DANMARKS OG GRØNLANDS GEOLOGISKE UNDERSØGELSE **RAPPORT 2025/32**

Digital Surface Geology Map of Denmark 1:25 000

Version 7

Lærke T. Andersen, Karen L. Anthonsen & Peter R. Jakobsen

Edited by Samuel P. Jackson

GEOLOGICAL SURVEY OF DENMARK AND GREENLAND
DANISH MINISTRY OF CLIMATE, ENERGY AND UTILITIES

G E U S

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English version of GEUS report 2023/29

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1. Introduction

This is version 7 of the Digital Surface Geology Map of Denmark, scale 1:25000. The map is a digitised version of field maps, mapped from 1890 to 2023. The digital versions 1, 2, 3, 3.1, 4, 5, and 6 were published in 1998, 2000, 2007, 2011, 2015, 2020 and 2021/22, respectively (Hermansen & Jakobsen, 1998, 2000, 2007, 2011, 2015), (Jakobsen & Tougaard, 2020) and (Jakobsen, Tougaard & Anthonsen, 2021).

The map can be downloaded seen and downloaded from [Denmark's Geology Portal]

1.1 New in this version

Version 7 includes newly mapped areas in Salling, Thy, Thyholm, and Jegindø (Fig. 1). The following map sheets have been fully or partly mapped:

Salling:
1116 II NE, 1116 II SE, 1116 II SW, 1115 I NE, 1115 I SE, 1115 I NW.

Thy, Thyholm, and Jegindø:
1115 I NW, 1115 IV NE, 1116 III SW, 1116 III SE, 1116 II SW, 1116 III NW, 1116 III NE, 1116 IV SW, 1116 IV SE, 1116 I SW, 1116 I NW, 1116 I NE.

Additionally, an area near Vrads (map sheet 1214 IV SE) and a small area at Kalvebod Fælled (map sheet 1513 I SE) have been mapped and included in this version.

1.2 Objectives

Large areas of Denmark's surface geology have been mapped by DGU/GEUS (Geological Survey of Denmark/Geological Survey of Denmark and Greenland) during the period 1890–2023, but some of these maps have not been published. The purpose of the Digital Surface Geology Map is to make all mapping data available, even if they have not been published as printed geological maps. An overview of published maps is provided in Chapter 6, Appendix 1.

1.3 Map content

The geological deposit map provides information on the lithology, genesis and distribution of sediments to approximately 1 m depth. The depth of 1 m has been chosen to get a soil sample below the plough layer and reach the original deposit, which is sampled and symbolised on a field map. If more than one original deposit is encountered within the upper metre, this appears as a double symbol. The map is colour coded according to the lowermost unit. For more details, see chapter 2.

1.4 Overview of mapped areas

In version 7 of the Digital Surface Geology map, 93% of the Danish land area has been mapped or classified as non-mappable, e.g. lakes, urban areas, gravel pits, and areas without access rights.

The mapping of the Digital Surface Geology Map is based on the division that the Geodetic Institute of Denmark (now KDS, the Agency for Climate Data) used until 2003 for their 1:25000 (4 cm maps) (Fig. 1).

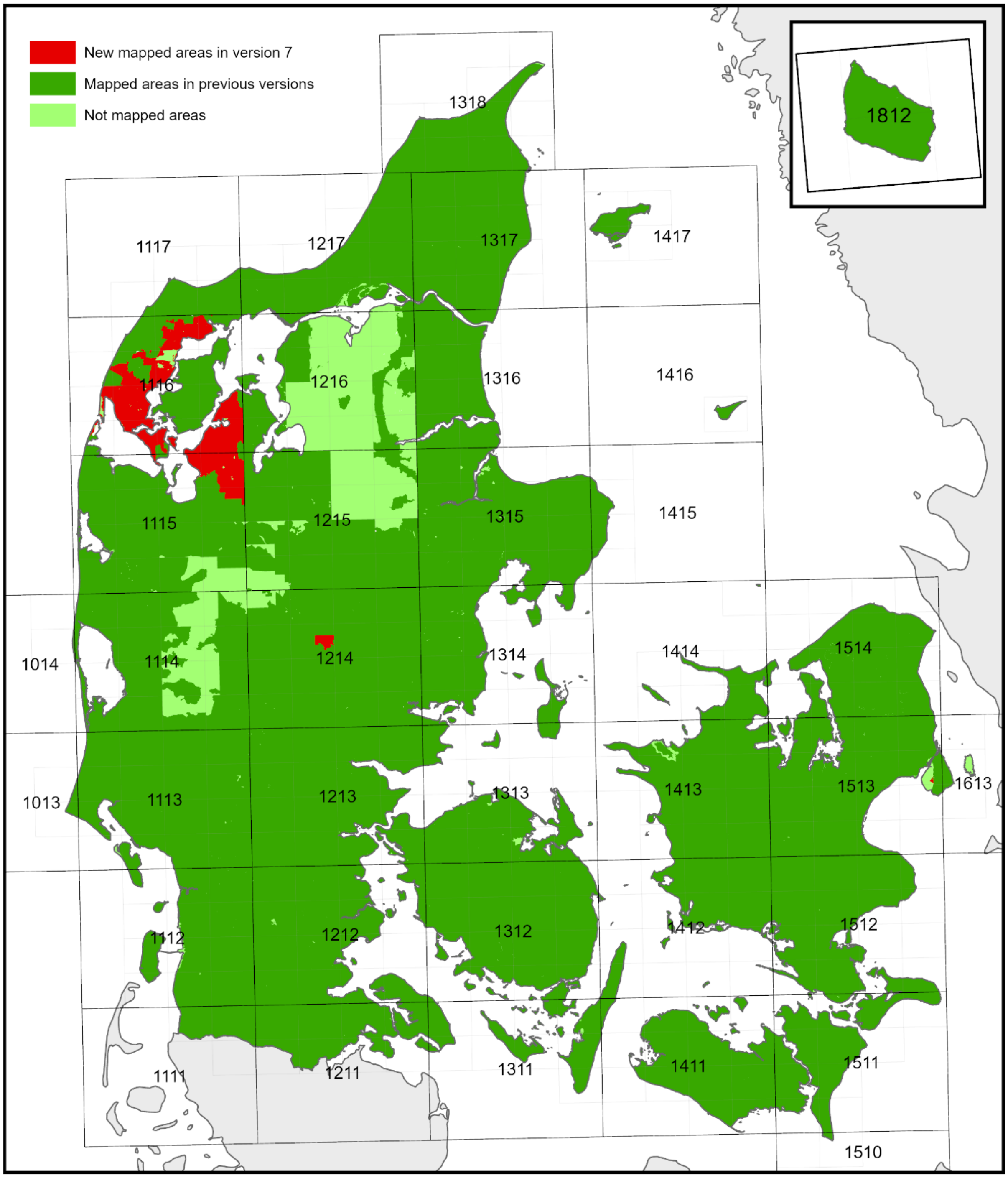

Figure 1. Overview of the newly mapped and digitised areas included in version 7, as well as areas previously mapped and remaining areas not yet mapped.

1.5 Mapping timeframe

Mapping of the Danish land surface areas began in c. 1890, and the first map was published in 1893. Figure 2 shows a historical overview of when the different sub-areas were mapped.

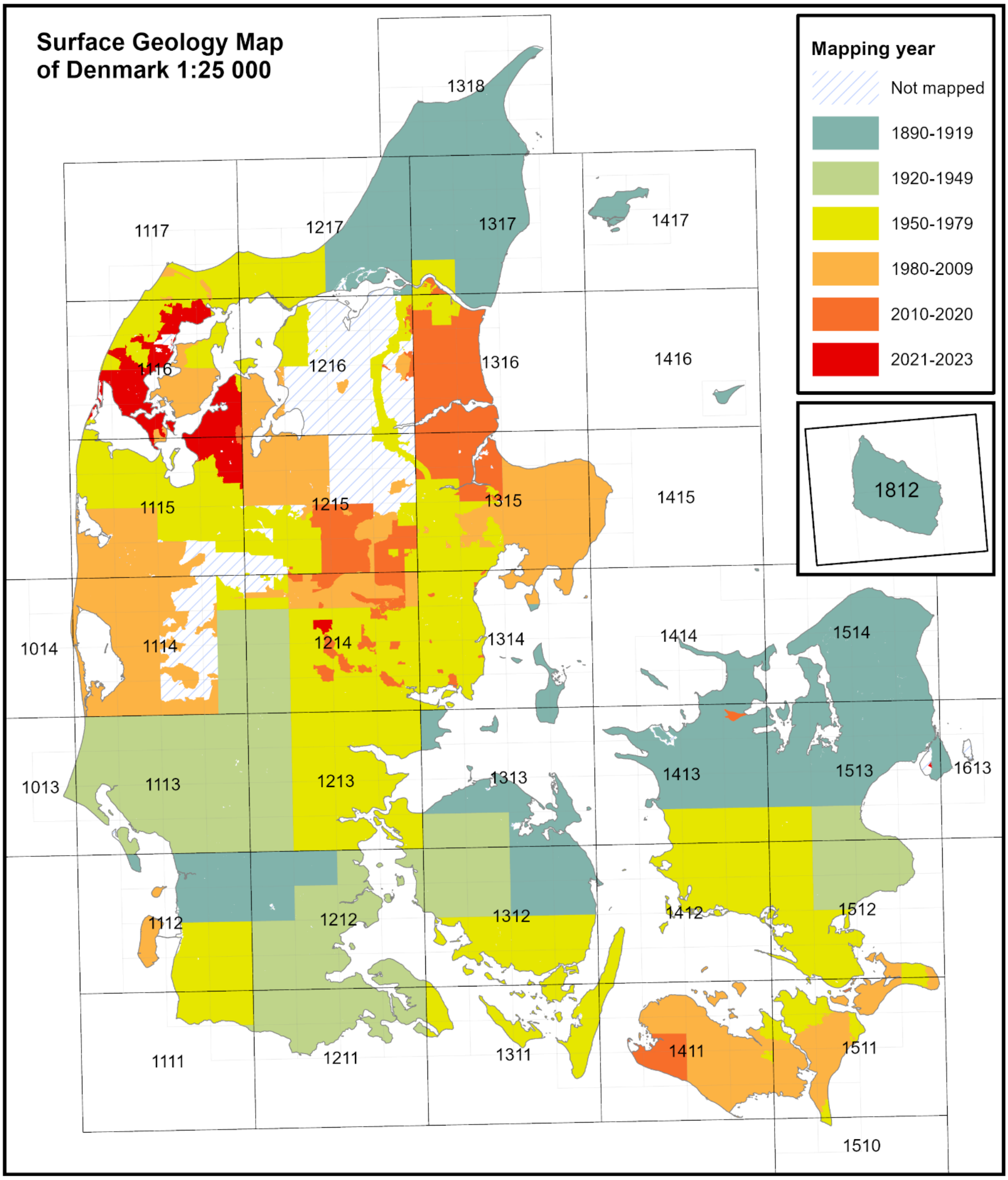

Figure 2. Overview of the mapping periods.

2. The geological mapping process

2.1 Mapping methodology

To determine the soil types, a 1-metre-long soil spear is used during the mapping, which is pressed down to a depth of approximately 1 m (Fig. 3). At this depth, the soils have only been exposed to soil-forming processes to a limited extent, and a sample close to the parent material is obtained. At the tip of the soil spear there is a groove in which a sample of the soil type is collected. The soil type is determined on site, and the result of each probe sample is drawn on the field map with a signature (Fig. 3). A determination of soil types is made every 100 to 200 m, but if the geology is very varied, with frequent changes in soil types, information is collected at shorter intervals. The demarcation between different soil types is made in the field based on the soil samples in combination with a geomorphological analysis of the landscape (Gravesen et al. 2006).

In addition to information collected with the soil spear, data is collected from gravel pits, coastal cliffs and other outcrops and is collated with the surface mapping. Descriptions of these outcrops can be found under the site descriptions in the associated field report (e.g. Jakobsen 2019 and Jakobsen et al. 2021).

Figure 3. The 1-metre-long soil spear is pressed into the ground. The sample is situated in a groove at the tip of the soil spear. The soil type is determined on site, and the result is plotted on the field map.

2.2 The systematic division of the soil types - the legend

The soils are deposited at different times and in different environments, which is the basis for the overall division of the soil types. The determination of the soil type is based on a lithological description of the soil, i.e. the composition of the material, and an interpretation of the depositional environment. The overall legend is shown in Figure 4.

Soils formed by the deposition of solid particles (mineral grains) are divided according to grain size into stone, gravel, sand, silt and clay (Table 1). A soil type, for example, designated as sand, contains predominantly grain sizes between 0.06 mm and 2 mm, which applies to all types of sand regardless of deposition environment and age. When the soil type is indicated by a grain size, other grain sizes may occur in the same soil type in minor quantities.

Boulder	> 200 mm
Stone	200 - 20 mm
Gravel	20 - 2 mm
Sand	2 - 0,06 mm
Silt	0,06 - 0,002 mm
Clay	< 0,002 mm

Table 1. The division into grain size fractions.

Till deposits have a special position in this context, as they appear as very unsorted sediments. Till deposits contain all grain sizes and are designated according to the characterising grain size fraction, and in special cases also according to the lime content, as described in Larsen *et al.* (1988).

Soils consisting of organic material are called peat or gyttja. Peat consists predominantly or entirely of incompletely decomposed plant remains, where the plant remains can be recognised with the naked eye. Gyttja is a mixture of finely divided animal and plant remains and a varied content of fine-grained deposits (clay and silt). Lignite is found in Miocene deposits in Central Jutland. Lignite is charred peat material, i.e. transformed peat.

Saltwater deposits often contain shells or shell fragments, and they also often contain marine microfossils such as foraminifera.

The Pre-Quaternary deposits are not subdivided but have each been assigned the designation originally defined in the ZEUS well database (Gravesen & Fredericia 1984) and which is still used in the Jupiter well database National well database (Jupiter).

On Bornholm, Pre-Quaternary crystalline bedrock rocks, sandstones and shales are found. However, in this edition of the digital soil maps, no distinction is made between the pre-Quaternary rocks on Bornholm, which are collectively designated PKV (Pre-Quaternary).

Figure 4. The Digital Surface Geology Map 1:25000 legend.

2.3 The letter symbols

The letter symbols are a mnemonic code composed of two or three letters, which indicate the type of deposit, geological age and lithology, e.g. ML (Clayey till) (Gravesen & Fredericia, 1984). An overview of the letter symbols used is shown in Figure 4.

There are a few three-letter symbols that are extensions of the two-letter symbols, e.g. KML (Limey till, clayey). Single symbols such as S (Sand) are used where the lithology is known, but not the age of the deposit and/or the deposit type.

Two letter symbols above each other indicate that there are 2 different soil types within the top metre. The lower soil type symbol indicates the soil type at a depth of 1 metre, and the upper letter symbol indicates the overlying soil type. For example, it could be marine silt over peat $\frac{HV}{FT}$ (Fig. 5).

Two juxtaposed soil symbols indicate that a mixture of the specified soil types occurs. This could be, for example, TS-TG, where both extramarginal meltwater sand and gravel occur within the same specified polygon and it has not been possible or appropriate to make a finer differentiation.

Figure 5. The spear grove shows grey marsh deposits over black peat.

In total, there are 82 letter symbols that can be used. During the mapping, 52 different letter symbols were used to describe the Quaternary soils. In addition, 18 letter symbols are used to describe pre-Quaternary deposits. Some polygons have been given the code PKV, which means that they are non-specified pre-Quaternary deposits.

In the first decades of mapping, fewer letter symbols were used than at present. Apart from addition of new symbols, some have been deleted or replaced. This is a change that reflects well over a century of development in geological knowledge of soil types and their formation. There may therefore be differences between an old map sheet that is adjacent to a map sheet that has been mapped within recent decades.

2.4 The colours

To facilitate reading of the digital soil maps, the soil types have been assigned colours. The colours are assigned according to the main division of the Quaternary deposits (Fig. 4). The individual deposit types are differentiated by shades of the main colour. The pre-Quaternary deposits have no colour symbol and therefore appear white.

3. Technical description of the map

3.1 The basis for the digitisation

Until 1998, the basis for Digital Surface Geology Maps was the analogue 'Preliminary Geological surface Maps', which are plainly drawn field maps primarily available at a scale of 1:25000 (Sørensen & Heller 1978; Jakobsen 1996), though map sheets 1115 I, II, III and IV, and 1116 III are available at a scale of 1:50000.

Before 1978, topographic map sheets at the scale of 1:20000 (Målebordsblade) were used as field maps, but this was changed to 4 cm maps (1:25000) from 1978 (Fig. 6). The old maps at 1:20000 were subsequently photographed and scaled down to 1:25 000 and drawn onto transparencies according to the Geodetic Institute of Denmark's 4 cm map frames (Fig. 7).

The 1:25000 digital geological surface maps constitute the basis for the geological maps that have been published in 1:50000 as printed maps, and which previously were published in 1:100000. An overview of the published and printed geological maps is given in Appendix 1.

3.2 Projection

The entire digital map (including Bornholm) is in UTM zone 32. The ellipsoid used is EU-REF89 (since the coastline and map sheet boundaries from the Geodetic Institute of Denmark are calculated with this), but the oldest maps, especially, have been through different projections and ellipsoids (Until 1934, a special Danish system was used). Most maps have been subjected to at least one transformation, but the uncertainty contribution from this is estimated to be within 5-10 metres.

3.3 Map scales

The present digital map is generally suitable for printing at a scale of 1:25000, but unlike topographic maps at this scale, the precision is not 2-3 real metres. The mapping method used means that a boundary between two soil types can be offset by up to 50-100 meters. In nature, an exact boundary between two soil types is difficult to determine as a clear line, as there often is a smooth transition between soil types.

3.4 Digital processing

Before 1992, the digital surface geology maps (Fig. 8) were produced from transparent copies of the Preliminary Geological Surface Maps (Fig. 7) by two different methods. Approximately 150 map sheets (mainly in Southern, Central and Eastern Jutland) were manually digitised on a digitising table and soil symbols were then added. The other map sheets were obtained by scanning and subsequent vectorisation of the drawn field maps (Fig. 6) in ArcGIS (Geographic Information System software developed by Esri). The maps were then "cleaned" of irrelevant line segments, polygon topology was built, and annotations indicating the soil type were added to each individual polygon.

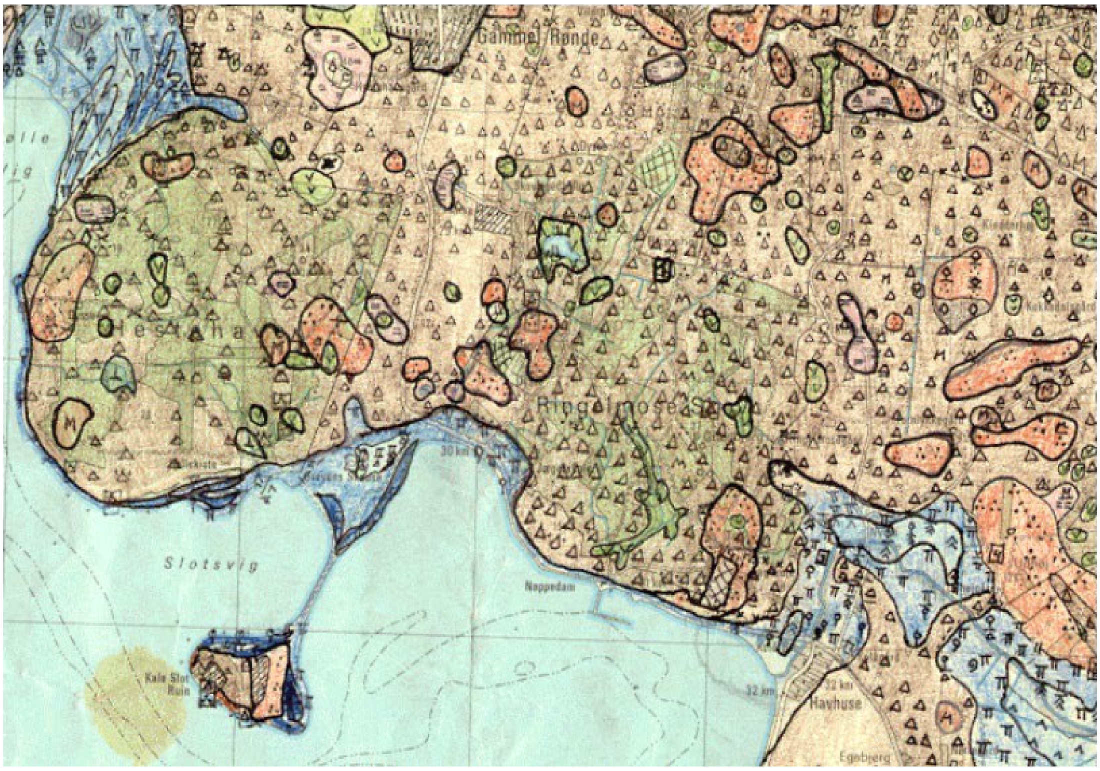

Figure 6. An excerpt of a drawn field map with mapping symbols and soil type delimitations from the 4 cm map 1315 II SV Rønde.

Figure 7. An excerpt of a Preliminary Geological Surface Map covering the same area as Fig. 6.

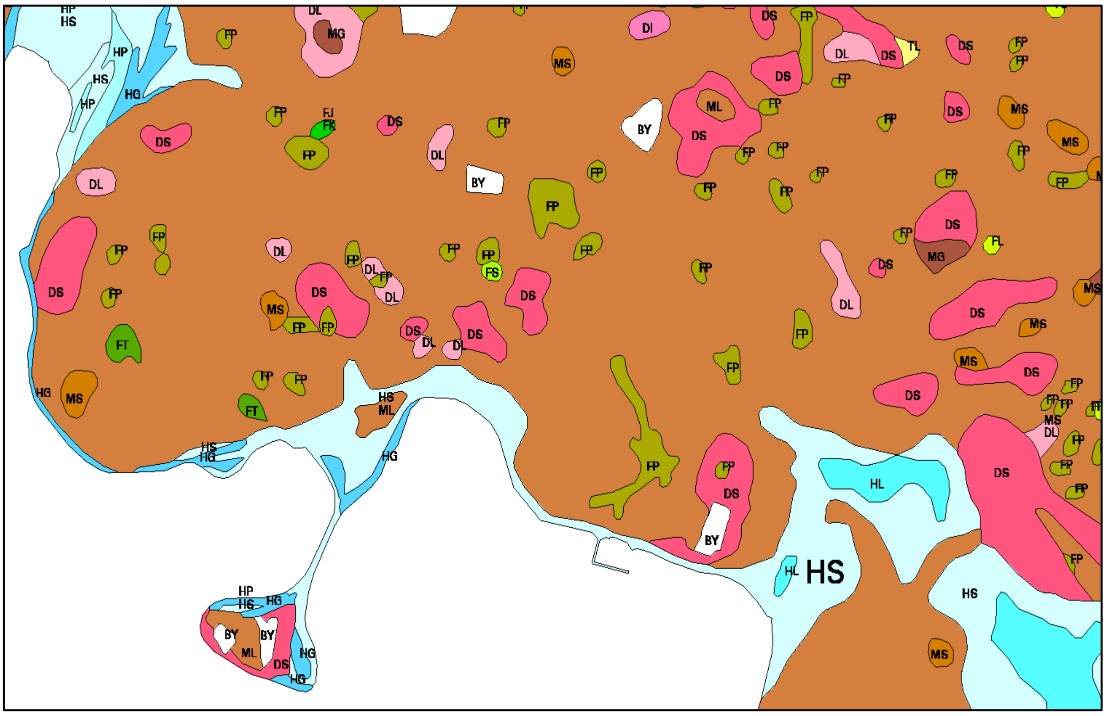

Figure 8. An excerpt of a Preliminary Geological Surface Map covering the same area as Fig. 6 and 7.

After 1992 the Digital Surface Geology Maps have been produced directly from drawn field maps, which have been scanned and the boundaries digitised from the screen.

Subsequently, the maps – both the hand-digitised and the vectorised – have been edge-matched so that the polygon boundaries at the map sheet boundaries match the neighbouring map sheets.

3.5 The letter codes

Each polygon is assigned 3 letter soil codes JSYM1, JSYM2 and TSYM, which are used as follows:

- For most polygons, only one soil type will be specified, in which case JSYM1, JSYM2 and TSYM will be identical.
- In cases with 2 different soil types within the uppermost metre, these soil types are specified as JSYM1 and JSYM2 respectively. For example, if HV (Alternating thin saltwater beds, marsh) forms a cover over FT (Freshwater peat) (as in Fig. 5), JSYM1 is given the code HV and JSYM2 the code FT. On a traditional soil type map, the polygon will appear with the code $\frac{\text{HV}}{\text{FT}}$, but in printouts from the digital version the notation HV/FT is used. Only in cases with vertical differentiation will there be a difference between JSYM1 and JSYM2.
- TSYM is an abbreviation for "interpreted" symbol. In most cases it will be identical to JSYM2. TSYM is used to control map colouring in GIS.

3.6 The topographic basis maps

Topographic information is typically indicated on the geological field maps. Coastlines, lakes and urban areas from these maps are included in the digitisation, as these lines are most often included in the soil type polygons. Lakes that have dried up or been refilled will appear with the boundaries that were valid at the time of mapping. The coastlines, in turn, have most often been replaced with a digital coastline delivered by the Geodetic Institute of Denmark in the late 1980s called D200 (topographic map of Denmark 1:200000). When this is done, it is to avoid breaks in the coastline at the map sheet boundaries (typically areas where two neighbouring maps have been mapped many years apart). Using a newer coastline, on the other hand, means that there may be unmapped areas where new land has been formed by deposition or damming since the mapping. Conversely, areas that have been eroded by the sea since the mapping took place are removed. In cases where the coastline has changed significantly compared to the D200 coastline from the 1980s, the current 1:10000 coastline from GDS (Geodatastyrelsen) has been used in mapping after 2005.

3.7 Line types

The polygons boundaries are divided into 4 different line types, which can be differentiated when drawing based on the attribute LTYPE (line type). These are the following line types:

1: Boundary between two different types of soil
2: Lakeshore
3: Boundary between mapped and unmapped areas
4: Coastline

GEUS has made a proposal for symbolising the line types, which assist the readability of the map, but users can choose how the different line types are symbolised, in terms of line colour, thickness and type.

3.8 Them files

The digital surface geology map is divided into four GIS map themes. The map themes are available as shape files and can be used in ArcGIS/ArcGIS pro and QGIS. The map is also available as PDF files with either Danish or English text and both the GIS-files and PDF-files can be downloaded for free at Danmarks Digitale Jordartskort 1:25 000 version 7.0 - ArcMap/ArcGISPro/QGIS - Denmark Data Center

The four GIS map themes are:

- **Jordart_25000,** containing the sediment type polygons where each polygon, in addition to information about version, area and perimeter, has the attributes JSYM1, JSYM2 and TSYM (see section 3.5)
- **Jordart_25000_linje,** containing the polygon boundaries and information about line type (attribute LTYPE), length and version.
- **Jordart_25000_kystlinje** is the coastline file that matches the new version.
- **Jordart_25000_kortlægningsår** is a polygon file with information about what year the areas were mapped.

3.9 Metadata

Metadata is ISO standard (ISO 19115:2003 / ISO 19139:2007) and can be accessed at GEUS GeoNetwork. Geus Geonetworks metadata catalogue

4. Short description of the sediments

4.1 Quaternary sediments

The following sections briefly review the Quaternary sediments identified during the mapping.

4.1.1 Postglacial layers

Postglacial freshwater deposits
Postglacial freshwater deposits are deposited in freshwater environments along streams or in lakes in the period after the ice age. They can be divided into deposits of clastic (mineral) material and of organic material.

The clastic deposits are divided according to grain size into:

FG; Freshwater gravel. Gravel deposited in freshwater, along streams or in lakes.

FS; Freshwater sand. Sand deposited in freshwater, along streams or in lakes. FS is often seen in depressions in the terrain and below terrain slopes, where it may be washed-out material, often with organic content (Fig. 9).

FI; Freshwater silt. Silt deposited in freshwater, along streams or in lakes. FI occurs very rarely, but most often in depressions in the terrain and below terrain slopes, where it may be washed-out material, probably with organic content.

FL; Freshwater clay. Clay deposited in freshwater, along streams or in lakes. FL is also seen in depressions in the terrain and below terrain slopes, where it may be washed-out material, often with organic content.

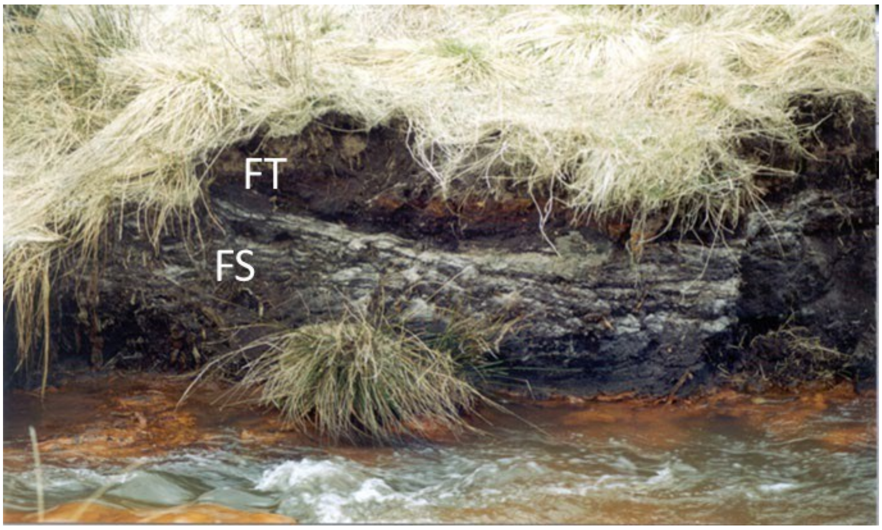

Figure 9. Freshwater peat (FT) overlying freshwater sand with organic-rich layers (FS) in the bank of a stream inlet.

The following freshwater deposits consist mainly of organic material:

FP; Freshwater gyttja. Gyttja formed in freshwater lakes.

FT; Freshwater peat. Peat deposits formed by the accumulation of plant material in lakes, streams or in raised bogs (Fig. 9).

FV; Alternating thin freshwater layers. Many thin layers of either clastic and organic soils, e.g. sand and peat, or alternating layers of clay and sand.

Figure 10. Rusty red bog iron lens (FJ) in Freshwater peat (FT).

The following freshwater deposits are formed by chemical precipitation, which is conditioned by specific chemical environments and conditions:

FK; Tufa, bog- and lake marl. Tufa is chemically precipitated lime which is precipitated where lime-saturated groundwater emerges at the surface of a spring. Lake marl is deposited in calcareous lake environments where almost pure lime layers can form. Bog marl is roughly synonymous with lake marl but usually contains more organic material.

FJ; Ochre and bog iron. Iron deposits formed in bogs and meadows where iron-rich groundwater flows up against acidic surface water (Fig. 10).

Postglacial delta deposits

The postglacial delta deposits were emplaced in the period after the ice age. They are currently only known from the Skjern River delta in Denmark. The Skjern River delta is formed by freshwater sediments building up a delta in front of the river's mouth into the sea. The deposits are thus laid down by a freshwater stream, but partially re-embedded by marine processes.

FHG; Delta gravel. Gravelly deposits formed in delta environments by freshwater streams, under the influence of marine processes.

FHS; Delta sand. Sandy deposits formed in delta environments by freshwater streams, under the influence of marine processes.

FHL; Delta clay. Clayey deposits formed in delta environments by freshwater streams, under the influence of marine processes.

Postglacial saltwater deposits

The postglacial marine deposits were deposited in the post-glacial period in the coastal zone, which is delimited by the marine-influenced land and the coastal seabed. For approximately the last 5000 years, the land has risen in relation to sea level northeast of a line that runs approximately from Ringkøbing to Præstø. In the raised areas, postglacial marine deposits can therefore be observed inland above the current sea level. In addition, there are larger areas with dammed and drained areas with postglacial marine deposits. All marine deposits may contain shells or shell fragments.

Figure 11. Saltwater gravel (HG) in a vegetated seawall facing Ringkøbing Fjord.

HG; Saltwater gravel. Gravelly deposits typically accumulated on the backshore, where the sediment is part of the seawall structure (Fig. 11).
HS; Saltwater sand. Sandy deposits found throughout the coastal zone (and further inland). On the backshore, HS is often seen between and in the seawalls (Fig. 12).
HSG; Saltwater shell gravel. Gravelly deposits where the gravel consists of marine mussel and snail shells.
HI; Saltwater silt. Silty deposits formed under calm conditions either in fjords, in lagoons behind barriers or at greater water depths.
HL; Saltwater clay. Clayey deposits formed under calm conditions either in fjords, in lagoons behind barriers or at greater water depths.
HP; Saltwater gyttja. Gyttja deposited under calm conditions either in fjords, in lagoons behind barriers or at greater water depths. For example, have large thicknesses of HP been deposited in Kolindsund.
HT; Saltwater peat, also called eve, which often consists of washed-up seaweed. HT is usually found together with the other postglacial marine deposits and usually deposited on the backshore behind or between beach walls. In protected bays or fjords, HT can also be deposited on the marine foreland, but in these cases the peat material may contain coastal vegetation.

Figure 12. Saltwater sand (HS) with shells on the back beach on Rømø. On top of the marine sand, an aeolian sand cover and dunes is forming.

HV; Alternating thin saltwater layers, marsh. Many thin layers of clay, silt and sand. HV is a typical deposit in the marsh, where the changing stream environments caused by flood and ebb, as well as deposits of storm sand layers have resulted in alternating layering. The sediments often have a significant content of organic material.

Postglacial aeolian deposits

Aeolian sand is deposited by wind and is found as dunes and aeolian sand covers.

EK; Aeolian dune sand. Occur primarily along the coast (Fig. 12 and 13) but also as inland dunes.

ES; Aeolian sand. Found mainly inland and can in places cover larger areas (Fig. 13). Aeolian sands are especially seen on heath plains and hill islands. They also occur along the Main Residence Line (Hovedopholdslinjen) running N–S through Jutland. Aeolian sand covers are also found in other areas of the country, for example in northern Djursland and North Zealand.

Figure 13. The photo shows a completely flat sandblasting surface and in the background are dunes making up the dune systems along the west coast at Ringkøbing.

4.1.2 Late glacial layers

Late glacial saltwater deposits

When the last ice melted, the sea flooded the lower ice-free areas and deposited widespread layers of marine sediments in Northern Jutland. The subsequent land uplift caused the deposits to be exposed above present sea level. They now constitute the flat, elevated (former marine) surfaces in Vendsyssel.

YG; Saltwater gravel. Gravelly deposits typically accumulated in the upwelling zone, where the sediment often is part of fossil beach walls.
YS; Saltwater sand. Sandy deposits formed within the coastal zone of the ice sea, but also in deeper water. In Vendsyssel, YS forms large, widespread layer series.
YL; Saltwater clay. Clayey deposits formed under calm conditions either in fjords, in lagoons behind barriers or at greater depths. In Vendsyssel, YL forms large, widespread layer series.
YP; Saltwater gyttja. Gyttja deposited under calm conditions either in fjords, in lagoons behind barriers or at greater water depths.

4.1.3 Glacial layers

Proglacial meltwater deposits

Proglacial freshwater deposits are transported and deposited by meltwater from glaciers. They are therefore similar to glacial meltwater sediments (DG, DS, and DL) but have not subsequently been overrun by a glacier. They can primarily be distinguished from glacial meltwater sediments based on morphology, where the deposits form heath plains, terraces in larger valleys such as the Gudenå valley, and proglacial lakes such as Stenstrup Issø on Funen. Heath plains and valley terraces typically contain TG and TS (meltwater gravel and sand) and the proglacial lakes typically consist of TS, TI, and TL (meltwater sand, silt, and clay).

Proglacial meltwater deposits also occur as washout material deposited in front of late-glacial ravines (valley scarp) as valley fills or in general below slopes.

TG; Meltwater gravel. Gravel deposited by meltwater (Fig. 14). The sediment often contains sand. TG is a coarse material that requires high energy for transport. Therefore, it is primarily transported over shorter distances and is thus deposited close to the ice edge and often in meltwater cones. In ravines, TG is deposited up towards the mouth of the ravine. TG can be found as valley fill material when the sides of the valley consist of coarse material.

TS; Meltwater sand. Sand deposited by meltwater (Fig. 14). The sediment often contains gravel. TS is more easily transported over longer distances than gravel, and TS is therefore found further from the ice edge than TG. TS is also found as valley fills in flat-bottomed valleys and in front of ravines.

TI; Meltwater silt. Silt deposited by meltwater. TI is deposited in a very calm environment e.g. in lakes.

TL; Meltwater clay. Clay deposited by meltwater in lakes, often contains silt. TL is also found as valley fills.

TV; Alternating layers of meltwater beds. Commonly alternating sand and meltwater clay.

Figure 14. Meltwater sand (TS) and meltwater gravel (TG) in a gravel pit on a heath plain at Højby, NW Zealand.

Glaciolacustrine deposits

Glaciolacustrine deposits are deposited in ice-dammed lakes, on the ice or along the edge of the ice. Glaciolacustrine deposits thus appear as free-standing hills (kames), glacial lake hills or plateaus that lie against higher hills.

ZG; Glaciolacustrine gravel. Gravelly deposits in glacial lake hills.

ZS; Glaciolacustrine sand. Sandy deposits in glacial lake hills.

ZI; Glaciolacustrine silt. Silty deposits in glacial lake hills.

ZL; Glaciolacustrine clay. Clayey deposits in glacial lake hills.

ZV; Alternating thin Glaciolacustrine beds. Alternating thin layers of clay, silt and fine sand deposited as washout material in an ice-dammed lake basin.

Meltwater deposits

Meltwater deposits are transported and deposited by glacial meltwater. The lithological composition is similar to the proglacial meltwater sediments, but the glacial meltwater deposits have subsequently been overlain by glaciers (Fig. 15).

DG; Meltwater gravel. Gravel deposited by meltwater. DG often contains sand.

DS; Meltwater sand. Sand deposited by meltwater. DS often contains gravel.

DI; Meltwater silt. Silt deposited by meltwater. DI is deposited in a very calm environment, possibly in lakes.

DL; Meltwater clay. Clay deposited by meltwater in lakes. DL often contains silt (Fig. 16).

DV; Alternating thin meltwater beds. Alternating thin layers of TS and TL.

Figure 15. Glacial meltwater sand (DS) and meltwater gravel (DG) in a gravel pit at Rudmose, south of Spjald. Note the steeply standing layers, which show that the layers have been pushed up and that they have been overlain by a glacier.

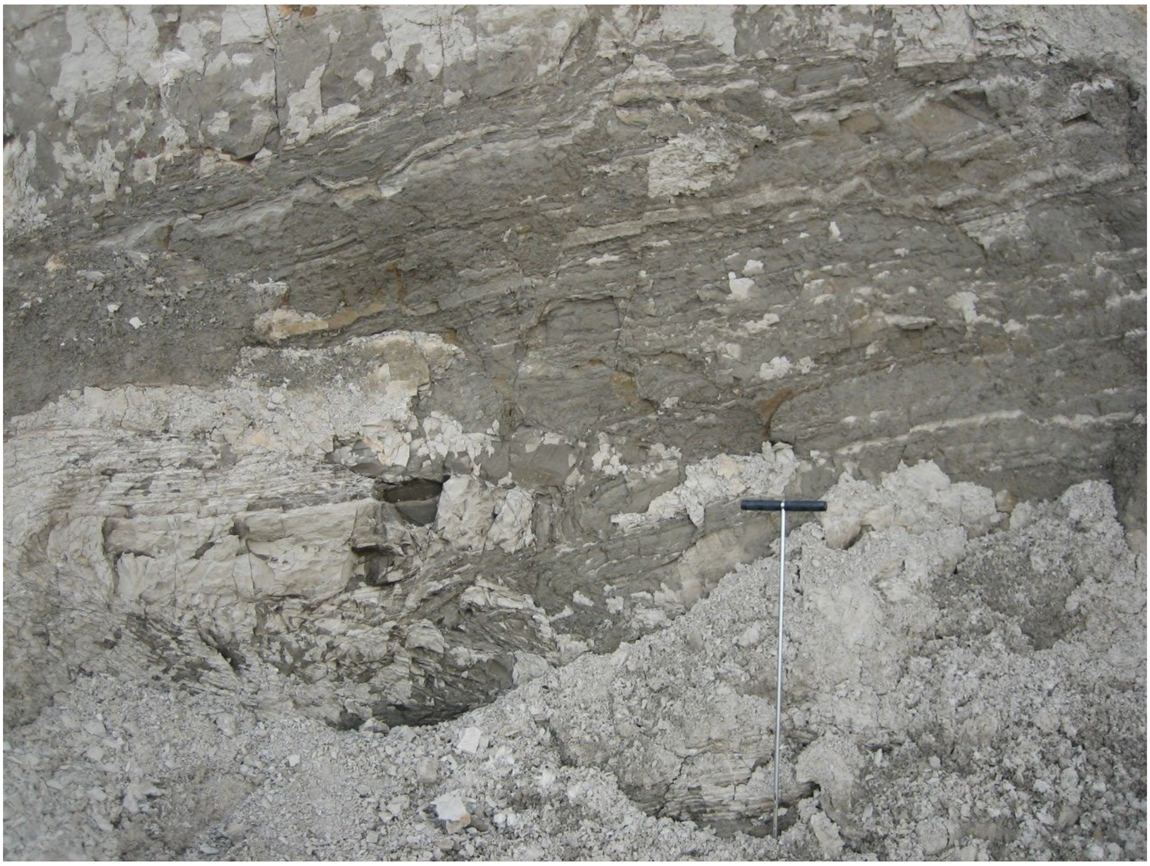

Figure 16. Layered meltwater clay with silt at Nees on Mors.

Till deposits

Till deposits are laid down by ice and consist of very unsorted sediments, which are broadly called diamicton (Fig. 17). A till is named after the characterising grain size fraction such as till clay, till sand or till gravel (Larsen et al. 1988). The tills may have been deposited under the ice (lodgement till), they may have been deposited in connection with the melting of the ice (ablation till) or they may have been melted out and slid down by the ice (flow till). The lithological composition does not vary between the till types, but ablation tills and flow tills are 'soft', where the lodgement till is more consolidated, due to pressure from the weight of the ice. No distinction is made between the three till types during the mapping of the soils.

MG; Gravelly till. Gravelly and stony diamicton with minor sand and clay content.

MS; Sandy till. Sandy, slightly clayey diamicton where the clay content is < 12%. Till sand is not malleable.

MI; Silty till. Silty, slightly clayey, slightly sandy diamicton where the clay content is < 12%.
ML; Clayey till. Sandy, silty and gravelly sediment, with a clay content of at least 12%. At a clay content of approximately 12 to 15% the till clay is plastic and malleable but is referred to as strongly silty or strongly sandy till clay depending on the grain size distribution. With a clay content > 15%, the soil is referred to exclusively as till clay. During mapping, a distinction is made between sandy till clay and till clay, but only ML is indicated on the map.

MV; Alternating thin till beds. Alternating thin layers of clayey and sandy diamicton.

KMG; Limey till, gravelly. Like MG, but with a high content of lime with visible lime clasts.

KMS; Limey till, sandy. Like MS, but with a high content of lime with visible lime clasts.

KML; Limey till, clayey. Like ML, but with a high content of lime with visible lime clasts.

Figure 17. Tille cliff on the southern Mors.

On the right, a close-up showing the unsorted composition of a till deposits.

4.1.4 Interglacial layers

Interglacial freshwater deposits

The interglacial freshwater deposits rarely occur at the surface and have only been observed as peat deposits on Holsted Bakkeø in West Jutland.

IT; Freshwater peat. Peat deposits formed by the accumulation of plant material in lakes, by streams or in raised bogs.

Interglacial saltwater deposits

The interglacial marine deposits have been observed at the surface in Vendsyssel, where they occur as raised marine deposits. In the southern Little Belt area and in the South Funen Archipelago the deposits often occur as glacial tectonic flakes in the coastal cliffs, but they have not been encountered at the surface.

QG; Saltwater gravel. Gravelly deposits typically accumulated in the upwelling zone, where the sediment is often within fossil beach ridges.

QS; Saltwater sand. Sandy deposits formed primarily within the coastal zone, but also in deeper water.

QL; Saltwater clay. Clayey deposits formed under calm conditions either in fjords, in lagoons behind barriers or at greater depths.

4.2 Pre-Quaternary layers

The pre-Quaternary deposits are divided by age and lithology. In some cases, the age is uncertain for example mica sand (GS) occurs in both Oligocene and Miocene deposits and it is rarely possible to determine the age precisely in the field. The following includes the pre-Quaternary deposits that have been encountered at the surface and are found on the surface geology map.

K; Chalk and limestone. Unspecified calcareous rock.

SK; Campanian-Maastrichtian chalk. White, marine sludgy chalk.

BK; Danian bryozoan and corallian limestone. A calcareous rock with many visible bryozoans.

ZK; Danian chalk / chalk and flint. Grey-white calcareous sandy chalk.

PL; Selandian clay, Palaeocene clay. Grey calcareous marine clay (Kerteminde Marl)

PS; Selandian sand, Palaeocene greensand. Marine sand with content of Glauconite (Lellinge Grønsand)

SL; Eocene Søvind Marl. Thick greenish-grey to light grey, strongly calcareous, marine clay.

RL; Eocene Røsnæs Clay. Thick reddish-brown marine clay.

LL; Eocene clay, plastic clay. Very thick greenish-grey to reddish-brown marine clay.

ED; Eocene diatomite. A marine deposited diatomaceous yellowish-grey clay deposit, with ash layers (Moler).

EE; Eocene volcanic ash. Occurs as layers in the Moler at Mors and in Ølst clay.

OL; Oligocene clay. Thick black or dark olive-grey marine clay, often with glauconite.

GL; Oligocene/Miocene/Pliocene mica clay. An unspecified micaceous marine clay deposit, usually black or dark brown.

GS; Oligocene/Miocene/Pliocene mica sand. An unspecified micaceous sand deposit.

GC; Oligocene/Miocene/Pliocene brown coal. Miocene peat, deposited in a deltaic environment and subsequently converted to brown coal.

GV; Oligocene/Miocene/Pliocene alternating layers. Alternating layers of GS and GL.

KS; Miocene quartz sand. Sand deposit consisting almost entirely of quartz sand grains.

PKV; Pre-Quaternary layers. Unspecified Pre-Quaternary rocks. Only used on Bornholm.

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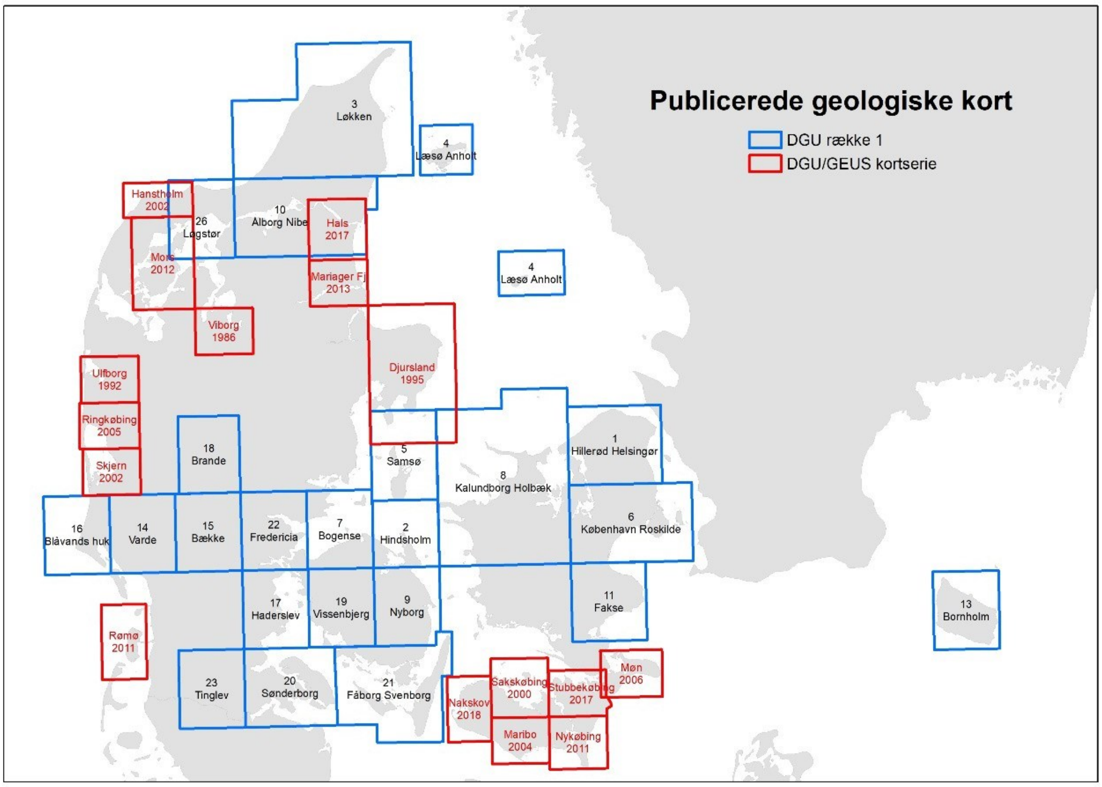
6. Appendix 1. Published geological maps and reports



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