

A glimpse at the historical seismology of the West Indies

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Abstract

This contribution describes the state-of-the-art of historical seismology in the West Indies. An overview of the current parametric earthquake catalogues shows that historical earthquakes in the Greater and Lesser Antilles are less well known compared to those which affected the Venezuelan and Central American regions. Problems are still numerous and hard to solve for most former earthquakes, known from the mid 16th century on. The analysis of the catalogues shows that they are incomplete, and that their reliability also should be reconsidered. In recent years, the author has investigated locally stored primary historical sources as well as those in foreign archives and libraries, for instance in France and the United States. The paper deals with some case histories, the 1692, 1751, 1767, 1770, 1830, 1842, 1852, 1860, 1887, 1892 earthquakes in the Greater Antilles, the 1690, 1727, 1839, 1843, 1867 and 1897 in the Lesser Antilles. The examples highlight that there is still a need for further improving our knowledge on the historical seismicity of the West Indies, and that the investigation of the sources and repositories located outside this region is an open way to fruitfully approach this task.

Key words *West Indies – historical seismology*

1. Introduction

This contribution presents a short glimpse at the historical seismology of the West Indies (fig. 1). Some personal experience of the area leads to a tentative appraisal of the state-of-the-art. While methodological and source problems are stressed, mostly from the author's own experience, no effort has been made to provide an up-to-date inventory of catalogues of different types or specific papers, the discussion being limited to a more or less representative sample of both. Indeed available information, often new, could fill a book.

Actually, the historical seismology of the West Indies is not a field of over-research as

some parts of the world are sometimes thought to be. While parts of the Caribbean area participated in the renaissance of historical seismology, mostly Venezuela and Central America, parts of it escaped it, aside from sweeping catalogues, often inspired by former ones, and considering only publications founded on genuine research with a renewal of knowledge and/or interpretation. Indeed the history of West Indian earthquakes forms a patchwork not easily mastered. It should not be forgotten, in a general way, that research often must be undertaken in not always easily accessible depositories, archives and libraries, in Europe and the United States.

2. Catalogues and studies of West Indies seismicity, and associated problems

Leaving aside classical seismological compilations, such as Perrey (1846), Poey (1857), Scherer's papers on the seismicity of Haiti

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(Scherer, 1911; Scherer, 1912), half a century later, emphasizing major events of the 18th century and mid 19th century (1751, 1770, 1842), should be hailed as a landmark. He encompasses in a modern way, not always attained nowadays, the many facets of historical seismology even if seismotectonic interpretation is still in its infancy. At the same time Taber and others investigate specific past and contemporaneous events with the same state of mind (*e.g.*, Reid and Taber, 1920).

However a slump followed, with different time spans from one island or cluster of islands to another. While seismotectonic discussion went on, more or less, often in a straightforward way, historical seismology was neglected to a large extent, sometimes in a paradoxical way. While Taber skilfully uses arguments from well-mastered historical seismology for an overall view of «the seismic-belt of the Greater Antilles» (Taber, 1922), the pages devoted to the West Indies by Sieberg's *Erdbebengeogra-*

phie in Gutenberg's famous *Handbuch* are a disaster, misleading as much by the choice of events as, it seems, by the short information given for them. Major events escape it, *e.g.*, the well known 1842 earthquake in northern Haiti or the major Cuban events of 1766 and 1852, while less important ones are nevertheless considered as *wichtigere Erdbeben* (strong earthquakes). In several cases sweeping information on damage should be carefully checked. For instance, it would be interesting to know if there is really any substance to the *Küstenabbruch* (coastal cliff fall) reported for the 1751 earthquake in Haiti, an event I know fairly well.

Later, a paradoxical message is delivered by Rutten and Raadshooven (1940). Quoting several older catalogues, Perrey (1846), Poey (1857), Salterain y Legarra (1884), they state that «they are [...] of no great use to modern researches as the combination of macroseismic and seismographic data, necessary for a good

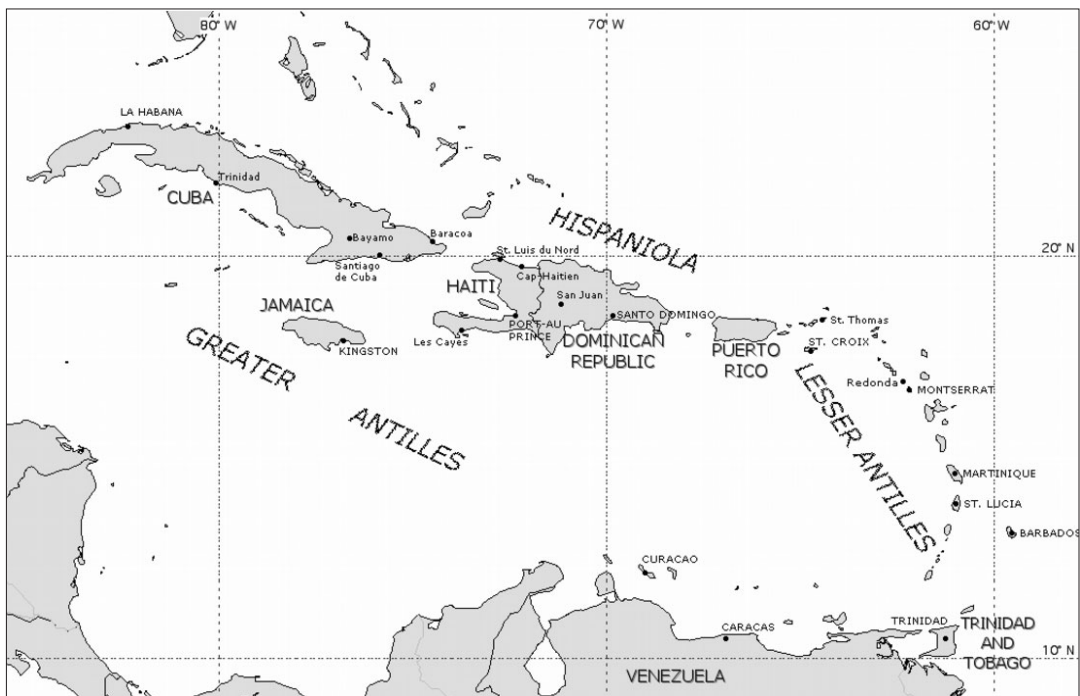


Fig. 1. Greater and Lesser Antilles: places mentioned in the text.

understanding of the phenomena, is only possible since about 30 years». Casually they also mention Scherer and some others. While shortcomings of catalogues, old as well as recent, are numerous, the authors clearly underestimate, as a kind of postulate, the value of historical seismology on the whole. Limiting their efforts to the instrumental period, from 1913 to 1938, they however have to admit many shortcomings of seismographical data. They are disturbed by the «remarkable fact that in the West Indies during the past 27 years quite a number of earthquakes with rather large intensity and spreading have been felt which are not registered in seismograms» (Haiti, Dominican Republic, Jamaica, Puerto Rico). Also «as far back as 1914 the strong Jamaica earthquakes have not been recorded at other observatories than St. Martial» (Haiti). Besides, a lot of strong events «have not found a place in the International Seismological Summary». Despising historical macroseismology in a general way, they nevertheless have to stress the importance of contemporaneous macroseismology evolving, of course, into the former. Later, look, for instance, at the Caribbean sketch of a paper devoted in 1973 to prediction criteria of major plate boundaries (Kelleher *et al.*, 1973). In a symptomatic way you will find a lot of question marks, not all easily identified and understood, for events of Lesser Antilles (1831, 1834) and Haiti (1751, 1770, 1860, 1887, 1911). Clearly the authors are not at ease with events of the past. We read: «Estimated rupture zones of Caribbean shocks since 1800; three great shocks of the 18th century are also included». What about other events with similar intensities, seemingly also important for such discussion? So the performance of historical seismology, a quarter of a century ago, seems poor at first glance. While question marks are still present for a lot of 19th century events, major events of the 18th century were rather well known at that time, with, of course, a steady improvement since. Of course problems are still numerous and hard to solve for most former earthquakes, known from mid 16th century onwards.

After a lot of more or less specific catalogues, with more or less shortcomings, new

ones have since been produced for the greatest part of the West Indies, also with shortcomings. It seems that the trend begins with the early catalogue devoted by Robson (1964) for the eastern Caribbean. It is mostly based on information easily available in Trinidad and neighbouring islands, using, besides Mallet (1853-1855) and, partly, Perrey (1846), information given by newspapers. He himself writes that «no attempt has been made to examine the source material from which these catalogues (Mallet, Perrey) [but not Poey] were compiled, a costly undertaking..., sources whose *reliability* it has not been possible to assess» (Robson, 1964). On the whole, assessments of intensities, some times clearly conventional, are not reliable. In most cases, macroseismic areas and epicentres are not discussed. Even Trinidad is not mastered, at least for events of the 18th century. Nevertheless this catalogue is useful for collecting a wealth of local, hardly interpreted information that can be used for a wider regional discussion. Data banks uncritically fed by Robson's (1964) catalogue would be misleading, with the exception of the use of such basic material. Personally I plan to exploit my files to provide a more balanced view of Trinidad's historical seismicity, mostly linked to earthquakes at some distance, which nevertheless are sometimes destructive.

Jamaica, a larger island, with better possibilities of comparison with other islands at similar scales, and with a larger background of historical seismology, is better mastered by Tomblin and Robson's (1977) catalogue, once more fed to a large extent by a systematic search in West Indian, chiefly Jamaican newspapers. While no thorough catalogue seems to have been recently devoted to Haiti, several regional or global catalogues, including of course the Haitian seismic activity, have been prepared for the Dominican Republic in a more or less repetitive way. Martinez Barrios' catalogue (1946) in the mid 20th century is followed in 1978 by Utrera (1978), adding information to Scherer's fundamental work (covering also the Eastern part of the island) and by a succession of catalogues by Acosta Segura (1987; n.d.). Sometimes these do not always meet expected standards, for example, with regard to sources.

Most interesting are the maps devoted by *Nuevo Atlas Nacional de Cuba* (1989) to the seismicity of the Caribbean and the country. While magnitudes are stressed from 1904 onwards (Alvarez Gomez, 1989), a map of epicentres is proposed from 1551 to 1983 (Chuy Rodriguez, 1989). Without discussing its conception from other points of view, even locations raise questions. Strikingly, a set of important towns appears, Trinidad, Bayamo, Baracoa, etc. Once more a frequent urban fixation appears. Furthermore, some isoseismal maps are provided, the oldest being for the western Cuban 1880 event. Isoseismals of major earthquakes of the area can be found elsewhere, notably for the 1842 Haitian event, encroaching on Cuba's Oriente, used for the preparation of an «isoseismal model» by Alvarez and Chuy Rodriguez (1985). The same authors (Chuy Rodriguez and Alvarez, 1988) also supply data on the 1751 and 1770 earthquakes in the Española island.

Satisfactory standards are attained by Feuillard's (1988) catalogue of the French islands, using not only former catalogues, like Poey (1857), famous French authors for several time-spans and specific events (like the many books and papers by Moreau de Jonnés, *e.g.* 1822), and newspapers (to a limited extent), but also a range of original sources, at least the more easily available ones in French archives. While most assessments of intensities seem reliable, there are once more some shortcomings in appraisals of macroseismic areas, mostly for smaller events, not only from the end of the 17th and the beginning of the 18th century but also from the 19th century. It should be stressed that this effort has been made by a specialist of instrumental seismology, convinced of the need of a better knowledge and a better use of historical information. It is one of the reasons why this pioneering work won wide approval, first, of course, in the French islands.

Personally I made intensive research over the years, a costly undertaking indeed, in archives and libraries not only in Santiago de Cuba, Port-au-Prince, Santo Domingo, Sainte-Croix, San Juan, Martinique, Barbados and Curaçao, with some results, although mostly limited to events of the second part of the 19th and

the first half of the 20th centuries. Most of the research was made in European and North American depositories storing a wealth of not easily accessible or forgotten sources for former events. Most information (some of it could be called «discoveries») was gathered in France and the United States, while a lot of work has still to be done in Great Britain, Copenhagen, etc.

Besides other harvests, major events have been revised for Haiti and the Dominican Republic (1751, 1770, 1842) and the Lesser Islands (1690, 1727-1928, 1839, 1843, 1851, 1870, 1897) partly published (Vogt, 1994), for the major part unpublished. Besides, many forgotten smaller events have been identified, possibly filling «gaps».

In a more general way I tried to discuss shortcomings of catalogues for some years, chosen at random, of the mid 19th century (Vogt, 2001a), a complex work going on, although slowly, avoiding, of course, poor and/or misleading data banks using to a large extent uncontrolled secondary information.

It is too early to assess the degree of craftsmanship and originality of a recently announced French data bank for the West Indies and the Caribbean sea (SisFrance-Antilles, 2002), described as containing 1600 events with their epicentral intensity, 4900 observations and 400 «références documentaires», the latter being a rather small number compared with the figures given for the data bank for France, respectively 5000, 9000 and 9800. Although the fields are not at all comparable, the gap between the figures for «références documentaires» is nevertheless striking, considering the wealth of material available for the West Indies.

One can ask, to what extent are these catalogues, learned papers and the like leading to reinterpretations of events, or to the discovery of forgotten ones? We all should admire people able to propose epicentral intensities of so many events, many of which are reported from only one town or even by one ship's captain. It should really be an outstanding achievement earning worldwide fame. Here and there it seems that specialists proceeded straight from their stock of catalogues, monographs, newspapers, etc., to rather summary data banks, with-

out bothering with any intermediate stage, at least any accessible one.

Actually the main interest is often for major quakes, for instance from intensity VII on, as also in some cases in other parts of the world. A recent discussion of the seismic potential of a part of Cuba takes into account only eight events from 1692 to 1913, a sharp contrast with a wealth of instrumental information for the period 1979-1989 (Alvarez and Bune, 1978; Chuy *et al.*, 1988; Cotilla *et al.*, 1997). In a large part of the West Indies, as elsewhere, it seems that less important historical earthquakes, even with question marks, could bring suggestions for a better informed seismotectonic discussion and for a better appraisal of the seismic potential at scales different from those of major earthquakes. Besides, events now considered as minor, *e.g.*, less than degree VII from available information, could in fact turn out, from further research, to be of higher intensity and a kind of Damocles' sword. Such a remark could apply to events known only from some town and not from the countryside, with possibly, in fact probably, a higher epicentral intensity.

In a paradoxical way, even the most important events are not always fully exploited from a proper seismological and a seismotectonic point of view. Most catalogues and data banks consider only the main shock and possibly one or another important aftershock. It is easily forgotten that the wealth of sources for several earthquakes is such that whole sequences can be followed, sometimes for months, in a rather precise way. Fine examples are, for instance, the famous earthquakes of 1751, 1770 (Haiti), 1852 (Cuban Oriente) and 1860 (Haiti). Such sequences deserve attention not only for a proper assessment of damage and intensity, but also for a tentative discussion of the migration of epicentres in paleoseismic areas and for the knowledge of types of sequences possibly by comparison with instrumentally known sequences in the same areas. Such remarks apply mostly to large islands. It is not always easy to distinguish in the Lesser Antilles, with their «island-hopping» problems, shocks belonging to such sequences from specific nearby events. Whatsoever, catalogues and data banks should provide, besides other basic requirements, two

major pieces of information. First they should systematically give appraisals of reliability, for the location of epicentres, epicentral intensities, etc., from a judgement founded on an intimate knowledge of sources and their whereabouts. In other words it should be the unavoidable task of those responsible for research and not left to somebody else, with talents for computer work. Furthermore, sources should always be identified in a proper way, to enable checking and possibly reinterpretation by others. Nowadays I could still echo the following words written about the absence of sources in the mid 19th century by Poey dealing at that time with Cuban earthquakes and storms: «*Malheureusement cet abandon a trop souvent lieu parmi les auteurs. On dirait qu'ils craignent qu'on puisse y recourir*» (Unfortunately, researchers too often abandon sources. It seems that they fear to find new information) (Poey, 1855).

Too often data banks escape revision like, in many cases, geological maps. Money spent, work done, epicentres located, intensities assessed, magnitudes calculated, etc. New information brought by historical seismology should not only be incorporated in a rough way, but should sometimes lead to drastic reinterpretation, with, possibly, consequences for seismotectonic discussion and appraisal of seismic risk.

Besides, let's insist on the correct sense of two words, among others, that are widely used in a haphazard and misleading way. The word «source» should apply to original records or their faithful copies, translations, summaries and to contemporaneous or later echoes using disappeared or inaccessible primary sources, to be exploited, of course, in a most critical way. Too often unreliable second-hand records and even catalogues are listed under this heading, in a most deceiving way. Similarly the word «archives» too often designates no more than some corpus of documentary material of any kind, including once again, catalogues, while it should be used in a strict sense to indicate genuine archive material with its specific problems of research. In a paradoxical way it is sometimes used by people without the least idea of what a depository is. In these matters, seismologists need to learn from historians.

3. Sample case histories

Luckily we know more and more examples of well-balanced convergent efforts by historical seismology and seismotectonic discussion with, in between, instrumental seismology. Only two examples from the French islands are given here. Once more we should mention Feuillard's (1988) «catalogue» with its broad perspective. Later a harmonious collaboration of Bernard and Lambert (1988) led to sizable results, although mostly classical sources, like Sainte-Claire Deville (who produced a lot of publications, *e.g.* 1861), have been used, with of course unavoidable minor disagreements, here and there, with other sources.

But we should avoid general optimism. After a first «renaissance», at the beginning of the 20th century, a long slump, over half a century or even a century, has been described, followed by another «renaissance». Some people think that historical seismology is coming to an end, that most work has been done, with wonderful data banks, while some strange elderly people are going on in a stubborn way. The trend is to jump from micro-seismology to bulldozer work relying, between these extremes, on often hasty, uncritical listings, with sometimes a paradoxical preference for important events. In some parts of the world such workmanship would satisfy the needs of seismotectonic overall interpretation. Actually, despite a lot of achievements, the West Indies are not ready for such a state of mind. While historical seismology question marks have diminished since the seventies they are still numerous, requiring intensive work to gather down-to-earth information and to (re)interpret numerous events and their setting.

Historical seismology is often used in a narrow, subordinate way, with a tendency to quantitative abstraction illustrated by several data banks, while qualitative informations should be of foremost interest, first of all for mastering the complex field of seismo-geological features. In some cases, in regions with large intervals between major events, only centuries-old earthquakes provide arguments for the assessment of this essential part of the discussion of seismic risk, the indirect one. Actually, personal work has been devoted to the identifica-

tion of cases of liquefaction, rockfalls, etc. in the different geological and geomorphological settings of the Greater and Lesser Antilles, with a wealth of information, still to be located precisely by fieldwork. Many examples were given at the workshop devoted to historical seismology at Perpignan in 2002 (Vogt, 2001b; Vogt, 2001c). Besides, specific papers have been devoted to such features for two major earthquakes of the Lesser Antilles (Vogt, 1993a; Vogt, 1995). So only a few examples are given here, with some references.

Widespread fissuring and liquefaction occurred during the major Jamaican events, foremost in 1692, with fine, easily interpreted information. So we read in a classical description: «... the earth opened in my own parish in multitudes of places and through these chasms spew'd out water to a considerable heighth above ground, in such quantities in some places that it made our gullies run on a suddain, tho' before exceeding dry... these gaping mouths being no less than 12, 20 or more foot deep under the earth and above two miles up the country, these, especially nigh the river, in the purest mould which had no clay or other consolidating matter beneath to oppose the force of the fountyains of the deep breaking up for where that was we do not find any cracks of the earth at all...» (Anonymous, 1693). Widespread cracking and liquefaction occurred in 1751 and 1770 in the wide Cul-de-Sac plain of Southern Haiti while such features are described in 1842 in the plain round Le Cap in Northern Haiti. Under different geological conditions such processes occur only locally, nevertheless in an impressive way. So we hear in 1842 from the mountains of Northern Haiti, near Chatard, that «[...] the earth opened and a clean stream of water spouted forth to the elevation of four feet like an artesian well» (Jamaica Standard, 1842). They are described similarly in 1843 from Nevis, St. Christopher, etc. Sometimes the lesson has been heard. So a «liquefaction potential map» has been prepared for Puerto Rico (Windeler *et al.*, 1995).

Rockfalls are widespread in many geological settings, once more in southern Haiti, in the 18th century, also in the Cuban Oriente, but mostly in the Lesser Antilles, for instance in Redonda in 1690, Monserrat in 1843, etc.

Further we have a fine knowledge of disastrous tsunamis, *e.g.*, in the Virgin Islands in 1867, with a wealth of information, and in northern Haiti in 1842 with precise information from towns, mostly from Le Cap. Besides this, more modest movements of the sea are often reported, for instance on the same coast in 1897. From Saint-Louis-du-Nord we hear that *«la mer s'est retirée très loin laissant beaucoup de poissons à sec, elle n'est revenue que bien doucement et est entrée jusqu'au milieu du bourg»* (Les Antilles, 1887).

Many sources discuss the behaviour of different types of buildings, the most interesting being the case of *mamposteria* buildings, a technique using a mixture of materials including irregular fragments of stone, brick or clay tile with soil and sand. While stone buildings, easily destroyed, are forbidden here and there, timber-built towns are easily burnt during earthquakes. To my knowledge, a specific paper has not yet been devoted to such discussions and events, although historians have published background information (Luopiès, 1986; Geggus, 1990). As an example let's quote instructions given in 1767 for a Saint-Domingue (nowadays Haiti) sugar plantation: *«vous êtes instruit... des malheurs causés dans presque toutes les Antilles par les tremblements de terre. Ce fléau doit vous engager donner à tout ce que vous avez en pierre la plus grande solidité possible. Si les bois étaient plus communs je préférerais cette construction à toute autre, par cette raison qui me fait croire qu'elle plus durable et plus propre à y résister...»* and, further: *«Je vous réitère la prière que je vous ai déjà faite de ne rien épargner pour la sûreté et la solidité...»* (Debien, n.d.).

Of course psychological and social problems, most important in the Caribbean, arise in earthquake-prone areas. In 1770 prophetic words uttered by a monk, soon expelled, led to some unrest among slaves at Port-au-Prince (Debien, 1979). In 1842 people from the country-side rushed into the destroyed town of Le Cap (Haiti) for systematic robbing, not easily stopped. After such a prediction made in 1906 in Santiago de Cuba a slight shock, seemingly confirming it, and possibly announcing a major

earthquake, produced a panic. Even the helpful intervention of the United States Marines in Jamaica in 1907 led to a political problem.

Ultimately these numerous facets of historical seismology could be important contributions for enlarged discussions of earthquake risk and earthquake potential including socio-economic perspectives (Marques *et al.*, 1983). However, earthquakes, whatsoever their cost, whatsoever their potential, are not always the major problem of the Caribbean area. They should be considered in a wider frame including, most of all, hurricanes. On the other hand sweeping appraisals of natural risks on the whole do not always master major earthquake problems (Cross, 1992).

4. Source materials for future studies

Finally let's have a glimpse at some types of records and depositories, already hinted at here and there, with some examples. They have been discussed in a wider range - West Indies, Central America and some South American countries - at the Trujillo (Venezuela) workshop in 1997 (Vogt, 2002). We will proceed here in a most summary, down-to-earth way, with random examples, among a surprising wealth of hitherto partly unexploited sources of all possible kinds.

In the West Indies themselves, archive sources, manuscript or in later editions, are mostly not available for the 18th century. As an example the Records of San Juan's Cabildo give here and there hints of earthquakes, *e.g.*, in 1786. Most work has to be undertaken in far-off depositories, first of all in Britain and France. So French archives, mainly *Archives Nationales*, keep a wealth of reports on major 18th century earthquakes of Saint-Domingue (Haiti) and the lesser French Islands. Some sources have been printed, officially, for the major Jamaican event of 1692 (Fortescue, 1901) or otherwise, for the 1727 Martinique earthquake (Bruneau-Latouche, 1991), or the 1751 Española event, from *Audiencia de Santo Domingo* files (Archivo Nacional de Cuba, Havana, 18th century).

For the 19th century, West Indian depositories are sometimes rewarding. As an example

the archives of the Netherlands West Indies in Curaçao have valuable reports on the effects of the 1843 earthquake, for instance on St. Eustatius. Of course, official reports are numerous in major British and French depositories. Once more, some of them are printed, for example by the *British Parliamentary Papers*, for 1843. Most important are consular reports, which, for example, are enlightening for the 1842 Haiti event and the 1867 earthquake and tsunami in Saint-Thomas.

Archives of families and traders easily escape attention and investigation by specialists. Luckily Debien, a historian, undertook for years a systematic and fruitful search in the archives of French planters families of former Saint-Domingue, bringing precise and useful information on a number of events (Debien, 1941). The diary of a French family from Martinique is a useful source for the 1839 earthquake (Fremont and Elisabeth, 1984).

Surprising finds are possible here and there. So we had the luck to find in a Philadelphia depository a fine report by a Leogane notary on damage produced there by the major 1770 Saint-Domingue earthquake.

Of course, many such sources have disappeared. While gaps are sometimes filled in complex, indirect ways other sources are clearly lost. As an example let's quote a seismological manuscript written by Courgerolles at Le Cap (now Haiti): «... un ouvrage fort étendu, perdu dans le premier incendie du Cap» gathering his numerous observations «tant par mes voyages que par mes recherches» (Courgerolles, 1803). Doubtless he had a fine first-hand knowledge of Saint-Domingue's seismic activity at the end of the 18th century.

Reports by travellers should be exploited in a systematic way. Several describe Saint-Domingue events from the end of the 18th century. One of them states, at Le Cap: «... se firent sentir graduellement les secousses de l'Est à l'Ouest pendant 39 secondes; plusieurs murs tombèrent et quelques maisons furent lézardées, des sources furent arrêtées, d'autres parurent; l'église paroissiale fut légèrement endommagée...» (Wimpffen, 1797). From a sailor we have a fine knowledge, from Port-au-Prince, of the sequence of March-April 1830, otherwise

not precisely known (Anonymous, 1830). Similarly the sequence of April-May 1860, in the South-Western part of Haiti, is best known from such a source, at Les Cayes: «... im Ganzen hatten wir 68 deutliche Stösse, ungerechnet die Schwankungen...» (Anonymous, 1860). Even later testimonies are useful. Years after the 1842 event in northern Haiti, a traveller still describes rents, «larges crevasses» in the Vallières mountains (Maris, 1860). After many years, souvenirs are recalled. So a former resident of Martinique, describing the 1776 Oléron (France) earthquake, makes a comparison with his West Indian experience: «... j'ai fait ma résidence pendant vingt ans à la Martinique; j'en ai ressenti quelque fois jusqu'à deux ou trois chaque année, mais je me suis jamais aperçu que les mouvements aient été aussi violents et aussi vifs...» (Journal Historique et Politique, 1776). Clearly he stayed there during a «gap». Similarly a Corsican, a former resident of Haiti, conveys in 1887, the year of the famous Ligurian earthquake, felt in northern Corsica, these West Indian reminiscences: «J'ai habité longtemps Port-au-Prince... où les tremblements de terre sont fréquents et les habitants sont prévenus de ces événements lorsque les cloches, mises en branle, sonnent d'une certaine façon» (Petit Bastiais, 1887).

The most informative and precise travellers are often ship's captains describing shocks felt either in some West Indian harbour or at sea, bringing news to European or North American harbours. A number of such reports are printed by the newspapers of Liverpool, Bordeaux, Le Havre, Bremen, Charleston, Portland, etc., for instance in 1842 and 1843.

First-hand reports, often reprinted elsewhere *in extenso*, abound in local newspapers with, in the Lesser Antilles, a steady problem of comparison between them, by «island-hopping». Unfortunately in the West Indies themselves, such newspapers, *Affiches Américaines* (Saint-Domingue, now Haiti), *Le Patriote*, *Sainte-Croix Avis*, *Saint-Christopher Advertiser*, *Dominican*, *Palladium* (St. Lucia), *Antigua Weekly Register*, *Les Antilles*, etc., in many cases have either disappeared or are not easily consultable. It is often preferable and less consuming of time and money to look for (of course,

often fragmentary) collections in British, French and North American libraries and/or archives. Luckily the Barbados press has been exploited, partly, by an earthquake researcher, with a fine file left in the island's archives. Of course historical publications, mainly those of local scope, should be sifted for information given here and there, mostly incidentally, on earthquakes, sometimes from unknown or not easily accessible sources, often filling gaps of knowledge, their authors being not always aware of the worth of their findings. As an example, chronicles of Santiago de Cuba proved useful despite shortcomings (Baccardi y Moreau, 1924), among others, for instance, from Puerto Rico and the French Islands.

For a long time proper historical research, in many cases, mentions earthquakes only casually, despite the fact that they act as a kind of catalyst for the knowledge of the wide field of economic and social history. Typically indexes sometimes skip the very word «earthquake».

Even the history of art should be considered. So a classical work on the monuments of Santo Domingo is helpful, not only from the proper architectural view of real or possible earthquake effects, but also for tracing sources (Palm, 1955). More or less imaginative pictures sometimes illustrate leaflets and learned papers, for instance for the major 1692 Jamaican event (Cundall, 1936). Later newspapers provide illustrations, for instance for the 1867 Saint-Thomas earthquake and tsunami (Illustrated London News, 1867).

Works of a more or less encyclopaedic kind also forward valuable information. For Saint-Domingue (now Haiti) the famous Moreau de Saint Méry's printed or unpublished life-work is a treasure box for hunters of 18th century earthquakes although the information is widely dispersed.

Whatsoever the kind of material, archives, newspapers, reminiscences, monographs, historical sketches, reports from missionaries and clergy are of particular interest. While psychological and specific religious reactions are of course dealt with at length, numerous valuable and sometimes unique earthquake data are forwarded, mostly from smaller islands. A fine example are quakers' letters on the 1692 Ja-

maica earthquake (Cadbury, 1971). Several newspapers, *Church Missionary Gleaner*, *Missionsblatt*, *Calwer Missionsblatt*, etc., have been exploited. Informing even on mid-18th century events, the Moravian Brothers' publications are most rewarding. Unfortunately Herrnhut's German headquarters did not allow access to their archives, which may be a rich resource. Even for well documented events of the beginning of the 20th century, religious echoes are of some interest. Salesians and Jesuits provided papers on the major 1907 Jamaican earthquake. Reporting on the 1918 Puerto Rico event *Die katholische Mission* stresses the fact that only the Catholic church was destroyed in Bayamo while the Protestant ones were intact, with comments on the wealth and rivalry of the Protestants.

Finally, more or less learned papers, contemporaneous or later, are of foremost interest. Reports were immediately compiled on the major earthquakes of Haiti 1842 and Cuban Oriente 1852 by local authors, the first being reedited a century later (Márquez, 1842). Besides it should not be forgotten that several papers in scientific publications are mainly copies, more or less commented, of information from newspapers, consular reports, etc., e.g., in *Comptes-Rendus de l'Académie des Sciences*. Century-old seismological monographs now belong partly to the field of historical seismology. A fine example is of course Reid and Taber's (1919) pioneering paper on the 1918 Puerto-Rican earthquake, a *chef d'oeuvre* thanks to their broad and modern views.

While many reliable sources often give isolated information on minor events, felt for instance at sea, thick files are filled by material for major earthquakes. Comparison of information of different origin and kinds allows a balanced appraisal of different facets of an event, discarding utter catastrophist and misleading views, and allowing modern interpretations.

A fine example of such a «portfolio» is the 1842 Northern Haiti earthquake, mentioned several times above, with a wealth of reliable sources. These include: testimonies by witnesses, for instance by a Haitian general writ-

ing down reminiscences from his youth (De-lorme, n.d.), the dramatic experience of a British missionary writing an informative «earthquake poem» (Bird, 1870; Eldin, 1878; Monthly Chronicle, 1842), local newspapers like *Le Patriote*, *Le Télégraphe*, *Le Temps*, not easily located, consular reports, foreign newspapers, for instance *Portland Adviser* and *Hamburgischer Correspondent* printing ship's captains reports, etc. Even for small islands like the Turks we are informed in a satisfactory way. Such «portfolios» have been gathered for 1751, 1770, 1843, etc. (Grases, 1990; Vogt, 1997) and partly exploited.

5. Conclusions

While specific problems arise in the West Indies (far-off sources, «island hopping», generations of research, different conceptions of catalogues and data banks, too often unsatisfactorily) their historical seismology illustrates in a sometimes extreme way more general issues. A cultural problem is often present (Vogt, 1993b; Vogt, 1996a; Vogt, 1996b). Authors with a narrow scientific or rather technical mind are not always able to master such a mysterious field, sometimes using unreliable information with an incredible credulity, not even always using the best, most critical, data banks in a proper way. For instance, one finds epicentral locations mapped indiscriminately from information with different degrees of reliability; barycentres are plotted irregardless that they are prone to drastic relocation from a newly discovered source or a reinterpretation. Further it should not be forgotten that here and there data banks are elaborated by people unable to master either genuine historical seismology, with cases of drastic misinterpretation, or advanced seismology. Besides the weight of shortcomings, not all of the numerous valuable arguments and suggestions given by historical seismology are properly implemented for the needs of seismology as a whole, for instance the analysis of earthquake sequences. Consequences could be disastrous in the case of the West Indies, with their major events,

often at large intervals, easily forgotten, and seismic gaps. Despite the work done so far, over-research is not yet a problem for the historical seismology of the West Indies.

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