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Forsmark

Mapping of unconsolidated Quaternary deposits

Field data 2002

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April 2003

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Contents

1 Introduction

SKB performs site investigations for localisation of a deep repository for high level radioactive waste. The site investigations are performed at two sites; Forsmark and Oskarshamn. This document reports the data gained within the activity mapping of unconsolidated Quaternary deposits in Forsmark. The work was conducted according to activity plan AP PF 400-02-12 (SKB internal controlling document).

2 Objective and scope

The mapping of unconsolidated Quaternary deposits started in mid August 2002 and will be finished by the end of 2003. The aim of this activity is to describe the aerial distribution of the uppermost unconsolidated deposits, and where possible, the stratigraphical distribution of all Quaternary deposits above the bedrock surface. The investigated area is 7x6 km large (see Figure 2-1). One third of that area was mapped during 2002. A final map (scale 1:10 000) will include all exposed rocks and all Quaternary deposits which have an area larger than 10x10 meter. The Quaternary deposits of the area have earlier been mapped by the Geological Survey of Sweden /1, 2/. These maps (scale 1:50 000) do, however, omit deposits with extensions less than 50x50 m.

The mapping project also involves collection of other data, such as fabric analyses in till and the direction of glacial striae, which show the direction of glacial movement. Further analytical work includes analyses of grain size distribution, mineralogy and geochemistry of selected samples obtained from drillings performed within other activities.

This report contains field data collected during 2002. The analytical data will be presented in a separate report during April 2003 (SKB P-03-14, Forsmark – Mapping of unconsolidated Quaternary deposits. Stratigraphical and analytical data). A final report and a digital map will be presented in December 2003.

Together, the information gained from the mapping of unconsolidated Quaternary deposits at Forsmark will be used to reconstruct the Late Quaternary development of the area and for hydrogeological modelling.

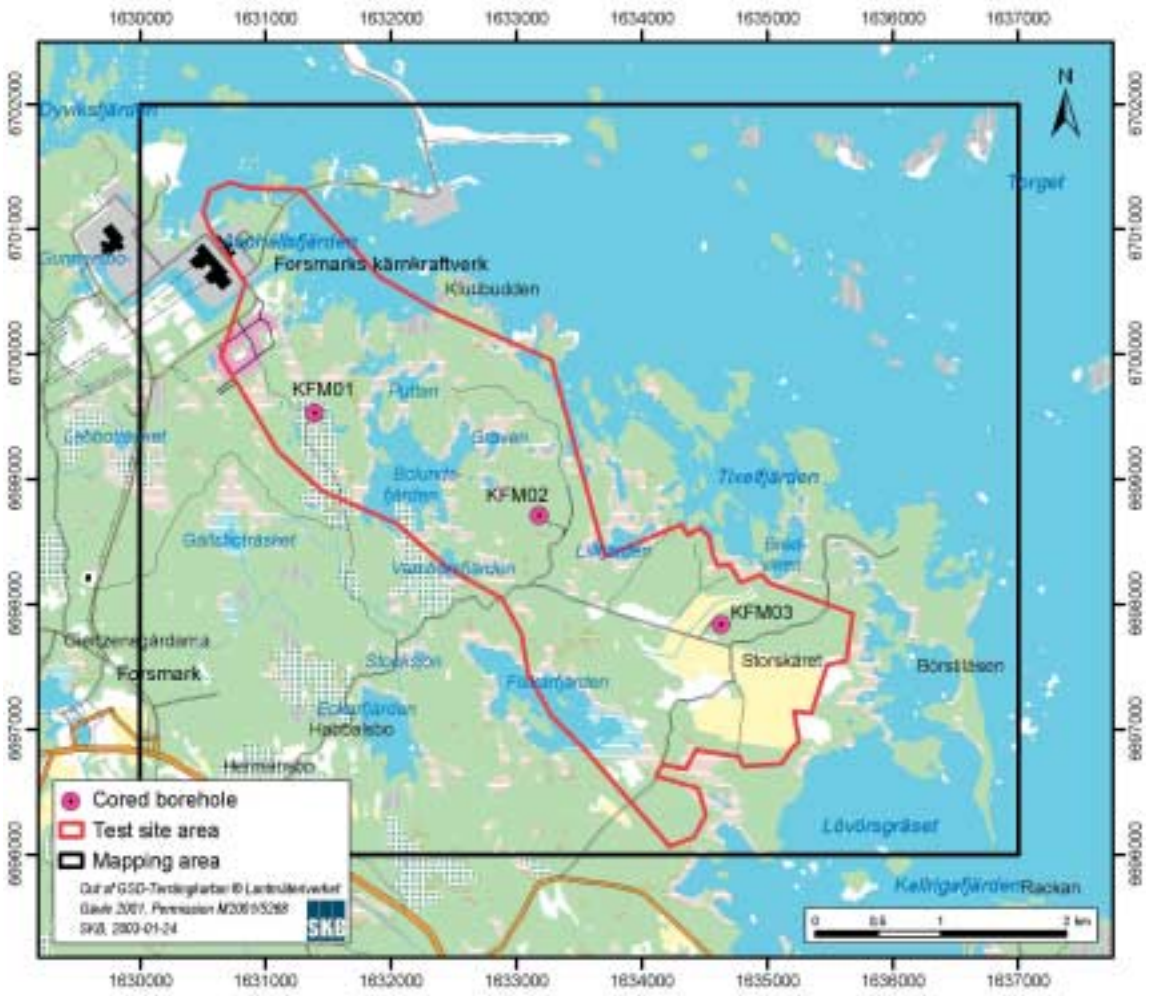

Figure 2-1. *Location of the area selected for mapping of unconsolidated Quaternary deposits at Forsmark.*

3 Equipment

3.1 Description of equipment

Equipment used for mapping of the uppermost unconsolidated Quaternary deposits are mapped using a spade and a hand driven probe. GPS and aerial photos (IR photos taken from a height of 4 600 m) are used for orientation. Most photos are taken using a digital camera.

4 Execution

The mapping was performed according to the activity plan AP PF 400-02-12 (SKB internal controlling document) following the method description for mapping of unconsolidated Quarternary deposits SKB MD 131.001 (SKB internal controlling document). Different Quaternary deposits are marked directly on the aerial photos in the field. The final map will show the distribution of Quaternary deposits at a depth of 50 cm. Surface layers thinner than 50 cm are also described (e.g. peat overlaying other deposits). The distribution of Quaternary deposits below 50 cm depth will be established from drillings and machine dug excavations.

Numerous previously unknown bedrock exposures have been defined in an earlier interpretation of the aerial photos. This new information is checked during the mapping.

4.1 Preparations

The GPS was controlled every day at a point with a known position (6699539 N, 1631321 E). This control defined a precision better than ±5 m.

4.3 Data handling

The locations of observation points (from surface mapping, stratigraphical observations, and measurements of glacial striae) were determined with GPS. The dates of the observations were notified and they were all given PFM numbers. All point coordinates and dates were later stored in SICADA under field note Forsmark 39. The geological information connected to the PFM numbers was stored in a data base for mapping of unconsolidated Quaternary deposits at the Geological Survey of Sweden (Jorddagboken, Version 5.4.3), and subsequently exported to SICADA (Field note Forsmark 39).

The drawings of Quaternary deposits made in the field on the aerial photos will later be scanned and transformed in to a map. This information will be included in a digital map of the Quaternary deposits in the investigated area to be presented in December 2003.

The deliverables to SKB from the mapping of unconsolidated Quaternary deposits during 2002 includes:

- Stratigraphy of lose deposits (SICADA)
- Directions of glacial striae (SICADA)
- Point observations from surface mapping (SICADA)
- Digital photos (File archive)

5 Results

The investigated area is flat and glacial till is the most common Quaternary deposit. The ground water table is situated close to the ground surface and the area is therefore rich in lakes and wetlands. In the easternmost part of the area there is a small esker (Börstilåsen) with a N-S direction. Glacial clay, gyttja clay, sand and peat cover many, often small (less than 50x50 m), surfaces. These deposits cover only a small fraction of the total area under investigation. The present mapping, so far, confirms most of what is shown on the earlier maps /1, 2/. However, the new mapping gives more information regarding the distribution of water laid sediments and peat. Numerous, earlier unknown, localities with exposed bedrock have also been found.

An ice moving from north (350º-360º) has formed most glacial striae. On certain sites there are older striae formed from north-west and west. Striae are also found on some large boulders (not measured since the boulders have been moved from their original position).

So far, little is known about the total thickness of the Quaternary deposits. Drillings close to KFM01 (Figure 2-1) showed that up to 12 m of till covers the bedrock. There is exposed bedrock only a few tenths of metres from the drilling sites. This implies that the bedrock surface is more undulating than the relatively flat ground surface suggests. Numerous additional drillings will take place in the nearest future, which together with geophysical data, will give more information on this matter.

In certain areas there are almost no bedrock exposures. One such area follows the western side of Bolundsfjärden and continues on the eastern side of Fiskarfjärden (Figure 2-1). It is likely that the total depth of Quaternary deposits is high in such areas.

Sandy till is the most common till type (at the mapping depth 50cm). The excavations at the drill sites KFM02 and KFM03 show that silty till is overlying the bedrock surface. In connection with the building of reactor 3 (Forsmark), a silty till was documented at the same stratigraphical position /3/. It is, however, not known if that silty till overly the bedrock in large parts of the area under investigation. The forthcoming stratigraphical investigations will hopefully answer that question. Around Storskäret (Figure 2-1) the till is clayey and to a large extent used as arable land. Gravelly till has been found at some localities but it seems to be less frequent.

The till has, in most areas, a medium boulder frequency. There is, however, a high frequency of large boulders in the easternmost part of the area, around Börstilåsen (The Börstil esker; Figure 2-1). Small areas with a high frequency of boulders do occur in the whole area under investigation, especially on the south side of rock outcrops. The clayey till round Storskäret (Figure 2-1) has a low boulder frequency. Stones in heaps around the fields are rounded and are of the same size.

Börstilåsen (Figure 2-1) is a relatively small esker with a NW-SE direction. In the investigated area the esker has a flat crest and reaches 5-6 m above the present sea level. The uppermost decimetres of the till has been washed out from clay and silt at places that have been exposed to wave washing. At some sites, which have been exposed to extreme wave washing, the uppermost till consist of a stone layer (shingle). Such

enrichments of stones can be seen at several places along the present shore (e.g. at Klubbudden; Figure 2-1). The effects of wave washing can also be seen at the crest of Börstilåsen (Figure 2-1) where a raised shingle shoreline can be seen.

The till and glacial clay are rich in $CaCO_3$, which emanates from limestone present at sea bottom north of the area.

The largest wetlands have a diameter of more than 500 m (e.g. Gällsboträsket; Figure 2-1). There are, however, plenty of wetlands, probably hundreds, which are less than 100 m across. The deposits on these small areas are often not shown on the earlier map of Quaternary deposits. The unconsolidated deposits of the wetlands are of varying genesis. Clay gyttja and glacial clay are the most common deposits. The glacial clay is often overlain by 20-40 cm of sand and gravel. In many wetlands these deposits are thicker than 50 cm (the mapping depth). The gyttja clay is often thinner than 1 m and underlain by till or glacial clay. The forthcoming investigation of lake sediments will give more information about the stratigraphy of the fine grained sediments.

Certain wetlands consist of a flat till surface e.g. large parts of the shores around Bolundsfjärden (Figure 2-1). Sand, gravel and glacial clay also occur at sites that are not wetlands. These sites are often not shown on the former maps of Quaternary deposits.

The peat covers less extensive areas than shown on the earlier maps of Quaternary deposits /1, 2/. The isostatic land upheaval in north Uppland is around 6 mm/yr. Most of the investigated area has been below sea level until quite recently. The first small islands reached above seal level 2 000 years ago. The area was still an archipelago 500 years ago. The sea most recently covered the present lakes and wetlands. This means that too little time has passed for a distinguished peat layer to form. There are, however, wetlands, e.g. around Eckarfjärden (Figure 2-1), which are covered by peat.

6 References

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