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Forsmark site investigation

Soil stratigraphy based on samples and protocols in the Forsmark area

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This report concerns a study which was conducted for SKB. The conclusions and viewpoints presented in the report are those of the author and do not necessarily coincide with those of the client.

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Abstract

In this study, samples from a total of 21 borings were investigated in order to gain additional information on the Quaternary stratigraphy in the Forsmark area. Soil samples from 19 borings were available for inspection. Two borings were assessed from the driller's notes. An individual Quaternary stratigraphy was established for each of the boring locations.

Sammanfattning

Sammanlagt undersöktes prover från 21 borrhål i denna studie för att utöka kunskapen om den kvartära stratigrafin i Forsmarksområdet. Från 19 borrhål fanns jordprover för bedömning. Två borrhål bedömdes med hjälp av borrhållprotokoll. För varje borrhåll upprättades en individuell kvartär stratigrafi.

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1 Introduction

This document reports the results gained by the study “Soil stratigraphy based on samples and protocols in the Forsmark area”, which is one of the activities performed within the site investigation at Forsmark. The work was carried out in accordance with activity plan AP PF 400-06-090. In Table 1-1 controlling documents for performing this activity are listed. Both activity plan and method descriptions are SKB’s internal controlling documents.

Figure 1-1 depicts the locations of the and the identifications of the boreholes sites included in this study.

Table 1-1. Controlling documents for performance of the activity.

Activity plan	Number	Version
Kvartärgeologisk bedömning av jordprover från borrhningar i Forsmarksområdet	AP PF 400-06-090	1.0
Method descriptions	Number	Version
Metodbeskrivning för jordartskartering	SKB MD 131.001	1.0

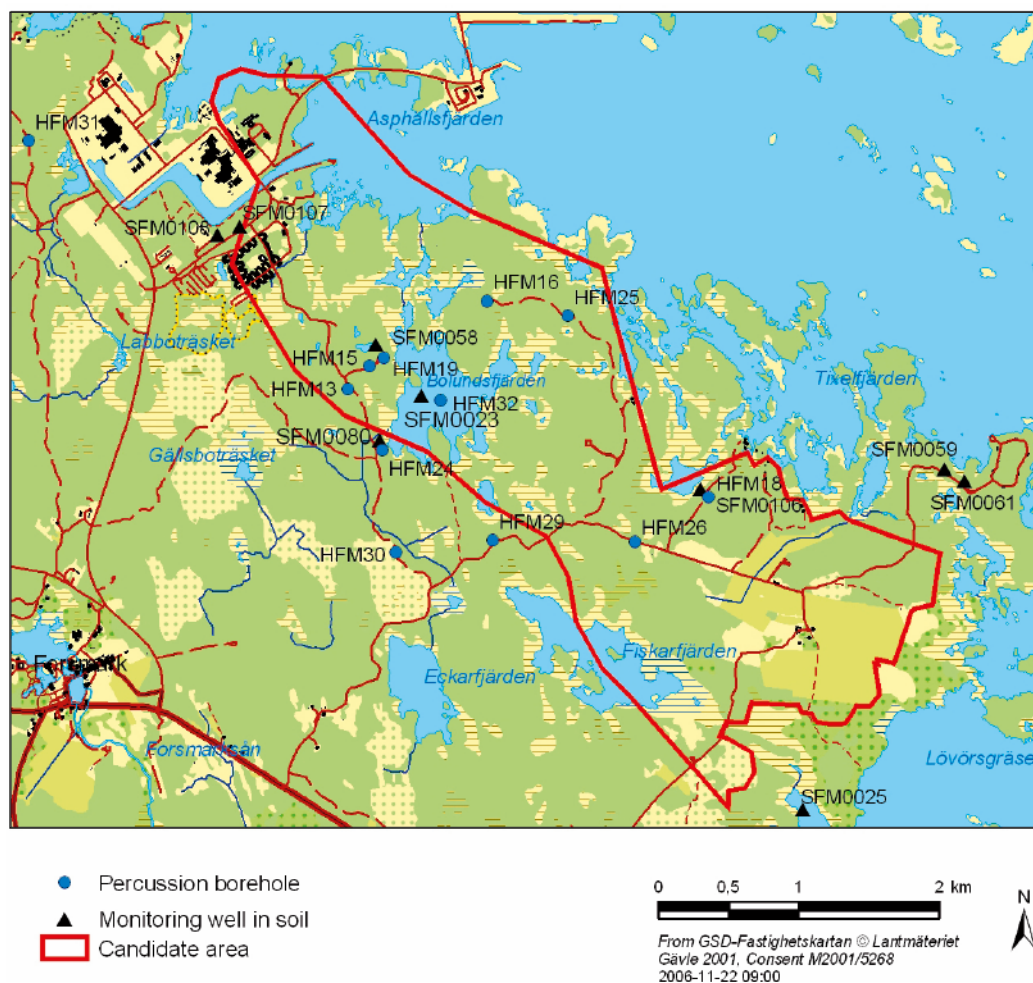


Figure 1-1. General overview over Forsmark site investigation area with locations of sites included in this study.

2 Objective and scope

This study aims at gaining additional information on glacial stratigraphy in the Forsmark area by assessing soil samples from several soil borings. The samples had been collected by percussion drilling from 2003 to 2006 and were evaluated Oct 16 through Oct 19, 2006. Although these drillings focused primarily on obtaining data from the bedrock, information on the Quaternary sediments is also provided which can be used to complete the overall knowledge about Quaternary stratigraphy and evolution in the area.

The present activity was executed after the completion of the activity “Mapping of unconsolidated Quaternary deposits 2002–2003” /1/, in order to obtain additional stratigraphical data from areas where information was insufficient.

A number of boring locations, where no geological assessment of the Quaternary deposits was available, were chosen for further investigation. Soil samples from these borings were to be evaluated and a Quaternary lithostratigraphy for each boring location should be established.

The samples had been obtained during the drilling process and generally collected over every 0.5 m interval. The average sample volume is approximately 1.0 litres, although in some cases only smaller samples or no sample at all had been recovered.

After ocular assessment of the samples, the interpreted data were stored in SKB’s internal database, where they are traceable by the activity plan.

3 Execution

3.1 General

This study was conducted in accordance with method description “Metodbeskrivning för jordartskartering” (SKB MD 131.001, SKB internal document), see Table 1-1.

The lithostratigraphy of the individual locations was interpreted after ocular assessment of samples collected during several previous activities within the site investigation in Forsmark. The interpretations are additionally supported by the evaluation of existing boring logs from the sites.

Each sample was individually assessed regarding its grain size and sorting. In addition, the shape and roundness of the gravel-sized clasts was evaluated and a rough estimate of the occurring rock types was made.

Poorly sorted sediments indicate glacial till, sorted gravelly sediments indicate a glaciofluvial environment. Freshly cut edges indicate rock cuttings (either from boulders or bedrock), whereas rounded clasts indicate deposition by running water. Glacial till usually contains angular, sub-rounded and rounded clasts. Many different rock types are usually found in glacial and glaciofluvial sediments, whereas uniformity is typical for rock cuttings. However, due to the nature of the sampling technique, mixtures of different sediment types occur on a regular basis.

Based upon the above-mentioned assessment and additionally aided by the evaluation of existing boring logs, a lithostratigraphy for each borehole was established.

3.2 Nonconformities

No nonconformities were encountered.



Figure 3-1. Typical till sample. The sediment's physical properties (grain size, sorting, clast roundness, rock types etc) were evaluated.

4 Results

Samples from a total of 19 borings were available for assessment. The number of samples per boring varies from one to 23. For two more borings only the driller's notes were available.

Most of the borings are located where till is present at the surface (Figure 4-1). Consequently, the Quaternary stratigraphy from these borings is generally limited to only one till layer, which only occasionally (HFM16 and SFM0080) is overlain by sand, interpreted as washout. The bedrock surface lies between 1.0 m and 11.5 m below ground surface at the investigated locations.

The uppermost till sample in several borings is depleted in fines, which is interpreted as the result of wave action. The grain-size composition of the till varies remarkably, resulting in the possible distinction of several till types in a number of borings. Due to the nature of the sampling technique, however, the samples do not provide sufficient information to distinguish several chronostratigraphical units, i.e. tills representing different ice advances. Therefore, only two different till types are distinguished: sandy till and clayey till (Table 4-1). The sandy till, which represents the uppermost till found in the area, varies from silty-sandy to gravelly sandy till. Based upon the data from other related investigations in the area /1, 2, 3, 4/, it is possibly justified to correlate the clayey till observed in HFM26 and SFM0106 with the clayey till encountered on top of the bedrock in other places in the area.

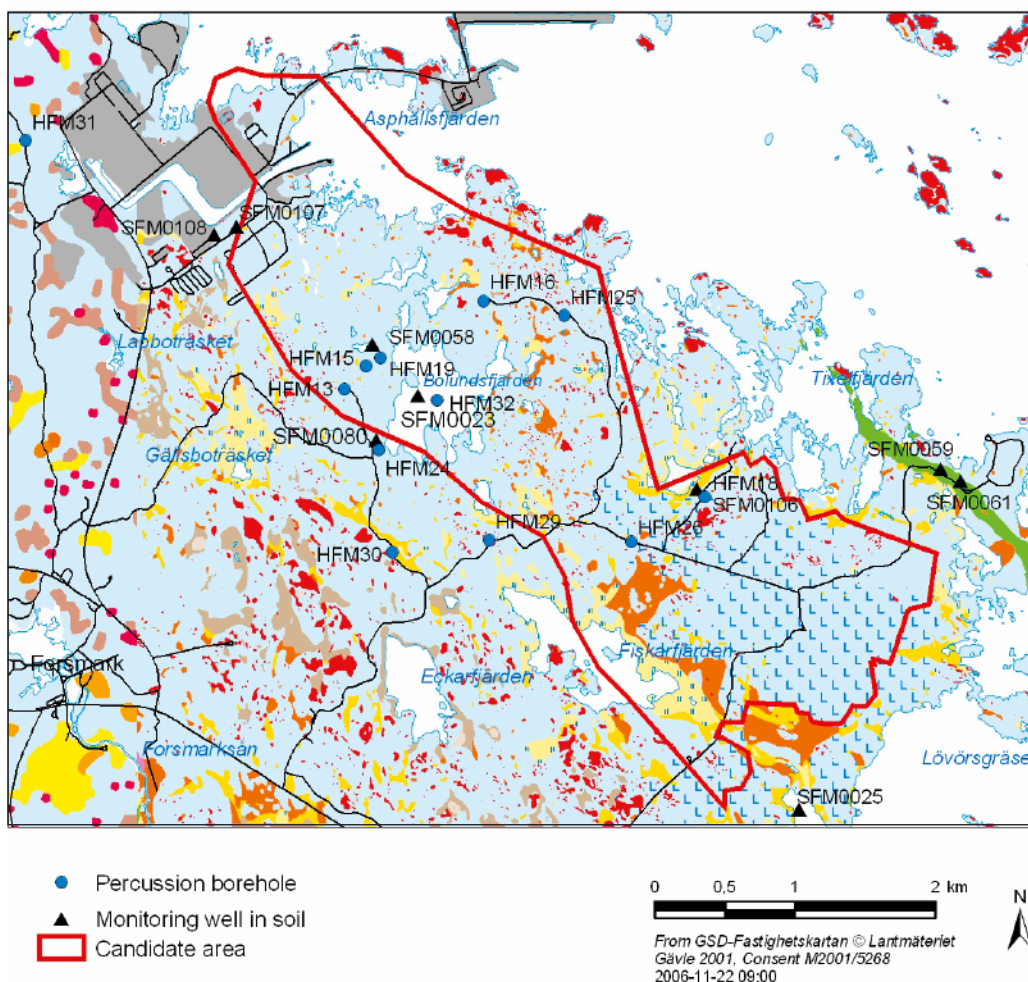


Figure 4-1. Quaternary map of the Forsmark site investigation area with locations of sites included in this study. For geological legend, see Solenius et al. /1/.

Table 4-1. Simplified Quaternary stratigraphy from the surveyed borings. Note that the item “sandy till” includes also silty-sandy and gravelly-sandy till. The available data did not justify a more detailed differentiation.

	Depth [m]		Layer No.	Quaternary deposits
	from	to		
HFM13	0.0	2.0	1	sandy till
	2.0	2.5	2	boulder
	2.5	4.05	3	sandy till
	4.05		4	bedrock
HFM15	0.0	1.0	1	topsoil
	1.0		2	bedrock
HFM16	0.0	1.0	1	washout sand
	1.0	2.5	2	sandy till
	2.5		3	bedrock
HFM18	0.0	1.5	1	topsoil/till
	1.5		2	bedrock
HFM19	0.0	5.5	1	sandy till
	5.5		2	bedrock
HFM24	0.0	0.5	1	topsoil
	0.5	11.5	2	sandy till
	11.5		3	bedrock
HFM25	0.0	2.7	1	sandy till
	2.7		2	bedrock
HFM26	1.5	2.5	1	sandy till
	2.5	5.5	2	clayey till
	5.5		3	bedrock
HFM29	0.0	2.5	1	sandy till
	2.5		2	bedrock
HFM30	0.0	4.0	1	fill
	4.0	5.5	2	boulder/bedrock
	5.5	13.5	3	fractured bedrock
	13.5		4	bedrock
HFM31	0.0	1.0	1	topsoil
	1.0	2.5	2	sandy till
	2.5		3	bedrock
HFM32	0.0	1.5	1	boulder/bedrock
	1.5	2.0	2	fractured bedrock
	2.0		3	bedrock
SFM0023	0.0	1.9	1	water
	1.9	2.4	2	gyttja (dy)
	2.4	4.4	3	sandy till
	4.4		4	bedrock
SFM0025	0.0	0.5	1	water
	0.5	1.6	2	gyttja (dy)
	1.6	4.8	3	sandy till
	4.8	5.75	4	bedrock
SFM0058	0.0	3.5	1	sandy till
	3.5		2	bedrock
SFM0059	0.0	5.3	1	glaciofluvial gravel
	5.3		2	bedrock
SFM0061	0.0	7.0	1	glaciofluvial gravel
	7.0		2	bedrock
SFM0080	0.0	1.0	1	washout sand
	1.0	7.2	2	sandy till
	7.2		3	bedrock
SFM0106	0.0	2.9	1	clayey till
	2.9		2	bedrock
SFM0107	0.0	5.2	1	sandy till
	5.2		2	bedrock
SFM0108	0.0	4.9	1	sandy till
	4.9		2	bedrock

In two of the surveyed locations, HFM30 and SFM0058, the lowermost samples are characterised by the occurrence of rock cuttings at several levels, interbedded by diamict sediments. These rock cuttings can be interpreted as to originate from large boulders within the till. However, the diamict sediments between the rock portions show signs of sorting and contain much water and differ thus remarkably from the till in general. Rudimentary sorting and a high water content has previously been observed in sediment-filled fractures at DS5 and DS6 /4, 5/. Hence, it is likely that the samples in the lowermost portion of borings HFM30 and SFM0058 represent fractured bedrock.

Two of the borings (SFM0059 and SFM0061) are located in the Börstilåsen esker. Consequently, the samples from these borings contain glaciofluvial gravel throughout the gross part of the section. Rock cuttings at several locations indicate large cobbles or boulders. The lowermost samples from both borings contain, compared to above, considerably more silt and some angular clasts. However, the sediment's sorting and a predominance of rounded clasts support the interpretation as glaciofluvial sediment.

For two of the borings (SFM0023 and SFM0025) no samples were available. The Quaternary stratigraphy for these locations is reconstructed from the driller's notes. It is probable, that the dy in these locations in fact is gyttja, since no dy has been identified in the lakes in the Forsmark area /6/.

In Table 4-1, a simplified Quaternary stratigraphy for all surveyed borings is presented. All data are stored in SKB's database (SICADA), where they are traceable by the activity plan number. Only data in the databases are accepted for further interpretations and modelling. Data presented in this report are regarded as copies of the original data. Data in the databases (SICADA and GIS) may be revised, if needed. However such revision of the database will not necessarily result in a revision of this report.

References

- /1/ **Sohlenius G, Hedenström A, Rudmark L, 2004.** Mapping of unconsolidated Quaternary deposits. SKB R-04-39. Svensk Kärnbränslehantering AB.
- /2/ **Hedenström A, Sohlenius G, Albrecht J, 2004.** Stratigraphical and analytical data from auger drillings and pits. SKB P-04-111, Svensk Kärnbränslehantering AB.
- /3/ **Sundh M, Sohlenius G, Hedenström A, 2004.** Stratigraphical investigation of till in machine-cut trenches. SKB P-04-34, Svensk Kärnbränslehantering AB.
- /4/ **Albrecht J, 2005.** Study of Quaternary sediments in connection with investigations of bedrock lineaments. SKB P-05-138, Svensk Kärnbränslehantering AB.
- /5/ **Leijon B, 2005.** Investigations of superficial fracturing and block displacements at drill site 5. SKB P-05-199, Svensk Kärnbränslehantering AB.
- /6/ **Hedenström A, 2003.** Investigations of marine and lacustrine sediment in lakes, SKB P-03-24. Svensk Kärnbränslehantering AB.