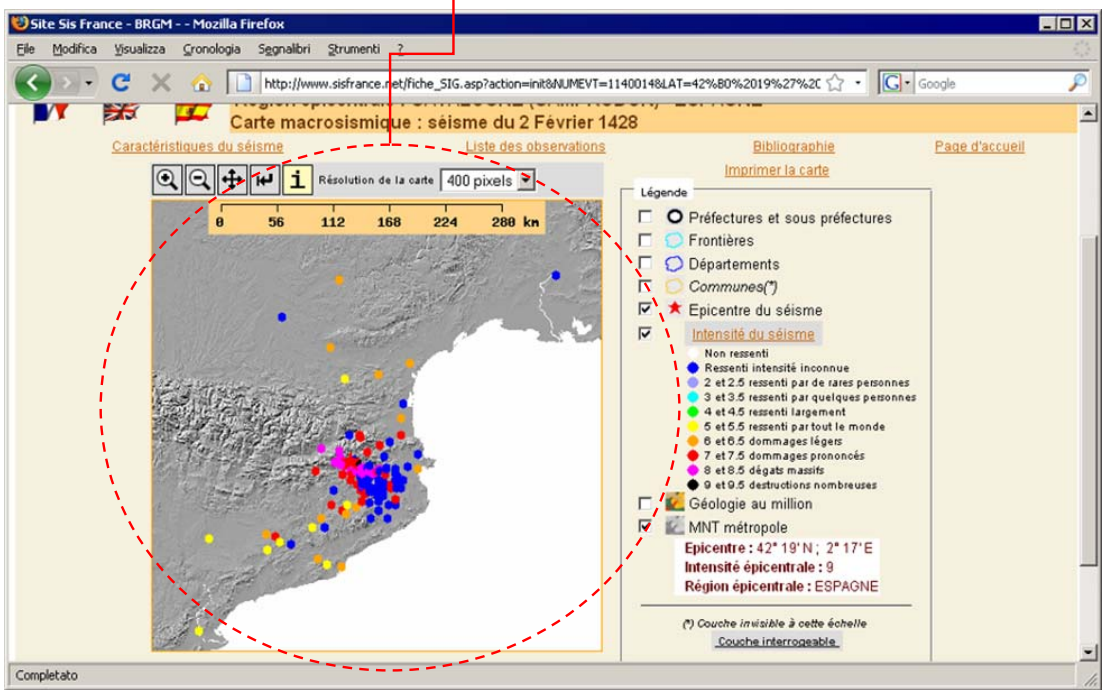


SisFrance. SisFrance: histoire et caractèristiques des sèismes ressentis en France. http://www.sisfrance.net/

Year	Mo	Da	Ho	Mi	Ct	Et	AxOr	Nmdp	Ixm	Root	RL	FN1	Rn	P1	C	CP1	IoOr	LatOr	LonOr	MOr	TM
1428	02	02	08				CATALUNIA	45	9-10	Banda & Correig, 1984	11	16580	020								
1428	02	02					Queralbs (Girona)		9-10	Susagna & Goula, 1999	12	16580	040								
1428	02	02	08				CATALOGNE (CAMPRODON)			SisFrance	12										



Year	Mo	Da	Ho	Mi	Ct	Et	AxOr	Nmdp	Ixm	Root	RL	FN1	Rn	P1	C	CP1	IoOr	LatOr	LonOr	MOr	TM
1428	02	02	08				CATALUNIA	45	9-10	Banda & Correig, 1984	11	16580	020								
1428	02	02					Queralbs (Girona)		9-10	Susagna & Goula, 1999	12	16580	040								
1428	02	02	08				CATALOGNE (CAMPRODON)	70	9	SisFrance	12										

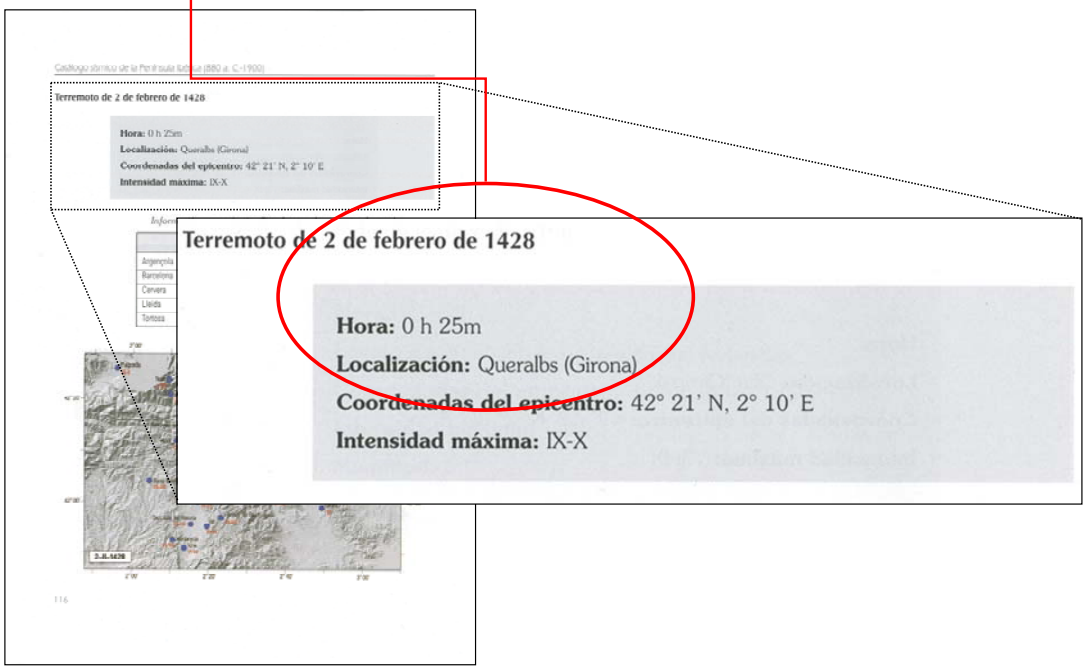


Year	Mo	Da	Ho	Mi	Ct	Et	AxOr	Nmdp	Ixm	Root	RL	FN1	Rn	P1	C	CP1	IoOr	LatOr	LonOr	MOr	TM
1428	02	02	08				CATALUNIA	45	9-10	Banda & Correig, 1984	11	16580	020								
1428	02	02					Queralbs (Girona)		9-10	Susagna & Goula, 1999	12	16580	040								
1428	02	02	08				CATALOGNE (CAMPRODON)	70	9	SisFrance	12	16580	060								

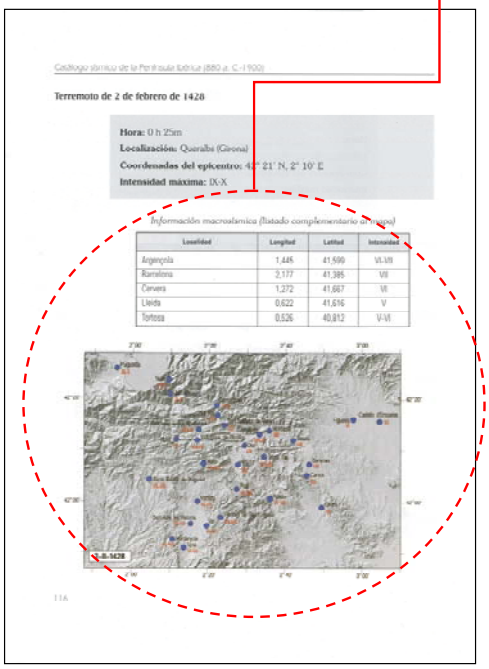
Year	Mo	Da	Ho	Mi	Ct	Et	AxOr	Nmdp	Ixm	Root	RL	FN1	Rn	P1	C	CP1	IoOr	LatOr	LonOr	MOr	TM
1428	02	02	08				CATALUNIA	45	9-10	Banda & Correig, 1984	11	16580	020								
1428	02	02					Queralbs (Girona)		9-10	Susagna & Goula, 1999	12	16580	040								
1428	02	02	08				CATALOGNE (CAMPRODON)	70	9	SisFrance	12	16580	060								
										Martinez S. & M., 2002	13										

Martinez Solares J.M. and J. Mezcua Rodriguez (eds), 2002. Catalogo sismico de la Peninsula Iberica (880 a.C.-1990). IGN, Madrid, 254 pp.

Year	Mo	Da	Ho	Mi	Ct	Et	AxOr	Nmdp	Ixm	Root	RL	FN1	Rn	P1	C	CP1	IoOr	LatOr	LonOr	MOr	TM
1428	02	02	08				CATALUNIA	45	9-10	Banda & Correig, 1984	11	16580	020								
1428	02	02					Queralbs (Girona)		9-10	Susagna & Goula, 1999	12	16580	040								
1428	02	02	08				CATALOGNE (CAMPRODON)	70	9	SisFrance	12	16580	060								
1428	02	02	00	25			Queralbs.GI			Martinez S. & M., 2002	13										

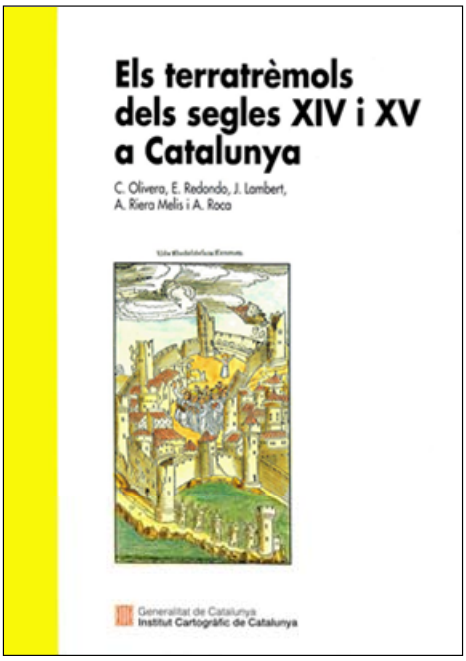


Year	Mo	Da	Ho	Mi	Ct	Et	AxOr	Nmdp	Ixm	Root	RL	FN1	Rn	P1	C	CP1	IoOr	LatOr	LonOr	MOr	TM
1428	02	02	08				CATALUNIA	45	9-10	Banda & Correig, 1984	11	16580	020								
1428	02	02					Queralbs (Girona)		9-10	Susagna & Goula, 1999	12	16580	040								
1428	02	02	08				CATALOGNE (CAMPRODON)	70	9	SisFrance	12	16580	060								
1428	02	02	00	25			Queralbs.GI	44	9	Martinez S. & M., 2002	13										



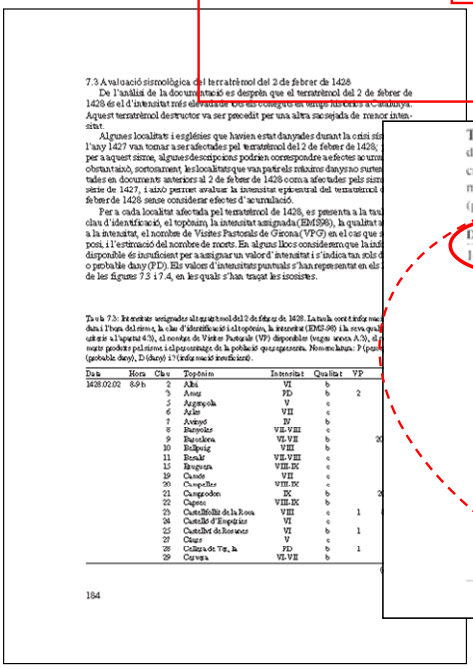
Year	Mo	Da	Ho	Mi	Ct	Et	AxOr	Nmdp	Ixm	Root	RL	FN1	Rn	P1	C	CP1	IoOr	LatOr	LonOr	MOr	TM
1428	02	02	08				CATALUNIA	45	9-10	Banda & Correig, 1984	11	16580	020								
1428	02	02					Queralbs (Girona)		9-10	Susagna & Goula, 1999	12	16580	040								
1428	02	02	08				CATALOGNE (CAMPRODON)	70	9	SisFrance	12	16580	060								
1428	02	02	00	25			Queralbs.GI	44	9	Martinez S. & M., 2002	13	16580	070								

Year	Mo	Da	Ho	Mi	Ct	Et	AxOr	Nmdp	Ixm	Root	RL	FN1	Rn	P1	C	CP1	IoOr	LatOr	LonOr	MOr	TM
1428	02	02	08				CATALUNIA	45	9-10	Banda & Correig, 1984	11	16580	020								
1428	02	02					Queralbs (Girona)		9-10	Susagna & Goula, 1999	12	16580	040								
1428	02	02	08				CATALOGNE (CAMPRODON)	70	9	SisFrance	12	16580	060								
1428	02	02	00	25			Queralbs.GI	44	9	Martinez S. & M., 2002	13	16580	070								
										Olivera et al., 2006	11										



Olivera C., Redondo E., Lambert J., Riera Melis A. and Roca A., 2006. Els terratrèmols dels segles XIV I XV a Catalunya, Barcelona, Institut Cartogràfic de Catalunya, 407 pp.

Year	Mo	Da	Ho	Mi	Ct	Et	AxOr	Nmdp	Ixm	Root	RL	FN1	Rn	P1	C	CP1	IoOr	LatOr	LonOr	MOr	TM
1428	02	02	08				CATALUNIA	45	9-10	Banda & Correig, 1984	11	16580	020								
1428	02	02					Queralbs (Girona)		9-10	Susagna & Goula, 1999	12	16580	040								
1428	02	02	08				CATALOGNE (CAMPRODON)	70	9	SisFrance	12	16580	060								
1428	02	02	00	25			Queralbs.GI	44	9	Martinez S. & M., 2002	13	16580	070								
1428	02	02	08					133	9	Olivera et al., 2006	11										



7.3 Avaluació sismològica del terratrèmol del 2 de febrer de 1428

De l'anàlisi de la documentació es desprèn que el terratrèmol del 2 de febrer de 1428 és el d'intensitat més elevada de les conegudes en temps historics a Catalunya. Aquest terratrèmol destructor va ser precedit per una altra sacsejada de menor intensitat.

Algunes localitats i esglésies que havien estat danyades durant la crisi sís[mica] l'any 1427 van tornar a ser afectades pel terratrèmol del 2 de febrer de 1428; per a aquest sisme, algunes descripcions podrien correspondre a efectes acumu[lats]. Obtenir això, sortosament, les localitats que van patir els màxims danys no surten [men]tades en documents anteriors al 2 de febrer de 1428 com a afectades pels sisms [de la] sèrie de 1427, i això permet avaluar la intensitat epicentral del terratrèmol [del 2 de] febrer de 1428 sense considerar efectes d'acumulació.

Per a cada localitat afectada pel terratrèmol de 1428, es presenta a la taula [7.3] la clau d'identificació, el topònim, la intensitat assignada (EMS98), la qualitat [associada] a la intensitat, el nombre de Visites Pastorals de Girona (VPG) en el cas que [...] posi, i l'estimació del nombre de morts. En algunes llocs considerem que la inf[ormació] disponible és insuficient per a assignar un valor d'intensitat i s'indica tan sols [...] o probable dany (PD). Els valors d'intensitats puntuals s'han representat en els [mapes] de les figures 7.3 i 7.4, en les quals s'han traçat les isosistes.

Taula 7.3: Intensitats assignades al terratrèmol del 2 de febrer de 1428. La taula conté informació sobre la data i l'hora del sisme, la clau d'identificació i el topònim, la intensitat (EMS-98) i la seva qualitat (vegeu criteris a l'apartat 4.3), el nombre de Visites Pastorals (VP) disponibles (vegeu annex A.3), el nombre de morts produits pel sisme i el percentatge de la població que representa. Nomenclatura: P (percepció), PD (probable dany), D (dany) i ? (informació insuficient).

Data	Hora	Clau	Topònim	Intensitat	Qualitat	VP	Morts
1428.02.02	8-9 h	2	Albi	VI	b		
		3	Amer	PD	b	2	
		5	Argençola	V	c		
		6	Arles	VII	c		
		7	Avinyó	IV	b		
		8	Banyoles	VII-VIII	c		
		9	Barcelona	VI-VII	b		20 (0,07%)
		10	Bellpuig	VIII	b		13 (2%)
		11	Besalú	VII-VIII	c		
		15	Bruguera	VIII-IX	c		
		19	Camós	VII	c		
		20	Campelles	VIII-IX	c		
		21	Camprodon	IX	b		200 (26%)
		22	Capsec	VIII-IX	b		
		23	Castellfollit de la Roca	VIII	c	1	80 (36%)
		24	Castelló d'Empúries	VI	c		6 (?%)
		25	Castellví de Rosanes	VI	b	1	
		27	Cáurs	V	c		
		28	Cellera de Ter, la	PD	b	1	
		29	Cervera	VI-VII	b		

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continued...

Year	Mo	Da	Ho	Mi	Ct	Et	AxOr	Nmdp	Ixm	Root	RL	FN1	Rn	P1	C	CP1	IoOr	LatOr	LonOr	MOr	TM
1428	02	02	08				CATALUNIA	45	9-10	Banda & Correig, 1984	11	16580	020					42.400	2.200		
1428	02	02					Queralbs (Girona)		9-10	Susagna & Goula, 1999	12	16580	040			SUGO999	9	42.350	2.167		
1428	02	02	08				CATALOGNE (CAMPRODON)	70	9	SisFrance	12	16580	060			SISFR	9	42.317	2.283		
1428	02	02	00	25			Queralbs.GI	44	9	Martinez S. & M., 2002	13	16580	070			MAME002		42.350	2.167		
1428	02	02	08					133	9	Olivera et al., 2006	11	16580	090				9	42.300	2.333	6.50	W

Year	Mo	Da	Ho	Mi	Ct	Et	AxOr	Nmdp	Ixm	Root	RL	FN1	Rn	P1	C	CP1	IoOr	LatOr	LonOr	MOr	TM
1428	02	02	08				CATALUNIA	45	9-10	Banda & Correig, 1984	11	16580	020					42.400	2.200		
1428	02	02					Queralbs (Girona)		9-10	Susagna & Goula, 1999	12	16580	040			SUGO999	9	42.350	2.167		
1428	02	02	08				CATALOGNE (CAMPRODON)	70	9	SisFrance	12	16580	060			SISFR	9	42.317	2.283		
1428	02	02	00	25			Queralbs.GI	44	9	Martinez S. & M., 2002	13	16580	070			MAME002		42.350	2.167		
1428	02	02	08					133	9	Olivera et al., 2006	11	16580	090	pl			9	42.300	2.333	6.50	W

Preferred root selection:
Most recent study with text, references and usable MDPs....