LANDESERDBEBENDIENST

EARTHQUAKE CATALOGUE FOR SOUTHWESTERN GERMANY

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Introduction

Seismic activity in Germany is predominantly concentrated in and alongside the Rhine region. Thus the Federal State of Baden-Württemberg in southwestern Germany is particularly affected by earthquakes. Baden-Württemberg's earthquake service, the *"Landeserdbebendienst"* (LED), is in charge of data collection and catalogue work. The service is based at Freiburg i. Br., where it is part of the State Geological Survey since 1993.

Instrumental time period (after ca. 1900 AD)

Instrumental recording of earthquakes has started in Baden-Württemberg at the beginning of the 20th century. Macroseismic investigations, however, prevailed until the 1960s, until with a denser seismic network continuous localisation and magnitude determination also for smaller shocks became possible. With the occurrence of the November 16, 1911 Swabian Jura earthquake (intensity VIII) seismic activity in Baden-Württemberg was focussed mainly in the Albstadt region. The 1911 event came as a surprise. It was followed by earthquakes of similar size in the years 1943 and 1978 and by many smaller shocks. Together they define the "Albstadt shear zone".

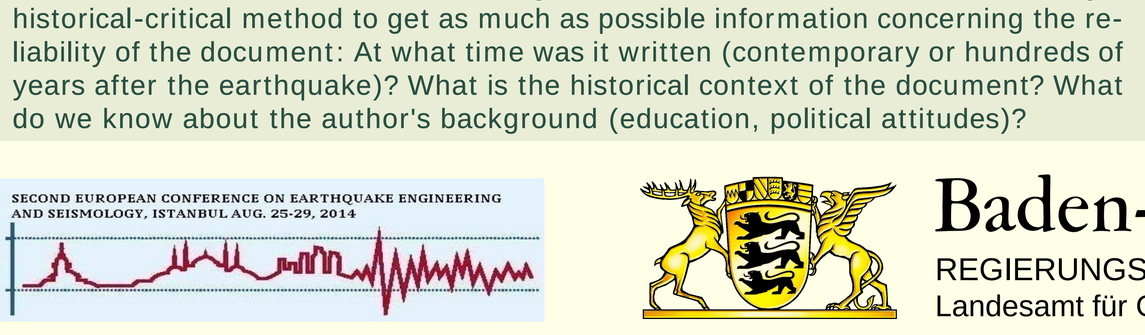
Figure 1: Earthquake damage at the church of Lautlingen due to 1911 Swabian Jura earthquake (LED archive, picture by Foto Binder, Ebingen).

Historical time period (after ca. 1000 AD)

Damaging earthquakes are reported in the Upper Rhine Graben area – bordering Germany, France and Switzerland – during historical times. Most well known is the earthquake of Basel/Switzerland 1356 (intensity IX) at the southern end of the Graben. Surprisingly, from the evaluation of existing German earthquake catalogues (e.g. Leydecker, 2011) a "lack of seismicity" before the 19th century in the area of Baden-Württemberg becomes obvious (Fig. 2).

Historical research

A systematic search for information about historical earthquakes will be undertaken, trying to trace back information to the primary historical sources. Typical sources for the tradition of earthquakes in Baden-Württemberg are chronicles, e.g. town chronicles or familiy chronicles. Very important are diaries, written by clergymen or lay persons, especially if they are written more or less contemporaneously. Because of the "fresh" impression of the event, even earthquakes with low intensities were recorded. Sometimes town chroniclers wrote notes concerning the history of their town, mentioning earthquakes as well (see the example of the town chroniclers of Freiburg i. Br. in Fig. 3).



"In this year 1664 on the day before the last or on the last day of December in the night between 9 and 10 first thunder – as if many cannons would have been fired at once – was heard here on the [castle]hill on the tower by the guard and also in Lehen and afterwards a[n earth]quake and a movement of the earth was noticed so that in Lehen the people ran out of the houses because they did not know what it was."

Figure 3: Historical notes of town chroniclers of Freiburg Franz Carl Vogel and Gabriel Preyss written probably in 1665. Stadtarchiv Freiburg i. Br., manuscript B2 number 4, page 264 and 265 (reproduction with kind permission of Stadtarchiv Freiburg), and extract with translation. See also Tab. 1.

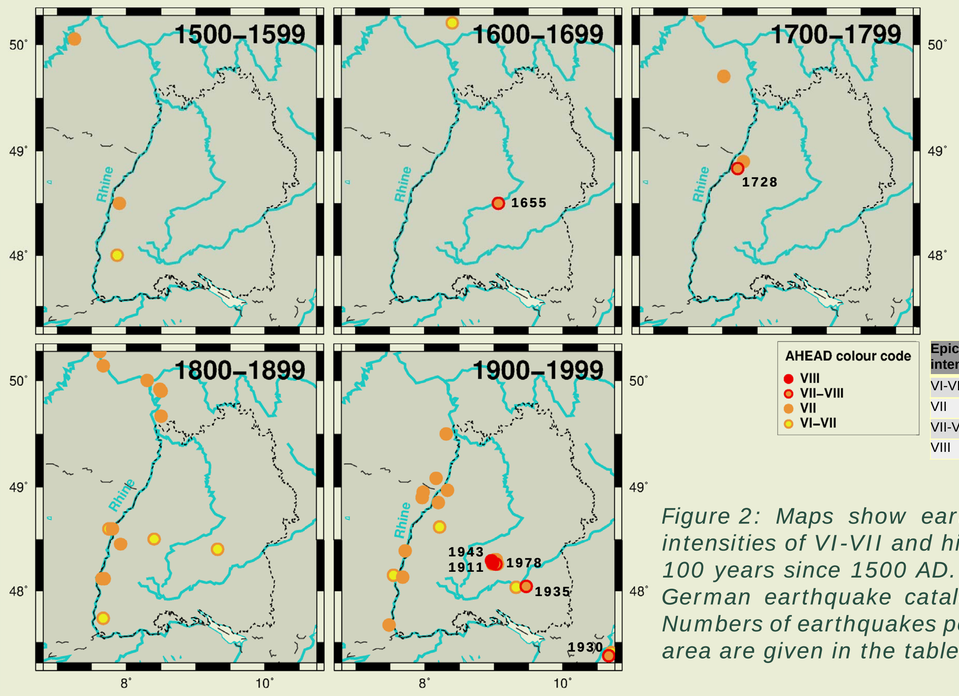
If earthquakes caused damages, reports of civil servants or architects about the condition of buildings are very helpful. Valuable sources are sermons from priests delivered after *"schröcklich"* (terrible) earthquakes. Several sermons delivered in the churches of Tübingen and Esslingen in the year 1655 were printed later on and contain a more or less detailed description of the Tübingen 1655 earthquake. Most historical documents are not published yet, but are conserved in archives and libraries. Due to the historical evolution of Baden-Württemberg – before 1806 the country consisted of about 600 small territories – historical documents are stored nowadays in different kinds of archives: state archives (e.g. Stuttgart, Karlsruhe), various municipal archives, district archives or ecclesiastical archives (e.g. Freiburg, Rottenburg). Preliminary information about the documents of an archive can be found in the archival inventories (*"Findbücher"*). Most inventories just give an overview of the archival sources, a search in the archives itselves therefore is indispensable. Historical documents found during our research need to be examined using a historical-critical method to get as much as possible information concerning the reliability of the document: At what time was it written (contemporary or hundreds of years after the earthquake)? What is the historical context of the document? What do we know about the author's background (education, political attitudes)?

Catalogue project

Earthquake hazard calculations increasingly demand earthquake catalogues of improved accuracy and completeness. In Baden-Württemberg the quality of the earthquake catalogue is not sufficient yet. For the historical time period catalogue data rarely go back to the primary sources but rely on later – mostly 19th and 20th century – compilations. Up to now just a few case studies based on primary historical sources exist. In 2013 a five-years project has been launched to elaborate and complete the earthquake catalogue of Baden-Württemberg for the last millennium. Existing regional catalogue subsets of the 20th century have already been reviewed and implemented into the data base. Comparisons will be made with existing catalogues for Germany, Switzerland and France.

"Earthquake deficit"

Taking the 19th and 20th century as a reference for seismicity rates, it can be hypothesised that many strong earthquakes are still missing in the Baden-Württemberg catalogue. The example given in Fig. 2 shows a statistical deficit of about 10 damaging earthquakes of intensity VII per 100 years from the 16th until the 18th century in the area of Baden-Württemberg and its vicinity. Presuming that information of all earthquakes of intensity VII (and up) have been put down in writing since about the 16th century and if respective documents have been preserved, we may hope that the Baden-Württemberg earthquake catalogue can be completed by thoroughly searching the archives. Other reasons for this apparent "earthquake deficit", as for example changes in seismicity rates or in intensity assessments, are also possible and will be evaluated in due course.



Epicentral intensity	1500-1599	1600-1699	1700-1799	1800-1899	1900-1999
VI-VII	1	1	0	6	9
VII	2	1	3	12	14
VII-VIII	0	1	1	0	3
VIII	0	0	0	0	2

Figure 2: Maps show earthquake epicentres with intensities of VI-VII and higher for time intervals of 100 years since 1500 AD. Data are taken from the German earthquake catalogue of Leydecker, 2011. Numbers of earthquakes per century within the map area are given in the table.

Data base

A relational data base system has been developed that hosts all catalogue and recording data of the earthquake service LED, including information about documentary sources (an example is given in Tab. 1) and intensity data points (IDP, example in Tab. 2).

TABLE 1	
source key	VOGPREY1663
source authors	Franz Carl Vogel and Gabriel Preyß
source year	between 1663 and 1683
source place	Freiburg im Breisgau
source archive	Stadtarchiv Freiburg, manuscript B2 No. 4
source quote	historical notes of Franz Carl Vogel and Gabriel Preyß, town chroniclers of the city of Freiburg i. Br.
source comment	handwritten manuscript on paper, German language, contemporary notes of two town chroniclers of Freiburg i. Br. covering the years 1663-1670 and 1677-1683

Table 1: Data base table for documentary sources, example: VOGPREY1663 (see also Fig. 3).

TABLE 2	
IDP identifier	########
event identifier	1664-Dec-30-21
responsible agency	LED
IDP latitude	48.017 N
IDP longitude	7.801 E
IDP region	BW (Baden-Württemberg)
IDP location (place name)	Freiburg-Lehen
IDP lower bound intensity	V
IDP upper bound intensity	VI
IDP most probable intensity	V
IDP intensity scale	EMS
IDP overall quality	moderate (1 trustworthy report)
felt flag	felt
damage flag	unknown
sound flag	sounds heard
lights flag	unknown
ground flag	unknown
earliest reporting date	1665 (probably)
earthquake evidence	yes
comment	Event date on the 31th of December is also possible. Reported time is between 21 and 22 hours. An affiliated IDP exists for the town center of Freiburg. In 1664 Lehen was a community on its own, today Lehen is part of the city of Freiburg i. Br.

Table 2: Data base table for intensity data points (IDP), example: IDP at Lehen near Freiburg i. Br. for an earthquake in 1664 (epicentre still unknown) based on the source VOGPREY1663 (see Tab. 1 and Fig. 3).

Seismological interpretations

Macroseismic evaluation accompanies the historical research. Key information is contained in the intensity data points. Table 2 shows an exemplary IDP for an earthquake in 1664 (epicentre and maximum intensity still unknown) as entered into the data base. Intensity information of this IDP is inferred from the source document given in Tab. 1.

Macroseismic maps

Macroseismic data collection and mapping has a long tradition in Baden-Württemberg. Macroseismic maps covering the last one hundred years will soon appear in print. An example is shown in Fig. 4.

Figure 4: Macroseismic map of the 1911 Swabian Jura earthquake drawn after Sieberg (Fiedler, 1954).

Literature:

Fiedler, G., 1954: Die Erdbebentätigkeit in Südwestdeutschland in den Jahren 1800-1950. – Von der Technischen Hochschule Stuttgart zur Erlangung der Würde eines Doktors der Naturwissenschaften genehmigte Abhandlung, Stuttgart.

Leydecker, G., 2011: Erdbebenkatalog für Deutschland mit Randgebieten für die Jahre 800 bis 2008. – Geologisches Jahrbuch, E 59: 1-198, Hannover.

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