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The French macroseismic database SISFRANCE: objectives, results and perspectives

Oona Scotti ([1]), **David Baumont** ([1]), **Grégory Quenet** ([2]) **and Agnès Levret** ([3])
([1]) *Institut de Radioprotection et de Sûreté Nucléaire, Fontenay-aux-Roses, France*
([2]) *Département d'Histoire, Université de Versailles-Saint-Quentin-en-Yvelines, France*
([3]) *Groupe APS, Site de Ruscino, Château-Roussillon, Perpignan, France*

Abstract
To comply with nuclear safety requirements, an in-depth research program for the revision of existing catalogues was initiated back in 1974. The priority of the partners involved in the SISFRANCE project was to establish the most exhaustive documentary databank in order to construct an intensity macroseismic database, concerning both epicentral and punctual observations. The architecture of the SISFRANCE database is presented. The strength of this parametric database is the attribution of reliability coefficients at all levels of interpretations going from the documentary sources to the final intensity estimate. To ensure homogeneity of the database, a general guideline was defined. The resulting macroseismic relational database SISFRANCE contains 65000 intensity observations attesting to the existence of 5283 earthquakes (575 with $I_o \geq$ VI) that have been felt on the French metropolitan territory over the past one thousand years. Thanks to the homogeneous methodology and to the continuous collaboration between BRGM, EDF and IRSN for the past 30 years, SISFRANCE is today a reference database and a key tool for seismic hazard assessment.

Key words *SISFRANCE database – macroseismic historical seismicity*

1. Introduction

The development of the French nuclear power program in 1974 imposed a better knowledge of seismicity. To comply with nuclear safety requirements, an in-depth research program for the revision of existing catalogues was initiated. This resulted in the creation of SISFRANCE: a relational database containing parametric information on French historical seismicity covering about a thousand years (Vogt, 1979; Vogt, 1981; Levret, 1987; Lambert and Levret, 1996; Lambert *et al*., 1997).

The purpose of the database was to collect and archive all the information pertaining to earthquakes that have been felt on French metropolitan territory. The SISFRANCE database proposes a complete description of earthquakes going from the documentary sources all the way through the quantification of the intensity observations. The strength of this parametric database is the attribution of reliability coefficients at all levels of interpretations going from the documentary sources to the final intensity estimate for all events irrespectively of their size.

After a brief recollection of the historical context that motivated the creation of SISFRANCE, the paper gives a synthetic description of the design of this database. A quantitative appreciation of the evolution of our knowledge

Mailing address: Dr. Oona Scotti, Institut de Radioprotection et de Sûreté Nucléaire, 92262 Fontenay-aux-Roses Cedex 77-83, France; e-mail: OONA.SCOTTI@irsn.fr

since the mid-seventies is presented through a comparison between the initial Rothé (1977) earthquake catalogue with the one extracted from the SISFRANCE database.

2. Historical context

At the time of the development of the French nuclear power program, the seismicity felt on the French metropolitan territory was known primarily on the basis of the work of J.P. Rothé, who compiled a number of different catalogues. For the events of the 20th century, Rothé's catalogue is based on macroseismic inquiries of the Bureau Central Sismologique Français (*Annales* and *Annuaires de l'Institut de Physique du Globe de Strasbourg*). For the events prior to the 20th century, Rothé's catalogue gathers mainly previous catalogues established by Perrey (1845), Montessus de Ballore (1906) and other regional and local compilers (*e.g.*, Villette, 1905; Pallassou, 1815) that were unfortunately built with insufficient historical critical analysis and with only a limited number of references for the documentary sources. Under the request of EDF, J.P. Rothé classified the events both geographically (according to their location) and chronologically.

The resulting unpublished catalogue provides for each event that mostly occurred in the 20th century: the date of occurrence, epicentral location, estimated epicentral intensity, the punctual intensities and some references to the documentary sources. Figure 1 illustrates the state of knowledge of the French historical seismicity at the beginning of the SISFRANCE project. The events of the instrumental catalogue

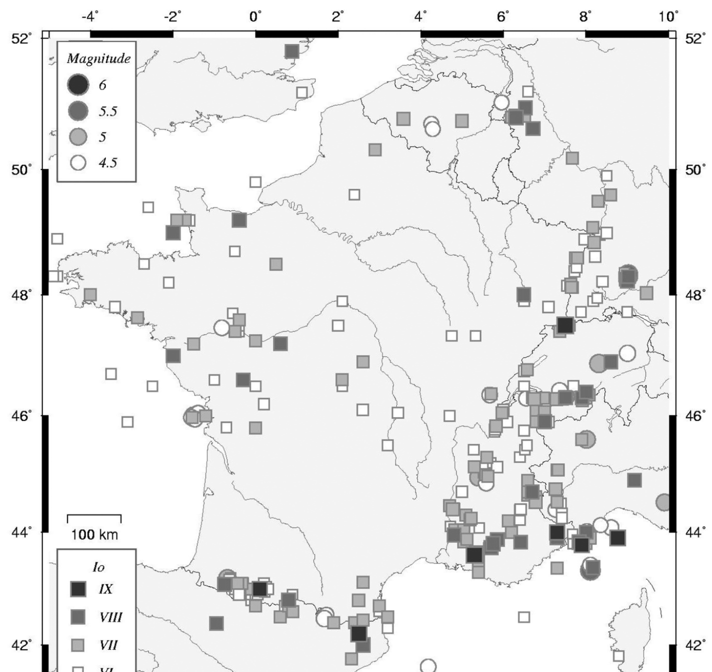

Fig. 1. State of knowledge at the beginning of the SISFRANCE project. Seismicity ($M \geq 4.5$ and $I_o \geq$ VI) reported in the historical (Rothé, 1977) and the instrumental (CEA/LDG seismicity: 1962-1973) catalogues.

(Laboratoire de Détection Géophysique, Bruyères le Châtel, France) that occurred between 1962 and 1973 are also superimposed.

Only a few events with a magnitude greater than 4.5 were reported in the instrumental catalogue. On the other hand, many events with an epicentral intensity greater than or equal to VI were reported by Rothé (1977) highlighting some important active structures, mainly in the south east part of France and along the Italian, Spanish and to a minor extent the German borders. Although France appeared as a country of low to moderate seismicity it seemed to be occasionally subjected to historically strong earthquakes.

3. Objectives

To comply with nuclear safety requirements, it was necessary to revisit the catalogues. Three French institutions were concerned, the BRGM (French geological and mining research board), the IRSN (French institute for radioprotection and nuclear safety, formerly CEA atomic energy commission) and EDF (French electricity board), joined their efforts. A research program was launched under the direction of J. Vogt with a common objective: produce the first comprehensive seismotectonic map of France (Vogt, 1981; Goguel *et al.*, 1985; Vogt and Massinon, 1985). One of six work packages that this project entailed, was the construction of a macroseismic database of all earthquakes felt on the French metropolitan territory (the SISFRANCE database was originally named SIRENE).

Seismic hazard for nuclear installations is based on a deterministic approach. This approach relies entirely on the estimation of the strongest intensities that a nuclear site could be submitted to (see RFS-2001 for the most recent text). The priority of the partners involved in the SISFRANCE project was thus to establish the most exhaustive intensity and documentary database, and to qualify all the information (for more details see Godefroy *et al.*, 1990; Godefroy and Levret, 1992). The raw and interpreted data were clearly separated allowing an easy update of the intensity evaluations (fig. 2). The different modifications of the SISFRANCE database were discussed annually and validated by the three partners. The consensual nature of this approach, albeit tedious, has paid off in the long run, because it led to a very homogenous evaluation of the intensity observations from the first through the second level of interpretation (fig. 2).

4. Methodology

To ensure the homogeneity of the database, the SISFRANCE partners defined a general guideline as follows:

i) Search for all the sources referenced in previous catalogues, with Rothé's catalogue as a starting point;

ii) Find new sources for all events that could be found in regional, municipal, occasionally parochial archives. Contemporary national or regional press journals were also searched. Perform a critical analysis of the documents by taking into account the historical, geographical and political contexts of the time. Archives of neighbouring countries were also consulted for the events that were felt in metropolitan France.

iii) Evaluate all the punctual intensities according to the MSK-64 intensity scale (Medvedev *et al.*, 1967).

iv) Attribute a degree of reliability to the documents and the different estimates.

v) Upgrade the database on an annual basis.

The working group had to face several types of difficulties when re-analysing the original catalogues used by J.P. Rothé in his compilation. First of all, it was important to distinguish between real and false earthquakes. In the early modern period, the natural phenomena (storm, landslide, earthquake) were all referred to as «terremotus» which was a source of confusion. A classic example of a problematic earthquake is the 1227 event. Due to a 16th century compiler's mistake between the locality of Salins (Savoy) and «Salviens», an antique tribe in Provence, southeast France, a landslide that occurred in Savoy at the end of 1248 became a major 1227 earthquake in Provence.

Concerning the Middle Age events and according to Alexandre (1990) who collaborat-

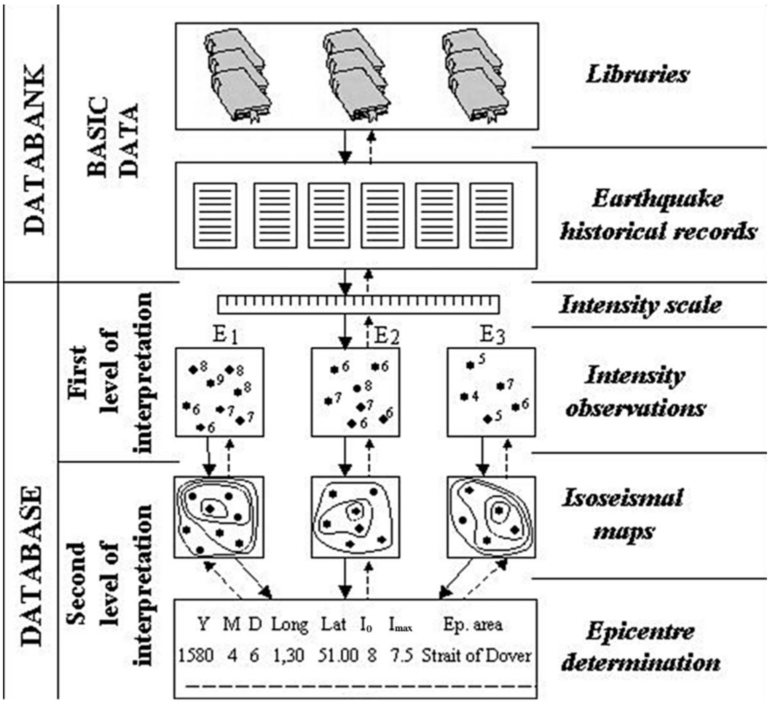

Fig. 2. Schematic relational links of the different levels of data interpretation (adapted from Stucchi, 1993). Based on the documentary sources archived in the databank, the intensities are evaluated at different sites using a given macroseismic intensity scale. The spatial distribution of the intensities is used to define the epicentral location and epicentral intensity.

ed closely with the working group, 75% of the data contained in the catalogues for this period (*e.g.,* Rothé, 1977; Perrey, 1845) were misinterpreted. Confusion was partly due to the use of different calendars in different regions. This problem remains today in some existing catalogues of the Mediterranean countries. An example of an event that was eliminated because of calendar mistakes is the 15 February 1154 and 5 February 1156 events, which correspond in fact to the 18 January 1155 Burgundy event. Confusion came also from name of localities that were wrongly transcribed.

In the 17th century, the word «Curensi», relative to the city of Chur, located in Switzerland, was transposed as «Turonensi», associated with the town of Tours (Lambert *et al.*, 1997). It was thus assumed that a destructive earthquake struck the city of Tours in 1295 whereas in reality, it occurred in Switzerland.

5. Quantifying

First level of interpretation – The intensity evaluation results from: i) a classification of buildings (typology and degree of damage) and ii) a statistical analysis of the distribution of the degree of damage for each building typology. In the SISFRANCE database, the intensities were estimated following the statistical methodology proposed by the MSK-64 intensity scale divided into 12 discrete degrees. Although half-degrees are not often considered, they were introduced in the intensity evaluation. The presence of a half-degree implies that either the intensity is uncertain (quality B or C) or the statistical evaluation is clearly midway between two intensity levels (quality A). Since information on materials and building techniques are very rarely available, it was necessary to assume a likely typology (based on the historical context of the area). A second difficulty came from the estimation of the intensity based on only a single building (*e.g.*, church, castle, and convent). In such cases, when possible, we rely on complementary information by studying traces of past earthquakes on private houses still existing to this day (Quenet and Levret, 2000; Rideaud and Levret, 2000, 2002).

Second level of interpretation – Isoseismal contours are then plotted by hand, ensuring the exclusion of abnormal intensities. The epicentral coordinates are computed using the barycentre of the isoseismals of maximal intensities (I_{max} or I_{max} -1). The epicentral intensity is taken either equal to the largest observed intensities, when well distributed data is available, or is deduced from attenuation laws, mostly for off-shore epicenters.

These methodological choices (I_o, half-degree, single building description, quality factor) can be illustrated through the interpretation of a few sources relating the 6 October 1711, Loudun-Moncontour earthquake (SISFRANCE, 2001; Baumont and Scotti, 2003). This is one of the strongest events known in the Poitou region, felt from Nantes to the West, to Le Havre to the North, and Limoges to the South. The most detailed evidence of the severity of the shock comes from Loudun (VII-VIII Q_{obs} = B), Moncontour (VII-VIII Q_{obs} = B), and Saint-Jouin sur Marne (VII Q_{obs} = B). Considering Moncontour for example, the text (Archives communales, Moncontour, 1711) mentions several collapsed houses, including that of the priest, which corresponds to a damage degree reaching 4 or 5. Assuming a building class A, this translates into intensity VII or VIII. Due to the vague terminology used in the text to describe the number of buildings affected, it is not possible to distinguish between these two evaluations. This uncertainty is therefore converted into a half-degree estimation (VII-VIII) accompanied by a weaker quality factor (Q_{obs} = B). The uncertainty in intensity evaluation is exacerbated when the description of damage concerns only one building. This is the case in Saint-Jouin sur Marne where the only source available relates damage occurring only to the abbey (Chronique de Henri Duplessis de Paumard). The description of the damage corresponds to a degree 3: four collapsed chimneys, open fissures in the vault and most of the window frames and doorframes. In this case, the building typology is assumed to be

Table I. The number of data present in the different tables of the SISFRANCE 2001 database subdivided by quality factors. Void refers to events for which no epicentral intensity could be estimated.

Quality factor	Epicentre		I_{OBS}	Isoseismal
	QI_0	Qloc	QI_{OBS}	
A	204	203	16440	101
B	942	333	46814	599
K	11	-	-	
C	643	224	2471	184
D	-	1772	-	-
E	214	436	-	-
I	1172	2315	-	-
Void	2097	-	-	-
Total	5283	5283	65725	884

of type B judging from what remains today. The minimal intensity in Saint-Jouin is thus assumed to be VII with a degraded quality factor B to reflect the single-building evaluation for this locality. Finally, the epicentral location is assumed to be at mid-distance between the highest intensity localities (Loudun and Moncontour), which are separated by 20 km (Lambert, 2003). To reflect the uncertainty of about 10 km in this estimation, a quality B is attributed. The epicentral intensity is assumed to be equal to the highest intensity observed but with a quality factor of B (constrained only by a few sparse observation points).

Third level of interpretation – Due to its consensual nature (three partners), it was decided to only provide intensities. Nevertheless, source parameters (magnitude, depth) have been determined for 140 events (Levret *et al.*, 1994) but are not calculated within the framework of the SISFRANCE project.

6. The SISFRANCE database: architecture and content (2001)

SISFRANCE has been managed through a relational database since 1986 (Godefroy *et al.*, 1980; Godefroy and Levret, 1992) using the same architecture and applying the same methodology. The BRGM manages the database on a UNIX server via Oracle-8 and a GIS interface. The BRGM is responsible for the systematic search of documentary sources, their interpretation and the intensity assessments. The results of these studies can be found in BRGM internal reports. In depth research, focused on specific events important for the safety of nuclear plants, were also conducted with teams of specialists from several neighbouring countries, in the framework of programs sponsored by the Commission of the European Communities (CEC) or the International Atomic Energy Agency (IAEA). The following case studies are examples of such focused research: the 1909 Lambesc, Provence earthquake (Levret *et al.*, 1986), the 1428 Catalonia, 1564 and 1644 Alps, earthquakes (Lambert, 1993), the 1580 Strait of Dover and the 1382 North Sea earthquakes (Melville *et al.*, 1996), the 1356, Basel, Swiss earthquake (Mayer Rosa and Cadiot, 1979), the 1799 Bouin, Bretagne (Levret *et al.*, 1996; Scotti and Levret, 2000) and 1887 Ligurian earthquake (Scotti and Levret, 2000), the 1708 Manosque, Provence earthquake (Quenet, 2001; Quenet *et al.*, 2003), and the 1704 Poitou earthquake (Quenet and Levret, 2000; Rideaud and Levret, 2002). In all cases, the working group meets yearly to discuss and validate these interpretations before updating the database.

The simplified conceptual model of the relational database is presented in fig. 3. The main table is the event table (EVTSIRENE), which exists if at least one observation (OBSIRENE) exists. Each observation refers to a locality (LOCALITES) and at least one bibliographic reference (BIBLIO, DOCUMENTS). The observations are then plotted on a map and the epicentral characteristics (intensity and location) of the event are deduced (EPCSIRENE). The database contains 5884 events including 458 doubtful and 143 false earthquakes. For the 5283 true earthquakes, 575 have an estimated epicentral intensity equal to or greater than VI MSK (280 with QIE = A, B, K and 295 with QIE = C, E, I) and 2545 have an unknown epicentral intensity. Some 65 000 intensity observations describe seismic events dating as far back as one thousand years.

The originality of this parametric database is the attribution of reliability coefficients at all levels of interpretations going from the documentary sources to the final intensity estimate. Concerning the documentary sources, reliability coefficients have been attributed based on a number of criteria (original source or copy, direct or indirect testimony, level of precision and of exaggeration). As summarized in table I, SISFRANCE attributes to the estimated epicentral location a quality factor from A (certain and reliable) to I (isolated intensity observation, insufficient, not to be used as epicentre location). It also qualifies the estimation of the epicentral intensity from A (well defined) through E (doubtful evaluation), I (isolated intensity observation) and K (calculated from an attenuation relationship). It is clear that the quality of this information is directly related to the spatial sampling and the reliability of the intensity data points in the epicentral area. The epicentral intensities are therefore to be considered with care, the uncertainty on their value being often of half a degree or

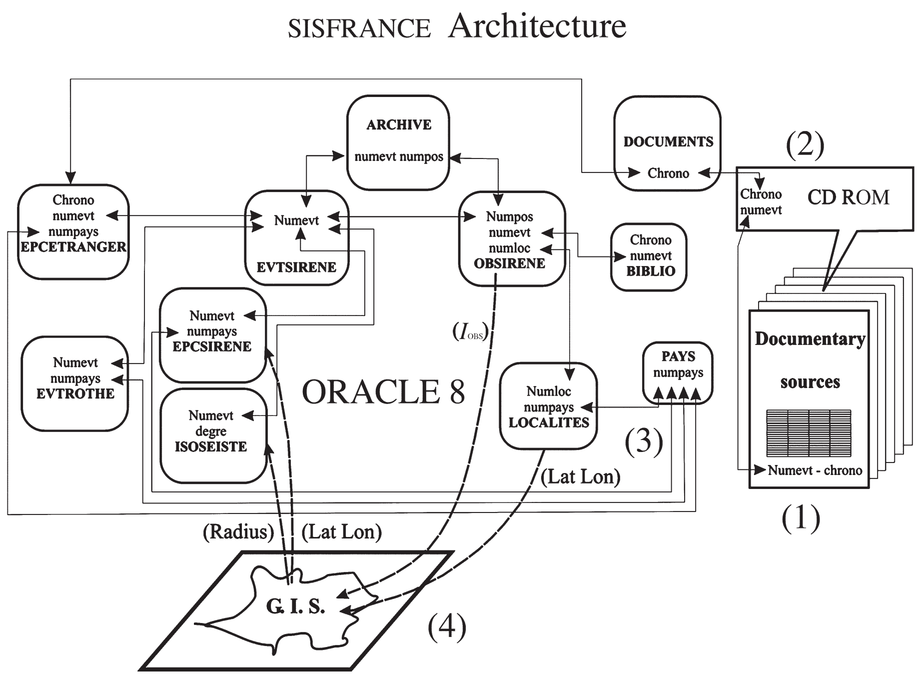

Fig. 3. Structure of the relational database SISFRANCE: from the (1) documentary sources, describing an event (2) in the different localities, the evaluated intensities (3) are plotted on a map, and (4) the epicentral parameters are deduced (from Godefroy *et al.*, 1990).

more. Similar quality factors are used to describe the reliability of the OBSIRENE table, the ISOSEIMAL table (see table I) and the BIBLIO table. Moreover, in the OBSIRENE table, there are different codes that qualify the physical phenomena that may have affected the locality associated with the intensity observation: effects on water wells, landslide effects, site effects and so on. These codes are meant to alert the users that the evaluated intensity observation may have to be considered with great care. A careful selection of the data on the basis of these codes is necessary before analysing the data for magnitude estimates.

In 2000, the historical database became partly available to the public via Internet (www.sisfrance.net). Only the most reliable observations are available online. As far as possible, the original documents are also available on the Internet site, irrespective of their associated quality factors.

7. Evolution of knowledge since Rothé's catalogue

Thanks to the continuity of the project over recent decades, numerous events are now known on the basis of 10 or more intensity observations, reaching on average 60 observations when focused research was conducted. For example, the 21 June 1660 event, which was known before the seventies on the basis of only three observations, is today described by 70 intensity observations (Vogt, 1983). Furthermore, since Rothé's catalogue, 94 new events with $I_o \geq$ VI were discovered on French territory (fig. 4a), 33 with $I_o \geq$ VII. Among the events in Rothé's catalogue for which no epicentral intensity was evaluated, 70 of them are now reported in SISFRANCE with an estimated epicentral intensity, although two thirds of them remain badly constrained (23 with QIE = C and

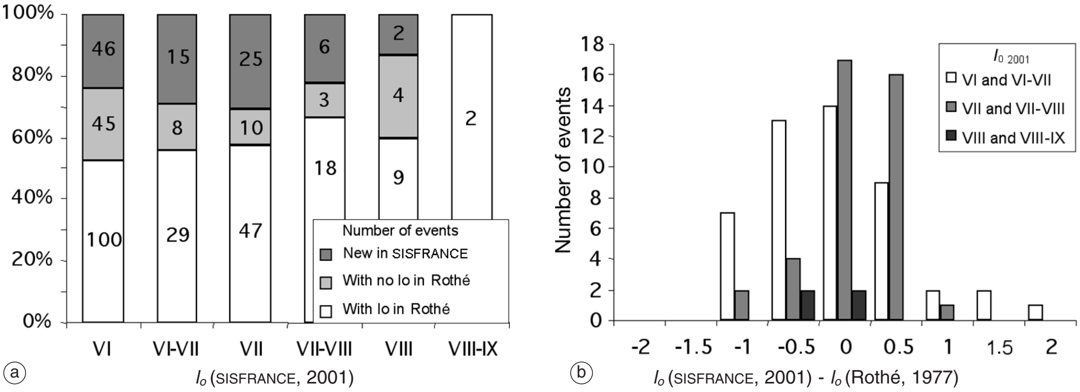

Fig. 4a,b. Comparison between the original Rothé catalogue (Rothé, 1977) and the present day catalogue extracted from the SISFRANCE (2001) database for real earthquakes that occurred in France before 1962 and for which the epicentral intensity, I_o is greater than or equal to VI: a) events with an estimated I_o that were added to the database (all qualities are considered). Fourteen quakes listed in Rothé's catalogue were identified as fake events; b) changes in the epicentral intensity evaluation for events with QIE A and B.

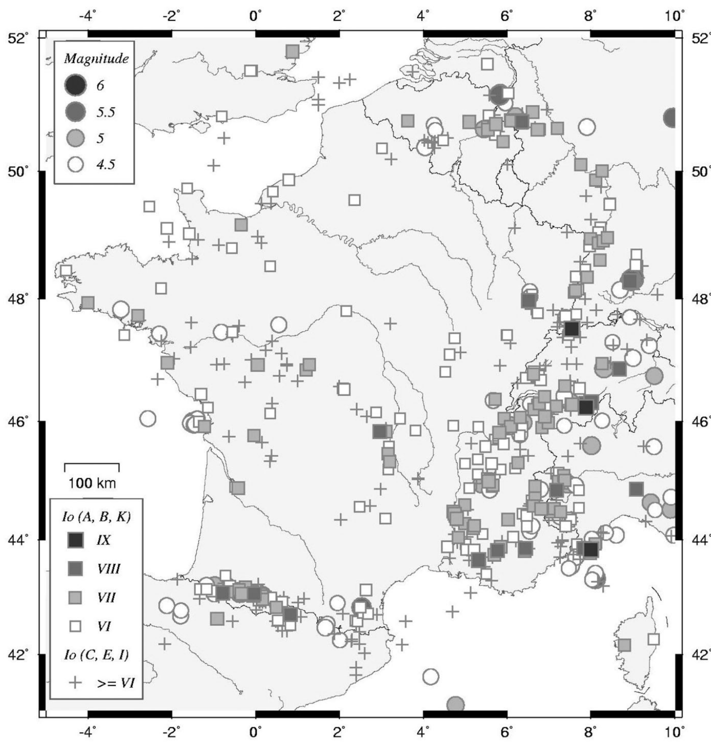

Fig. 5. State of knowledge in 2002. Historical (extracted from SISFRANCE (2001) database) and instrumental seismicity recorded in French catalogues (CEA/LDG 1962-2002). Historical events are represented by the squares when the epicentral intensity evaluation is sufficiently reliable and by crosses when it is considered uncertain.

methodology applied to evaluate the intensity, the epicentral intensities were re-evaluated for a better consistency. Figure 4b shows the evolution of epicentral intensity for the most reliable epicentral estimates ($I_o \geq$ VI and QIE A and B).

The differences of evaluation between the SISFRANCE database and Rothé's catalogue (1977), remains overall symmetrical and centred on 0. Most of the changes are smaller than half-degree, which can be considered as the minimal uncertainty of the epicentral intensity evaluation. However, it can be noticed that 50% of Rothé's I_o = VII-VIII or VIII were augmented by half degree, whereas 50% of I_o = VIII or VIII-IX were reduced by half degree. Figure 5 shows a map of the most significant earthquakes ($M \geq 4.5$ or $I_o \geq$ VI) reported in the historical and instrumental French catalogues the present day. It is remarkable that the instrumental catalogue in 2002 does not show any moderate magnitude seismicity in Central France and in the Strait of Dover whereas clearly the historical catalogue shows several earthquakes generating intensities greater than VI for the past centuries. The comparison of fig. 1 and 5 shows that in the 1970's, the main active zones were already well depicted by the historical seismicity. Naturally, thanks to the efforts conceded in the past 25 years, the seismic activity of these zones is now better quantified, but most importantly better qualified. Indeed, for half of the events ($I_o \geq$ VI), the epicentral intensity is still poorly constrained, particularly in Central Western France.

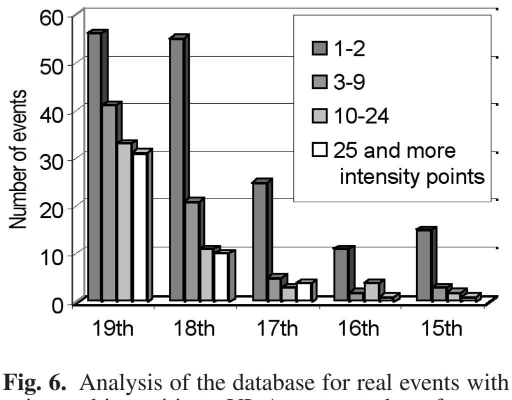

Fig. 6. Analysis of the database for real events with epicentral intensities ≥ VI: A great number of events are only known through less than 10 data points. The number of events decreases as a function of time. The change observed between the 17th and 18th centuries marks the appearance of the printed sources.

8. Perspectives

Although the SISFRANCE database could be further improved for instance by explicitly distinguishing primary and secondary sources in the bibliography, by allowing the user to access the interpretative study (from the sources to the intensity quantification) for at least the most important events, by far, the main challenge is to find new strategies to improve our knowledge concerning the numerous important earthquakes ($I_o \geq$ VI) for which only a few observation points are available (fig. 6).

There is little hope of improving our knowledge through medieval archives: there are only a few and they have already been well exploited (as a means of comparison, the number of French medieval sources is only half of those available for the single town of Venice, Italy).

The most fruitful period to focus research may be the 16th century to the 19th century where the French National archives provide 118 000 units (before 1789). The press, which gave rise to abundant information, has already been widely explored, however, this period is also rich in manuscripts and administrative archives that are waiting to be thoroughly exploited because they may contain valuable documentary sources.

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REFERENCES

ALEXANDRE, P. (1990): Les Séismes en Europe Occidentale de 394 à 1259, Nouveau catalogue critique, *Observatoire Royale de Belgique, Série Géophysique (Bruxelles),* p. 266.

Archives Communales De Moncontour (Vienne), *Registre Paroissial* (1711).

Baumont, D. and O. Scotti (2003): Ré-examen des intensités des secousses produites par les séismes de Loudun - Moncontour (1711), de Parthenay (1772), et de Ste-Maure (1657), *Int. Rep. IRSN/DPRE/SERGD No. 03-24*.

Chronique de Henri Duplessis de Paumard, Sénéchal de Saint-Jouin (Deux-Sèvres), Archives privées.

Godefroy, P., S. Thirion, J. Lambert and B. Cadiot (1980): Informatisation du patrimoine de sismicité historique de la France, *Bull. BRGM*, 2ème série, Section IV (2), 139-145.

Godefroy, P., J. Lambert, A. Levret and P. Vaskou (1990): The French macroseismic database «sirene», in *22nd General Assembly of the European Seismological Commission,* Barcelona.

Godefroy, P. and A. Levret (1992): Creation and management of a database dedicated to historical and contemporary macroseismicity in France: various applications in earthquake engineering, in *Recent Advances in Earthquake Engineering and Structural Dynamics*, edited by V. Davidovici (Ouest Editions, Press Académiques), 89-116.

Goguel, J., J. Vogt and C. Weber (1985): La carte sismotectonique de la France, in *Génie Parasismique*, edited by V. Davidoci (Presses de l'école nationale des Ponts et Chaussées, Paris), 187-192.

Lambert, J. (1993): Materials of the CEC Project: review of historical seismicity: the Catalonian (1428) and Alpine (1564-1644) earthquakes: review of research in France, in *Historical Investigation of European Earthquakes, Materials of the CEC Project «Review of Historical Seismicity in Europe»* edited by M. Stucchi (CNR, Milano), 145-161.

Lambert, J. (2003): Un nouveau repère dans l'aire pléistoséiste du séisme poitevin du 6 octobre 1711, in *Documentation, Séismes 1708-1711, BRGM ARN-JL-L-03/172*.

Lambert, J. and A. Levret-Albaret (1996): *Mille ans de séismes en France, Catalogue d'épicentres. Paramètres et Références* (Ouest Éditions, Nantes), pp. 70.

Lambert, J., P. Bernard, G. Czitrom, J.Y. Dubie, P. Godefroy and A. Levret-Albaret (1997): *Les Tremblements de Terre en France: Hier, Aujourd'hui, Demain* (Éditions du BRGM, Orléans), p. 196.

Levret, A. (1987): Historical seismicity in France and its role in the assessment of seismic risk on French nuclear sites, in *Historical Seismicity of Central Eastern Mediterrenean Region* (ENEA-IAEA, Rome-CRE, Casaccia).

Levret, A., J.C. Backe and M. Cushing (1994): Atlas of macroseismic maps for French earthquakes with their principal characteristics, *Natural Hazards*, **10**, 19-46.

Levret, A., M. Cushing and G. Peyridieu (1996) Etude des caractéristiques des séismes historiques en France, in *Atlas 140 Cartes Macrosismiques*, edited by Institut de Protection et Sûreté Nucléaire.

Levret, A., C. Loup and X. Goula (1986): The Provence earthquake of June 1909 (France). A new assessment of near field effects, in *Proceedings of the 8th Conference of EAEE* (Lisbon).

Mayer Rosa, D. and B. Cadiot (1979): A review of the 1356 Basel earthquake, *Tectonophysics*, **53**, 325-333.

Medvedev, S.V., W. Sponheuer and V. Karnik (1967): Seismic intensity scale version 1964, *Punl. Inst. Geody*. Jena, **48**.

Melville, C.P., A. Levret, P. Alexandre, J. Lambert and J.Vogt (1996): Historical seismicity of the Strait of Dover-Pas de Calais, *Terra Motae*, **8**, 626-647.

Montessus De Ballore, F. (1906): Les tremblements de terre, *Géographie Sismologique* (Paris).

Pallassou, P.B. (1815): Liste de plusieurs tremblements de terre ressentis dans les Pyrénées, in *I.D., Mémoires pour Servir à l'Histoire Naturelle des Pyrénées et des Pays Adjacents*, T1 Pau, Vignancour, 260-284.

Perrey, A. (1845): *Mémoire sur les Tremblements de Terre Ressentis en France, Belgique et Hollande, depuis le Quatrième Siècle de l'Ère Chrétienne jusqùà Nos Jours (1843 inclus)* (M. Hayez, Bruxelles), p. 110.

Quenet, G. (2001): Les tremblements de terre en France XVII-XVIII siècles. Une histoire sociale du risque, *Thèse de l'Université Paris I, sous la Dir. de Daniel Roch*e.

Quenet, G. and A. Levret (2000): Aspects méthodologiques de la recherche en sismicité historique: application au séisme de 1704 en Poitou, in *Archéosismicité et Vulnérabilité du Bâti Ancien*, edited by R. Marichal, *Actes des IV° Rencontres du Groupe APS*, Perpignan 1999, 87-105.

Quenet, G., G. Poursoulis, A. Levret and N. Lambert (2003): Le séisme de 1708 à Manosque, France: une approche pluridisciplinaire pour une estimation quantifiée de ses effets, in *Archéosismicité et Vulnérabilité: Environnement, Bâti Ancien et Société,* edited by R. Marichal, *Actes des VI° Rencontres du Groupe APS*, Perpignan, p. 200 (in press).

Rfs-2001, Règles fondamentales de sûreté relatives aux installations nucléaires de base (http:// www.asn.gouv.fr/data/information/decision12b.asp).

Rideaud, A. and A. Levret (2000): Traces de séismes historiques sur le bâti ancien en moyenne Durance: Beaumont-de-Pertuis, in *Archéosismicité et Vulnérabilité du Bâti Ancien*, edited by R. Marichal, *Actes des IV° Rencontres du Groupe APS*, Perpignan, 1999, 39-64.

Rideaud, A. and A. Levret (2002): Traces du séisme de 1704 sur le bâti de la région de Vendœuvre du Poitou, in *Archéosismicité et Sismicité Historique: Contribution à la Connaissance et à la Définition du Risque*, edited by R. Marichal, *Actes des V° Rencontres du Groupe APS*, Perpignan, 2000, 165-176.

Rothé, J.P. (1977): *Listes chronologiques d'épicentres en liaison avec les évènements de SisFrance*, Travaux inédits et Annales et Annuaires de l'Institut de Physique du Globe de Strasbourg.

Scotti, O. and A. Levret (2000): How to calculate seismic parameters for large offshore historical earthquakes, in *27th General Assembly ESC*, Lisbon, Portugal.

Sisfrance (2001): *Fichier de Sismicité Historique de la France*, BRGM/EDF/IRSN (on line: http://www. sisfrance.net/).

Stucchi, M. (1993): Historical seismology and seismic

hazard, *Ann. Geofis.*, **XXXVI** (1), 177-189.
VILLETTE, J. (1905): *Les Tremblements de Terre dans les Ardennes et les Régions Voisines* (Sedan, E. Laroche).
VOGT, J. (1979): Les tremblements de terre en France, Orléans, *Mémoire BRGM No. 96,* p. 220.
VOGT, J. (1981): Carte sismotectonique de la France à 1:1000000. *Mémoire BRGM, 111*, Orléans.
VOGT, J. (1983): The Pyrenees earthquake of 1660: Effects in France, *Disasters*, **7** (3), 191-193.
VOGT, J. and B. MASSINON (1985): Sismicité historique et sismicité instrumentale, in *Génie Parasismique*, edited by V. DAVIDOCI (Presses des Ponts et Chaussées, Paris), 179-186.