DANMARKS OG GRØNLANDS GEOLOGISKE UNDERSØGELSE RAPPORT 2015/24

Earthquake Hazard in Denmark

Peter Voss, Trine Dahl-Jensen & Tine B. Larsen

GEOLOGICAL SURVEY OF DENMARK AND GREENLAND
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G E U S

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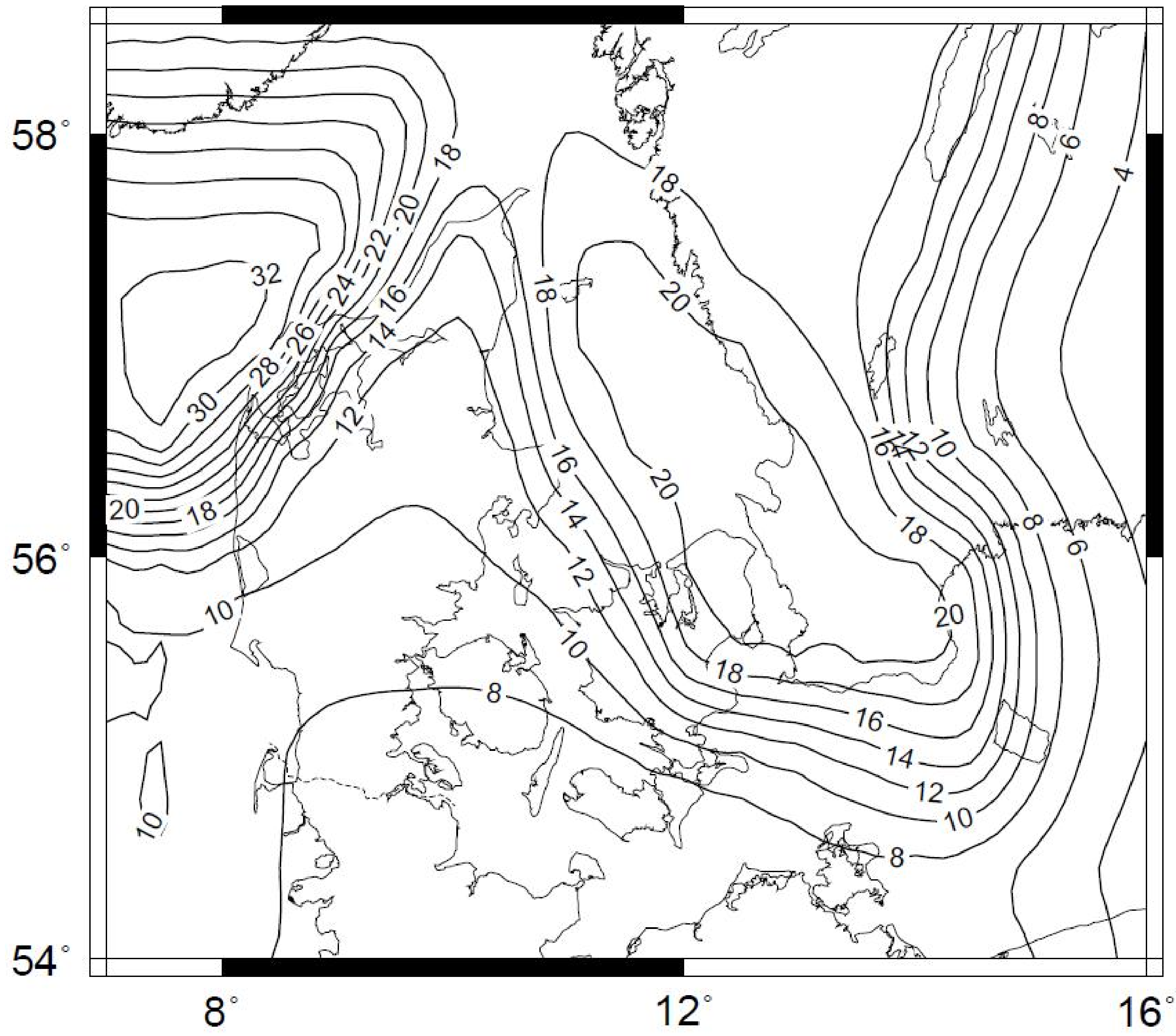

by

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Content

1. Foreword

This report provides the seismic hazard map of Denmark compiled by GEUS for the purposes of seismic zoning within the Eurocode 8 context. It was commissioned to assist the drafting of the Danish National Annexes to Eurocode 8. Eurocode 8 is the European Union building standard for design of structures for earthquake resistance. The geology and seismicity is very diverse across Europe, and it is necessary for each country to carry out their own analysis based on local conditions.

The values are intended to give a general indication of the expected hazard level. The map in figure 16 is provided with a return period of 475 years, showing the peak ground acceleration (PGA) for rock site conditions. Values were computed over an area bounded by 53deg.N – 59deg.N and 4deg.E – 18deg. E. The analysis is only carried out for on-shore conditions and the calculations should be re-evaluated after 10 years due to increasing uncertainty; ultimo 2024.

Seismic hazard in Denmark is low with respect to many other parts of the world, but the historical records do tell of earthquakes with large impact e.g. in 1759:

"…To the west of the Kattegat in Aalborg an upper storey of St. Bochs or Budolphi church fell down. This caused great damage to an extension of the building and the collapse of the two ends of the church which were only restored in 1764. Elsewhere in the town arches were cracked and several buildings moved on their "ground wall" foundations…"

Quote from (Wood 1988)

2. A general introduction to Danish earthquakes

Denmark is located far away from the plate boundaries where most earthquakes occur. However, many small earthquakes are registered in Denmark year round. Every few years one of the Danish earthquakes is not just registered on the instruments, but is strong enough to be felt by people. The Danish earthquakes are primarily caused by stress build-up from the Mid Atlantic Ridge pushing the Eurasian Plate.
The majority of the Danish earthquakes have their epicenter in Kattegat or Skagerrak and the northern part of the North Sea. This is also where the largest earthquakes are registered. Some earthquakes have their epicenter on land mainly in Nordvestjylland and in central Sjælland. The seismicity is very sparse in the rest of the country.

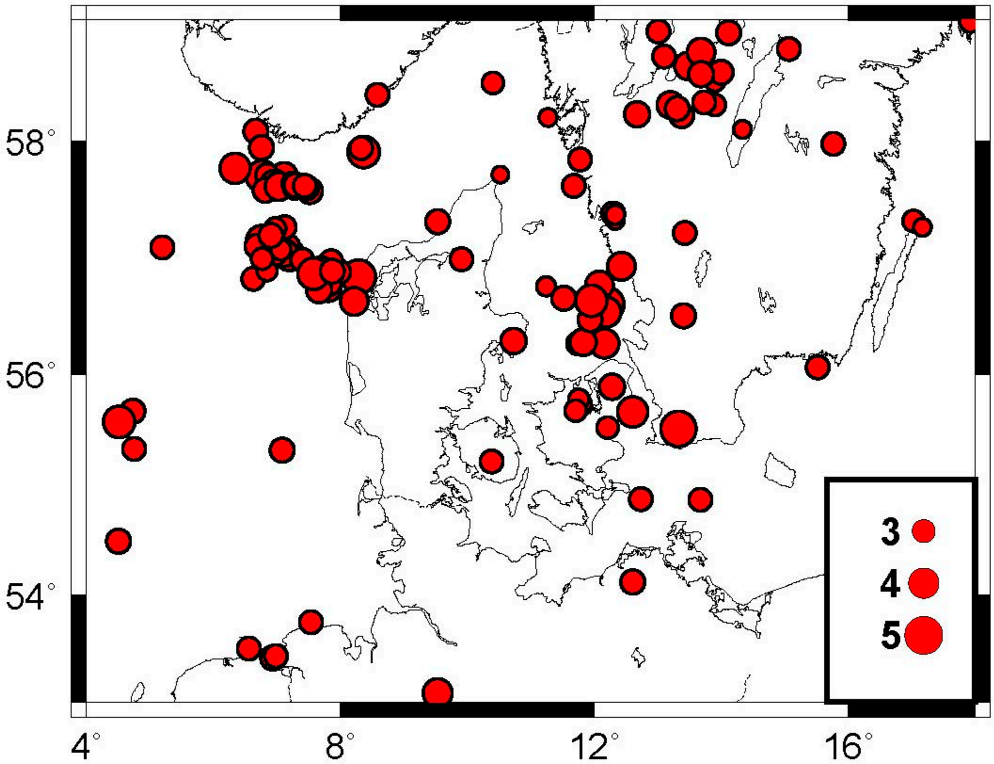

Figure 1 Earthquakes in the map area over magnitude 3 from 1960-2013. The size of the red dots is scaled to the magnitude of the earthquake.

Any analysis of the seismicity in Denmark has to distinguish between earthquakes occurring before 1930 and earthquakes occurring after. The first seismograph started recording on a daily basis in Copenhagen in 1930. Earthquakes occurring before the installation of the seismograph can only be evaluated from historical reports without supporting data. Without data it is not possible to calculate an epicenter, nor is it possible to evaluate the magnitude of the earthquake on the Richter scale or the moment magnitude scale. Instead the intensity of a historical earthquake is assigned a value on the Mercalli scale. This is a 12 step scale (See Chapter 3) describing the effects of an earthquake on humans, nature and buildings. It is important to emphasize that there is no direct mapping between the Mercalli scale and the Richter scale.

2.1 Instrumentally recorded earthquakes

It is GEUS's assessment that all earthquakes on Danish territory since 1930 with a magnitude of at least 4.0 on the Richter scale have been registered. During the last 10 years improved instrumentation has lowered the detection threshold resulting in a magnitude of completeness of 2.5. Smaller earthquakes are also registered, but it cannot be guaranteed that the catalogue is complete for smaller earthquakes.
The uncertainty on the calculated epicenters depends on both the number of seismographs on which an earthquake is registered as well as the geographical distribution of the seismographs relative to the epicenter. As larger earthquakes are typically registered by more instruments than the smaller earthquakes, the accuracy of the epicenter is improved for larger earthquakes. Generally the accuracy is also better for newer earthquakes than older ones due to improved data quality, data abundance and better methods. GEUS supplement own data with data from neighboring countries. As a conservative measure an uncertainly of 50 km is assumed on all Danish epicenters.

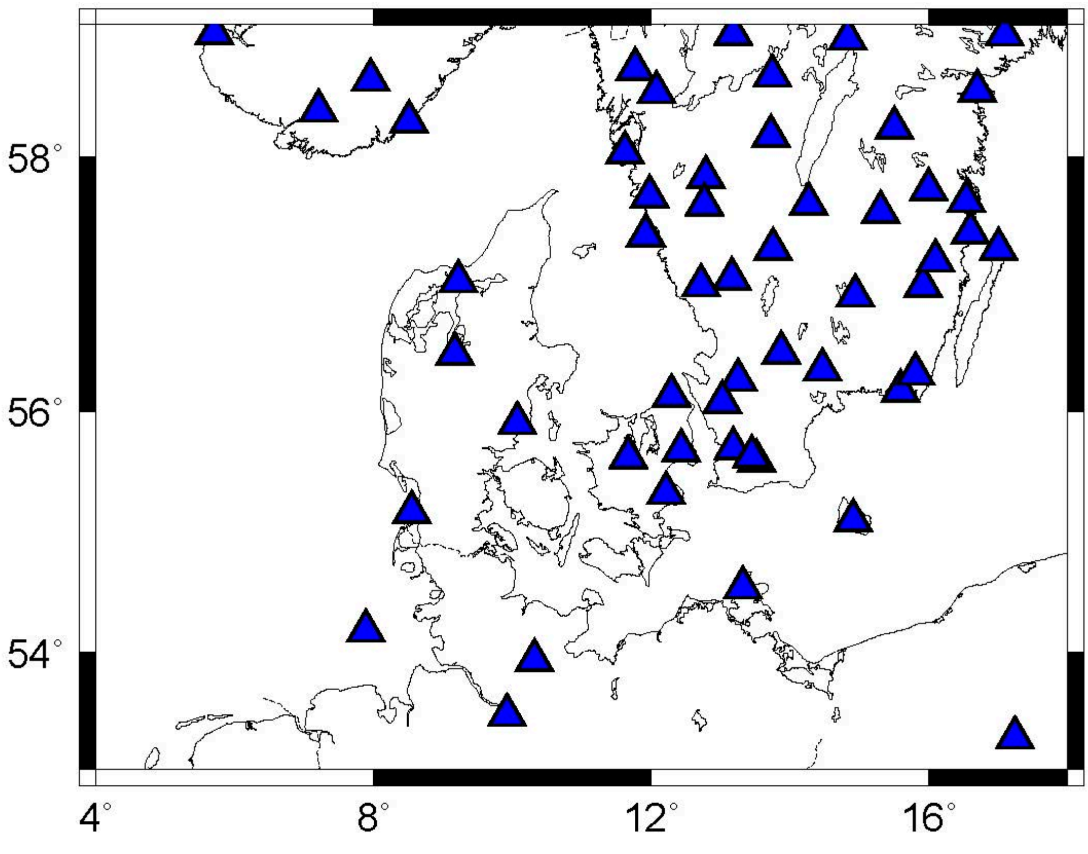

Figure 2 Map of past and present stations in Denmark and surrounding countries used in this study.

The seabed below the Danish territorial waters is still littered with unexploded mines from World War II. As the mines still pose a potential threat to fishery and other marine activities, the Danish Navy searches for the mines and destroy them by detonation, where they are found. GEUS receive notifications from the navy regarding many of the large detonations. Some of the blasts are clearly registered not only on the Danish seismographs, but also on the seismographs in neighbouring countries. Known explosions are removed from the earthquake catalogue. This still leaves many potential explosions of which GEUS are not informed, both in the Danish waters as well as explosions from mining activities in Norway and Sweden. The seismograms from the potential explosions are evaluated by a seismologist and flagged appropriately in the data base. There is a grey zone of events that cannot clearly be identified as explosion or earthquake.

2.2 Pre-instrumental earthquakes

Historical earthquakes are known only from written reports without supporting data. Old reports contain valuable information about the earthquakes, but it can be hard to distinguish earthquakes from other natural phenomenon such as storm and thunder. It is necessary to read the reports with a critical eye, as the neutral observations are often accompanied by more or less realistic interpretations and conclusions, as a result of the limited understanding of geophysical processes at the time.
It is also important to search for information about an earthquake over a large geographical area to gain insight into what may have happened. An example is the devastating earthquake in Lisbon in 1755. The shaking from the earthquake was felt clearly over a large part of Europe including Denmark. If a study of the reports from this earthquake included only local Danish sources, one could mistakenly have deduced, that the shaking originated from a Danish earthquake. Without scientific measurements neither epicenter nor magnitude are known. In some cases it is possible to estimate an epicenter and a magnitude, but these estimates are subject to considerable uncertainty.

2.3 Seismicity in Denmark

Denmark and in particular the Danish waters are frequently shaken by very small earthquakes. Very few of these earthquakes can be felt by people. Every few years an earthquake is strong enough to be felt, but only a few earthquakes though history have caused minor damage to buildings. A credible account of minor, visible displacements in the top soil comes from an earthquake in 1841 (Forchhammer 1869). The displacements were most likely not deeply rooted on a fault. Rather they were the result of secondary effects, as the sediments settled in response to the shaking. A similar displacement was observed in Kaliningrad, Russia, after an earthquake in 2004, measuring 5.2 on the Richter scale (Gregersen et al., 2007). Reports of intensity VII (See Appendix B) damage are also given from the 1759 earthquake in Northern Kattegat (Wood 1988). The earthquakes in 1759 and 1841 are most likely the largest earthquakes ever described as local earthquakes in Den-

mark. It is expected that an earthquake of at least a similar magnitude can strike in the future.
A small, but shallow earthquake near Holbæk in 2001 caused minor damage to a few houses. The damage was verified by seismologists. The most dramatic cause of the earthquake was a plaster wall plate that broke behind the television of a family watching the evening news. The house was built by the family themselves and they had not carried out a geotechnical investigation of the land before constructing the foundation of the house. The house was located close to the epicenter.
More accounts from earthquakes felt in Denmark can be found in chapters 4 and 5.

3. Richter scale and Mercalli scale

Richter's original magnitude scale (ML) was extended from observations of shallow earthquakes 100 km away to observations of earthquakes of any distance and of focal depths ranging between 0 and 700 km. Because earthquakes excite both body waves, which travel into and through the Earth, and surface waves, which are constrained to follow the natural wave guide of the Earth's uppermost layers, two magnitude scales evolved - the mb and MS scales. The standard body-wave magnitude formula is

$$mb = \log10(A/T) + Q(D,h)$$

where A is the amplitude of ground motion (in microns); T is the corresponding period (in seconds); and Q(D,h) is a correction factor that is a function of distance, D (degrees), between epicenter and station and focal depth, h (in kilometers), of the earthquake. The standard surface-wave formula is

$$MS = \log10\,(A/T) + 1.66 \log10\,(D) + 3.30$$

There are many variations of these formulas that take into account effects of specific geographic regions, so that the final computed magnitude is reasonably consistent with Richter's original definition of ML. Negative magnitude values are permissible. (http://earthquake.usgs.gov/learn/topics/measure.php)

The Danish magnitude scale (Wahlström 1978; Geodætisk_Institut 1983; Gregersen 1999) is defined as:

$$ML = \log(a) + \log(V(T)) + 1.61 \log(\Delta) - 2.76$$

Where:
a - vertical ground amplitude in μm
V(T)-magnification of Wood-Anderson seismograph at the relevant period
Δ-epicentrale distance in km

The local magnitude scale (ML) does not distinguish between the amplitude of the S body wave and the surface wave as they arrive more or less at the same time. The magnitude mb uses specifically body waves, and MS specifically surface waves. The local Danish ML magnitude scale relies on the maximum amplitude observed.

The magnitude on the Richter scale is related to the earthquake itself. In contrast, the Mercalli scale – or intensity scale – describes the effect an earthquake has, and is thus dependent on both the size of the earthquake and on where it was experienced.

The European Macroseismic Scale 1998 (Grünthal 1998; Musson & Cecić 2002) is the basis for evaluation of seismic intensity in European countries. Unlike earthquake magnitude, which indicates the energy a quake expends, EMS98 intensity denotes how strongly an earthquake affects a specific place. The European Macroseismic Scale has 12 divisions, as follows. The Mercalli scale in Danish can be found in Appendix B.

I. Not felt—Not felt, even under the most favourable circumstances.

II. Scarcely felt—Vibration is felt only by individual people at rest in houses, especially on upper floors of buildings.

III. Weak—The vibration is weak and is felt indoors by a few people. People at rest feel a swaying or light trembling.

IV. Largely observed—The earthquake is felt indoors by many people, outdoors by very few. A few people are awakened. The level of vibration is not frightening. Windows, doors and dishes rattle. Hanging objects swing.

V. Strong—The earthquake is felt indoors by most, outdoors by few. Many sleeping people awake. A few run outdoors. Buildings tremble throughout. Hanging objects swing considerably. China and glasses clatter together. The vibration is strong. Topheavy objects topple over. Doors and windows swing open or shut.

VI. Slightly damaging—Felt by most indoors and by many outdoors. Many people in buildings are frightened and run outdoors. Small objects fall. Slight damage to many ordinary buildings; for example, fine cracks in plaster and small pieces of plaster fall.

VII. Damaging—Most people are frightened and run outdoors. Furniture is shifted and objects fall from shelves in large numbers. Many ordinary buildings suffer moderate damage: small cracks in walls; partial collapse of chimneys.

VIII. Heavily damaging—Furniture may be overturned. Many ordinary buildings suffer damage: chimneys fall; large cracks appear in walls and a few buildings may partially collapse.

IX. Destructive—Monuments and columns fall or are twisted. Many ordinary buildings partially collapse and a few collapse completely.

X. Very destructive—Many ordinary buildings collapse.

XI. Devastating—Most ordinary buildings collapse.

XII. Completely devastating—Practically all structures above and below ground are heavily damaged or destroyed.

In some cases it is possible to estimate the magnitude of a historical earthquake. This can be done if good eyewitness reports exist for both the historical earthquake and for a modern, well-recorded earthquake in the same area. If the felt reports from the instrumentally recorded earthquake cover the same area as felt reports from the historical earthquake, it is possible to estimate the epicenter position of the historical earthquake by comparison. A similar estimate can be done for the magnitude.

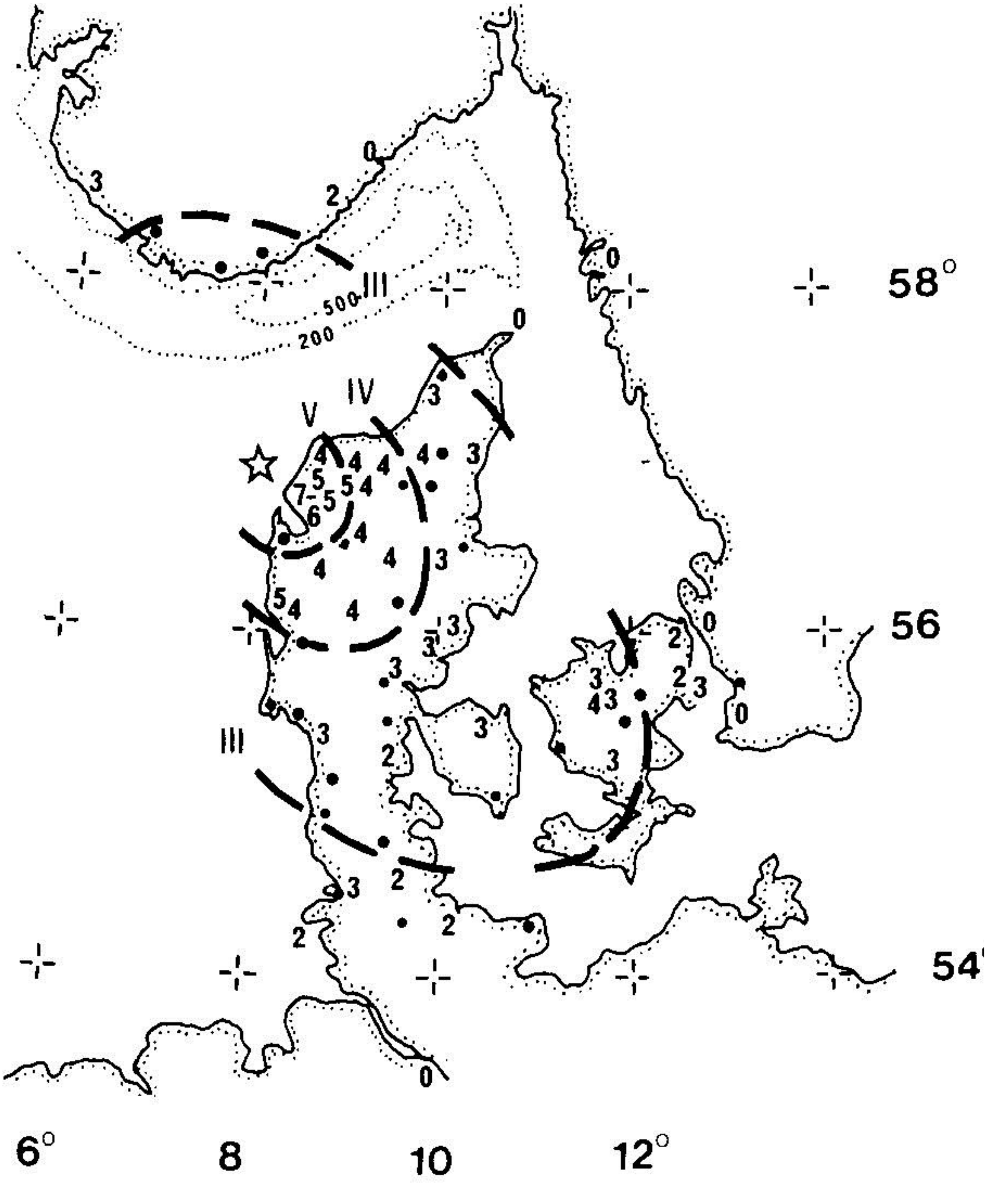

Figure 3 Intensity distribution (Mercalli scale) and isoseismal map of the earthquake of 3 April 1841. Reproduced from (Ambraseys 1985).

4. The earthquakes with the highest recorded intensities in Denmark

Felt earthquakes in Denmark are split into pre-instrumental and instrumental earthquakes. For the pre-instrumental earthquakes we do not have information on the magnitude, but for some earthquakes information on the maximum intensity is reported. For the list of instrumentally recorded earthquakes we have a magnitude and a position, and as a minimum a report of the earthquake being felt. For some we have more detailed information and many reports.

From the lists three earthquakes are described in more detail, including two earthquakes with the highest reported intensity – VII on the Mercalli scale. In addition, 23 earthquakes have maximum intensities of IV reported – se Chapter 5

Date time UTC	Max intensity	Location	Magnitude	reference
1841-04-03	VII	Offshore Thy	Unknown	(Forchhammer 1841, 1869; Ambraseys 1985)
1759-12-22	VII	N Kattegat	Unknown	(Wood 1988)
2010-02-19 21:09	VI	Offshore Thy	4.3	(Dahl-Jensen *et al.* 2013)
2012-08-12 02:57	VI	E of Anholt	4.1	(Dahl-Jensen *et al.* 2013)
2008-12-16 05:20	VI	Skåne	4.8	(Voss *et al.* 2009)
2001-11-06 05:28	VI	Holbæk	2.8	(Larsen *et al.* 2008)
1969-04-05 19:09	V-VI?	North Sea	4.3	(Gregersen *et al.* 1998)
1985-06-15 00:40	V	Kattegat	4.7	(Arvidsson *et al.* 1991)
1904-10-23 kl 10	V	Olso Fjord	5.4	(Harboe 1915; Lehmann 1956; Gregersen *et al.* 1998; Bungum *et al.* 2009)
1913-07-29 kl 04	V	West Jutland?	?	(Harboe 1915; Lehmann 1956)

Table 1: Earthquakes with intensity V-VII.

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4.1 1841-04-03 at 16 utc. Maximum reported intensity VII. Off-shore Thy. Magnitude unknown

Intensities of up to VII (Figure 3) are reported from particularly Thy, Mors, Hanherred (and southern Norway). (Lehmann 1956) describes intensities up to VII. Grüenthal & Wahlström (2012) describe the maximum intensity to VI and estimate a magnitude of 4.5 on the Richter scale and place the epicentre in the North Sea. Also GEUS places the epicentre in the North Sea. Based on the damage reports in (Forchhammer 1841, 1869), GEUS estimate that the maximum intensity reached VII, also when taking the poorer building standard of the day into account.

Details from the reports:
Examples from (Forchhammer 1869): ”I Thisted faldt flere Skorsteenspiber ned, og flere bygninger fik Revner, een endda i den Grad at den maatte nedrives. … Saaledes fik Kirken i Vestervig en Mængde Revner …”. På strækningen mellem Boddum og Klitmøller er der beretninger om at kalken faldt ned fra lofter og vægge. På Mors revnede en kirke og enkelte skorstene faldt ned i Tødse (?). Nær Vestervig blev der observeret bølgende bevægelser i gulve. Der berettes om en kone i Vixøe (?) hvis balje blev halvt tømt pga. jordens gyngende bevægelse.

There are many tales about cracks in the ground after the earthquake, but Forchhammer rejects most as having other causes than the earthquake. Forchhammer concludes that one crack oberserved in Vestervig Sogn is caused by the earthquake (Forchhammer 1869). The crack was approxmately 13 m long, and the southern side liftet 2.5-7.5cm relative to the northen side. The crack was only discovered three weeks after the earthquake, but the description of the crack is trustworthy, and we have no information to contradict that the crack was caused by the earthquake

4.2 1759-12-22 at mid day. Maximum intensity reported VII. Northern Kattegat. Magnitude unknown

This earthquake is described in (Wood 1988) and the descriptions below are quoted directly:
In both western Sweden and Sjaelland the earthquake was claimed to have lasted between one and three minutes (KDPT, 24/12, 7/1/60). At Hamburg it lasted "about a minute". The time was somewhere between 12.30 and 12.45: one report from Sjaelland records the clock striking the quarter as the tremor ceased. The region of strongest vibration and consequent damage extends across north-eastern Jutland, the northern fringe of Sjaelland, and the western edge of Bohuslan, Sweden. Around Gothenburg - "there are notes in various parish records that church walls had collapsed (cracked) in several places on the west coast" - Holmberg (1843). Several chimneys were knocked down in Ålingsås and Gothen-

burg (Gazette de France, 12 and 19 January 1760), where unsupported furniture moved around and porcelain and wood-burning stoves fell over or broke (KDPT, 7/11-60). At Walda (Vallda), to the south of Gothenburg, a letter describes how glass and porcelain fell down, and tiles fell off the roof of the writer's house (GM, 5/1160). On the road from

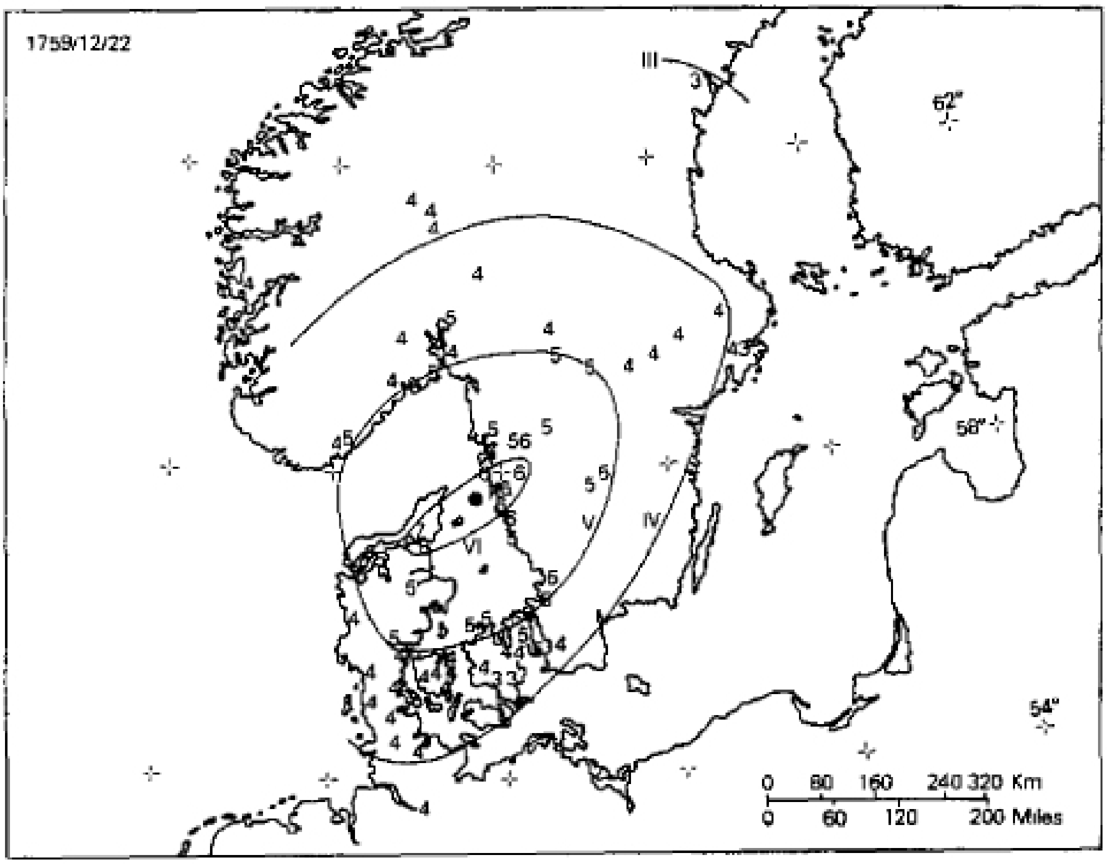

Figure 4 Mercalli intensities (Mercalli scale) and approximate isoseismals for the 22 December 1759 North Kattegat earthquake. Reproduced from (Wood 1988).

Marstrand to Varberg (south of Gothenburg) slight cracks had formed between the bridges and the adjoining river banks (GM, 5/1/60). Holmberg describes a large earthfall into the Gota River (which passes through Gothenburg). At both Marstrand and Walda there were disturbances in the sea at Walda "waves washed strongly at the foot of the cliff', and at Marstrand a party going home from a fishing trip on a flat sea, suddenly felt waves rocking the boat quite hard; water flew up on both sides into the boat, and the oars jumped out of their rollocks".

To the west of the Kattegat in Alborg an upper storey of St. Bochs or Budolphi church fell down (KDPT, 31112). This caused great damage to an extension of the building and the collapse of the two ends of the church (Trap, 1961) which were only restored in 1764. Elsewhere in the town arches were cracked and several buildings moved on their "ground wall" foundations. At Alborg the ice on the Limfjorden broke, as also at Vejle, where the following morning the ice was found to have been broken and lifted up. The same is told about many lakes and rivers in Sweden (KDPT, 28/12). At Walda ice on the lakes was broken, even where the lakes were frozen to the lake floor (GM, 5/1/60).

Further south in Jutland, at "Chatouller" (location unknown) some new buildings were cracked and ripped and doors were forced open, a phenomenon also observed at Odense "and other places". In Vejle objects fell and "people who were up could not stand still on the ground". A woman said that as she was walking along the street it was just as if she had become lifted off the ground and she became so confused in the head that she hardly knew where she was. The watchman says the same. A man who wanted to get out of bed fell back into it.
In Helsingør, on the north coast of Sjaelland, the hammer in the bell in Olai Church tower rang by itself, in the same way as when it chimes slowly (KDPT, 28/12). In the same place plaster came off the roofs and at Some roof tiles fell.
These observations suggest that Modified Mercalli intensity (MMI) VI effects were very widely distributed with MMI VII experienced locally around the coast of Bohushin, Sweden and in Alborg, northern Jutland. The spread of the region suffering minor building damage, from Alborg to Alingsas, is 150 km. No intensity VI effects are reported from Norway (allthough in Christiana (Oslo) panes of windows fell) and while isolated observations, such as the ringing of church bells, and fall of plaster at Helsingør, the fall of tiles at Som, and the bursting open of locked doors at Vejle, are all commensurate with intensity VI affects, these all appear be isolated observations within a prevailing intensity V region. In Jutland the earthquake is mentioned as being generally felt in all the principal towns although stronger in north Jutland (KDPT, 31112). Across Sjaelland, from where Horrebow collected his observations, the earthquake was "was not so strong as to cause building damage but it knocked over some objects, and knocked down some pictures in a church. The earth felt as if it were in a cradle. Houses were rattling - there was a loud noise of windows and doors, and doors sprang open, even those that were locked. Beds were moving as if in big waves - but quicker. Everything was creaking, plates and spoons rattling, furniture moving." Along the north and east coasts of Sjaelland it was strongest, while in the extreme southwest of the island it was only perceived by sensitive observers. A report from England that at Elsinor (Helsingør) “the sea was so agitated that several ships were driven from their anchors" (Gentleman’s Magazine, January 1760) must be poetic license as it cannot be corroborated from local sources.

4.3 2010-02-19 at 21:09 utc. Maximum intensity reported VI. North Sea. Magnitude 4.3

GEUS received close to 350 reports from people who felt this earthquake. Three reported damage of intensity VI (Lemvig, Herning and Thisted). The reports from individuals are read and an intensity is assigned to the report. These are then plotted on a map with an internationally used colour code. At this earthquake, a common report was snow suddenly falling off the roof.

The smaller blue stars are aftershocks, which are removed from the earthquake list before calculating hazards.(Dahl-Jensen *et al.* 2013)

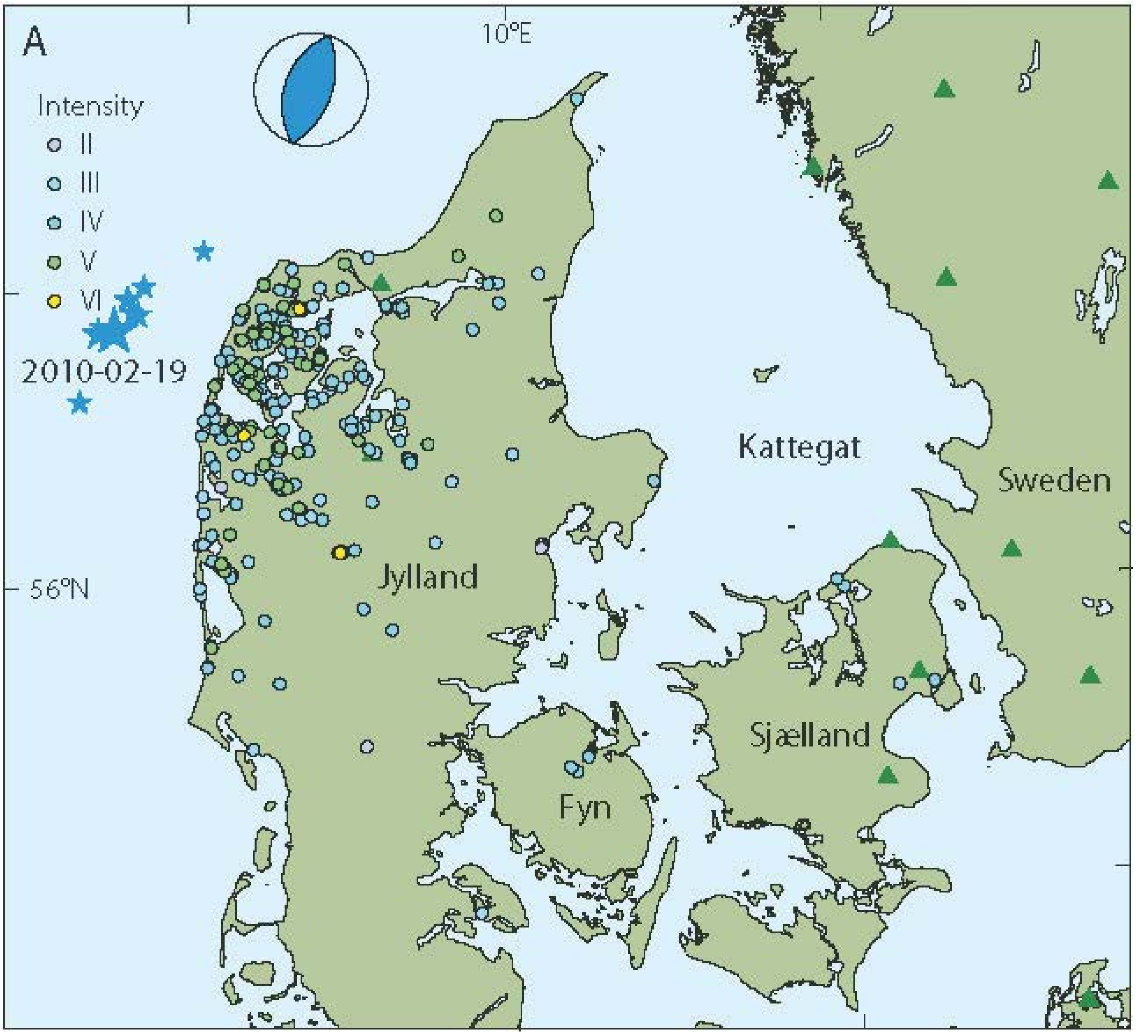

Figure 5 Reports of observed intensity (Mercalli scale) from the public. The earthquakes are marked by blue stars scaled by size. North Sea on 19 February 2010 magnitude 4.3. GEUS received 344 reports from people who felt the earthquake. Seven small aftershocks (magnitude 1.9 to 2.8) were observed during four weeks after the main earthquake. Modified from (Dahl-Jensen et al. 2013).

4.4 2012-08-06 at 02:57 utc. Maximum intensity reported VI. East of Anholt. Magnitude 4.1

GEUS received almost 450 reports from people who felt this earthquake. International reporting supplied an additional 69 reports, mainly in Sweden. One reported damage of intensity VI; see images of building damage in figure 7. (Dahl-Jensen *et al.* 2013)

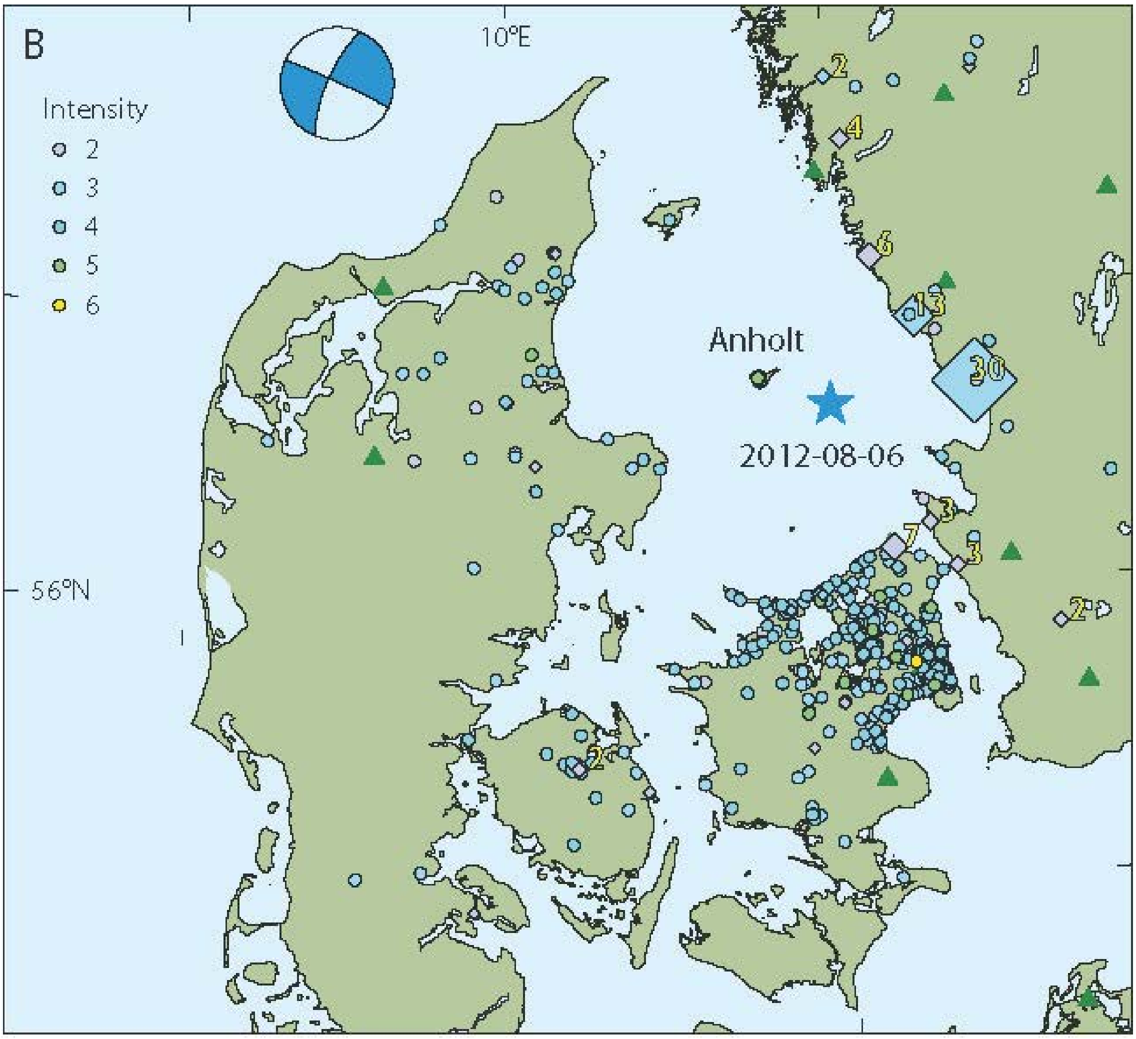

Figure 6 Reports of observed intensity (Mercalli scale) from the public. The earthquake is marked by a blue star. Kattegat on 6 August 2012 magnitude 4.1. In addition to reports received by GEUS (441), we have reports from the United States Geological Survey (in all 76 reports of which more than half are from Sweden (30 in Halmstad and 13 in Falkenberg) marked with diamonds scaled to the number of individual reports, and from The Swedish National Seismic network (SNSN) (16 reports) – marked with dots in Sweden – are included. Modified from (Dahl-Jensen et al. 2013).

Figure 7 The report from Herlev concerning this damage reads: Der er muligvis opstået et revne i hjørnesammenføjningen mellem to betonelementer og en knækket afdækningsplade ved fundamentet. Jeg skal have bebyggelsen til at kontrollere det. A following mail exchange clarified: hjørnesammenføjning er fra tidligere, men afdækningspladerne er knækket pga af jordskælvet.

4.5 2008-12-16 at 05:20 utc. Maximum intensity reported VI. Skåne. Magnitude 4.8

This earthquake was widely felt in Denmark – GEUS received over 4000 reports - and woke up many people in Copenhagen and Southern Sweden. The earthquake is described in (Voss *et al.* 2009).

4.6 2001-11-06 at 05:28 utc. Maximum intensity reported VI. Holbæk. Magnitude 2.8

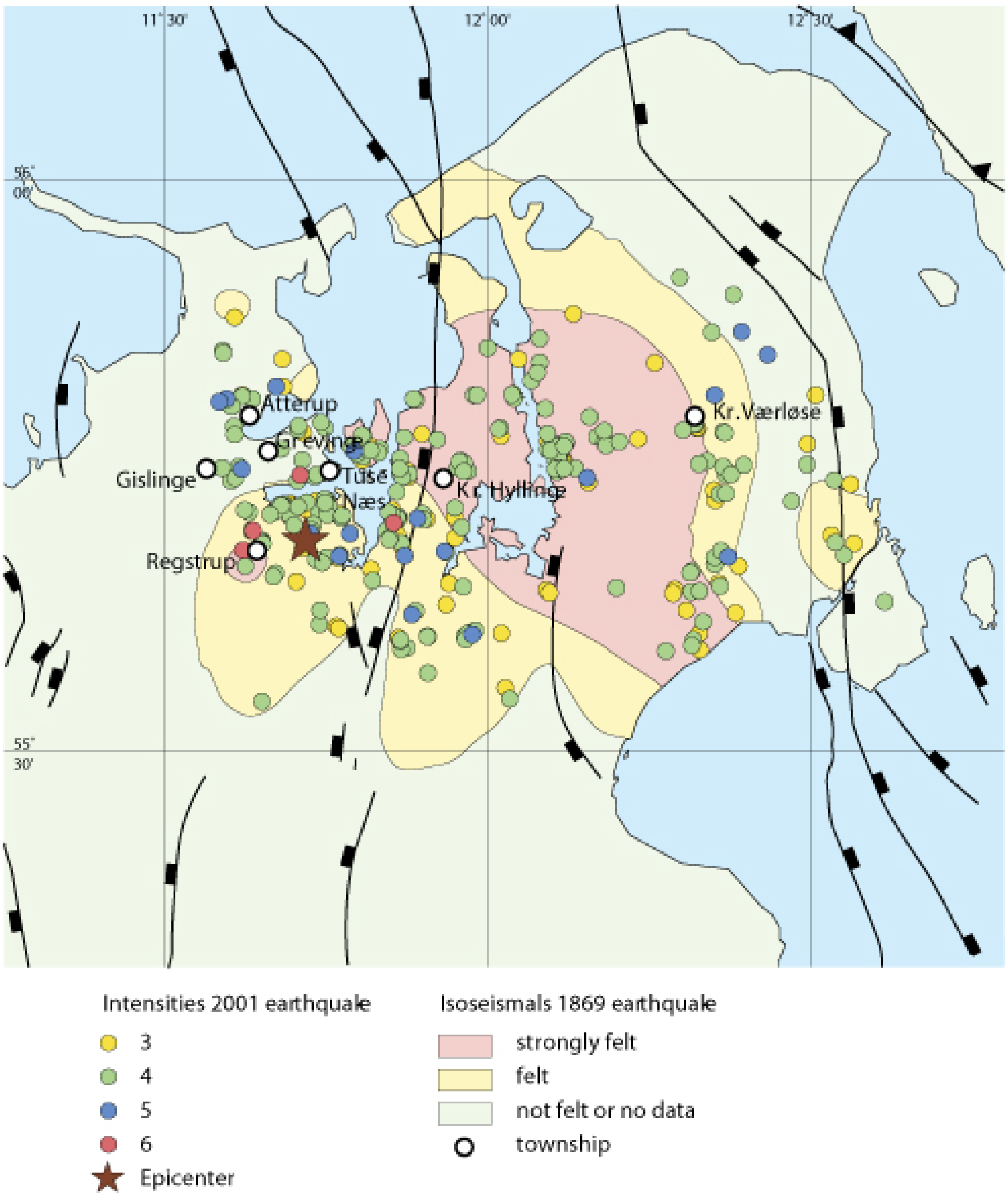

Figure 8 Map showing where the November 2001 earthquake (coloured dots) and the January 1869 earthquake (shaded areas) were felt. Each dot represents one observer, and the dots are colour coded according to the intensity on the European Macroseismic Scale. 6: modest damage to weak structures, 5: loose objects moved, 4: houses rattle, 3: the earthquake was felt. The shaded areas from the 1869 earthquake are redrawn from (Johnstrup 1870). Faults are redrawn from (Vejbæk & Britze 1994). Reproduced from (Larsen et al. 2008).

From (Larsen *et al.* 2008): Earthquakes on Sjælland are in general small and seldom felt. This small earthquake measuring just 2.8 on the Richter Scale was felt and heard over a surprisingly large area of Sjælland, Denmark on November 6, 2001. The earthquake caused people to abruptly leave their houses near the epicentre, and minor damage to several buildings was observed. The felt area is oriented strongly asymmetrically with respect to the epicentre, but it correlates well with the local geology. Specifically the shaking was felt in a region where the depth to the Top Chalk surface is small, and the thickness of the Quaternary sediments is less than 50 m. In 1869 an earthquake was felt strongly in the exact same area, and contours separating the felt area from the area where nothing was felt coincide almost exactly for the two earthquakes. This supports that geology and not human subjectivity is the determining factor in delineating the felt area for this earthquake.

In all, over 400 reports were made from people who felt the earthquake. Many of the observers describe that they have found minor cracks in wallpaper or poor quality brick walls. When there is any doubt weather a crack has been caused by the earthquake or if it was previously there, this information has been ignored when determining the intensity for an observation point.

The earthquake was felt very strongly over a large area, and frightened many people. Many, even among those who felt the earthquake at intensity 4, describe that they initially thought that a car or a truck had hit their house. Many feared that their furnace had exploded, and others thought that the roof of their house had suffered serious damage by an unknown cause. The earthquake was felt particularly dramatically in the Tuse Næs and Regstrup areas not far from the epicentre. In those areas many observers report that it felt as though their houses settled. One family in Kr. Hyllinge saw the plaster wall behind their television crack, as they were watching the evening news. In Gislinge an observer describes that it felt as though her house was pulled over an old-fashioned washboard, and in Grevinge another observer looked up and saw the ceiling was in motion.

What scared the majority of people the most, however, appears to be the sounds associated with the earthquake. 171, or more than half of the felt reports describe hearing various sounds from the earthquake. The observations of sound are scattered throughout the felt area, and not just close to the epicentre (Figure 8). The sounds appear to have the highest dB levels closest to the epicentre, but apart from that there is no clear geographical pattern in how the earthquake was heard. A few observers, including one in Atterup, which is at or very near the epicentre, describe hearing a cracking sound (as in cracking a whip), and the same is observed by one person in Kr. Værløse. All over the affected area people describe hearing a deep humming sound or distant rumbling not quite like thunder or anything else they have ever heard. Within approximately 30 km of the epicentre many heard a loud bang, not quite like an explosion. Then there is a 20 km wide band from a distance of 30 to 50 km, where only rumbling is heard, and then again a little less than 50 km away some hear rumble and some hear a bang. We interpret a bang to be a higher frequency sound than a rumble, and it is therefore not surprising that the majority of the observations of a bang are relatively close to the epicentre, as the higher frequencies are dampened quicker than the low frequencies. (Larsen *et al.* 2008)

4.7 1969-04-05 at 19:09 utc. Maximum intensity reported V (VI?). North Sea. Magnitude 4.3

Reports on this earthquake are sparse, but the available information is reported (Gregersen *et al.* 1998): A seismologist (Dr. Erik Hjortenberg, now retired) toured the shoulder of Jylland and found many people, who had felt the earthquake with intensities 3 and 4, extending to 5 or 6 in singular locations. Some people did report small cracks in walls, or fallen plaster. But just next door, many neighbours did not feel any shaking. On the southern coast of Norway, in the small town of Farsund, the earthquake is reported to have been felt as well. The strongest shaking was close to the coast of Jylland, toward the Skagerrak Sea.

4.8 1985-06-15 at 00:40 utc. Maximum intensity reported V. Kattegat. Magnitude 4.7

This earthquake is one of the large in the Danish area, and is reported in (Arvidsson *et al.* 1991).

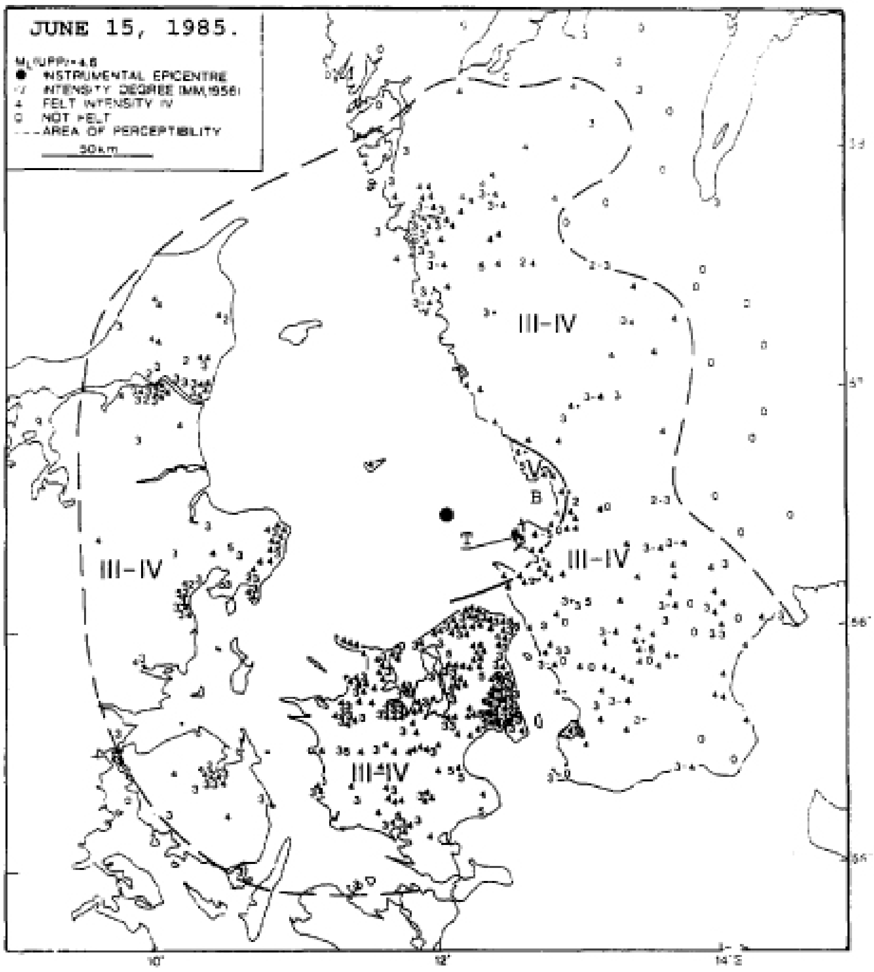

Figure 9 Isoseismal map of the June 15, 1985 earthquake. T denotes Torekov, where minor damage was onserved, and B denotes Bay of Laholm. Some coastal population cen-

tres are indicated by hatching.The numbers refer to the Mercalli scale. Reproduced from (Arvidsson et al. 1991).

It was accompanied by two aftershocks on 1986-04-01, magnitude 4.1 and 1990-05-24, magnitude 3.2, both felt.

4.9 1904-10-23 at 10 utc. Maximum intensity reported V. Olso Fjord. Magnitude 5.4

According (Lehmann 1956) this earthquake was felt in northern Denmark. A reanalysis based on recorded data presents a magnitude of 5.4 (Bungum *et al.* 2009).

4.10 1913-07-29 at 04 utc. Maximum intensity reported V. West Jutland. Magnitude unknown.

(Lehmann 1956) reports this earthquake as felt with intensity V in Ringkøbing, W Jutland, but also wider with lower intensity.

5. Felt earthquakes

5.1 Pre-instrumental felt earthquakes

Medd. fra Dansk Geol. Forening. København Bd. 13 [1956] 101

DANSKE JORDSKÆLV

Nr.	Aar	M.	D.	T.	I.	egn hvor jordskælvet er mærket	beskrevet af:	mat. opb. i:
1	1073							
2	1076	IV	22					
3	1173							
	1193							
	1194							
	1195							
4	1198							
	1199							
5	1272	V	6					
	1277							
	1375							
6	1409	VIII	24					
7	1515	I	13			(København)		
8	1541	VII	24					
9	1629	IX	6			Bornholm		
10	1632	II	29			Sjælland og Skaane		
	1634	X	11					
	1647	XI	16					
	1661	I	4					
11	1677	V	16	21		ved Limfjorden, Vendsyssel		
12	1709	II	11			København, Roskilde, Køge, m.m.		
13	1745	II				Tyholm. (Norge II, 7)		
14	1755	XI	1			(Lissabon)		
15	1759	XII	22	12		Danmark, især nordlige og østlige egne. (Norge, Sverige)	Horrebow	
16	1764					Limfjorden, nordvestlige Jylland		
17	1769	VI	8			Salling		
	1776	II	10					
	1783	XII	17					
18	1784	IV	6	21		Frederikssund, Jægerspris		
19	1794	I	1	16		Mors. (Norge?)		
	1796							
20	1809	XI	23	14		nordøstlige Sjælland		
21	1815	XII	28	4		Aalborg og omegn		
22	1829	VIII	18	15		nordøstlige Sjælland. (Sverige)	(Kjellén)	
	1830	IV	3					
23	1841	IV	3	16	VII	Danmark, især Ty, Mors, Hanherred. (sydl. Norge)	Forchhammer	M.M.
24	1844	XII	21	21		nordvestlige Jylland		
25	1869	I	28	12	IV$^{1}/_{2}$	nordlige Sjælland	Johnstrup	M.M.
26	1869	IX	4	23		Fur, Salling		
27	1875	VIII	13	18	IV$^{1}/_{2}$	Bornholm	Johnstrup	M.M.
28	1881	V	21	23	IV	østlige Sjælland. (Skåne)	Hintze	M.M.
29	1895	II	17			Tistrup		M.M.
30	1895	XII	16	13	IV	nordvestlige Jylland. (Norge)	Hintze. (Kolderup)	M.M.
31	1900	VIII	16	12	IV	nordvestlige Jylland	Hintze	
32	1904	X	23	11	V	Danmark, især nordlige og østlige egne. (Norge, Sverige)	Hintze, Harboe, m. fl.	(M.M.)
33	1911	V	8	13		Stadil, Husby Klit		
34	1912	III	27	21	IV	vestlige Jylland		
35	1912	XII	1	12	IV	nordvestlige Jylland	Harboe	
36	1913	VII	29	5	V	Ringkøbing, vestlige Jylland, m. m.		
37	1921	VIII	23			Bornholm. (Sverige)	(Sahlström)	G.I.
38	1921	VIII	24			Bornholm. (Sverige)	(Sahlström)	G.I.
39	1929	V	23	19	IV	Nordvestlige Jylland. (Norge)	Lehmann (Kolderup)	G.I.
40	1929	V	30	0	III	Nordvestlige Jylland. (Norge)	Lehmann (Kolderup)	G.I.
41	1929	VII	19			Holbæk		G.I.
42	1930	XI	1	0	IV$^{1}/_{2}$	Sjælland, Fyn. (Skåne)	Lehmann (Sahlström)	G.I.
43	1931	VI	7	1	IV	sydvestlige Jylland, m. m. (ep. Nordsøen)54.00N, 1.25E	magnitude 5.6	G.I.
44	1932	X	30	16	IV	Sydty, Mors		G.I.
45	1941	XI	28	4	IV	nordvestlige Jylland		G.I.
46	1945	VIII	17	2	IV$^{1}/_{2}$	Anholt, østlige Jylland		M.M.
47	1948	V	7	19		Tisted		G.I.
48	1949	XI	4	8		Stevns		G.I.
49	1954	VI	4	22	IV	Stevns	Jensen	G.I.
50	1954	X	18	17	IV	nordvestlige Jylland	magnitude 4.6	G.I.

Table 2. From (Lehmann 1956)

5.2 Instrumentally recorded felt earthquakes

Year	Mth	Day	Latitude Deg	Longitude Deg	Depth km	ML	Max int.	Location	reference
1929	05	23	57.18	6.61			III	North Sea	(Gregersen *et al.* 1998)
1930	10	31	55.50	12.70		4.5	IV	Copenhagen	“
1941	11	28					IV	Jutland	“
1954	06	04	55.40	12.60			III	Falsterbo	“
1954	10	18	56.82	8.26	44	4.6	III	Krik Vig	“
1969	04	05	57.13	7.04	33	4.3	V (VI?)	North Sea	“
1973	10	30	59.00	17.00	17		III	Skagerrak	“
1985	06	10	55.6	4.70	22.7	3.5	IV (off-shore)	North Sea	“
1985	06	15	56.61	12.23	9	4.7	V (in SW Sweden)	Kattegat	“
1986	04	01	56.50	12.11	2.1	4.2	IV	Kattegat	“
1989	01	20	57.90	8.39	21.8	4.3	III	Skagerrak	“
1993	07	07	55.55	4.50	15	4.3	IV (off-shore)	North Sea	“
1995	10	04	56.75	12.16	26.4	4.1	IV (in Sweden)	Kattegat	“
1995	11	30	55.64	12.26	25	2.5	IV	Tåstrup	“
1996	12	17	55.574	12.879	13.4	2.7	IV	Skåne	(Voss *et al.* in prep.)
1997	12	04	56.911	7.690	8.5	3.4	IV	North Sea	“
1998	07	08	57.203	8.423	15	3.4	IV	Ferring	“
2001	06	02	56.801	7.803	59.3	3.5	V	North Sea	“
2001	10	21	56.733	7.661	29.1	3.4	IV	North Sea	“
2001	11	06	55.677	11.701	19.7	2.8	VI	Holbæk	(Larsen *et al.* 2008)
2003	07	10	56.745	9.283	11.4	2.7	IV	Jutland	“
2004	02	23	55.516	12.184	36.3	2.9	VI	Bay of Køge	“
2004	09	21	54.82	19.96	10	5.2	V	Baltic Sea	“
2008	12	16	55.5	13.6	9	4.8	VI	Skåne	(Voss *et al.* 2009)
2010	02	19	56.874	7.581	38.7	4.3	VI	North Sea	(Dahl-Jensen *et al.* 2013)
2012	08	06	56.600	11.948	22.1	4.1	VI	Kattegat	“

Table 3. Instrumentally recorded felt earthquakes.

Many additional earthquakes were felt, but with less information. A list is included in appendix C.

6. Method for calculating earthquake hazard in Denmark

The probabilistic seismic hazard analysis (PSHA) we applied in this work is based on the methodology initially developed by (Cornell 1968). The analysis was performed using the CRISIS software program (Ordaz *et al.* 2007) for 8 source areas in Denmark. The source areas are given by a grid system between 53°N to 59°N latitude, and 4°E to 18°E longitude, see Figure below. The location of each area is based partly on the previously observed seismicity and partly on the geology of the area. The coordinates of the source areas are given in appendix D.

Hazard estimation is only valid for on-shore areas. Hazard due to liquefaction caused by earthquakes is not included in this work. Saturated sands may be subject to liquefaction during earthquakes.

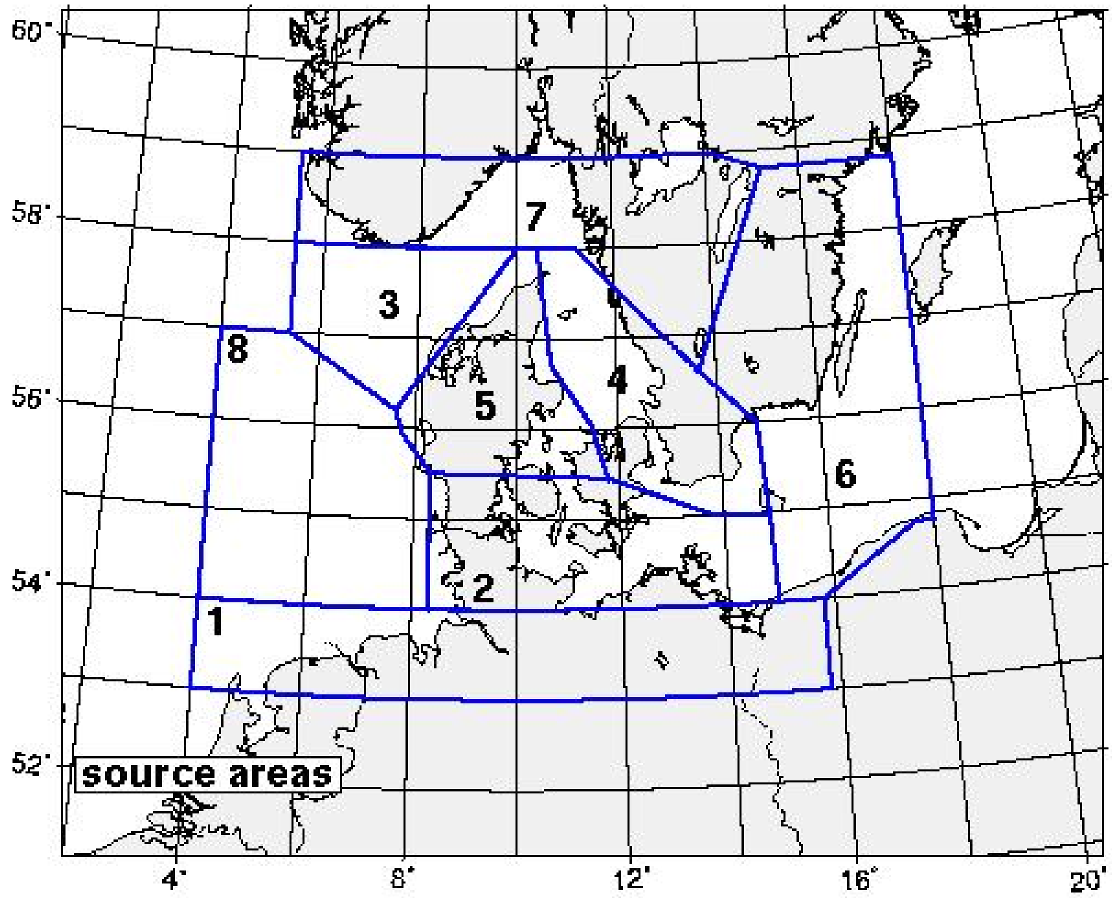

Figure 10 Source Areas in Denmark.

6.1 Active faults

We have no record or documentation for active faults in Denmark; active faulting is therefore not included in the hazard evaluation. Figure 11 shows the mapped top pre-Zechstein faults within Denmark (Vejbæk & Britze 1994) and well located earthquakes. Most earthquakes occur at many km's depth, and shallower faults are therefore not included.

Figure 11 shows that there are many mapped fault systems in the Danish area with observed earthquakes nearby and many without. Furthermore, many of the earthquakes are not located near known faults.

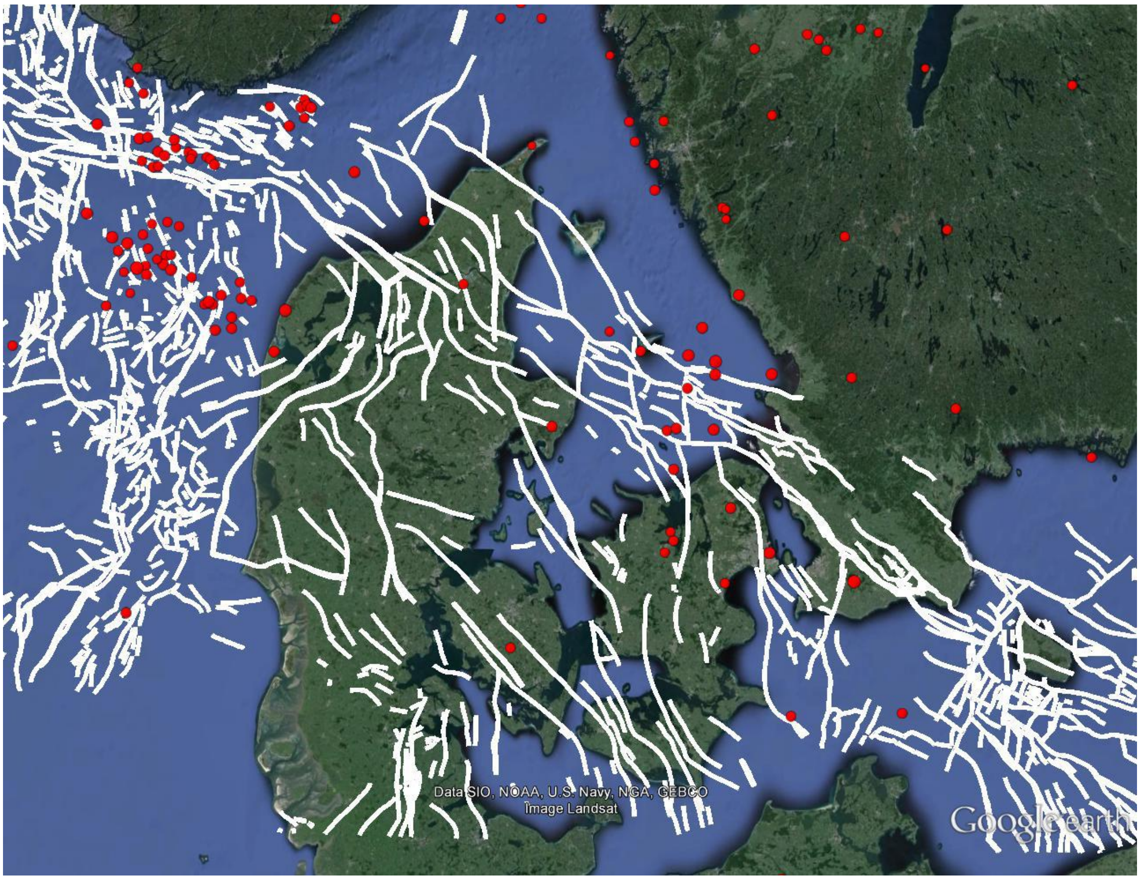

Figure 11 All well located earthquakes in GEUS database observed on at least three stations and pre top-Zechstein faults in Denmark (Vejbæk & Britze 1994).

6.2 Attenuation

The attenuation of earthquake signals has not been determined for Denmark and such investigation was beyond the scope of this work. We have therefore applied the global reference model by (Spudich et al. 1997) that describes attenuation from normal faults in hard-rock conditions.

6.3 Data

The data used in the PSHA are based on the GEUS earthquake database. The yearly earthquake activity of each of the source areas was given by the yearly number of earthquakes equal to or larger than magnitude 3 for a 54 year period [1960; 2013]. An analysis of the completeness of the earthquake database shows that the database is complete for earthquakes equal to or larger than 3 since 1960, see figure 12.

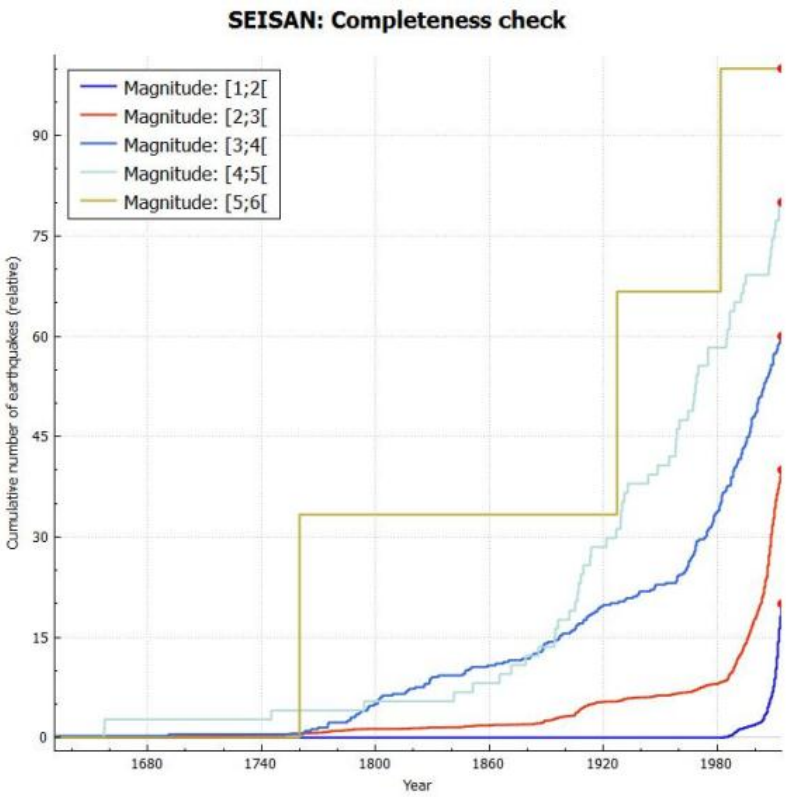

Figure 12 Accumulative count of earthquakes in magnitude intervals. When the increase of earthquakes become constant with time (i.e. a straight line with constant slope) all earthquakes in this magnitude range are observed. For example, for earthquakes between magnitude 3 and 4 the line becomes straight around 1960.

This part of the earthquake database is assumed to consist of only natural earthquakes. Explosions often occur in our region and they sometimes generate seismic signals similar to those of earthquakes, but in the GEUS earthquake database known and suspected explosions are marked specifically and not included in this work. Most explosions occur during working hours. Figure 13 shows the distribution per hour of the earthquakes used in this work and the variation shows that the earthquake list is likely not to be biased by unknown explosions.

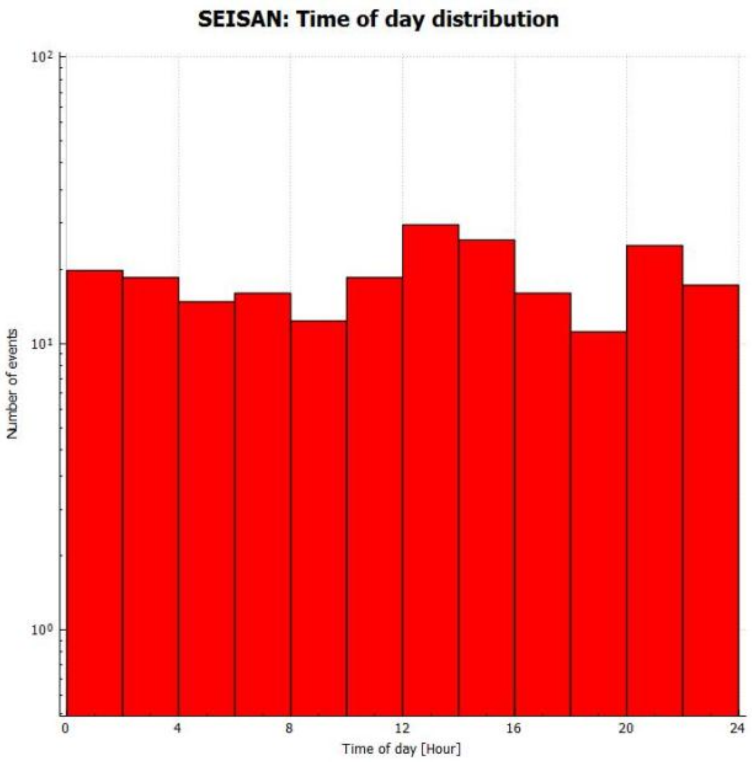

Figure 13 Distribution of earthquakes used in this study by time of day. Naturally occurring earthquakes should be evenly distributed, while controlled explosions occur during working hours.

The earthquake depths used in the PSHA are derived from the located depth of the earthquakes in each source area. The largest magnitude of an earthquake in the given period of completeness [1960; 2013] is also derived for each source area. Table 4 includes both the depth and the largest magnitude.

Known aftershocks and pre-shocks have not been included in the hazard evaluation since they are not independent earthquakes, which is required in probabilistic seismic hazard analysis.

The maximum magnitude an earthquake potentially could produce in the future in each source area is based on an estimate from the historically recorded earthquakes in the region, both the instrumental recorded earthquakes and the earthquakes where only macro seismic information is available. No statistical method exist for determination of the maximum magnitude an earthquake can generate, since it depends on non-linear relationships between many unknown such as the stress field and complex geological parameters. Figure 14 illustrates an attempt to determine the maximum magnitude by a Gumbel III distribution of UK earthquakes (BGS 2014b). But the Gumbel III distribution clearly under-predicts the largest observed earthquake in the UK, a magnitude 6.1 earthquake that occurred in the North Sea on JUN 7th 1931 (54.08N; 1.5E).

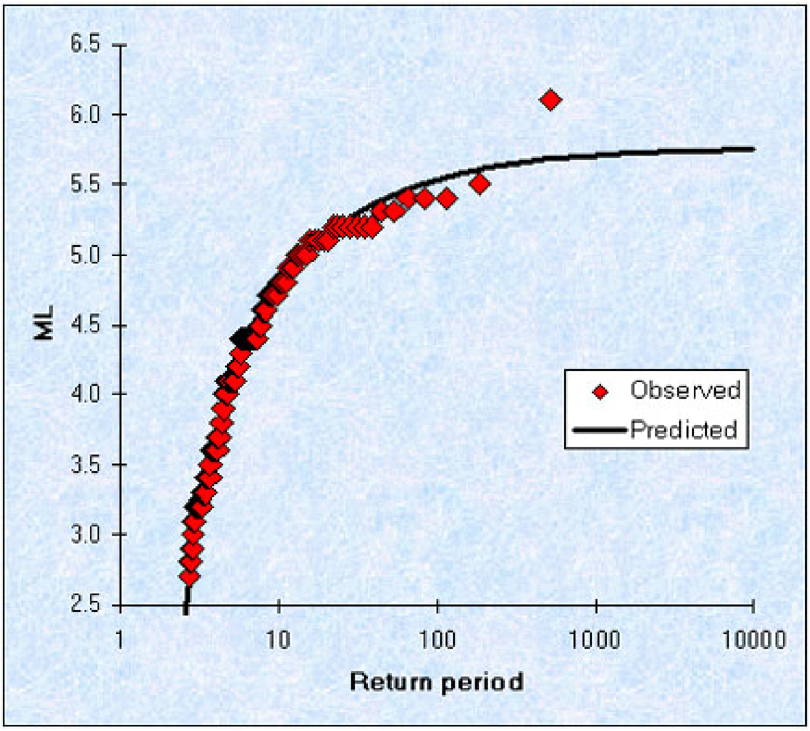

Figure 14 An attempt to determine the maximum magnitude by a Gumbel III distribution of UK earthquakes (BGS 2014a).

Another example of challenges with maximum magnitude estimation is from Lithuania (Lithuania has an area 1.5 larger than Denmark) where no earthquakes are recorded (Janutyte *et al.* 2013) but in 2004 a magnitude 5.2Mw (5.3ML) earthquake (Wiejacz & Dębski 2006; Gregersen *et al.* 2007) was observed just 60 km from the Lithuania boarder in Kaliningrad district, Russia. Since Lithuania and the Kaliningrad district are located in a similar tectonic frame one will therefore assume that Lithuania could be subject to an earthquake of the same magnitude.

We have in this work examined the magnitude of the largest reported earthquakes in our region. These earthquakes are assumed to occur under the same stress field as we have today, we have therefore not included reported earthquakes form the post-glacial period since they occurred under a different stress field, like the approximately 10.000 year old earthquake in Northern Sweden that could have exceeded a magnitude of 8 (Bödvarsson *et al.* 2006).

The list below shows some of the major earthquakes in our region, they are all within or near the Danish borders. The given magnitudes are based on individual studies and the amount of information available to derive the magnitudes decreases as one goes back in time. From these and the distribution of the earthquake database we estimate the maximum magnitude that an earthquake in Denmark could produce is 5.3 +/- 0.1 in the frame of a PSHA with a return period of 475 years.

2008 Skåne, magnitude 4.8 ML (Voss *et al.* 2009)
2004 Kaliningrad, magnitude 5.2Mw or 5.3ML (Wiejacz & Dębski 2006; Gregersen *et al.* 2007)

1985 Kattegat, magnitude 4.7ML (Gregersen *et al.* 1998)
1931 North Sea (54.08N; 1.5E), magnitude 6.1 (BGS 2014b)
1904 Oslofjord, magnitude 5.4 Ms (Bungum *et al.* 2009)
1759 Kattegat, magnitude 5.4 to 5.6 Estimated from macroseismic information (Wood 1988)

Source area No	Number of M ≥ 3	Yearly activity	Depth [km]	Max. M observed
1	7	0.130	15.1	3.9
2	4	0.074	16.2	3.2
3	44	0.810	22.5	4.6
4	22	0.407	10.9	4.8
5	5	0.093	17.3	3.7
6	2	0.037	14.7	3.3
7	25	0.463	10.7	4.2
8	10	0.185	18.2	4.2

Table 4. Source area number, number of earthquakes with magnitude ≥ 3 in the period [1960;2013], number of earthquakes per year with magnitude ≥ 3, depth of earthquakes in source area, maximum magnitude.

In PSHA the b-value is needed to describe the relationship between different levels of magnitude. In regions with high earthquake activity this can be done for each source region, but since Denmark is located in a region with low seismic activity we have computed one b-value for the whole area. The figure below show the number of earthquakes in 0.5 magnitude bins and the cumulative values used to compute the b-values of 0.96 +/- 0.1.

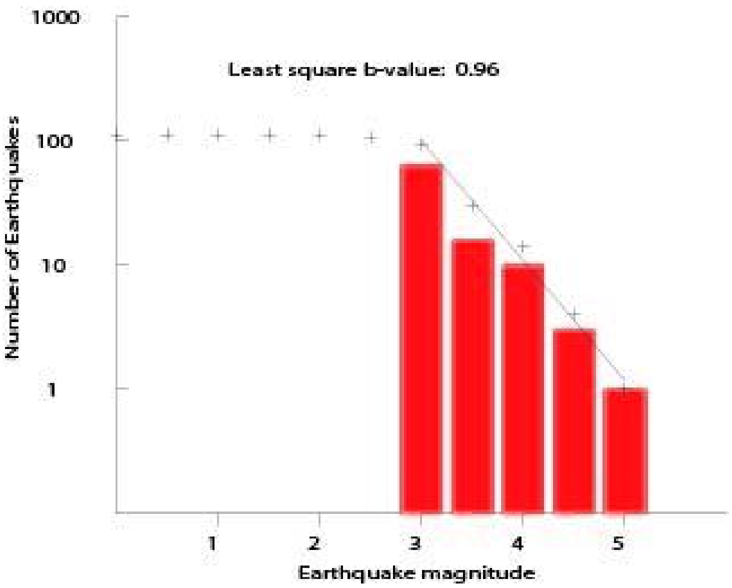

Figure 15 The number of earthquakes in magnitude bins of 0.5 are plotted, and the cumulative values used to compute the b-value (the slope of the line) of 0.96 +/- 0.1.

7. Hazard map for Denmark, Ground Type A, return period 475 years

The hazard map for Denmark is calculated assuming Ground Type A for the entire region. Type A is defined as “rock or other rock-like geological formation, including at most 5 m of weaker material at the surface” (EU 2004) . More details about the physical properties of Type A can be found in Chapter 8. The variations in site response to earthquakes are not known in detail for Denmark due to the limited number of earthquakes and the sparse seismograph network.

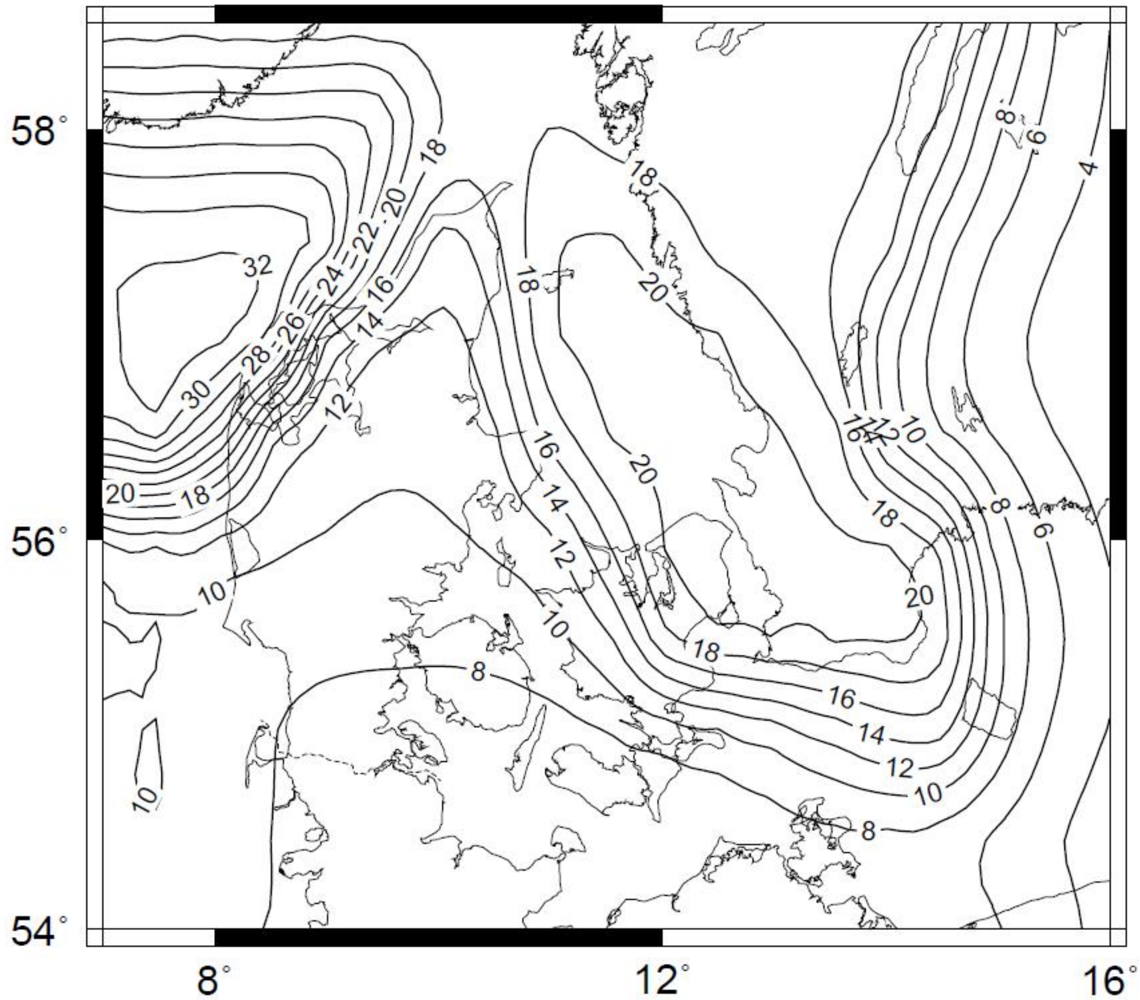

Figure 16 The estimated hazard for Ground Type A given by the peak ground accelerations [cm/s^2] for a return period of 475 years, which correspond to a 90% non-exceedance probability in 50 years. Given values are only valid onshore and should be re-evaluated after 10 years due to increasing uncertainty; ultimo 2024.

The hazard map (figure 16) reflects the observed seismicity. The highest levels of seismicity are found in Skagerrak and Kattegat, and the associated calculated hazard shows higher levels in NW Jutland and NE Zealand than in the rest of the country. The seismicity and hazard are lower in the southern part of Denmark. The variations in peak ground acceleration go from [6 cm/s^2 - 30 cm/s^2].

The estimated peak ground accelerations are similar to those obtained for Denmark in 4 other studies: (Wahlström & Grünthal 2000) used two different approaches and they find that the acceleration varies between [10 cm/s^2 - 35 cm/s^2] or [0 cm/s^2 - 25 cm/s^2], in (Wahlström & Grünthal 2001) they find that it varies between [20 cm/s^2 - 25 cm/s^2] and (Giardini *et al.* 2014) find that the acceleration varies between [0 cm/s^2 - 30 cm/s^2].

The overall seismic hazard in Denmark is low compared to the seismic hazard in many other regions of the earth. However, large destructive earthquakes can occur unexpectedly even in areas with low seismicity, as illustrated by the magnitude 6.4 Latur earthquake in central India on 30 September, 1993 (Gupta 1993).

Given values are only valid onshore and should be re-evaluated after 10 years due to increasing uncertainty; ultimo 2024.

8. Elastic response spectrum

There is no national information about these parameters for Denmark. We recommend using the same parameters as for Britain (consistent with the values in the tables 5 and 6)

Ground type	S	T_B(s)	T_C(s)	T_D(s)
A	1.0	0.15	0.4	2.0
B	1.2	0.15	0.5	2.0
C	1.15	0.20	0.6	2.0
D	1.35	0.20	0.8	2.0
E	1.4	0.15	0.5	2.0

Table 5. Values of the parameters describing the recommended Type 1 elastic response spectra (Table 3.2 from (EU 2004)).

Ground type	S	T_B(s)	T_C(s)	T_D(s)
A	1.0	0.05	0.25	1.2
B	1.35	0.05	0.25	1.2
C	1.5	0.10	0.25	1.2
D	1.8	0.10	0.30	1.2
E	1.6	0.05	0.25	1.2

Table 6. Values of the parameters describing the recommended Type 2 elastic response spectra (Table 3.3 from (EU 2004)).

S is the soil factor

T_B is the lower limit of the period of the constant spectral acceleration branch

T_C is the upper limit of the period of the constant spectral acceleration branch

T_D is the value defining the beginning of the constant displacement response range of the spectrum

Table 3.1: Ground types

Ground type	Description of stratigraphic profile	Parameters		
		$v_{s,30}$ (m/s)	N_{SPT} (blows/30cm)	c_u (kPa)
A	Rock or other rock-like geological formation, including at most 5 m of weaker material at the surface.	> 800	–	–
B	Deposits of very dense sand, gravel, or very stiff clay, at least several tens of metres in thickness, characterised by a gradual increase of mechanical properties with depth.	360 – 800	> 50	> 250
C	Deep deposits of dense or medium-dense sand, gravel or stiff clay with thickness from several tens to many hundreds of metres.	180 – 360	15 - 50	70 - 250
D	Deposits of loose-to-medium cohesionless soil (with or without some soft cohesive layers), or of predominantly soft-to-firm cohesive soil.	< 180	< 15	< 70
E	A soil profile consisting of a surface alluvium layer with v_s values of type C or D and thickness varying between about 5 m and 20 m, underlain by stiffer material with v_s > 800 m/s.			
S_1	Deposits consisting, or containing a layer at least 10 m thick, of soft clays/silts with a high plasticity index (PI > 40) and high water content	< 100 (indicative)	–	10 - 20
S_2	Deposits of liquefiable soils, of sensitive clays, or any other soil profile not included in types A – E or S_1			

Table 7. The Ground Types as defined in Table 3.1 from (EU 2004).

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Appendix A Time series from the Danish seismographs for selected Danish earthquakes

Data from 10 Danish earthquakes recorded on Danish seismographs can be downloaded from: http://seis.geus.net/data/earthquakedata2014.zip

Each file contain data from one component of a Danish seismograph. The components are marked by at code, Z/N/E, that give the direction of the recorded motion: Z is up/down, N is North/South and E is East/West. Data domain is acceleration and the unit is nm/s^2 (nanometer per second squared).
The data is in ASCII and the format contain a master header of 12 lines followed by a data channel header of 12 lines,
A file name is e.g. A2014-08-15-2236-22S.BSD___001HH_N and the header of this file looks like:

```
 Acceleration                  1114 227  8 15 22 36 22.470   264.740

 BSD HH Z    0.00   264.74










BSD  HHZ114227 815 22 36 22.470  100.00  26474                          G4
                                                                    .7560965E-02










        293          54         240         110         149         105         218
         61         282         234         147          97         109         124
        288          68         291         118         225         113         145
        151         261          82         304         259          31         100
         66         132         341         -13         225          54         231
.
.
```

Note that `7560965E-02` is the gain, `26474` is the number of samples and `100.00` is the number of samples per second.

The format of the data described in Appendix B in:

http://seis.geus.net/software/seisan/seisan.pdf

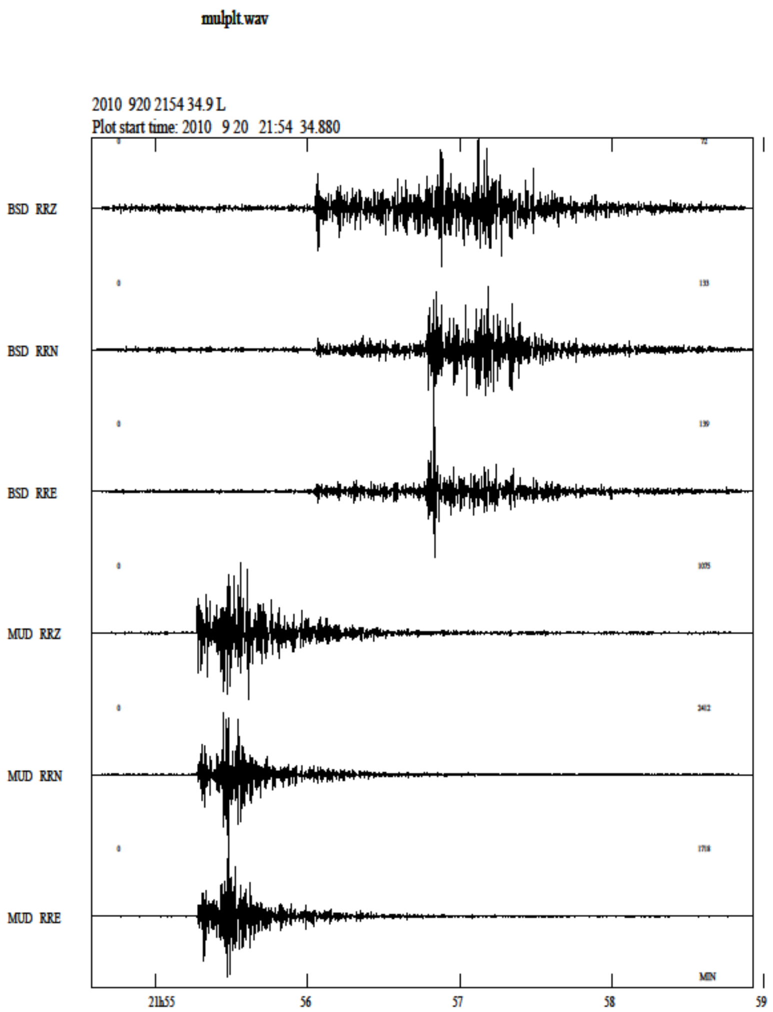
The earthquake data refers to this list:

The format of the list is described in Appendix C

```
 2004  223 0838 26.51LQ 55.524  12.212 33.7  DNK 50 0.3 2.9LDNK 3.0CDNK        1
 2001 11 6 1805 28.01LQ 55.677  11.701 19.7  DNK  4 0.1 2.8LDNK 3.4CDNK 2.6WDNK1
 2003  822 0349 38.1 L  56.665  11.518 15.0  DNK 11 1.2 3.2LDNK 3.3CDNK        1
 2012  8 6 0257 15.9 L  56.641  11.948 15.0  DNK 65 0.7 4.3LDNK                1
 2002  827 2306 37.4 L  57.718  10.521  4.9  DNK 15 1.1 2.2LDNK 2.8CDNK 3.2bDNK1
 2010  219 2109  1.0 R  56.875   7.580 39.7  DNK111 1.2 4.3LDNK 3.9WDNK        1
 2014  815 2236 34.2 LQ 54.920  15.039 23.5  DNK 12 0.5 2.6LDNK                1
 2010  920 2155  1.3 R  56.270   8.108  7.5  DNK 23 0.7 2.5LDNK 2.6CDNK        1
 2001  915 0652 32.8 L  57.046   9.287  0.4  DNK  5 1.6 2.7LDNK                1
 2010  113 0550 34.1 L  57.000   9.929 40.1  DNK 49 0.4 2.4LDNK 2.8CDNK        1
 2009  6 8 0354  2.4 LQ 57.344  10.282 38.3  DNK 20 1.0 2.6LDNK                1
 2008 1216F0520  2.7 LQ 55.604  13.548 18.1FFUPP 11 0.6 4.7LDNK         4.4LUPP1
 2004  921 1332 31.6 LQ 54.940  20.117  0.1  DNK 26 1.3 5.6LDNK 3.4sDNK 4.8WDNK1
```

Stations:

```
MUD   56.460N  9.170E  Mønsted Kalkgrube
COP   55.683N 12.433E  Vestvolden, Rødovre
BSD   55.110N 14.910E  Bornholm
GOET  57.034N  9.220E  Gøttrup
LLD   55.333N 12.215E  Stevns
GID   56.126N 12.296E  Gilleleje
```



Data example

Appendix B The European Macroseismic Scale 1998 – Mercalli-scale

The European Macroseismic Scale 1998 (Grünthal 1998; Musson & Cecić 2002) is the basis for evaluation of seismic intensity in European countries. Unlike earthquake magnitude, which indicates the energy a quake expends, EMS98 intensity denotes how strongly an earthquake affects a specific place. The European Macroseismic Scale has 12 divisions, as follows (in Danish):

Mercalli-skalaen er den mest brugte intensitetsskala til klassifikation af jordskælvs virkninger på mennesker, bygninger og natur. Den moderne skala bliver fagligt kaldt den modificerede Mercalliskala, idet californiske seismologer har fundet det formålstjenligt at ændre den til en mere entydig beskrivelse med f.eks. bilers rokken som en del af beskrivelsen, der i virkeligheden er 2-3 gange så omfattende som den korte version, der er gengivet herunder.

Virkningerne af et jordskælv er afhængige af jordskælvets størrelse, dets richtertal, samt af afstanden til jordskælvet og af jordbundsforholdene.

Virkningerne går fra netop følt i trin II til komplet ødelæggelse i trin XII. Omkring et jordskælv vil normalt ses et uregelmæssigt mønster af aftagende intensitet fra jordskælvets Epicenter. Skalaen har 12 trin og kan beskrives i kort form:

I: Kun via fintmærkende seismografer erkendes rystelsen.

II: Føles af få personer i ro.

III: Sammenlignes med forbikørende lastbil.

IV: Føles af de fleste. Vinduer og døre knager.

V: Føles af næsten alle. Mange vågner.

VI: Møbler bevæges. Enkelte skorstene vælter.

VII: Skade på middelgode bygninger.

VIII: Møbler vælter.

IX: Ødelæggelser på middelgode bygninger. Vandledninger knækker.

X: Jernbaneskinner bøjes. Jordskred.

XI: Kun få bygninger bliver stående.

XII: Komplet ødelæggelse. Genstande kastes op i luften.

Appendix C Felt events in our region from the GEUS database.

The list is extracted from the GEUS database of seismological events and contains all events where a report is received that someone has felt the event. Some are reports from our neighbouring counties. Some events are not natural earthquakes but explosions or presumed explosions (marked with a E or P in colum 23). The format (Nordic Format) is defined as follows (Havskov & Ottemøller 1999):

```
Columns Format Description                    Comments
  1            Free
  2- 5   I4    Year
  6            Free
  7- 8   I2    Month
  9-10   I2    Day of Month
 11            Fix o. time                    Normally blank, an F fixes origin time
 12-13   I2    Hour
 14-15   I2    Minutes
 16            Free
 17-20   F4.1  Seconds
 21            Location model indicator       Any character
 22      A1    Distance Indicator             L = Local, R = Regional, D = Distant, etc.
 23      A1    Event ID                       E = Confirmed explosion
                                              P = Probable explosion
                                              V = Volcanic
                                              Q = Confirmed earthquake
                                              ' ' = Presumed earthquake
                                              X = Landslide
 24-30   F7.3  Latitude                       Degrees (+ N)
 31-38   F8.3  Longitude                      Degrees (+ E)
 39-43   F5.1  Depth                          Km
 44      A1    Depth Indicator                F = Fixed, S = Starting value
 45      A1    Locating indicator             ----------------------------, * do not
locate
 46-48   A3    Hypocenter Reporting Agency
 49-51         Number of Stations Used
 52-55         RMS of Time Residuals
 56-59  F4.1   Magnitude No. 1
 60 A1         Type of Magnitude L=ML, b=mb, B=mB, s=Ms, S=MS, W=MW,
                                 G=MbLg (not used by SEISAN), C=Mc
 61-63  A3     Magnitude Reporting Agency
 64-67  F4.1   Magnitude No. 2
 68 A1         Type of Magnitude
 69-71  A3     Magnitude Reporting Agency
 72-75  F4.1   Magnitude No. 3
 76 A1         Type of Magnitude
 77-79  A3     Magnitude Reporting Agency
 80 A1         Type of this line ("1"), can be blank if first
               line of event
Colum:
         1111111111222222222233333333334444444444555555555566666666667777777778
12345678901234567890123456789012345678901234567890123456789012345678901234567890


 1632  229  1 0  0.0 L  55.800  12.500  0.0  PEN                          3.5WPEN1
 1657  423 11 0  0.0 L  59.000  12.000  0.0  PEN                          4.4WPEN1
 1657  5 4 1045  0.0 L  59.000  10.500 28.0  AMB                          4.8WAMB1
 1661 1231 2359  0.0 L  56.500  14.500  0.0  PEN                          2.0WPEN1
 1673  5 1  0 0  0.0 L  58.500  11.500  0.0  PEN                          3.5WPEN1
 1676 1231 2359  0.0 L  57.700  11.900  0.0  PEN                          2.0WPEN1
 1686  1 1  0 0  0.0 L  58.300  15.400  0.0  PEN                          2.0WPEN1
 1690 1231 2359  0.0 L  58.000  12.000  0.0  PEN                          2.5WPEN1
 1691  2 6  3 0  0.0 L  56.200  14.000  0.0  PEN                          3.0WPEN1
 1693 1231 2359  0.0 L  58.300  12.300  0.0  PEN                          2.5WPEN1
 1694 1231 2359  0.0 L  58.100  12.400  0.0  PEN                          2.5WPEN1
 1694  1 1  9 0  0.0 L  57.400  12.200  0.0  PEN                          2.0WPEN1
 1697  217 19 0  0.0 L  57.000  13.500  0.0  PEN                          2.5WPEN1
```

```
1701  2 1  2 0  0.0 L  56.500  14.500  0.0  PEN                       2.0WPEN1
1703  219  5 0  0.0 L  57.400  12.600  0.0  PEN                       2.0WPEN1
1708 10 3 14 0  0.0 L  58.200  13.300  0.0  PEN                       2.5WPEN1
1711  911  0 0  0.0 L  58.200  13.300  0.0  PEN                       2.0WPEN1
1714 1224  8 0  0.0 L  58.500  14.500  0.0  PEN                       2.0WPEN1
1716  727  0 0  0.0 L  58.900  14.900  0.0  PEN                       2.0WPEN1
1725  2 1  0 0  0.0 L  58.100  11.300  0.0  PEN                       2.0WPEN1
1729 1013  8 0  0.0 L  58.400  12.300  0.0  PEN                       2.0WPEN1
1747  725 15 0  0.0 L  57.500  12.000  0.0  PEN                       2.5WPEN1
1751  523 18 0  0.0 L  58.000  13.700  0.0  PEN                       2.0WPEN1
1751 1223 12 0  0.0 L  56.600  13.000  0.0  PEN                       2.0WPEN1
1752  316 22 0  0.0 L  59.000   5.700  0.0  PEN                       2.0WPEN1
1752  415 15 0  0.0 L  59.000   5.700  0.0  PEN                       2.0WPEN1
1753 1116 15 0  0.0 L  57.400  12.500  0.0  PEN                       2.0WPEN1
1754  123  0 0  0.0 L  58.300  13.000  0.0  PEN                       2.0WPEN1
1754  2 2  0 0  0.0 L  58.300  12.900  0.0  PEN                       2.0WPEN1
1755  320  0 0  0.0 L  57.300  12.100  0.0  PEN                       2.0WPEN1
1755 1228 20 0  0.0 L  57.300  12.100  0.0  PEN                       2.0WPEN1
1756 1227 11 0  0.0 L  57.700  12.200  0.0  PEN                       2.0WPEN1
1759  5 1  0 0  0.0 L  57.300  15.200  0.0  PEN                       2.0WPEN1
1759 1222  045  0.0 L  57.700  11.100 10.0  PML               5.6SPML 5.5WPEN1
1760  822 1230  0.0 L  57.700  16.400  0.0  PEN                       2.0WPEN1
1760 1225  0 0  0.0 L  58.700  13.600  0.0  PEN                       2.0WPEN1
1761 1220 16 0  0.0 L  58.300  13.500  0.0  PEN                       3.0WPEN1
1762 1125  0 0  0.0 L  58.200  13.300  0.0  PEN                       3.0WPEN1
1765  212  0 0  0.0 L  58.200  13.300  0.0  PEN                       2.0WPEN1
1766  128  230  0.0 L  56.300  12.800  0.0  PEN                       3.0WPEN1
1767 12 6  030  0.0 L  58.300  13.500  0.0  PEN                       2.0WPEN1
1769  9 5 2145  0.0 L  56.600  12.300  0.0  PEN                       3.0WPEN1
1772  1 1  0 0  0.0 L  58.200  13.300  0.0  PEN                       2.0WPEN1
1772 1231 2230  0.0 L  58.400  12.300  0.0  PEN                       2.0WPEN1
1773  114  2 0  0.0 L  56.500  15.500  0.0  PEN                       2.0WPEN1
1773 1125  0 0  0.0 L  58.200  13.300  0.0  PEN                       2.0WPEN1
1774 1112  0 0  0.0 L  58.200  13.300  0.0  PEN                       2.0WPEN1
1774 1224  0 0  0.0 L  58.200  13.400  0.0  PEN                       3.0WPEN1
1775  1 1  4 0  0.0 L  58.300  13.100  0.0  PEN                       2.0WPEN1
1775  1 2  530  0.0 L  58.200  13.300  0.0  PEN                       3.0WPEN1
1775  523  0 0  0.0 L  58.200  13.300  0.0  PEN                       3.0WPEN1
1775  718  0 0  0.0 L  58.200  13.300  0.0  PEN                       2.0WPEN1
1776  110  0 0  0.0 L  58.200  13.300  0.0  PEN                       2.0WPEN1
1776 1026  0 0  0.0 L  58.200  13.300  0.0  PEN                       2.0WPEN1
1777  529  0 0  0.0 L  58.200  13.300  0.0  PEN                       2.0WPEN1
1779  5 7  2 0  0.0 L  57.300  12.100  0.0  PEN                       2.0WPEN1
1781  329  0 0  0.0 L  58.200  13.300  0.0  PEN                       2.0WPEN1
1782  421  0 0  0.0 L  59.000  16.000  0.0  PEN                       2.0WPEN1
1783  715  0 0  0.0 L  58.500  15.000  0.0  PEN                       2.0WPEN1
1784  322 1630  0.0 L  56.900  12.700  0.0  PEN                       2.0WPEN1
1785  2 4 2030  0.0 L  58.500  13.700  0.0  PEN                       3.0WPEN1
1786  3 4  0 0  0.0 L  56.500  12.300  0.0  PEN                       2.0WPEN1
1786  321  0 0  0.0 L  58.200  13.300  0.0  PEN                       2.0WPEN1
1786  730  623  0.0 L  58.200   6.400  0.0  PEN                       3.0WPEN1
1787  110 2330  0.0 L  58.200  13.300  0.0  PEN                       3.0WPEN1
1788  224  0 0  0.0 L  56.500  12.300  0.0  PEN                       2.0WPEN1
1788  424 1330  0.0 L  58.200  13.300  0.0  PEN                       2.0WPEN1
1788  8 2 1047  0.0 L  59.000   5.700  0.0  PEN                       2.0WPEN1
1789  320 2030  0.0 L  58.500  14.500  0.0  PEN                       3.0WPEN1
1791  8 6  330  0.0 L  58.400  13.800  0.0  PEN                       3.0WPEN1
1792  7 6  1 0  0.0 L  55.600  13.200  0.0  PEN                       3.0WPEN1
1793  1 1  0 0  0.0 L  58.100   8.000  0.0  PEN                       2.0WPEN1
1795  815 22 0  0.0 L  58.200  13.600  0.0  PEN                       3.0WPEN1
1796  221 15 0  0.0 L  58.700  14.700  0.0  PEN                       3.0WPEN1
1796  228  9 0  0.0 L  58.200  13.600  0.0  PEN                       2.0WPEN1
1796  913 22 0  0.0 L  58.800  14.900  0.0  PEN                       3.0WPEN1
1799  312  943  0.0 L  58.000  13.500  0.0  PEN                       3.0WPEN1
1801  726  630  0.0 L  58.500  13.300  0.0  PEN                       3.0WPEN1
1801  730 13 0  0.0 L  58.300  13.500  0.0  PEN                       3.0WPEN1
1801  9 5  2 0  0.0 L  58.300  13.500  0.0  PEN                       3.0WPEN1
1802  7 4  3 0  0.0 L  58.500  14.500  0.0  PEN                       3.0WPEN1
1803  724 22 0  0.0 L  59.000  10.000  0.0  PEN                       3.0WPEN1
1809  119  0 0  0.0 L  58.000  14.000  0.0  PEN                       3.0WPEN1
1814  120  0 0  0.0 L  58.500  17.000  0.0  PEN                       2.0WPEN1
1815  9 8 2130  0.0 L  59.000  17.000  0.0  PEN                       3.0WPEN1
1816  3 1  0 0  0.0 L  58.500  14.500  0.0  PEN                       2.0WPEN1
1816  329 11 0  0.0 L  57.500  12.000  0.0  PEN                       3.0WPEN1
1818  120  0 0  0.0 L  58.500  13.400  0.0  PEN                       2.0WPEN1
```

1818	2 2	0 0	0.0	L	58.300	13.300	0.0	PEN		2.0WPEN1
1820	1113	1145	0.0	L	58.000	13.200	0.0	PEN		3.0WPEN1
1823	727	4 0	0.0	L	58.400	13.200	0.0	PEN		2.0WPEN1
1824	814	0 0	0.0	L	57.700	11.700	0.0	PEN		2.0WPEN1
1825	9 3	0 0	0.0	L	57.800	15.800	0.0	PEN		3.0WPEN1
1825	1118	0 0	0.0	L	58.100	13.700	0.0	PEN		3.0WPEN1
1827	1117	0 0	0.0	L	57.500	12.800	0.0	PEN		2.0WPEN1
1827	1124	0 0	0.0	L	57.500	12.800	0.0	PEN		2.0WPEN1
1827	12 3	0 0	0.0	L	57.700	11.700	0.0	PEN		2.0WPEN1
1828	3 8	515	0.0	L	56.700	12.800	0.0	PEN		3.0WPEN1
1828	924	3 0	0.0	L	58.100	12.700	0.0	PEN		3.0WPEN1
1828	930	030	0.0	L	57.500	12.800	0.0	PEN		3.0WPEN1
1829	818	1415	0.0	L	57.700	11.500	0.0	PEN		3.0WPEN1
1833	113	19 0	0.0	L	58.400	15.200	0.0	PEN		3.0WPEN1
1835	6 7	1030	0.0	L	58.100	13.600	0.0	PEN		2.0WPEN1
1841	4 3	1540	0.0	L	57.000	8.500	20.0	PML	4.5SPML	5.3WMAC1
1843	1231	2359	0.0	L	56.400	16.200	0.0	PEN		2.0WPEN1
1845	1231	2359	0.0	L	58.200	14.000	0.0	PEN		3.0WPEN1
1845	1 4	230	0.0	L	58.400	8.800	0.0	PEN		2.0WPEN1
1846	1118	030	0.0	L	58.300	13.100	0.0	PEN		2.0WPEN1
1846	12 8	21 0	0.0	L	58.100	12.100	0.0	PEN		2.0WPEN1
1846	1210	21 0	0.0	L	58.200	12.200	0.0	PEN		2.0WPEN1
1847	2 2	20 0	0.0	L	58.300	13.200	0.0	PEN		2.0WPEN1
1847	312	0 0	0.0	L	58.300	15.300	0.0	PEN		3.5WPEN1
1847	316	0 0	0.0	L	58.300	15.300	0.0	PEN		3.0WPEN1
1849	4 2	230	0.0	L	58.000	11.800	0.0	PEN		3.0WPEN1
1849	1024	0 0	0.0	L	56.500	14.500	0.0	PEN		2.0WPEN1
1850	8 1	17 0	0.0	L	58.200	14.000	0.0	PEN		3.0WPEN1
1851	413	1145	0.0	L	58.800	10.800	10.0	PML	4.6SPML	3.5WPEN1
1852	2 4	11 0	0.0	L	59.000	5.700	0.0	PEN		2.0WPEN1
1853	113	2 0	0.0	L	58.200	12.200	0.0	PEN		2.0WPEN1
1855	220	0 0	0.0	L	57.100	12.200	0.0	PEN		2.0WPEN1
1859	118	17 0	0.0	L	58.800	11.500	0.0	PEN		3.0WPEN1
1860	812	2130	0.0	L	56.000	14.100	0.0	PEN		2.0WPEN1
1861	1215	1 0	0.0	L	55.500	13.200	0.0	PEN		2.0WPEN1
1862	1 7	2 0	0.0	L	56.900	13.900	0.0	PEN		2.0WPEN1
1863	4 7	14 0	0.0	L	59.000	6.000	0.0	PEN		3.5WPEN1
1865	5 7	1320	0.0	L	59.000	6.100	15.0	PML	4.9SPML	4.7WPEN1
1867	5 7	9 0	0.0	L	58.000	6.300	0.0	PEN		3.0WPEN1
1869	128	12 0	0.0							1
1869	1231	2359	0.0	L	55.400	13.300	0.0	PEN		3.0WPEN1
1869	719	20 0	0.0	L	55.200	13.100	0.0	PEN		2.0WPEN1
1871	630	17 0	0.0	L	58.100	8.000	0.0	PEN		4.7WPEN1
1874	1222	9 0	0.0	L	58.700	11.200	0.0	PEN		2.0WPEN1
1877	3 5	1230	0.0	L	58.500	15.700	0.0	PEN		3.5WPEN1
1877	11 8	17 0	0.0	L	58.400	8.800	0.0	PEN		2.0WPEN1
1879	2 2	1720	0.0	L	58.800	16.000	0.0	PEN		4.0WPEN1
1881	521	22 0	0.0	L	55.800	12.700	0.0	PEN		3.0WPEN1
1881	12 4	1830	0.0	L	58.200	6.400	0.0	PEN		3.0WPEN1
1883	1 5	1950	0.0	L	57.500	16.200	0.0	PEN		2.0WPEN1
1883	325	1635	0.0	L	57.300	12.400	0.0	PEN		3.0WPEN1
1883	729	20 0	0.0	L	59.000	15.200	0.0	PEN		2.0WPEN1
1883	1220	2030	0.0	L	57.300	15.200	0.0	PEN		2.0WPEN1
1884	110	1110	0.0	L	57.000	16.400	0.0	PEN		2.0WPEN1
1884	229	2130	0.0	L	58.300	13.300	0.0	PEN		2.0WPEN1
1885	10 9	830	0.0	L	59.000	17.500	0.0	PEN		2.0WPEN1
1886	1 6	3 0	0.0	L	59.000	9.000	0.0	PEN		3.5WPEN1
1886	116	3 0	0.0	L	57.200	6.400	15.0	PML	4.5SPML	1
1886	1223	14 0	0.0	L	55.400	13.400	0.0	PEN		2.0WPEN1
1886	1223	2210	0.0	L	56.900	12.500	0.0	PEN		2.0WPEN1
1887	911	1527	0.0	L	58.100	8.000	0.0	PEN		3.5WPEN1
1887	1119	10 1	0.0	L	58.100	8.000	0.0	PEN		2.5WPEN1
1888	130	22 0	0.0	L	56.500	14.500	0.0	PEN		2.0WPEN1
1888	131	3 0	0.0	L	57.300	15.800	0.0	PEN		3.0WPEN1
1888	227	330	0.0	L	58.800	6.700	0.0	PEN		3.5WPEN1
1888	328	2 0	0.0	L	56.500	14.500	0.0	PEN		2.0WPEN1
1888	4 2	10 1	0.0	L	59.000	6.400	15.0	PML	3.6SPML	4.0WPEN1
1888	411	6 0	0.0	L	56.500	14.500	0.0	PEN		2.0WPEN1
1888	415	21 0	0.0	L	58.500	16.500	0.0	PEN		2.0WPEN1
1888	417	2 0	0.0	L	57.700	15.900	0.0	PEN		2.0WPEN1
1888	423	1255	0.0	L	59.000	10.500	0.0	PEN		2.5WPEN1
1888	529	2 0	0.0	L	55.400	13.500	0.0	PEN		2.0WPEN1
1888	723	330	0.0	L	58.300	14.500	0.0	PEN		2.0WPEN1
1888	8 2	12 0	0.0	L	58.500	15.000	0.0	PEN		2.0WPEN1
1888	813	12 0	0.0	L	58.300	14.500	0.0	PEN		2.0WPEN1

1888	818	6 0	0.0	L	55.400	13.800	0.0	PEN		2.0WPEN1
1888	9 7	4 0	0.0	L	58.500	6.200	0.0	PEN		2.5WPEN1
1888	1227	10 0	0.0	L	58.500	6.200	0.0	PEN		3.5WPEN1
1889	422	1112	0.0	L	58.800	5.800	0.0	PEN		2.5WPEN1
1890	2 9	10 0	0.0	L	58.100	15.000	0.0	PEN		2.0WPEN1
1890	10 8	445	0.0	L	58.300	6.300	0.0	PEN		3.5WPEN1
1891	118	152	0.0	L	58.200	16.600	0.0	BAT		2.0WBAT1
1892	1014	23 0	0.0	L	56.600	14.400	3.0	BAT		2.2WMAC1
1892	1015	130	0.0	L	56.600	14.400	0.0	BAT		2.2WMAC1
1893	2 5	0 0	0.0	L	58.800	13.800	6.0	BAT		2.2WBAT1
1893	926	18 0	0.0	L	58.400	13.400	4.0	BAT		2.2WBAT1
1894	1 5	6 0	0.0	L	58.700	16.300	16.0	BAT		3.2WBAT1
1894	122	2030	0.0	L	58.700	12.400	3.0	BAT		2.3WBAT1
1894	122	23 0	0.0	L	58.700	12.400	0.0	BAT		2.0WBAT1
1894	212	0 0	0.0	L	58.000	7.500	7.0	BAT		2.2WBAT1
1894	421	330	0.0	L	55.500	14.400	0.0	BAT		2.0WBAT1
1894	422	2132	0.0	L	55.500	14.400	14.0	BAT		4.1WBAT1
1894	430	19 7	0.0	L	55.500	13.200	6.0	BAT		2.2WBAT1
1894	10 6	15 0	0.0	L	58.900	4.600	15.0	PML	4.0SPML	3.4WMAC1
1895	112	930	0.0	L	56.400	13.000	8.0	BAT		2.7WBAT1
1895	126	2130	0.0	L	58.100	6.500	9.0	BAT		2.2WMAC1
1895	128	2 0	0.0	L	56.800	14.000	4.0	BAT		2.2WBAT1
1895	129	2345	0.0	L	58.800	5.800	3.0	BAT		2.3WBAT1
1895	12 6	1 0	0.0	L	58.500	8.800	3.0	BAT		2.3WBAT1
1895	1216	930	0.0	L	58.200	8.000	7.0	BAT		2.2WBAT1
1895	1216	1245	0.0	L	57.600	7.900	15.0	PML	4.1SPML	4.0WPEN1
1896	910	2030	0.0	L	57.000	14.000	13.0	BAT		3.7WBAT1
1896	910	2330	0.0	L	57.000	14.000	0.0	BAT		2.0WBAT1
1896	922	0 0	0.0	L	58.700	16.500	10.0	BAT		3.1WBAT1
1896	1021	17 0	0.0	L	56.500	14.500	6.0	BAT		2.3WBAT1
1896	1022	1520	0.0	L	58.200	13.100	6.0	BAT		2.2WBAT1
1896	1212	1245	0.0	L	59.000	14.800	6.0	BAT		2.2WBAT1
1897	1 9	115	0.0	L	56.000	14.000	10.0	BAT		3.6WBAT1
1897	616	1230	0.0	L	58.500	13.100	6.0	BAT		2.2WBAT1
1898	5 2	930	0.0	L	56.100	12.900	4.0	BAT		2.2WBAT1
1898	911	1953	0.0	L	58.700	5.400	18.0	BAT		3.5WBAT1
1899	1 2	0 0	0.0	L	58.500	15.000	3.0	BAT		2.3WBAT1
1899	221	21 0	0.0	L	58.500	8.800	3.0	BAT		2.3WBAT1
1900	8 7	1515	0.0	L	59.000	10.000	7.0	BAT		2.2WBAT1
1900	0816	12		D				DNK		1
1900	1227	22 0	0.0	L	57.100	12.800	6.0	BAT		2.2WBAT1
1901	311	2330	0.0	L	58.600	16.200	4.0	BAT		2.2WBAT1
1902	3 1	1615	0.0	L	58.700	5.600	5.0	BAT		2.2WBAT1
1902	429	1315	0.0	L	57.200	13.400	12.0	BAT		4.0WBAT1
1902	817	1345	0.0	L	58.600	9.800	12.0	BAT		3.9WBAT1
1902	1012	0 0	0.0	L	55.500	13.900	6.0	BAT		2.2WBAT1
1903	919	1715	0.0	L	58.500	15.200	4.0	BAT		3.3WBAT1
1903	1111	1715	0.0	L	58.300	7.500	2.0	BAT		2.4WBAT1
1904	927	0 0	0.0	L	58.300	14.600	6.0	BAT		2.2WBAT1
1904	1017	2130	0.0	L	57.600	16.200	6.0	BAT		2.2WBAT1
1904	1021	315	0.0	L	57.600	12.100	4.0	BAT		2.2WBAT1
1904	1023	218	0.0	L	59.000	10.000	6.0	BAT		2.7WBAT1
1904	1026	1 0	0.0	L	55.800	13.300	3.0	BAT		2.3WBAT1
1904	1029	020	0.0	L	58.300	13.000	6.0	BAT		2.2WBAT1
1904	12 9	030	0.0	L	58.600	12.100	6.0	BAT		2.2WBAT1
1904	1211	2145	0.0	L	58.700	11.300	6.0	BAT		2.2WBAT1
1904	1212	210	0.0	L	58.700	11.300	0.0	BAT		2.0WBAT1
1904	1213	2151	0.0	L	58.700	11.300	24.0	BAT		4.2WBAT1
1905	1 8	0 0	0.0	L	58.700	11.500	6.0	BAT		2.2WBAT1
1905	115	1035	0.0	L	56.500	13.100	14.0	BAT		3.1WBAT1
1905	115	21 0	0.0	L	58.800	11.800	6.0	BAT		2.2WBAT1
1905	118	0 0	0.0	L	58.700	11.300	6.0	BAT		2.2WBAT1
1905	2 3	830	0.0	L	58.800	11.800	6.0	BAT		2.2WBAT1
1905	316	054	0.0	L	57.800	13.100	4.0	BAT		2.2WBAT1
1905	320	1130	0.0	L	58.800	11.800	6.0	BAT		2.2WBAT1
1905	7 3	2127	0.0	L	58.600	10.900	20.0	BAT		3.7WBAT1
1905	7 4	030	0.0	L	59.000	11.100	7.0	BAT		2.2WBAT1
1905	9 7	1348	0.0	L	58.500	15.100	6.0	BAT		2.2WBAT1
1905	11 7	845	0.0	L	58.500	11.600	23.0	BAT		3.4WBAT1
1906	111	1630	0.0	L	58.900	8.400	14.0	BAT		2.2WMAC1
1906	324	330	0.0	L	56.500	13.000	5.0	BAT		2.7WBAT1
1906	414	0 0	0.0	L	57.400	15.100	6.0	BAT		2.2WBAT1
1906	5 7	1643	0.0	L	57.400	15.100	6.0	BAT		2.2WBAT1
1906	6 3	324	0.0	L	57.600	6.200	15.0	PML	4.5sPML	4.2WKRK1
1906	822	513	0.0	L	57.400	15.100	0.0	BAT		2.0WBAT1

1906	1210	1615	0.0	L	58.000	5.700	15.0	PML	4.2sPML	4.2WBAT1
1907	1 9	1730	0.0	L	59.000	11.300	5.0	BAT		2.2WBAT1
1907	114	332	0.0	L	58.800	12.500	3.0	BAT		2.3WBAT1
1907	115	5 0	0.0	L	56.700	13.000	6.0	BAT		2.2WBAT1
1907	129	0 0	0.0	L	56.800	13.200	10.0	BAT		2.6WBAT1
1907	131	330	0.0	L	56.900	14.000	11.0	BAT		2.6WBAT1
1907	2 6	17 0	0.0	L	58.100	13.600	4.0	BAT		2.6WBAT1
1907	3 2	2230	0.0	L	56.900	13.500	6.0	BAT		2.2WBAT1
1907	3 3	2 0	0.0	L	56.900	13.500	6.0	BAT		2.2WBAT1
1907	322	2130	0.0	L	58.200	13.600	3.0	BAT		2.3WBAT1
1907	4 5	140	0.0	L	58.400	13.100	0.0	BAT		2.0WBAT1
1907	4 9	2030	0.0	L	58.200	12.800	6.0	BAT		2.2WBAT1
1907	827	13 2	0.0	L	58.800	5.800	5.0	BAT		2.2WBAT1
1907	911	945	0.0	L	58.700	11.900	6.0	BAT		2.5WBAT1
1908	1 4	7 0	0.0	L	58.300	12.700	8.0	BAT		2.3WBAT1
1908	1 8	19 0	0.0	L	58.300	11.500	0.0	BAT		2.0WBAT1
1908	1 8	2230	0.0	L	58.300	11.500	20.0	BAT		4.4WBAT1
1908	1 9	1 0	0.0	L	58.300	11.500	0.0	BAT		2.0WBAT1
1908	1 9	245	0.0	L	58.300	11.500	0.0	BAT		2.0WBAT1
1908	115	630	0.0	L	58.300	12.700	7.0	BAT		2.2WBAT1
1908	2 1	130	0.0	L	58.900	12.800	6.0	BAT		2.2WBAT1
1908	2 3	1835	0.0	L	58.900	12.800	8.0	BAT		2.7WBAT1
1908	224	0 0	0.0	L	58.100	6.800	3.0	BAT		2.2WMAC1
1909	110	0 0	0.0	L	58.000	14.500	6.0	BAT		2.2WBAT1
1909	111	1345	0.0	L	58.400	6.000	5.0	BAT		2.2WBAT1
1909	118	417	0.0	L	58.500	14.900	6.0	BAT		2.2WBAT1
1909	121	2345	0.0	L	58.800	17.000	6.0	BAT		2.2WBAT1
1909	2 8	0 0	0.0	L	56.600	12.900	4.0	BAT		2.1WMAC1
1909	215	1 0	0.0	L	58.000	6.700	13.0	BAT		3.2WBAT1
1909	3 5	1953	0.0	L	58.600	11.400	21.0	BAT		3.6WMAC1
1909	314	0 0	0.0	L	56.500	15.900	6.0	BAT		2.2WBAT1
1909	315	758	0.0	L	59.000	11.200	23.0	BAT		4.1WBAT1
1909	316	940	0.0	L	58.600	11.700	6.0	BAT		2.1WMAC1
1909	4 8	2015	0.0	L	58.400	15.100	6.0	BAT		2.8WBAT1
1909	727	0 0	0.0	L	56.000	14.000	3.0	BAT		2.7WBAT1
1910	212	22 0	0.0	L	58.500	14.900	6.0	BAT		2.2WBAT1
1910	315	0 0	0.0	L	56.300	14.700	5.0	BAT		2.4WBAT1
1910	516	22 0	0.0	L	59.000	11.200	7.0	BAT		2.2WBAT1
1910	518	16 8	0.0	L	59.000	5.600	7.0	BAT		2.2WBAT1
1910	10 4	2237	0.0	L	58.300	14.300	4.0	BAT		2.2WBAT1
1911	1 9	5 0	0.0	L	55.500	14.300	3.0	BAT		2.3WBAT1
1911	219	1635	0.0	L	58.900	9.500	3.0	BAT		2.3WBAT1
1911	220	21 3	0.0	L	57.900	12.000	8.0	BAT		3.4WBAT1
1911	418	640	0.0	L	58.200	7.400	15.0	PML	3.7sPML	3.6WMAC1
1911	0508	13		D				DNK		1
1911	625	0 3	0.0	L	58.400	12.300	6.0	BAT		2.2WBAT1
1911	8 8	10 0	0.0	L	56.500	13.100	4.0	BAT		2.2WBAT1
1911	12 9	540	0.0	L	58.600	13.400	6.0	BAT		2.1WMAC1
1912	122	325	0.0	L	58.900	11.800	6.0	BAT		2.2WBAT1
1912	123	330	0.0	L	58.900	11.800	6.0	BAT		2.2WBAT1
1912	128	2320	0.0	L	58.800	11.800	6.0	BAT		2.2WBAT1
1912	2 2	550	0.0	L	58.400	6.900	2.0	BAT		2.5WBAT1
1912	0327	21		D				DNK		1
1912	330	0 0	0.0	L	58.500	14.800	4.0	BAT		3.0WBAT1
1912	1029	19 0	0.0	L	57.500	14.700	6.0	BAT		2.2WBAT1
1912	12 1	12 0	0.0	L	56.700	7.700	15.0	PML	4.0sPML	1
1913	227	3 0	0.0	L	56.200	15.300	4.0	BAT		2.2WBAT1
1913	729	4 0	0.0	L	56.100	8.200	15.0	PML	4.2sPML	1
1913	1214	2 0	0.0	L	57.900	7.500	10.0	BAT		3.4WBAT1
1914	110	7 0	0.0	L	58.400	9.000	7.0	BAT		2.8WBAT1
1914	111	233	0.0	L	57.800	13.000	0.0	BAT		2.0WBAT1
1914	7 2	630	0.0	L	56.800	13.400	6.0	BAT		2.5WBAT1
1914	722	130	0.0	L	55.500	13.000	6.0	BAT		2.2WBAT1
1915	228	2015	0.0	L	58.000	7.300	5.0	BAT		2.2WBAT1
1915	318	218	0.0	L	58.200	6.200	9.0	BAT		3.4WBAT1
1915	724	2330	0.0	L	58.200	7.100	7.0	BAT		2.2WBAT1
1915	8 8	345	0.0	L	58.200	7.000	3.0	BAT		2.3WBAT1
1916	217	030	0.0	L	57.100	13.300	6.0	BAT		2.1WMAC1
1916	224	0 0	0.0	L	57.100	13.300	6.0	BAT		2.1WMAC1
1916	3 7	655	0.0	L	57.000	13.300	0.0	BAT		2.0WBAT1
1916	11 4	23 5	0.0	L	58.600	13.200	11.0	BAT		3.4WMAC1
1917	130	1430	0.0	L	58.400	15.000	15.0	BAT		3.2WBAT1
1917	131	19 0	0.0	L	57.200	12.400	10.0	BAT		2.5WBAT1
1917	711	22 0	0.0	L	58.400	8.600	5.0	BAT		2.2WBAT1
1917	821	19 2	0.0	L	58.100	7.000	5.0	BAT		2.1WMAC1

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1918  6 8  315  0.0 L  57.800  13.400 10.0  BAT                              3.1WBAT1
1918 1028 1316  0.0 L  58.300   6.300  7.0  BAT                              2.2WBAT1
1920  1 9  9 5  0.0 L  57.400  13.000  7.0  BAT                              3.4WBAT1
1920 1022  040  0.0 L  57.400  14.300  6.0  BAT                              2.2WBAT1
1920 1027  445  0.0 L  58.200  12.500  6.0  BAT                              2.2WBAT1
1921  823 22 0  0.0 L  55.000  15.000  8.0  BAT                              4.0WBAT1
1923  921 1142  0.0 L  53.500   2.000 10.0  PML                      4.0sPML        1
1923 1013  4 0  0.0 L  58.300  11.500 13.0  BAT                              3.0WBAT1
1926 1019 1717  0.0 L  57.700   7.800 15.0  PML                      4.0sPML 4.2WBAT1
1927 0124 0518 24.0 L  58.5     6.0         ISS                              5.6sPAS1
1927  2 2 2030  0.0 L  58.500   6.000  7.0  BAT                              2.8WBAT1
1927  215 1655  0.0 L  57.600  13.500  8.0  BAT                              2.5WMAC1
1927  3 2  845  0.0 L  58.600  13.600 25.0  BAT                              2.6WMAC1
1928  320  335  0.0 L  58.200  13.600  7.0  BAT                              2.9WBAT1
1928  4 2  4 0  0.0 L  58.400  11.400  8.0  BAT                              3.0WBAT1
1928  4 2  9 0  0.0 L  58.400  11.400  6.0  BAT                              2.0WBAT1
1928  727 1455  0.0 L  58.800  14.000  8.0  BAT                              2.9WBAT1
1929  523 1836 24.6 L  57.182   6.613  0.0  DNK                      4.4sPML 4.9WBAT1
1929  529 2331 11.3 L  57.299   6.346 11.4  DNK                      4.3sPML 4.7WBAT1
1929 1026  915  0.0 L  57.000  13.500  0.0  BAT                              2.0WBAT1
1929 1026 11 0  0.0 L  57.000  13.500  0.0  BAT                              2.0WBAT1
1929 1026 1343 35.0 L  56.750  14.000  0.0  BAT  2                           4.2WBAT1
1929 1026 2030  0.0 L  57.000  13.500  0.0  BAT                              2.0WBAT1
1929 12 1 1910  0.0 L  58.100  16.700  9.0  BAT                              2.9WMAC1
1930  5 0  0 0  0.0 L  55.400  13.500  6.0  BAT                              2.2WBAT1
1930  831  130  0.0 L  56.500  13.300  6.0  BAT                              2.8WBAT1
1930 10 2 17 5  0.0 L  58.400  16.600  6.0  BAT                              2.2WBAT1
1930 10 9  0 0  0.0 L  55.200  12.100  0.0  BAT                              2.0WBAT1
1930 1031 2316 38.9 L  55.665  12.606 62.3  DNK  5 0.2 4.0LDA                       1
1930 1101  000  0.0 L                       DNK                                     1
1930 1112  455  0.0 L  58.400  13.800 20.0  BAT                              3.7WBAT1
1931  126  2 0  0.0 L  58.400  13.900  6.0  BAT                              2.2WBAT1
1931  6 7  025  0.0 L  54.100   1.500 15.0  PML                      5.5sPML 6.0WKRK1
1931  927  948  0.0 L  58.600  13.700 10.0  BAT                              2.3WMAC1
1932  211 1633  0.0 L  56.000  14.600 12.0  BAT                              3.6WBAT1
1932  412  655  0.0 L  56.200  14.300  6.0  BAT                              2.2WBAT1
1932  412 20 9  0.0 L  56.200  14.300  6.0  BAT                              2.2WBAT1
1932  7 2  2 0  0.0 L  59.000  12.000  3.0  BAT                              2.3WBAT1
1932 0903 1906      L  58.60   13.00                     4.2L JH 4.2AUPP     1101
1932 1018  550  0.0 L  58.900   5.600  9.0  BAT                              2.4WBAT1
1932 1030 1600  0.0 L                       DNK                                     1
1935  331 1459  0.0 L  58.700  13.600  6.0  BAT                              2.7WBAT1
1935  813 2230  0.0 L  57.400  13.500 11.0  BAT                              3.3WBAT1
1936  323 1930  0.0 L  57.900  12.600  7.0  BAT                              2.9WBAT1
1937  3 5 1655  0.0 L  56.500  13.000  6.0  BAT                              2.8WBAT1
1937  3 6  1 0  0.0 L  56.500  13.000  0.0  BAT                              2.0WBAT1
1937 10 9 21 3  0.0 L  56.800  13.000  8.0  BAT                              3.6WBAT1
1938  311  940  0.0 L  58.900  11.100 15.0  BAT                              2.8WBAT1
1938  927 2042  0.0 L  58.100  13.300 11.0  BAT                              3.1WMAC1
1938 12 8 16 9  0.0 L  58.500  13.500  7.0  BAT                              3.4WBAT1
1941 1128  400  0.0 L                       DNK                                     1
1942  220  636  0.0 L  57.600  11.600  0.0  BAT                              2.9WBAT1
1943  829  535  0.0 L  58.900   5.900 15.0  PML                      4.5sPML 3.9WMAC1
1945  112  215  0.0 L  57.400  12.500  8.0  BAT                              3.0WBAT1
1945  213 2050  0.0 L  59.000  11.500  2.0  BAT                              2.7WBAT1
1945  426 1930  0.0 L  56.100  14.400  6.0  BAT                              2.1WMAC1
1945  427  2 0  0.0 L  56.100  14.700  5.0  BAT                              2.5WMAC1
1945  427 19 0  0.0 L  56.100  14.700  5.0  BAT                              2.5WMAC1
1945 0817  200  0.0 L                       DNK                                     1
1946  424 10 0  0.0 LE 55.400  15.600  0.0  BAT                              2.0WBAT1
1946  424 1130  0.0 LE 55.400  15.600  0.0  BAT                              2.0WBAT1
1946  424 15 0  0.0 LE 55.400  15.600  0.0  BAT                              2.0WBAT1
1946  424 1830  0.0 LE 55.400  15.600 18.0  BAT                              4.3WBAT1
1946  424 1910  0.0 LE 55.400  15.600  0.0  BAT                              4.0WBAT1
1946  424 2030  0.0 LE 55.400  15.600  0.0  BAT                              2.0WBAT1
1946  424 2120  0.0 LE 55.400  15.600  0.0  BAT                              2.0WBAT1
1946  425 1030  0.0 LE 55.400  15.600  0.0  BAT                              2.0WBAT1
1946  425 11 0  0.0 LE 55.400  15.600  0.0  BAT                              2.0WBAT1
1946  425 1130  0.0 LE 55.400  15.600  0.0  BAT                              2.0WBAT1
1946  425 12 0  0.0 LE 55.400  15.600  0.0  BAT                              2.0WBAT1
1946  425 1245  0.0 LE 55.400  15.600  0.0  BAT                              2.0WBAT1
1946  425 1325  0.0 LE 55.400  15.600  0.0  BAT                              2.0WBAT1
1946  425 14 0  0.0 LE 55.400  15.600  0.0  BAT                              2.0WBAT1
1946  425 1430  0.0 LE 55.400  15.600  0.0  BAT                              2.0WBAT1
1946  425 1730  0.0 LE 55.400  15.600  0.0  BAT                              2.0WBAT1
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1946  425 20 0  0.0 LE 55.400  15.600  0.0  BAT                                2.0WBAT1
1946  426  445  0.0 LP 55.400  15.600  0.0  BAT                                2.0WBAT1
1946  426  6 0  0.0 LE 55.400  15.600  0.0  BAT                                2.0WBAT1
1946  820 1545  0.0 L  58.100  14.500  8.0  BAT                                2.9WMAC1
1946 1130 2155  0.0 L  58.500  11.600 13.0  BAT                                3.4WBAT1
1946 12 7  347  0.0 L  58.200  13.700  6.0  BAT                                2.8WBAT1
1947  227 2242  0.0 L  57.400  13.500  9.0  BAT                                3.5WBAT1
1947  4 9 2237  0.0 L  59.000  10.000  7.0  BAT                                3.5WBAT1
1947  515  545  0.0 L  58.400   8.800  3.0  BAT                                2.3WBAT1
1948  3 4  645  0.0 L  58.600  13.700  8.0  BAT                                2.9WMAC1
1948 0507 1900  0.0 L                       DNK                                       1
1948  5 8 22 0  0.0 L  57.200  12.700  5.0  BAT                                2.6WBAT1
1948  722 2015  0.0 L  55.400  15.600 18.0  BAT                                4.0WBAT1
1949 1104  800  0.0 L                       DNK                                       1
1950  3 1 2152  0.0 L  58.800   6.000  3.0  BAT                                2.3WBAT1
1952 10 3 2243  0.0 L  59.000   5.900  0.0  BAT                                3.1WBAT1
1954  604 2103  0.0 L  55.4    12.6         DNK                                       1
1954 1018 1644 32.2 L  56.846   8.291 25.5 *DNK  4 0.8 4.6LDA              4.6LDA 1
1954 1027  810 16.0 L  58.900  14.600  9.0  BAT         2.5LBER            2.6WMAC1
1955 1115  848 56.0 L  58.300  13.700 13.0  BAT         2.8LBER            3.0WBAT1
1955 12 5  0 0  0.0 L  58.200  13.600 16.0  BAT         2.3LPEN            2.3WBAT1
1956  215  350  0.0 L  57.500  13.500  0.0  BAT         2.3LBER            3.2WBAT1
1956  7 8 2316 23.0 L  58.000  13.000  2.0  BAT         2.0LBER            2.2WBAT1
1956  7 9 2036  0.0 L  58.500  13.600  6.0  BAT         2.0LPEN            2.0WBAT1
1957  6 2  550  0.0 L  57.900  14.800  9.0  BAT         2.5LPEN            2.5WBAT1
1957 1117 1619 40.0 L  57.700   8.900 15.0  PML                    4.1sPML        1
1958  2 9 2321  5.0 L  54.200   1.800 15.0  PML                    4.4sPML        1
1958  710 1523 20.0 L  58.500   9.500 15.0  PML                    4.0sPML 3.6WBAT1
1958  917  622 43.0 L  58.500  13.600 15.0  BAT         3.2LBER            3.0WBAT1
1958  929 1340  0.0 L  56.600  13.700 11.0  BAT         2.9LBAT            2.9WMAC1
1958 1030 1255 24.0 L  59.000  11.000  0.0  BAT                            2.0WPEN1
1960  316 1435  0.0 L  58.400  12.000 12.0 *BAT         2.4LPEN            2.4WBAT1
1960 1020 1150 12.0 L  56.400  13.300 23.0 *BAT         2.8LBER            3.1WWAL1
1961  4 4 1148 49.6 L  56.950  13.290  0.0 *BAT         2.8LBAT            2.1WMAC1
1963 1011 1639 40.5 L  58.600  13.100  0.0 *BAT         2.9LPEN            3.0WBAT1
1964  714  533 56.7 L  57.03    7.2   36   *DNK 41      4.0LDA             4.0LDA 1
1965 1114  820 35.0 L  57.900   8.400 15.0 *PML                    3.8sPML 4.1WBAT1
1966  2 9 2354  5.0 L  57.800   8.200 15.0 *PML 11                 3.6sPML 2.0WPEN1
1966  8 2  653 35.0 L  57.900   8.300 15.0 *PML 12                 3.8sPML 4.2WBAT1
1967  821 1341 49.3 L  57.092   4.593 15.0  DNK 46 3.4 4.5LDNK             4.5LDA 1
1968  2 6  127 32.0 L  57.330  12.330 16.0 *BAT         2.4LBAT            3.0WMAC1
1968  312  732 36.0 L  58.700  13.100  0.0 *ISC  6      3.1LBAT            2.8WMAC1
1968  429 2159 20.6 L  57.566   8.853 15.0  DNK 11 2.9             4.1sPML 3.0WPEN1
1968  9 3 2235 16.9 L  58.570  14.000  0.0 *ISC  9      3.2LBAT            3.7WMAC1
1969  4 5 1909 47.1 L  57.155   6.764  0.1  DNK 23 1.4 4.2LDNK             4.3LDA 1
1972  621 1137 16.0 L  58.790  13.700  0.0 *PEN         2.3LPEN                   1
1973  722  4 2 56.0 L  58.300  13.900  0.0 *HEL  4      2.8LBAT            3.0WMAC1
1974  2 5 2234  1.2 L  58.100  14.330 18.0 *BAT  6      2.3LBAT            3.1WMAC1
1974  521 1651 22.0 L  58.300  13.200  0.0 *HEL 13      3.5LBAT            3.3WMAC1
1974 1028 2156 29.5 L  57.380  12.330  9.0 *BAT  6      2.6LBAT            3.2WMAC1
1976  316  627  8.0 L  58.800  13.800  0.0 *HEL  4      2.6LBAT            2.7WMAC1
1976  7 3  725 56.8 L  58.402  14.211  0.0 *ISC  7      2.7LBAT            2.7WMAC1
1977  6 2 1332 15.4 L  53.082   9.536  4.0 *ISC 57      3.9LLDG                   1
1977  827 1614 51.0 L  59.000  12.450  0.0 *PEN  5                         2.0WPEN1
1977  9 5 2340 18.8 L  57.244  14.392  0.0 *ISC 11                         3.0WPEN1
1978  425  1 2 36.4 L  58.829   5.562  0.0 *ISC  5                         3.0WPEN1
1980  411 0419 11.2 L  57.983  12.403  0.0F DNK 18 1.1                     2.7LUPP1
1980 0605 1211 39.0 R                       DNK 62                         3.3LUPP1
1980  826 0315 44.0 L  57.861  15.272  0.2  DNK  9 0.7 2.3LDNK             2.0LNAO1
1980 1125 0239 50.6 L  58.414  13.899  9.9  DNK 22 2.4                     2.4LUPP1
1981  213 0639  9.0 L  58.893  14.113 10.0F DNK 28 2.4                     3.3LUPP1
1981  9 6 0411 59.8 L  57.030   6.880 40.0  DNK 84 1.1 5.2LDNK             4.2LBER1
1981 10 7 0437 12.1 LI 58.755  14.986 10.2  DNK 21 0.8                            1
1981 10 7 0505 35.3 LI 58.770  15.048  0.0  DNK 19 0.7                            1
1981 1027 0513 43.7 L                       DNK 44                         2.9LSNN1
1981 1111 0248 51.1 L  57.151  13.278 10.5  DNK 16 1.0                     2.7LUPP1
1983  415 2346 57.8 L  57.939  12.250  6.2  DNK 15 0.7                     1.8LEGT1
1983  712 1904 27.2 L  58.062  14.694  6.7  DNK 15 0.7                     2.5LNAO1
1983  924 0208 18.4 L  58.247  13.754  0.0  DNK 10 0.8                     2.2LEGT1
1985  610 1528 42.2 L  55.600   4.621  5.1  DNK 36 1.4 3.3CDNK                    1
1985  615 0040 20.5 L  56.608  12.190  9.1 *DNK 44 1.2 4.7LDA  4.4CDNK 4.9LDNK1
1986  4 1 0956 53.5 L  56.544  12.183  7.2  DNK 37 1.4 4.1LDNK 3.9CDNK        1
1987  820  114 33.8 L                       DNK  0                                    1
1989  120 0933 47.5 L  57.911   8.362 15.0F DNK 26 0.9 4.2LDNK 3.4CDNK        1
1989 1130 1400  0.0 LE                      DNK  0                                    1
```

```
1990  524 0951 56.9 L  56.478  11.931 10.0F DNK 15 1.3 3.2LDNK 3.6CDNK        1
1991  823 0407 46.5 LX 58.871   5.769  0.1  DNK 12 0.9 2.7CDNK                1
1993  3 6 0126 45.6 L  57.946   6.754 62.4  DNK 14 1.2 3.3LDNK 3.3CDNK        1
1993  7 7 1148  8.3 L  55.578   4.517 15.6  DNK 15 1.1 4.2LDNK 3.4CDNK        1
1994  211 2356 53.6GL  64.557 -52.979  2.0  DNK 13 2.6                        1
1994 1018 1838 18.2 L  55.598   5.055  0.2  DNK10850.4 4.1LDNK 3.5CDNK 3.3LNAO1
1995  2 2 2126  9.5 L  57.980   0.508 40.0  DNK 32 0.5 3.0LDNK 2.7CDNK        1
1995  530 0400 16.8 L  56.292  10.724 28.9  DNK 15 1.1 3.4LDNK 3.2CDNK        1
1995 0620 1710  0.0 LE                 0.0F DNK  0                            1
1995 10 4 2049 42.2 L  56.779  12.080  9.9  DNK 31 1.5 3.8LDNK 3.9CDNK        1
1995 1130 0523 52.4 L  55.644  12.255 24.8  DNK  4 0.7 1.3LDNK                1
1995 1130 0523 52.4 L  55.644  12.255 24.8  DNK  4 0.7 1.3LDNK                1
1996 1217 1815 14.2 L  55.578  12.935 15.0  DNK 73 1.2 2.6LDNK                1
1997 12 4 2203 45.2 L  56.911   7.690  8.5  DNK 48 1.5 3.4LDNK 3.8sDNK        1
1998  7 8 2314 43.5 L  56.563   8.102 34.7  DNK 7419.2 3.3LDNK 3.4CDNK        1
1998  826 1730  0.0 LP                 0.0F DNK  0                            1
1998 12 9 1434  0.0 LE                 0.0F DNK  0                            1
2000 1019 1027 24.5 L  57.639   6.962 12.6  DNK 51 1.8 3.8LDNK 3.5CDNK 3.2WDNK1
2000 1129 2207 54.6 L* 59.059  11.184 15.0F DNK 21 1.6 4.3LDNK 3.8CDNK 3.7LNAO1
2000 1228 1203 41.5 LP 55.171  10.679  0.0F DNK  7 1.6 2.7CDNK         1.9LNAO1
2001  5 7 0943 31.7 L  56.626   3.122  4.5  DNK 48 1.4 3.6LDNK 4.1sDNK 4.9WDNK1
2001  6 2 0044 51.7 L  56.801   7.803 59.3  DNK 39 0.8 3.5LDNK 3.4CDNK 2.7WDNK1
2001 1021 0031 26.7 L  56.733   7.661 29.1  DNK 47 1.3 3.4LDNK                1
2001 11 6 1805 28.01L  55.677  11.701 19.7  DNK  4 0.1 2.8LDNK 3.4CDNK 2.6WDNK1
2003  710 0505 39.9 L  56.745   9.283 11.4  DNK 16 1.3 2.7LDNK 2.8CDNK        1
2003 1128 2321 21.9 L  57.370  10.712  0.1  DNK  4 1.3 2.8LDNK         2.3LNAO1
2004  223 0838 26.51L  55.524  12.212 33.7  DNK 50 0.3 2.9LDNK 3.0CDNK        1
2004 0708 1230  0.0 LP                      DNK  0                            1
2004  9 3 0931 26.8 L* 58.168   7.744 17.5F DNK 21 1.3 3.4LDNK 2.9CDNK 2.9LNAO1
2004  921 1105  5.6 R  55.067  20.299  0.0  DNK 30 3.5 5.2LDNK 4.5WDNK        1
2004  921 1332 31.6 L  54.940  20.117  0.1  DNK 26 1.3 5.6LDNK 3.4sDNK 4.8WDNK1
2004  928 1153 41.2 L  57.828   7.607 15.0  DNK 3611.8 3.4LDNK 2.9CDNK 2.9WDNK1
2006  724 1257 21.3 LE 56.371  12.063  0.0F DNK  3 0.0 2.2LDNK                1
2007  1 7 0150 53.3 L  61.896   1.090 10.0F DNK 4916.3 4.7LDNK                1
2007  128 1030 54.6 L  57.771   6.338 37.6  DNK 80 0.6 4.1LDNK 3.3CDNK 3.1WDNK1
2007  6 4 1734 44.5 L  57.064   1.755 10.0F DNK 76 0.7 3.8LDNK 3.7CDNK 3.9LBGS1
2008 0201 1220  0.0 LP 56.75    8.87   0.0FFDNK  0                            1
2008  227 0056 46.8 D  53.405  -0.179 35.0  DNK295 2.3 4.7LDNK 4.3CDNK 3.3sDNK1
2008 1216 0520  3.2 R  55.666  13.422 14.3  DNK 78 2.7 4.8LDNK 4.4CDNK 3.4sDNK1
2009  416 0959  4.9 R  56.655  13.529 12.4  DNK  6 0.7 3.2LDNK                1
2009  7 7 1911 45.8AL  75.227 -72.591 29.3FFDNK  9 0.8 4.6LDNK 5.8sDNK 5.4bDNK1
2010  219 2109  1.0 R  56.875   7.580 39.7  DNK111 1.2 4.3LDNK 4.0WDNK        1
2012  529 1854 15.6 RE 56.242  10.575  0.0F DNK  9 0.5 1.9LDNK                1
2012  8 6 0257 16.6 L  56.600  11.947 22.1  DNK 31 0.7 4.1LDNK                1
2013  219 1657  2.4GR  61.161 -42.225  8.8  DNK 10 0.7 3.8LDNK 4.4SDNK 4.1bDNK1
2013  411 2302 52.5GL  60.581 -44.073  4.4  DNK 15 1.3 3.9LDNK 4.1sDNK 4.2WDNK1
2013 1021 0256  5.9 L  66.859 -53.133 21.4  DNK  3 0.1 2.1LDNK                1
```

Appendix D Coordinates of Source areas

```
COORDINATES OF THE SOURCES AREAS

----------
SOURCE AREA 1
  Geometry parameters:
    Number of vertex : 4
       Long          Lat        Depth(km)
      4,00000     53,00000     15,10000
     15,80000     53,00000     15,10000
     15,80000     54,00000     15,10000
      4,00000     54,00000     15,10000

----------
SOURCE AREA 2
  Geometry parameters:
    Number of vertex : 9
       Long          Lat        Depth(km)
      8,31000     54,00000     16,20000
      8,31000     55,51000     16,20000
     11,78000     55,45000     16,20000
     13,74000     55,02000     16,20000
     14,88000     54,97000     16,20000
     14,95000     54,00000     16,20000
     14,10000     54,00000     16,20000
     12,02000     54,00000     16,20000
      9,77000     54,00000     16,20000

----------
SOURCE AREA 3
  Geometry parameters:
    Number of vertex : 8
       Long          Lat        Depth(km)
      6,00000     58,00000     22,50000
      7,00000     58,00000     22,50000
      8,00000     58,00000     22,50000
      9,00000     58,00000     22,50000
     10,00000     58,00000     22,50000
      7,59000     56,20000     22,50000
      5,40000     57,00000     22,50000
      5,40000     58,00000     22,50000

----------
SOURCE AREA 4
  Geometry parameters:
    Number of vertex : 10
       Long          Lat        Depth(km)
     10,42000     58,00000     10,90000
     11,21000     58,00000     10,90000
     13,65000     56,60000     10,90000
     14,74000     56,00000     10,90000
     14,79000     55,62000     10,90000
     14,88000     54,97000     10,90000
     13,74000     55,02000     10,90000
     11,78000     55,45000     10,90000
     11,47000     56,05000     10,90000
     10,69000     56,71000     10,90000

----------
SOURCE AREA 5
  Geometry parameters:
    Number of vertex : 8
       Long          Lat        Depth(km)
      7,59000     56,20000     17,30000
     10,00000     58,00000     17,30000
     10,42000     58,00000     17,30000
     10,67000     56,71000     17,30000
     11,47000     56,05000     17,30000
     11,78000     55,45000     17,30000
      8,31000     55,51000     17,30000
      7,74000     55,94000     17,30000
```

SOURCE AREA 6
Geometry parameters:
Number of vertex : 13

Long	Lat	Depth(km)
16,00000	58,80000	14,70000
17,00000	58,80000	14,70000
18,00000	58,80000	14,70000
18,00000	57,00000	14,70000
18,00000	54,75600	14,70000
17,64000	54,75600	14,70000
15,79000	54,00000	14,70000
14,95000	54,00000	14,70000
14,88000	54,97000	14,70000
14,79000	55,62000	14,70000
14,74000	56,00000	14,70000
13,65000	56,60000	14,70000
15,20000	58,80000	14,70000

SOURCE AREA 7
Geometry parameters:
Number of vertex : 13

Long	Lat	Depth(km)
5,40000	58,00000	10,70000
6,00000	58,00000	10,70000
7,00000	58,00000	10,70000
9,77000	58,00000	10,70000
11,21000	58,00000	10,70000
13,65000	56,60000	10,70000
15,19800	58,80000	10,70000
14,10000	59,00000	10,70000
12,02000	59,00000	10,70000
9,77000	59,00000	10,70000
7,00000	59,00000	10,70000
6,00000	59,00000	10,70000
5,40000	59,00000	10,70000

SOURCE AREA 8
Geometry parameters:
Number of vertex : 10

Long	Lat	Depth(km)
4,00000	56,00000	18,20000
4,00000	57,00000	18,20000
5,40000	57,00000	18,20000
7,59000	56,20000	18,20000
7,74000	55,94000	18,20000
8,31000	55,51000	18,20000
8,31000	54,00000	18,20000
7,01000	54,00000	18,20000
6,00000	54,00000	18,20000
4,00000	54,00000	18,20000

Appendix E Return periods 2500 years and 50 years

Based on the same input material as the main map (Figure 16) maps of the estimated hazard for Ground Type A given by the peak ground accelerations [cm/s^2] for return periods 2500 years and 50 years are shown in figure E1 and E2.

The background material for these maps is not checked with respect to the return period as for the map in figure 15, and we recommend using the value 4 +/-2 cm/s^2 for the 50 year return period, and 40 +/-20 cm/s^2 for the 2500 year return period.

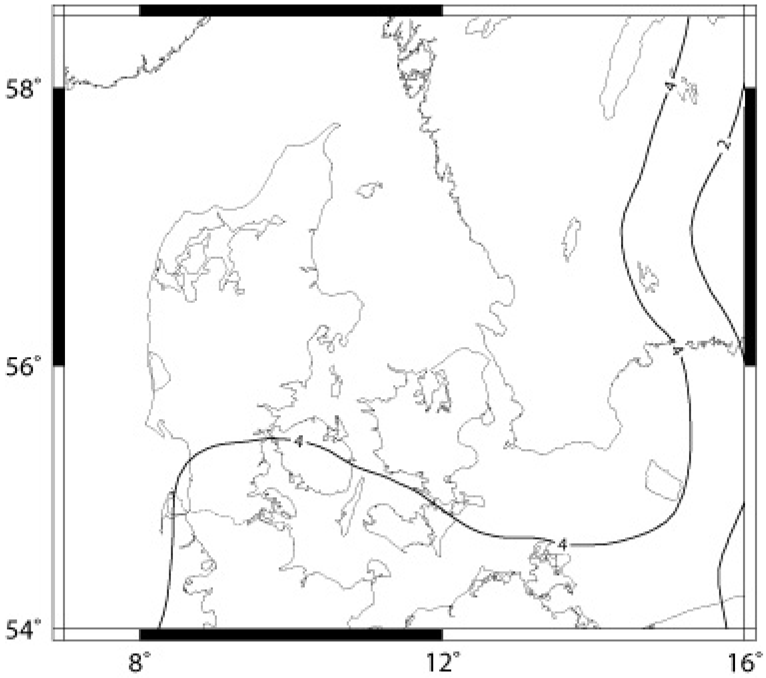

Figure E1 The estimated hazard for Ground Type A given by the peak ground accelerations [cm/s^2] for a return period of 50 years, which correspond to a 80% non-exceedance probability in 20 years. Given values are only valid onshore and should be re-evaluated after 10 years due to increasing uncertainty; ultimo 2024.

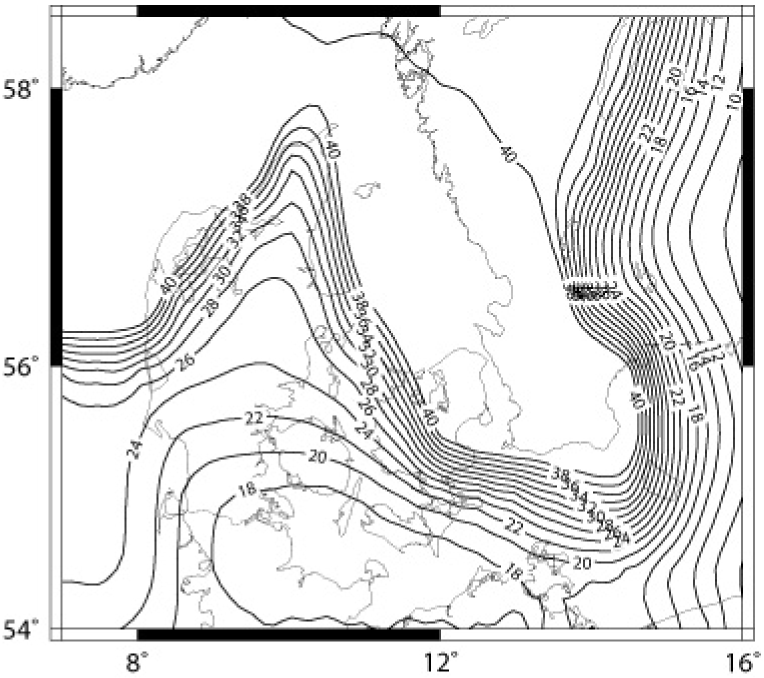

Figure E2 The estimated hazard for Ground Type A given by the peak ground accelerations [cm/s^2] for a return period of 2500 years, which correspond to a 90% non-exceedance probability in 250 years. Given values are only valid onshore and should be re-evaluated after 10 years due to increasing uncertainty; ultimo 2024.