NEW DATA ABOUT HISTORICAL EARTHQUAKES OCCURRED ON THE ROMANIAN TERRITORY

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The goal of the present paper is to enrich qualitatively and quantitatively the existing database about historical earthquakes occurred on the Romanian territory and in the adjacent areas by revaluating and completing it with new information obtained after some complex research activities.

In this respect there were studied the old book funds existing in Bucharest, especially those from the religious and cultural institutions – monasteries, libraries, archives and museums, starting with the documents existing under the custody of the Romanian Patriarchy. For the beginning there were researched three thousand books appeared between 1683–1902 where there were found information about some earthquakes occurred between 1802 and 1913.

By this research, there is achieved the extension in the past of the database regarding the seismicity of the Romania's territory, by emphasizing seismic events that, according to some seismicity schemes, can repeat in the future, thus, being taken into account the major contribution of the historical seismicity to the seismic hazard assessment.

Key words: historical earthquakes, The Romanian Patriarchy, Vrancea Seismogenic Zone, seismic hazard.

1. INTRODUCTION

During the history of the human civilization, earthquakes have been considered among the biggest natural calamities. In the prehistoric times, since man used to get a shelter in caves, pit houses and later on in cottages, the material damages and human losses caused by earthquakes were relatively rare and the fear inspired by the motion of the earth was more psychological.

The influence of the earthquakes over the people who lived in those times was extraordinary because they would regard the destroying action of earthquakes as an implacable evil as it could be noticed in Seneca's descriptions-4BC-69AD, who defined the earthquake as the most terrifying and destroying geological phenomenon: "*The earthquake is an evil that spreads everywhere; it is inevitable and damaging for*

everybody. Besides the destruction of people, houses and entire towns, it can make disappear nations and even entire nations without leaving a trace of what has been once".

So, starting from The Middle Ages and continuing with the period of Renaissance, earthquakes have been considered as signs and miracles and not natural phenomena. To state that an earthquake was not a natural phenomenon and not something sent by God, it was a herezy. That's why the motivation of making a spatial and temporal statistics for earthquakes was rather a problem of historical interest and even one with a religious purpose in order to take into account the times when God used to spread His anger [1]. The concept of what we call today *"seismicity"* was unknown at that time, although the chroniclers had already noticed and written down that some zones were more exposed to earthquakes than others [1].

The first information regarding earthquakes is dated from the 18th century BC.

Paradoxically, once man started to build long lasting houses and large human conglomerates appeared (towns, metropolises), the damages caused by earthquakes had a greater importance.

More eloquent descriptions of earthquakes are missing, but on the stamps of those times are rendered images and suggestive scenes regarding the destroying action of earthquakes over people and constructions.

Starting from the second half of the 17th century, earthquakes have become an important subject over which there has been done some scientific research. In this aspect, the historical documents must be analyzed to come up with the information referring to the acting way of these phenomena.

The interest for studying these phenomena started to grow in the 18th century when a great number of earthquakes occurred in Europe among which we can mention the earthquake from Lisbon in 1775, considered the strongest. At that time, it produced varied reactions, giving an important impulse for the study of earthquakes both scientifically and educationally.

The lack of the necessary instruments for stocking information on the occurred earthquakes, imposed the research of the historical sources, fact that led to obtaining various studies exclusively based on historical descriptions of the previous events. All these analyzed data, gathered and interpreted, offered information that contributed to the elucidation of the nature of earthquakes [1].

2. HISTORICAL SEISMICITY

As regards the chronological evolution of natural seismic events, every region of the world has a specific seismic history divided in three periods: the first is called the period of "*paleoseismicity*" for which the information regarding some powerful events are preserved within the old faults of the Earth's surface and they are waiting to be discovered and interpreted by geologists in order to establish their age and the relief changes they have produced. Then there is the so-called "*historical period*" where the effects of some seismic events are qualitatively described by historians and if they are well interpreted they, can allow the

evaluation of the date, place and of one or more intensity values and, rarely, of an "*equivalent magnitude*" [9].

These historical data, by their nature, are incomplete from statistic and scientific point of view. The third and the last period called the period of "*instrumental seismology*" debuted modestly by the end of the last century, in most regions by installing some uncalibrated equipments which reached a high degree of accuracy in the last fifty years or even less.

As a conclusion, the bank of instrumental seismic data that have a greater accuracy, covers only a few decades; that of the qualitative "*historical documents*" – a few centuries, while the "*paleoseismic*" information extend over millions of years in the past (see fig. 1). Presently it has increased the interest for a better quality of the interpretation of the documents from the "*historical period*" with the purpose of extending in the past to cover all the information from that period, by increasing the accuracy of the location and the "*equivalent magnitude*" evaluated for the most significant seismic events. Though all the information obtained for the above mentioned periods of time are useful, each of them predominating over a certain period of time, yet, the historical records represent the main source of information, at least for the last millennium [10] (see fig. 1).

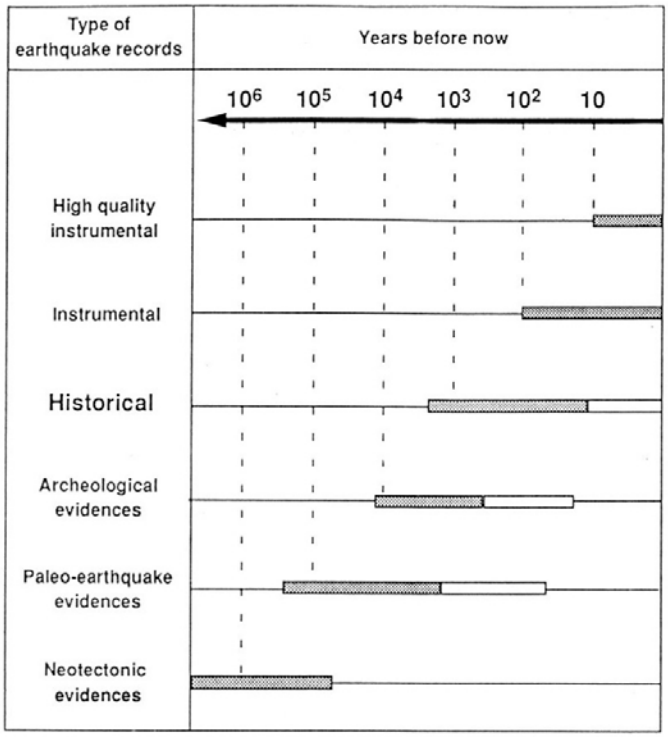


Fig. 1. – Time intervals covered by different types of information about earthquakes (from [10]). There are underlined the time windows for which each of them represents the main source of information.

In order to achieve this desiderate, we have to obtain, first of all, the primary data, as for different environments, the "*historical*" period differs in length (time) and quality from one region to another and it requires a special approach regarding the interpretation of its elements and of the original documents [9].

Macroseismic information and especially those extracted from the historical documents have an important role in assessment of the seismicity and seismic hazard.

The investigation of the historical earthquakes has known a remarkable development, especially due to the stimulation of "*combining and corroborating*" activities, methods and the points of view belonging to both disciplines – History and Seismology. It can be said that the result of these "*combining and corroborating*" determined the creation of a scientific discipline called "*Historical Seismology*" [16], which is considered a branch of Seismology that also uses historical methods. As a branch of Seismology, the *Historical Seismology* has a well defined role, that of "*extending in the past, as much as possible, the seismicity knowledge of a territory*".

The study of the historical seismicity of a territory requires the collaboration with specialists in historical documentation. Thus, the group of researchers involved in the study of historical earthquakes started a collaboration with an experienced team of researchers from the field of historical research, that study and come up with the dates from chronicles, reports, articles from that time, letters etc., in the present case being searched the old book fund existing under the custody of the Romanian Patriarchy. These collaborations are necessary because many of the studies referring to historical earthquakes, compiled over the years, can be affected by numerous errors caused by the lack of understanding of the perception of the historical documents from those who have investigated them; for example, the misinterpreting the primary sources as secondary ones and attributing overvalues to the records. Another error appears after dating the seismic events. Thus, if an earthquake is written down in a primary source at a certain date, its wrong writing in another material (the secondary source) can indicate the occurrence of two earthquakes instead of one. The same error can appear in the case of establishing the hour of producing the earthquake. These errors appear partly as the effect of the misunderstanding of the applied procedures which make us state that the historical seismic events need a multidisciplinary study.

As a conclusion, in most of the cases the problems are the same-the difficulties that appear at the moment of interpreting the different types of sources, the discrimination and the elimination of the *"fake earthquakes"* and the critical issues that can occur at the moment of establishing the earthquakes parameters from the historical documents.

The seismicity of the Romanian territory is documented for a time interval longer than one millennium, that is from 984 up to now, exactly on 1023 years. The historical seismicity has been and is intensely studied for various purposes, as those of the seismic hazard assessment, the seismic prediction, etc. Yet, the resolution and the consistency of the seismological data are not uniform and/or homogenous for the whole period [13].

The seismicity of Romania is characterized by two main components, mainly the Vrancea subcrustal seismicity (very confined and active) and the crustal seismicity (more dispersed and less active) (see figures 2 and 3) [13].

It is obvious the fact that, generally speaking, the seismicity of the Romanian territory is strongly determined by the Vrancea seismogenic continuous process at intermediate depths beneath the bending area of the South-Eastern Carpathians. It is supposed that the Vrancea Seismogenic Zone is centered on the "*triple active junction*" of three major tectonic units – the East European Plate, Intra-Alpine Subplate and Moesian Subplate. According to this hypothesis, these plates converge in a triple junction and are dynamically pushed by the major tectonic structures from the geodynamic ensemble of the East-Mediterranean Alpine region. This convergence determines the occurrence of two types of earthquakes in the Vrancea Seismogenic Zone – intracrustal earthquakes, placed within the earth's crust (less than 60–70 km deep) and subcrustal earthquakes placed under the earth's crust (below 70 km deep). The monitoring and the quantification of the Vrancea earthquakes in time evidentiate the fact that these are responsible of the ninety percent from the seismic activity of the country.

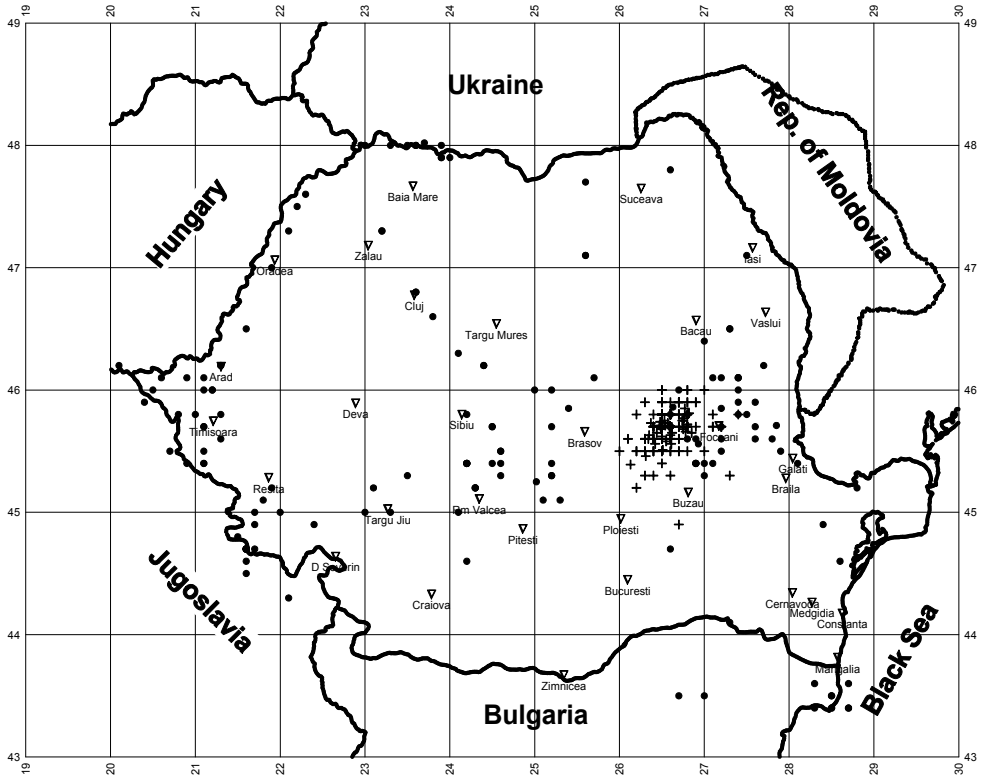


Fig. 2. – Epicentral distribution of the historical earthquakes occurred between 984 and 1977 (preinstrumental and instrumental) with Mw ≥ 4 (subcrustal earthquakes are presented with crosses and crustal earthquakes with dots).

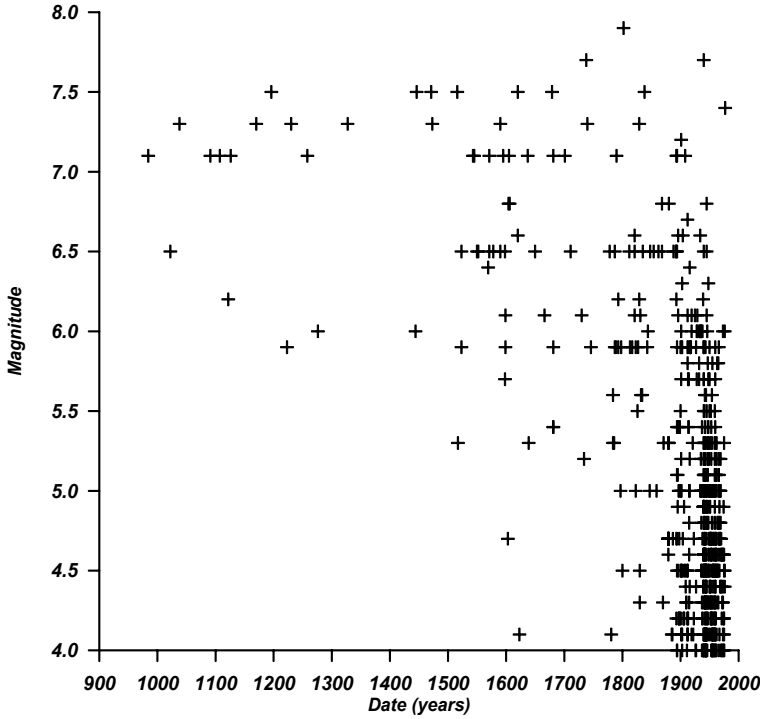


Fig. 3. – Seismic history of Romania's territory.

3. NEW DATA ABOUT ROMANIAN HISTORICAL EARTHQUAKES

With the purpose of discovering new records about the historical earthquakes occurred on the Romanian territory, firstly, there will be presented the obtained results after the research of the old book funds which is under the custody of the Romanian Orthodox Church. The research activity of the historical records about the existing seismic motions on old books implies the knowledge of the Cyrillic and Slavonic alphabet, of Latin and Greek and some experience in the work of reading notes. The mentioned book fund contains 4563 Romanian and foreign old books, the owners of the books being the cult institutions (churches, monasteries) from Bucharest and from neighborhoods. For the beginning, there have been searched 3000 books appeared between 1683–1902. There were found 40 records about the seismic motions. These records refer to a series of earthquakes occurred in – 1803, 1812, 1831, 1861, 1880, 1888, 1900, 1913 (1 record), 1802, 1829, 1837, 1893 (2 records), 1838 (5 records), 1892 (4 records), 1894 (3 records), 1901, 1903 (6 records), in parenthesis is specified the number of records found for each year.

In the following table there are presented the earthquakes that had records and their number.

Table 1

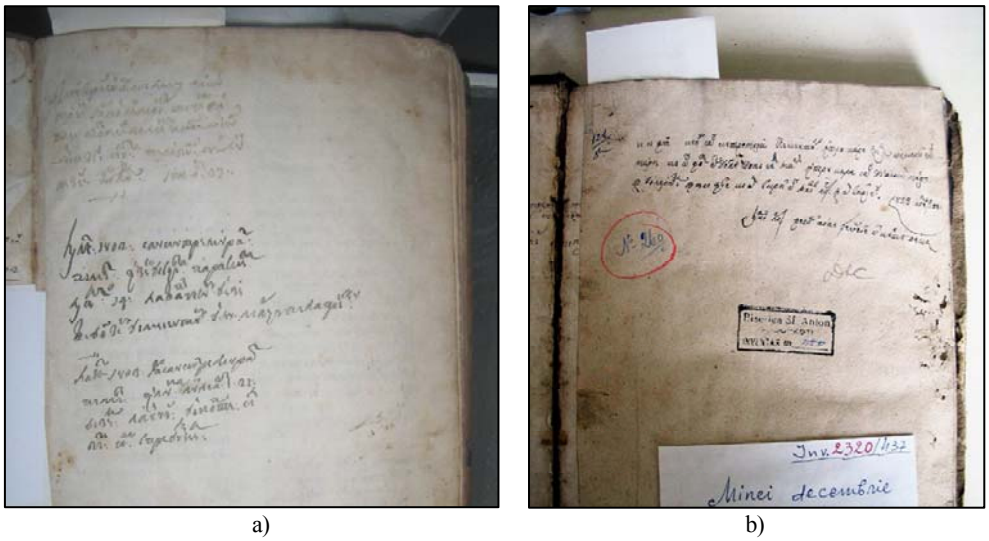
The earthquakes and their historical records

No.	Earthquake		No. of records	**References–Religious books/** Information about earthquakes in other papers
	Dating on Old Style	Dating on New Style		
1.	1802/10/14	1802/10/26	2	**Minei pe luna mai, Ramnic, 1780; Tipic bisericesc, XVIIIth century** / [16], [7], [6], [2], [15].
2.	1803/03/22	1803/04/03	1	**Tipic bisericesc, XVIIIth century** / No reference
3.	1812/05/05	1812/05/17	1	**Panihida, Ramnic, 1809** / [7] (mentioned on Old Style date)
4.	1829/11/14	1829/11/26	1	**Ceaslov, Bucharest, 1806** / [7], [15], [2].
5.	1829/11/22	1829/12/04	1	**Minei pe luna decembrie, Venetia, 1774** / No reference
6.	1831/12/08	1831/12/20	1	**Infruntarea jidovilor, Iasi, 1803** / In Florinesco's catalogue is mentioned an earthquake on 21st of December, not on 20
7.	1837/01/12	1837/01/24	2	**Minei pe luna aprilie, Ramnic, 1780; Minei pe luna august, Buda, 1805 /** [5]
8.	1838/01/11	1838/01/23	5	**Minei pe luna ianuarie, Buda, 1805; Psaltire, Iasi, 1817; Ceaslov, Sibiu, 1830; Cuvantul Sfantului Efrem Sirul, Neamt, 1819; Triod, Bucharest, 1769** / [7], [16], [6], [3], [15]
9.	1861/03/17	1861/03/29	1	**Ceaslov, Bucharest, 1806** / [7]
10.	1880/12/13	1880/12/25	1	**Psaltire, Buda, 1818** / [7], [2], [15]
11.	1888/09/16	1888/09/28	1	**Minei pe luna septembrie, Ramnic, 1779 /** No reference
12.	1892/10/02	1892/10/14	4	**Minei pe luna octombrie, Buda, 1804; Vietile sfintilor pe luna octombrie, Bucharest, 1835; Penticostar, Bucharest, 1782** / [15], [4], [8], [7], [6] – Romania-Bulgaria transborder earthquake
13.	1893/04/19	1893/05/01	1	**Penticostar, Bucharest, 1856 /** [6]
14.	1893/08/29	1893/09/10	1	**Minei pe luna august, Bucharest, 1852** / [7], [11], [15]
15.	1894/08/19	1894/08/31	3	**Minei pe luna august, Buda, 1804; Minei pe luna august, Bucharest, 1852** / [12], [6], [15]
16.	1900/08/15	1900/08/28	1	**Minei pe luna august, Buda, 1804 /** No reference
17.	1901/03/18	1901/03/31	4	**Triod, Buda, 1848; Molitvenic, Brasov, 1811; Triod, Ramnic, 1782; Minei pe luna decembrie, Ramnic, 1779** / [15], [11] – Bulgarian earthquake
18.	1901/03/28	1901/04/10	1	**Evanghelie, Buzau, 1837** / No reference
19.	1901/09/17	1901/09/30	1	**Minei pe luna septembrie, Ramnic, 1779** / No reference
20.	1903/08/31	1903/09/13	6	**Minei pe luna august, Bucharest, 1852; Minei pe luna septembrie, Bucharest, 1852; Minei pe luna august, Neamt, 1831; Liturghie, Bucharest, 1858; Evanghelie, Buzau, 1837; Minei pe luna august, Buda, 1804** / [12], [15], [4]
21.	1913/06/01	1913/06/14	1	**Minei pe luna iulie, Buda, 1805** / [15] –Bulgarian earthquake

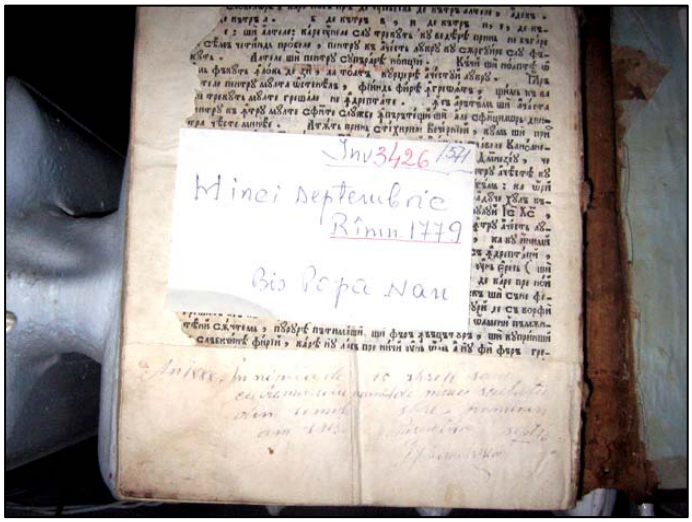
There has to be mentioned the fact that for the historical seismic events that have been noted over the years under the form of catalogues or others by numerous authors ([18], [7], [19], [13], [4], [14] etc.) it has been necessary the passing from the dates on Old Style (the Julian calendar) to the New Style (the Gregorian calendar) – see the table above. Thus, by an order published in the Official Monitor, our country passed from the Julian calendar to the Gregorian one in 1924. Although, the historians sustain that all the records made up to 1924 remained in history on the old dates, in our case this passing to the new dates was neccessary to have a uniformity with the other earthquakes catalogues published up to now, thus avoiding the appearance of the doubles.

In this paper there will be given as examples some of the records about the above mentioned historical earthquakes.

As it can be observed in the table above, for the earthquakes occurred on 1803.04.03, 1829.12.04, 1888.09.28, 1900.08.28, 1901.04.10 and 1901.09.30 there were not found information in other papers, fact that determines us to make the following statement according to which either these earthquakes haven't been mentioned so far or their intensities have been small, their effects having not been written down in any historical material. For example the earthquake on **3rd of April 1803** was described as follows: **"*In the year of 1803 the earth shook again in the month of March the 22nd at one hour in the night between Saturday and Sunday*" (Tipic Bisericesc, sec. XVIII)**. Another earthquake from this category is the one occurred on the **4th December 1829** which was described in the following way: **"*All people should know that the earth shook the second time after the big one from 1802 and the mountains and the hills split and that it was me who wrote on the 22nd of November 1829 (the 4th of December), me, Ionita chancellour, the priest's Gheorghie***



a) b)



c)

Fig. 4. – Historical records of a) 1803.04.03, b) 1829.12.04 and c) 1888.09.28 earthquakes.

son*" (Minei pe luna decembrie, Venetia, 1774).** As regards the description of the earthquake of **28th of September 1888**, the note contains the following text: "Year 1888, the night between 15 and 16 the earth shook so hard that I woke up. So I wrote for mentioning"* (Minei pe luna septembrie, Ramnic, 1779).**

So, in order to discover more information about these earthquakes, all types of existing sources must be searched, information that are necessary for obtaining a real image over their occurrence. Moreover, many from the materials related with the historical earthquakes can be found distributed in places far from where the earthquakes occurred.

4. CONCLUSIONS

The analysis of the records contained in the books from the Romanian Patriarchy, shows that a part of the quoted earthquakes do not appear in any earthquake catalogue up to now and the new information about some known earthquakes haven't been taken into consideration so far in the studies of different authors. Thus it can be stated that, the old book fund existing under the custody of the Romanian Patriarchy hasn't been searched so far. By the investigations done by the research team involved in this activity, there was underlined the studying, processing and interpreting the information about the historical earthquakes existing within the book funds and the historical sources unsearched so far. These facts give a greater value to the records found in the religious books, being very

useful for the achievement of the Romanian earthquake catalogue completeness. Due to the fact that the sources haven't been known so far, the contained information don't appear in the catalogues and specialized papers, these being updated with information found in books.

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