

# Conception of a macroseismic catalogue for Catalonia (Spain)

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## Abstract

Since 1989 the Servei Geològic de Catalunya has been collecting macroseismic information of the North East of Spain and the South of France to create a comprehensive and reliable catalogue which would be of use in seismic hazard assessment. Existing compilations have been submitted to a critical analysis and comparison, bearing in mind the results of recent historical research. For the seismicity of the present century macroseismic information is being studied by analyzing the original questionnaires. For each earthquake the felt intensities are stored on a data bank system. Due to the geographic location of the area under scrutiny, near the French border, collaboration with French agencies has been necessary to achieve joint information for Pyrenean earthquakes. Ancient instrumental records taken in two observatories (FBR and EBR) working since the beginning of this century have helped to determine focal parameters.

**Key words** *macroseismicity – Spain – database*

## 1. Introduction

One of the problems associated with earthquake hazard assessment in regions of moderate seismicity is the lack of knowledge of observed ground motion over long periods of time. It is a feature common to these regions that information must be based on few large events with the need for historical investigations. On the other hand it is important to carefully analyze the information collected in previous compilations about a maximum number of earthquakes.

In this paper we present the current situation of an ongoing project of the Servei Geològic de Catalonia which aims to establish a macroseismic catalogue that will include the recent

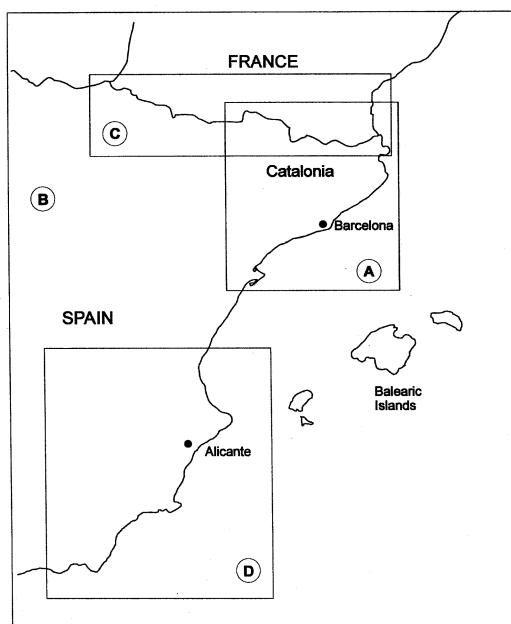
results of historical research into a few important earthquakes that have occurred in Catalonia together with data taken from the most representative compilations of an extensive area carried out in Spain and France.

## 2. Area of study

In order to analyze the seismic hazard of the Catalan region (region A in fig. 1) a catalogue is needed made up both of information from this region and of the surrounding region (region B in fig. 1) which comprises the eastern half of the Iberian Peninsula and the South of France. One significant difficulty must be taken into account when creating the catalogue which arises from the particular geographical situation, the border with France being to the north of region A and the presence of the maritime zone to the east, where it will be difficult to measure seismicity.

Zone D (SE Spain) is considered in order to investigate if major events could be felt in Catalonia.

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**Fig. 1.** Geographical situation of the area of study (A) Catalonia and the zones of influence of the different sources of information: B = Eastern Spain; C = Pyrenees; D = Southeastern Spain.

Catalonia can be considered, at present, as a region with moderate seismicity. However important earthquakes have been known to occur in the past. In fact, in 1373 there was an earthquake of intensity VIII-IX(MSK) in the Central Pyrenees; during 1427-1428 there was a seismic crisis in the Eastern Pyrenees of intensity IX, and more recently, an earthquake that occurred in the Central Pyrenees in 1923 reached maximum intensity VIII. Over the last 10 years intensity V has not been surpassed.

Over the whole of the region under study the greatest seismic activity is in the border area between France and Spain (Pyrenees) and in the South-East of Spain.

### 3. Sources of information

The procedure followed to produce the catalogue is basically to analyse critically ex-

isting compilations and to incorporate specific studies carried out on important earthquakes which have affected the area (Olivera *et al.*, 1994a,b).

Figure 1 shows the geographical location of the zones of influence of the different sources of information that have been considered.

For the whole region B data of the «Instituto Geográfico Nacional» (Mezcua i Martínez-Solares, 1983; IGN, 1991) have been considered, adding French information (BRGM-CEA-EDF: SIRENE, 1994) for the border area C. For the area A the compilations of Fontserè and Iglèsies (1971) and of Suriñach and Roca (1982) have also been taken into account. For the southern area D the work of Bisbal (1984) provides the latest check of seismicity in that area.

For practical purposes when processing the available data the catalogue has been separated into two periods: previous to and post 1900. It must be remembered that the type of information and also its acquisition is of a different nature. The macroseismic information for the first period includes studies of historical seismicity and for the second the analysis of detailed macroseismic questionnaires.

### 4. Catalogue previous to 1900

For this period the data base for each event contains a record with different parameters for each source of information. From the critical analysis of all the information and the incorporation of the different historical studies we can define the epicentre with the parameters shown in table I.

The data base of the Servei Geològic de Catalunya (SGC) includes a total of 595 events. Table II shows a classification of all the events according to different criteria. Whether or not the event was included in the reference catalogue (IGN, 1991) has been accounted for. There are 104 new events. For each of these classes it has been considered whether the epicentre and its intensity can be assigned or not. The proposed parameters of the epicenters come from the critical analysis of the different catalogues or from specific studies.

**Table I.** List of parameters included in the database of the catalogue previous to 1900 of the Servei Geològic de Catalunya (SGC).

NEVENT	Identification code of earthquake
LON	Longitude of epicentre
LAT	Latitude of epicentre
QUAL	Index of the quality of the epicentre (three classes)
NAT	Nature of the earthquake (false, doubtful)
DATA	Date of the event
INT	Intensity of the epicentre (scale MSK)
QINT	Index of the quality of the intensity (three classes)
INFO	Aftershock or premonitory
LOC	Location near the epicentre
COM	Bibliographical references and/or comments
REF	Source preferred accounting for the choice of parameters

**Table II.** Classification of the events of the catalogue previous to 1900 concerning our contribution respect to the reference catalogue (IGN, 1991).

	Not included in the IGN catalogue		Included in the IGN catalogue						
	SGC: epicentre and $I_0$ defined	SGC: epicentre and/or $I_0$ undefined	SGC: epicentre and $I_0$ defined	Modified	Unmod- ified	IGN: epicentre and $I_0$ defined	IGN: epicentre and/or $I_0$ undefined	Poor infor- mation	Non seismic events
From specific studies SGC	1	3	12	1	2	2	7	2	19
From critical comparison of catalogues	65	13	10	53	126	23	5	242	9

Of all the 595 events selected, 248 have assigned epicentral parameters, 285 correspond to earthquakes which do not have sufficient information to assign the epicentral parameters, and 62 to events considered to be of a doubtful seismic origin or clearly of non-seismic origin.

As a relevant example, we can mention the case of the main event of a series of earthquakes which occurred in 1373. It was *included in the IGN catalogue* with the epicenter situated in the region of Olot (Girona) and epicentral intensity VIII (MSK). After a *specific study carried out in the SGC* (Olivera *et al.*,

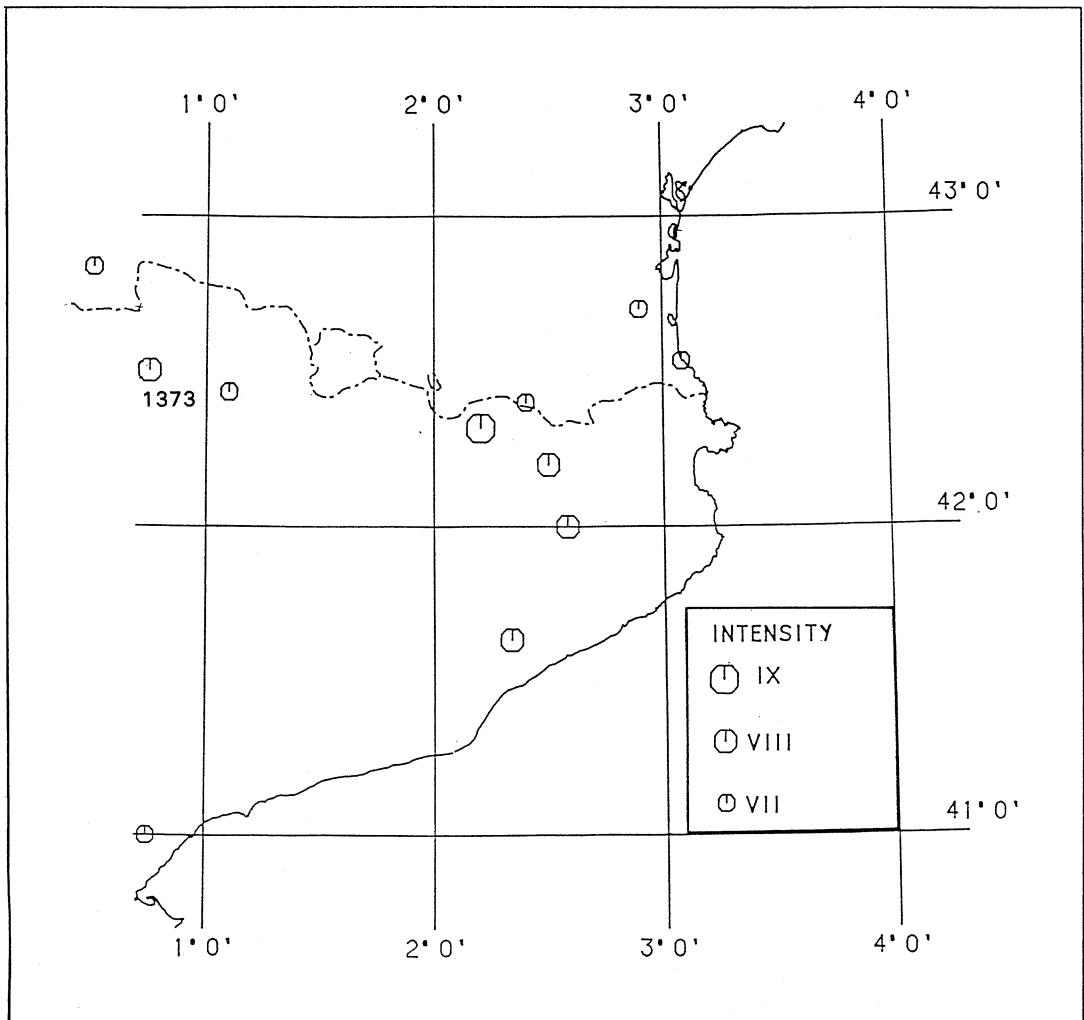
1994b) the epicentre was *modified* and in the SGC catalogue it is situated in the NW of Catalonia, 200 km far from the initial epicenter and with an epicentral intensity equal to VIII-IX (MSK).

The epicenters of known earthquakes having caused some damage ( $I \geq VII$  MSK) inside the zone A after this revision are shown in fig. 2.

### 5. Post 1900 catalogue

Given that at the beginning of the 20th century seismological activity started in Catalonia at the Observatories Fabra (Barcelona) and Ebre (Roquetes), a different methodology has been applied to 20th century events.

For this period, the study of data collection is focused on Catalonia (region A, fig. 1). The



**Fig. 2.** Epicentres of earthquakes having caused some damage ( $I \geq VII$  MSK) in Catalonia before 1900. The epicentre of the 1373 event mentioned in the text is pointed out.

epicentral parameters of the post-1900 catalogue are basically the same as those of the previous catalogue shown in table I. The methodology applied also consists of a critical review of other compilations and moreover of an examination of the epicentral parameters obtained from the data of local intensities inferable from the original macroseismic questionnaires.

These questionnaires are in the archives of the Fabra Observatory of the Royal Academy of Sciences and Art of Barcelona, which started its seismology studies in 1907. This date coincides with the implementation in this Observatory of the Italian seismographs, Agamenone, Cancani and Vicentini, and with the beginning of the macroseismic studies of regional earthquakes, such as that of 18th February 1907 (Comas i Solà, 1907).

As well as the original questionnaires, available since 1914, these archives contain other information: letters, diaries, bulletins and monographs related to the time of the earthquake. These data provide information on a total of 280 earthquakes felt by the population, of which 106 are more reliable due to the fact that they were felt in more than one place.

The study of the spatial distribution of the data of specific intensities allows us to situate the epicentre with sufficient accuracy in most cases. It has only been since the 1970s, with increasing number and quality of seismographs in the study area, that the instrumental determination of epicenters has become more accurate than macroseismic estimation.

On the other hand specific intensities allow us to investigate the intensity attenuation with distance (Susagna *et al.*, 1994) which in some cases will assist in calculating the epicentre and its intensity in the case of offshore earthquakes.

## 6. Conclusions

With regard to earthquakes before the 20th century, the proposed catalogue consists of the epicentral parameters together with an assessment of the quality of the information based on a critical analysis of the compilations of the

previously taken seismic data and on the results of studies recently made of some of the important historical earthquakes. The catalogue covers the eastern half of the Iberian Peninsula and the South of France.

As a result of this revision it has been possible to check all the data, and to eliminate a number of important errors and this has allowed the unification of criteria in order to obtain a catalogue of homogeneous data.

With regard to the earthquakes of the 20th century, the revision of the existing catalogues has been completed by including the interpretation of macroseismic surveys contemporary to the events and with early instrumental data.

The complete seismic catalogue, taken in its widest sense, is being put on a computer data base (DBASE IV for PCs) to facilitate its use in a wide range of applications.

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