P-04-91

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Bedrock mapping

Stage 2 (2003) – Bedrock data from outcrops and the basal parts of trenches and shallow boreholes through the Quaternary cover

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March 2004

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Contents

1 Introduction

Geological mapping of the bedrock forms one of the surface activities performed within the initial site investigation programme at Forsmark. The work follows the directives in the steering document for the activity that is entitled "Bedrock mapping at Forsmark, 2002–2003" (AP PF 400-02-11). The mapping procedure has been carried out in accordance with the method description for bedrock mapping (SKB MD 132.001).

The project has been organised into several distinct working phases. Planning involved execution of work during two time stages, 2002 and 2003. The results of the field activities carried out during stage 1 (2002) were reported earlier /Stephens et al, 2003a/. This document presents an updated assessment of the location and form of outcrops in the Forsmark area as well as new outcrop data that have been acquired during stage 2 (2003) of the project. A revised version of the outcrop database that was generated in connection with the bedrock-mapping activities during stage 1 (2002) of this project is also provided.

This outcrop information is complemented by data pertaining to the character of the bedrock that was temporarily exposed in connection with trenching activities, during mapping of the Quaternary cover deposits /Sundh et al, 2004/. Furthermore, the character of the bedrock at the base of several shallow boreholes through the Quaternary cover /Johansson, 2003/ is also presented in this report. The generation and presentation of both these data sets follow the directives in a complementary steering document for these two activities (AP PF 400-03-74). The determination of the bedrock at the base of the shallow boreholes has been carried out in accordance with the method description for the study of drill cuttings in percussion boreholes (SKB MD 142.001).

The bedrock-mapping project aims to present a new, detailed geological map of the bedrock in the candidate area at Forsmark and its surroundings at the scale 1:10 000. The area selected for mapping is constrained by the coordinates shown in Table 1-1 and is shown in Figure 1-1. The first version of this map, which was based on the geological and geophysical information available at the end of April 2003, was presented earlier (SKB GIS database under Field note Forsmark 22).

Table 1-1. Coordinates of the area selected for bedrock mapping in the Forsmark area.

Corner ID	Northing in RT 90, 2.5 gon V (metres)	Easting in RT 90, 2.5 gon V (metres)
1	6706371	1632471
2	6698593	1640249
3	6691522	1633178
4	6699300	1625400

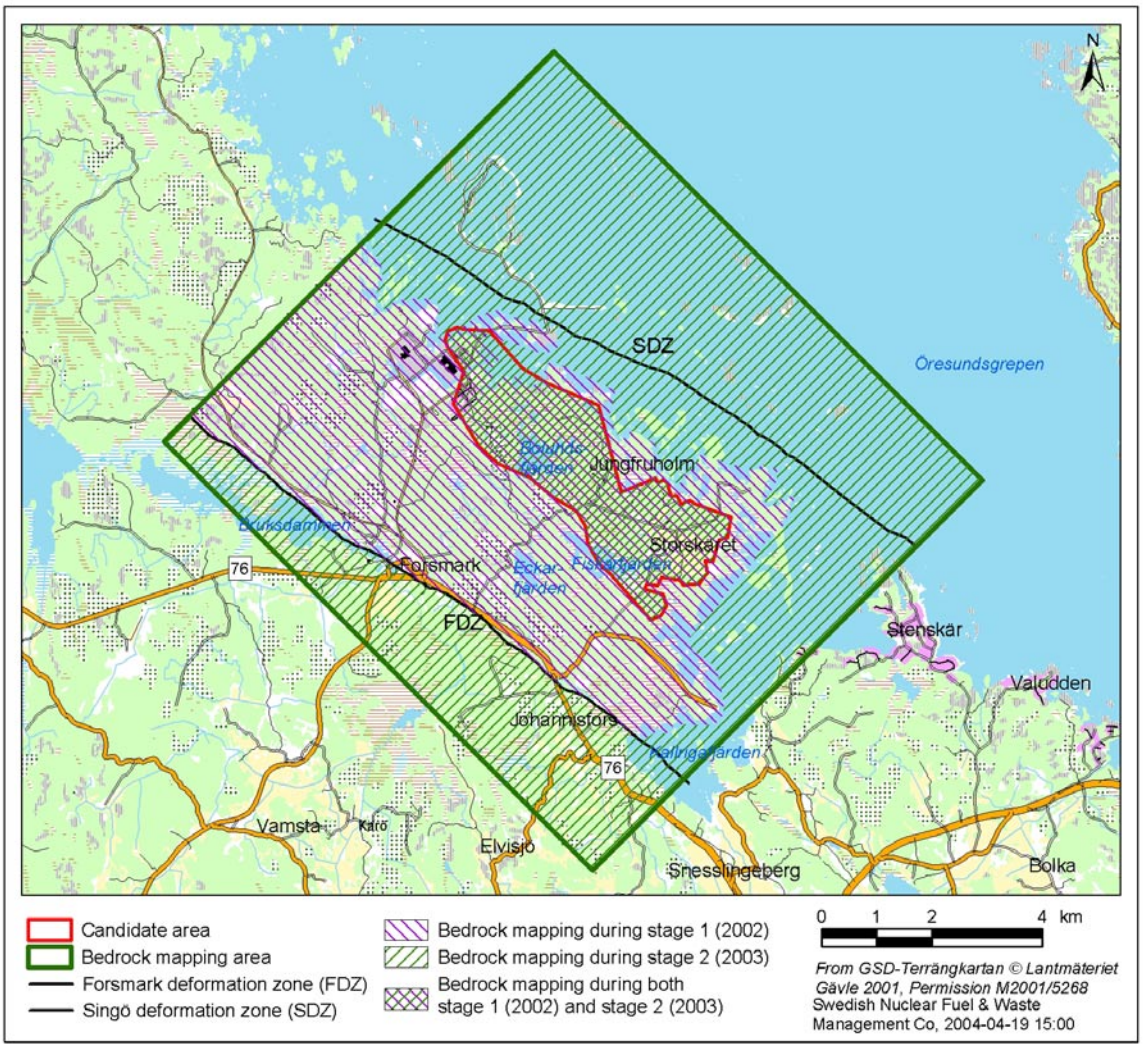

Figure 1-1. *Location of the area selected for bedrock mapping at Forsmark and the areas mapped during stage 1 (2002) and stage 2 (2003). Map produced with the help of Helena Nyman.*

2 Objective and scope

The location and form of inferred outcrops in the bedrock-mapping area were determined at an initial stage by the interpretation of infrared aerial photographs /Stephens et al, 2003a/. On the basis of the field investigations during 2002, some modification of this outcrop information was completed in the areas mapped during stage 1 of the project (Figure 2-1 and /Stephens et al, 2003a/). One of the aims of the fieldwork during 2003 has been to further refine the location and form of outcrops in the areas selected for bedrock mapping during 2003 (Figure 2-1).

Geological mapping of the Quaternary cover deposits has also been carried out in the central part of the bedrock-mapping area /Sohlenius et al, 2003, 2004/. The field activities associated with this mapping have determined, with much better precision, the location and form of the outcrops that were detected by the interpretation of infrared aerial photographs (Figure 2-1).

Accumulation of bedrock outcrop data during stage 2 of the bedrock-mapping project has mainly been focused outside the candidate area. Fieldwork has been carried out (Figure 1-1):

- In the area that lays south-west of the Forsmark deformation zone, predominantly south and south-west of road 76.
- In the coastal areas that surround the candidate area.
- In the archipelago that lies north-east of the Singö deformation zone, even further to the north-east of the candidate area.

The field investigations associated with the mapping of the Quaternary cover deposits /Sohlenius et al, 2003, 2004/ have divided many of the outcrops that were defined in connection with the aerial photographic study /Stephens et al, 2003a/ into clusters of smaller outcrops that lie very close to each other. These field activities have also documented several “new”, small outcrops that are clearly isolated from the outcrops inferred from the aerial photographic information. In order to optimise our understanding of the bedrock geology inside the candidate area, the stage 2 bedrock mapping campaign has also aimed to visit and to document the bedrock geology at the “new”, isolated outcrops inside the candidate area (Figure 1-1).

The documentation of both reference samples and field photographs were not available in digital format prior to the planned delivery of the stage 1 outcrop data /Stephens et al, 2003a/. This information has now been added to the outcrop database that was completed during stage 1 of the bedrock mapping project /Stephens et al, 2003a/. Following a more systematic check of reference samples and/or field study, some modifications in rock type have been carried out at 15 observation points in the outcrop database for 2002. Furthermore, improvements to the free text in this database have been completed. All these amendments are included in a revised outcrop database for stage 1 (2002) of the bedrock mapping project.

Excavation of several trenches was carried out in connection with the mapping of the Quaternary cover deposits /Sundh et al, 2004/. At the base of eight of these trenches, the bedrock has been exposed beneath the Quaternary cover. The character of the bedrock at these temporary outcrops has been documented. Furthermore, data from drill cuttings,

which bear on the character of the bedrock at the base of shallow boreholes through the Quaternary cover /Johansson, 2003/, have been generated at 21 locations in the bedrock-mapping area.

In summary, the material generated in connection with the stage 2 working activities reported here consists of five types:

- An updated GIS-database over the outcrops within the project area at Forsmark. The quality of outcrop definition differs markedly between the area covered by the mapping of the Quaternary cover deposits and that which relies more heavily on the interpretation of the infrared aerial photographs (Figure 2-1).
- Outcrop data from 1065 observation points visited during 2003 (Figure 2-2a). These data include rock type and various rock type attributes. Each of the observation points is identified with an ID-code (PFM-number).
- A revised version of the outcrop database for stage 1 (2002). This database contains information on rock type and various rock type attributes from 1054 observation points (Figure 2-2b). Each of the observation points is identified with an ID-code (PFM-number).
- Data from eight observation points at temporary outcrops that were exposed during trenching work (Figure 2-3). These data include rock type and various rock type attributes. Each of the observation points is identified with an ID-code (PFM-number).
- Data bearing on the character of the bedrock from drill cuttings that were obtained from the base of 21 shallow boreholes through the Quaternary cover (Figure 2-3).

The fieldwork during stage 2 of the bedrock-mapping project was initiated in May 2003 in the area that lies to the south-west of the Forsmark deformation zone. The mapping of the coastal areas and the archipelago was carried out during two periods, June and August 2003. Account was taken during these periods for access restrictions related to nesting birds. The complementary fieldwork inside the candidate area and the mapping of trenches were completed during parts of June, July and August 2003.

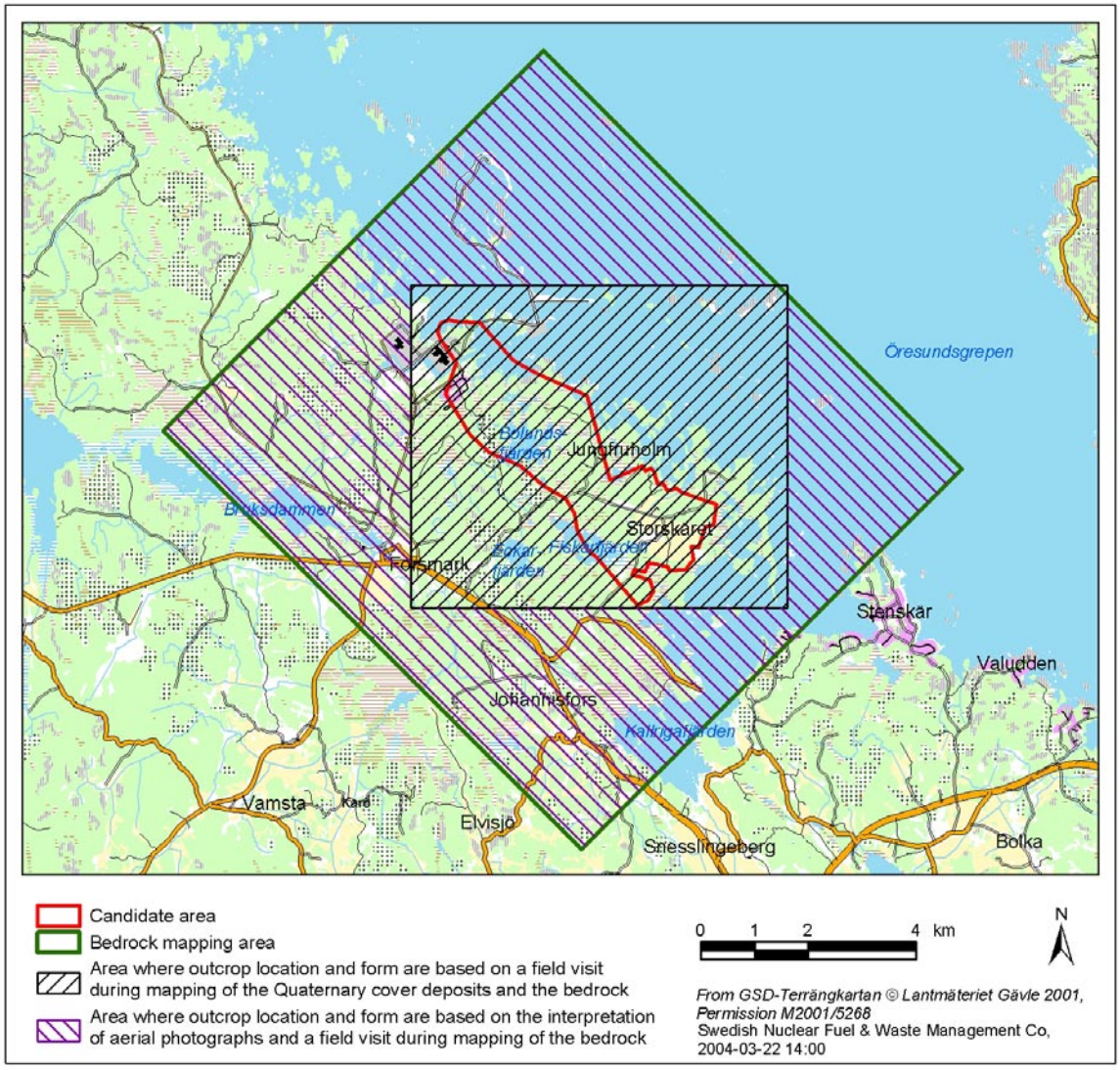

Figure 2-1. *Basis for the documentation of outcrops in the bedrock mapping area. Outcrop definition is of higher quality in the area where the Quaternary cover deposits have been mapped. Map produced with the help of Helena Nyman.*

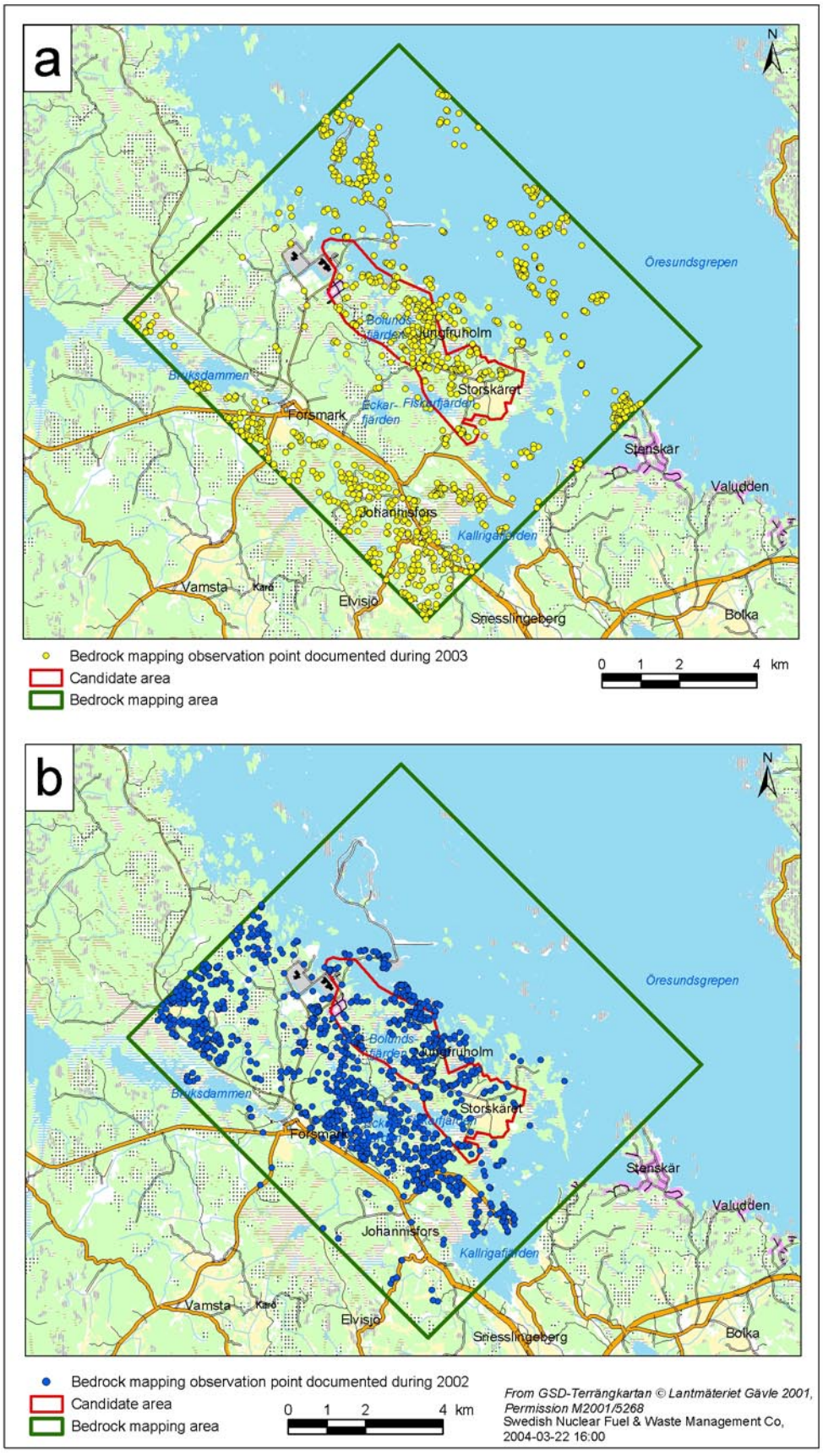

Figure 2-2. *a) Location of the observation points where bedrock outcrop data were collected during 2003 (1065). b) Location of the observation points where bedrock outcrop data were collected during 2002 (1054). Map produced with the help of Helena Nyman.*

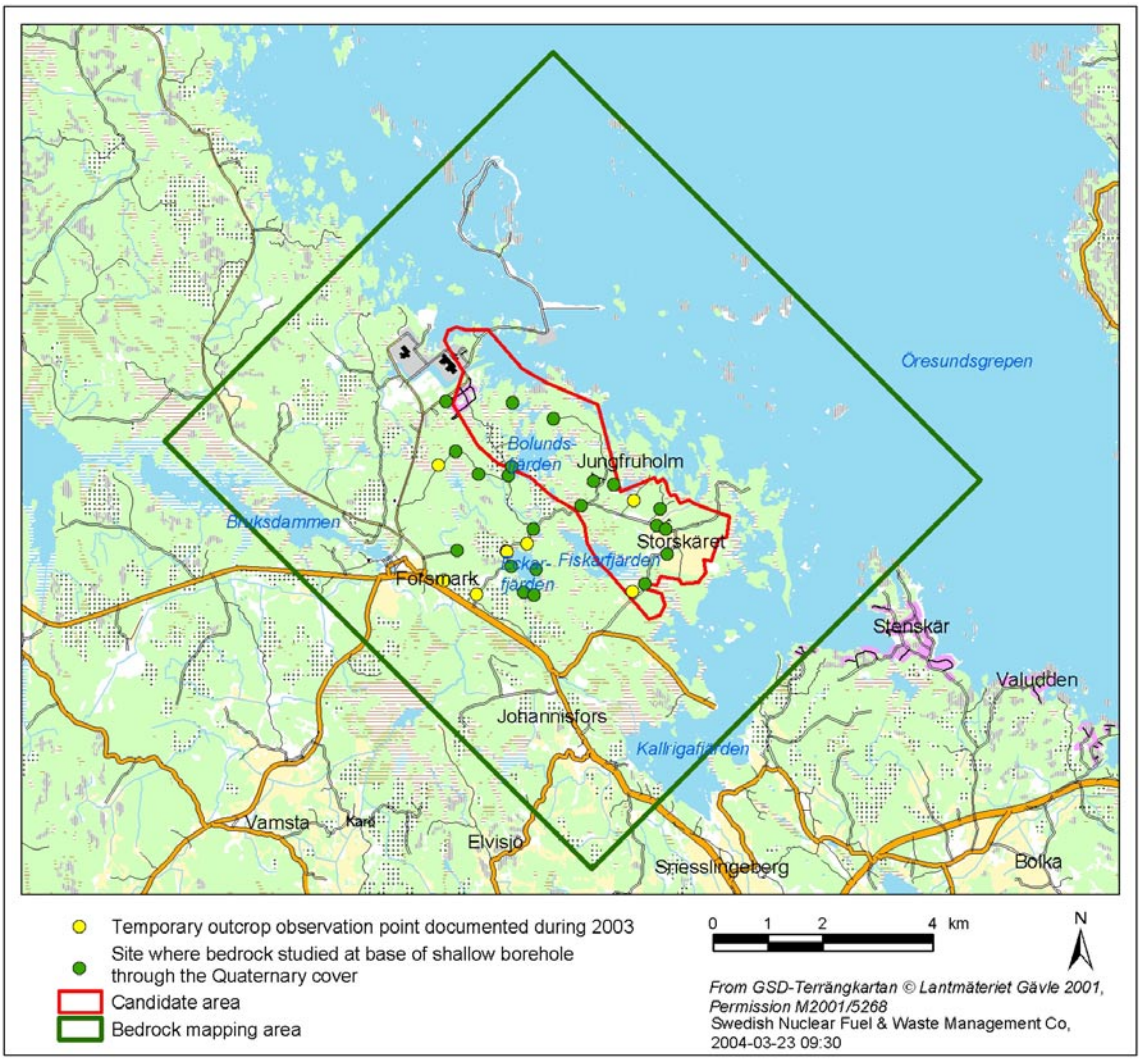

Figure 2-3. *Location of the observation points where the character of the bedrock has been investigated at the base of trenches (8) and shallow boreholes (21) through the Quaternary cover. Map produced with the help of Helena Nyman.*

3 Equipment

3.1 Description of equipment

The following equipment was used during the field investigations (Figure 3-1):

- Garmin GPS 12.
- Silva compass.
- Instrument to measure magnetic susceptibility, SM-20 (GF Instruments, Czech Republic).
- Camera.
- Hammer.
- Brush.
- Magnifying lens.
- Magnet.
- Measuring tape.
- Sample bags.
- Topographic field map at the scale 1:10 000 generated from orthorectified aerial photographic data.
- Field notebook with standard observation protocol.
- Various complementary material including pencils, tape, safety equipment etc.

Transport to the field area was carried out with the help of hired cars and by outboard motorboat in order to reach the islands and remote outcrops along the coast.

Figure 3-1. *Standard field equipment used in connection with the bedrock-mapping work.*

4 Execution

4.1 Preparations

Most of the preparatory work which involves the documentation of previous work carried out in the area (see Appendix 7 in MD 132.001) was already completed and reported in connection with the feasibility study in the Östhammar municipality. Key descriptions of the geology of the Forsmark area and its immediate surroundings are presented in /Stålhös, 1991; Hansen, 1989; Carlsson and Christiansson, 1987/. Relevant summaries of the geology, which assess this earlier work and which were completed in connection with the feasibility study, include /Bergman et al, 1996, 1998; Bergman and Isaksson, 1996; Lindroos, 1996; Stephens and Isaksson, 2000/. An updated summary of the geology can be found in the version 0 site descriptive model for the Forsmark area /SKB, 2002/.

The preparatory work that involves the assembly of field maps and equipment as well as other practical arrangements for field activities was mostly completed prior to the initiation of fieldwork 2002. The only new preparatory work prior to stage 2 (2003) was the completion of new and clean, topographic field maps at the scale 1:10 000. These field maps were updated with the latest interpretation of lineaments and outcrops. The relevant lineament interpretation corresponds to that delivered to SKB at the end of April 2003 (SKB GIS database under Field note Forsmark 117) and described in /Isaksson et al, 2004a/. The relevant location of outcrops corresponds to that reported in /Stephens et al, 2003a/ and (SKB GIS database under Field note Forsmark 41), with some modification after contact with the group of geologists from the Geological Survey of Sweden (SGU) who mapped the Quaternary cover deposits during 2002.

An ongoing separate activity within the Forsmark site investigation programme aims to assess and feed into various databases the geological data that were generated in connection with the building activity in the vicinity of both the Forsmark nuclear power plants, and the final repository for low- and medium-active nuclear waste (SFR). No further work with these historical data was carried out in connection with the preparatory work for the bedrock-mapping project. This work will be completed during 2004 in connection with the compilation of the bedrock geological map.

4.2 Execution of tests/measurements

At the start of each day's field activities, the geologist visited a fixed point to test the drift in the co-ordinate values (RT 90, 2.5 gon V) obtained from the Garmin GPS 12 instrument used by the geologist. The average co-ordinate values for the fixed point were registered after a few minutes. The results of this test were delivered to SKB in connection with the completion of the field activity diaries (*aktivitetsdagbok*).

Each of the 1065 observation points was designated an ID-code (PFM-number) and both the date and the co-ordinates estimated by the Garmin GPS 12 instrument were documented in a standard observation protocol. In general, an attempt was made to apply the ID-code to the area that is 10 m or less from the point at which the GPS co-ordinates were registered. However, in several of the larger outcrops, the field survey documents a larger area (> 10 m) around the measured point. The dominant rock type at each of the observation points was

marked on the topographic field map at the scale 1:10 000. Different pen colours were used in order to distinguish different rock types. In some of the well-exposed areas, where the bedrock was similar in the different outcrops, some observation points were not assigned an ID-code but simply plotted on the topographic field map with the help of the coloured pen system.

Both descriptive and numerical data were registered in the standard observation protocol. The different types of data are listed in Table 4-1.

Documentation of object and rock type as well as measurements of magnetic susceptibility are compulsory for each observation point. Completion of the other data categories varies from outcrop to outcrop and is dependant on the character of the bedrock at the outcrop. Since the bedrock in the Forsmark area is generally complex, some comments in free text form were registered in the observation protocol for virtually all of the outcrops (1059 of 1065). If more than one rock type occurs at an outcrop, the rock types are presented in their order of spatial importance in the outcrop (rock type 1, rock type 2 etc), and the documentation of points 2–14 is repeated for each rock type. Structural measurements of predominantly ductile mesoscopic structures were carried out. Eight measurements of the magnetic susceptibility in, at least, the dominant rock type were completed at most observation points.

Following each day's field activities, key information for all the observation points, predominantly rock type and structural measurements, were plotted on a clean outcrop map at the scale 1:10 000 at the field office. This process was necessary in order to plan carefully the following day's field activities.

Table 4-1. Types of numerical and descriptive data registered in the standard observation protocol.

Type of data	Content
Descriptive	1. Object (predominantly outcrop but also uncertain outcrop and prospect/excavation).
Descriptive	2. Rock type (nomenclature for igneous rocks follows the recommendations of the International Union of Geosciences, see /Le Maitre, 2002/. This nomenclature is also used by the Geological Survey of Sweden).
Descriptive	3. Occurrence of rock type.
Descriptive	4. Texture.
Descriptive	5. Structure.
Descriptive	6. Grain size − groundmass (nomenclature for igneous rocks follows that used by the Geological Survey of Sweden).
Descriptive	7. Grain size − megacryst (nomenclature for igneous rocks follows that used by the Geological Survey of Sweden).
Descriptive	8. Colour.
Descriptive	9. Key mineral.
Descriptive	10. Occurrence of key mineral.
Descriptive	11. Stratigraphic position.
Numerical	12. Measurements of mesoscopic structures.
Numerical	13. Measurements of magnetic susceptibility.
ID-code	14. Reference sample number (linked to the rock type).
Numerical	15. Photograph (how many at the observation point?).
Numerical	16. Sketch (how many at the observation point?).
Descriptive	17. Comments in free text form.

4.3 Data handling

The preparation of an updated version of the outcrop GIS-layer, that shows the positions and approximate shape of the outcrops in the project area, was carried out in close co-operation with the group of geologists from SGU who are mapping the Quaternary cover deposits. The areas covered by both bedrock and Quaternary cover mapping overlap in the central part of the bedrock-mapping area, including the candidate area. A single integrated outcrop map was produced for this area, based on all the field observations. The outcrop GIS-layer for the Forsmark area was delivered to SKB as an ESRI-shape file and archived in the SKB GIS database under Field note Forsmark 232.

With the assistance of a special programme developed at the Geological Survey of Sweden for the handling of bedrock outcrop data (BGDATA, version 1.6), the data documented in the 1065 standard observation protocols were transferred into an Access database. The data obtained from the eight observation points at the base of the temporary trenches were transferred with the help of the BGDATA programme into a separate Access database. Subsequently, these data as well as the revised version of the outcrop database from 2002, which contains 1054 observation points, were delivered to SKB, both in Access and in Excel formats. In order that they could be included in SKB's SICADA database, each of these three data sets was organised into key groups (see below). These procedures were followed in accordance with the recommendations received from SKB. The data were subsequently exported at SKB into the SICADA database. The field data from 2003 are stored in SICADA under Field note Forsmark 134, the data from the base of the temporary outcrops are stored under Field note Forsmark 219 and the data from the revised version of the outcrop database from 2002 are stored under Field note Forsmark 22.

The data from the drill cuttings at the base of the 21 shallow boreholes were delivered to SKB using a standard Excel format. The data were subsequently exported at SKB into the SICADA database and stored under Field note Forsmark 219.

4.4 Analytical work

The bedrock-mapping project aims to generate the following bedrock analytical data in representative bedrock samples from the Forsmark candidate area and its surroundings:

- Physical properties including:
  1. Magnetic susceptibility.
  2. Anisotropy of the magnetic susceptibility.
  3. Magnetic remanence.
  4. Electrical resistivity.
  5. Density.
  6. Porosity.
  7. Gamma-radiation.
- Petrographic properties including modal analyses (QAPF-analysis).
- Geochemical properties (major, minor and trace elements including REE)
- Geochronological data.

Data bearing on the physical properties of the bedrock and linked to the field activities during 2002 were presented in /Mattson et al, 2003/. These data were interpreted in /Isaksson et al, 2004b/. Petrographic and geochemical data generated from samples collected during the field activities during 2002 were presented and interpreted in /Stephens et al, 2003b/. Corresponding data sets from 2003 as well as all the geochronological data will be presented in three separate P-reports during 2004.

5 Results

5.1 Outcrops − modified location and form

The interpretation of the infrared aerial photographic data during stage 1 of the project yielded over 1500 inferred outcrops of variable size in the bedrock-mapping area (see Figure 5-1 in /Stephens et al, 2003a/). This interpretation formed an important basis for the bedrock-mapping work. Subsequent field activities, in connection with both the bedrock mapping and, especially, the mapping of the Quaternary cover deposits, have documented the presence of several "new" outcrops. Furthermore, some of the inferred outcrops have been found to be block concentrations and have been deleted from the original outcrop GIS-layer. It is important to keep in mind that even sites where the Quaternary cover is thin (< 50 cm) have been marked as outcrops during the mapping of the Quaternary deposits. A revised outcrop map that shows the location and form of outcrops in the bedrock-mapping area is presented here (Figure 5-1).

The outcrop database contains 3064 polygons, approximately 620 of which are situated within the candidate area (Figure 5-1). The bedrock mapping programme has generated data from 2119 observation points within the entire study area and 413 observation points within the candidate area (Figure 2-2). There are three reasons for the difference between the number of outcrops and the number of observation points:

- The disintegration of outcrops that were inferred from the infrared aerial photographic study into a cluster of smaller outcrops. Often only one observation point has been registered at these clusters.
- The inclusion of sites with a thin (< 50 cm) Quaternary cover where it is not possible to study the bedrock.
- The strategic decision made in collaboration with SKB that it is not necessary to visit all the outcrops in the marginal parts of the bedrock-mapping area. This is especially relevant for the area that lies south and south-west of road 76.

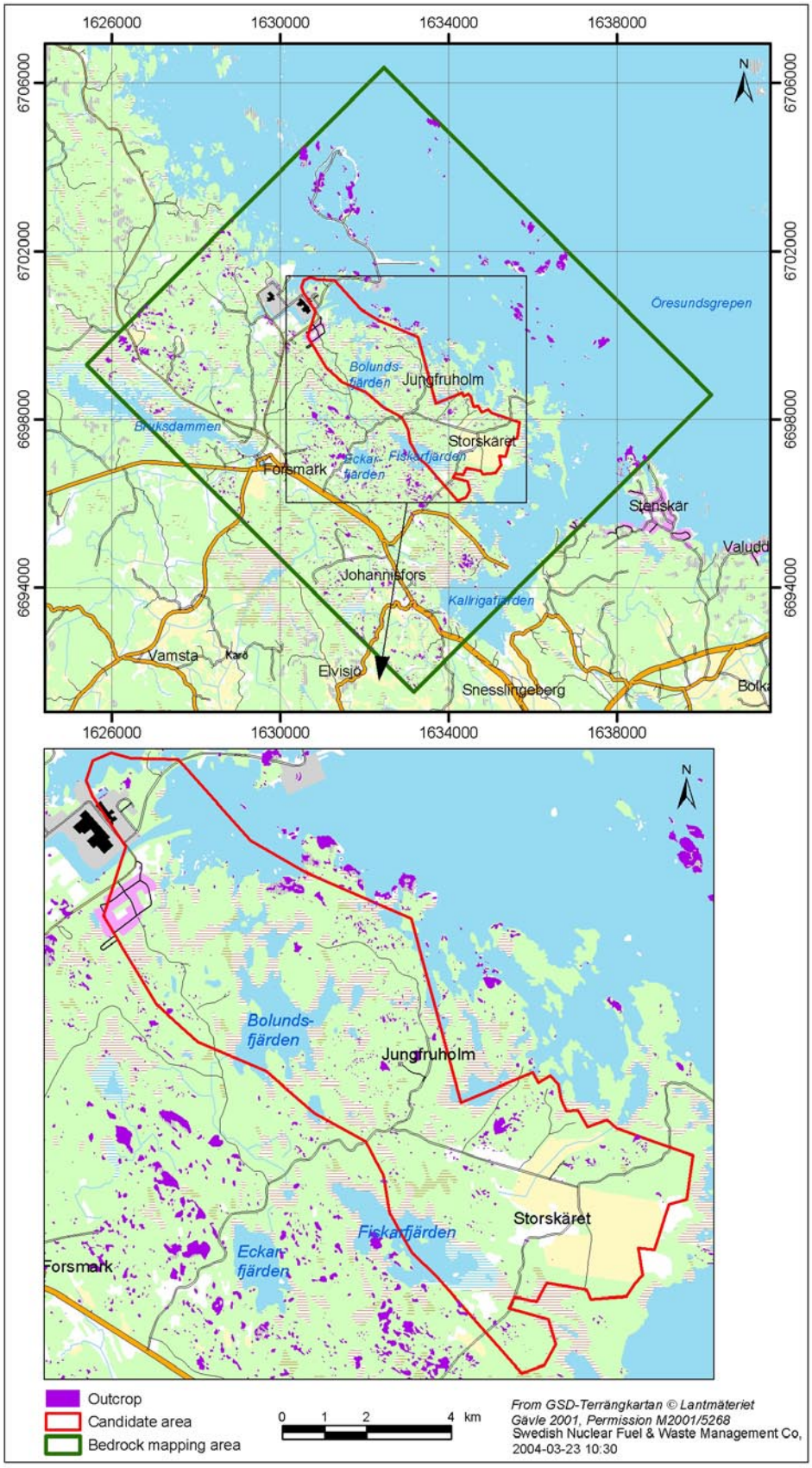

Figure 5-1. *Location and form of outcrops in the Forsmark area. Outcrops include sites where the Quaternary cover is < 50 cm thick. The basis for the interpretation of outcrops is shown in Figure 2-1. Map produced with the help of Helena Nyman.*

5.2 Outcrop data 2003

The outcrop data at the 1065 observation points that were documented during the 2003 field season have been organized into different data groups (Table 5-1). A description of the outcrop in free text form is available at 1059 of the 1065 observation points under the data group entitled “observation comments”.

Table 5-1. Outcrop data groups.

Data group	Content
1	Outcrop coordinates and date.
2	Outcrop rock type, occurrence, stratigraphic position, photographs and samples.
3	Outcrop rock type, texture.
4	Outcrop rock type, structure.
5	Outcrop rock type, groundmass grain size.
6	Outcrop rock type, megacryst grain size.
7	Outcrop rock type, key minerals.
8	Outcrop rock type, structure orientation.
9	Outcrop rock type, magnetic susceptibility.
10	Observation comments.

No attempt is made in this report to list all the outcrop data. However, a brief summary of these data is presented in Tables 5-2 to 5-4. The data summarised in Table 5-2 emanates from the south-western part of the bedrock-mapping area. This area extends from Bruksdammen in the north-west to Elvisjö in the south-east and is situated south-west of the Forsmark deformation zone (Figure 1-1). The data summarised in Table 5-3 comes from the area between the Forsmark and Singö deformation zones (Figure 1-1). The majority of these outcrops lie within the candidate area. The data summarised in Table 5-4 comes from the outboard area that lies north-east of the Singö deformation zone. No further analysis of the outcrop data is presented in this report.

Table 5-2. Summary of bedrock outcrop data from the area south-west of the Forsmark deformation zone.

Rock type, order 1- dominant rock type at 351 observation points	
Rock type	The main rock types are: 1. Tonalite-granodiorite (26%) 2. Tonalite (16%) 3. Granodiorite (14%) 4. Granodiorite-granite (13%) 5. Gabbro (11%) 6. Granite (7%) 7. Felsic volcanic rock (3%) 8. Diorite-quartz diorite (3%) 9. Ultramafic rock (2%) 10. Pegmatitic granite (2%) 11. Other rocks (3%) Among the group “other rocks” occur amphibolite, pegmatite and unspecified granitoid.
Occurrence	Since most of the rock types judged to be dominant in an outcrop occur as parts of larger mappable rock units, the type of occurrence has generally not been documented.
Stratigraphic position	Svecofennian supracrustal rocks and early Svecokarelian intrusive rocks are present in the Forsmark area. The stratigraphic position of younger intrusive rocks has only in part been specified.
Texture	These data document the predominance of equigranular rocks in the Forsmark area.
Structure	Virtually all rocks are metamorphic in character. Both the Svecofennian supracrustal rocks and the early Svecokarelian intrusive rocks were affected by metamorphism under amphibolite-facies conditions. However, in most cases, the primary character of these can still be recognised. The data document the importance of lineated and, in part, foliated rocks. The occurrence of highly fractured rocks has also been documented.
Groundmass grain size	The groundmass grain-size data are variable. There is an important component of medium-grained rocks. Note that the grain size of pegmatites and pegmatitic granites has seldom been documented in this data set.
Megacryst grain size	There is very little documentation of this parameter. This reflects the generally equigranular character of the rocks (see texture).
Key minerals	Documentation of key minerals are few in the south-western area. Only a few occurrences of garnet as porphyroclast or aggregate, epidote as fracture filling, and K-feldspar as megacryst have been noted.
Structure orientation	397 measurements have been carried out, predominantly mineral lineation (270) and foliation (103).
Magnetic susceptibility	2592 measurements have been carried out.

Rock type, order > 1- subordinate rock types at 351 observation points	
Rock type	The main rock types are: 1. Pegmatite (34%) 2. Amphibolite (32%) 3. Aplite (4%) 4. Tonalite (4%) 5. Leucogranite (4%) 6. Granite (4%) 7. Felsic volcanic rock (3%) 8. Unspecified granitoid (2%) 9. Granodiorite (2%) 10. Other rocks (11%) Among the group “other rocks” occur gabbro, diorite, ultramafic rock, pegmatitic granite, unspecified felsic rock and calc-silicate (skarn) rock.
Occurrence	Various modes of occurrence have been documented for the subordinate rock types at the 351 observation points. The most common are band, inclusion and dyke.
Stratigraphic position	Svecofennian supracrustal rocks and early Svecokarelian intrusive rocks are present in the Forsmark area. The stratigraphic position of younger intrusive rocks has only in part been specified.
Texture	These data document the predominance of equigranular rocks in the Forsmark area.
Structure	Virtually all rocks are metamorphic in character. Both the Svecofennian supracrustal rocks and the early Svecokarelian intrusive rocks were affected by metamorphism under amphibolite-facies conditions. However, in most cases, the primary character of these rocks can still be recognised. The data document the importance of lineated and, in part, foliated rocks. Locations where discordant relationships are present between younger and older intrusive rocks are also documented.
Groundmass grain size	The groundmass grain-size data are variable. The documentation of finer-grained rocks is more frequent in the subordinate rock types relative to the rock type, order 1. Note that the grain size of pegmatites and pegmatitic granites has seldom been documented in this data set.
Megacryst grain size	There is very little documentation of this parameter. This reflects the generally equigranular character of the rocks (see texture).
Key minerals	Documentation of key minerals are few in the south-western area. Only a few occurrences of garnet as porphyroclast or aggregate, epidote as fracture filling, and magnetite (in pegmatite) have been noted.
Structure orientation	196 measurements have been carried out, predominantly the strike direction of dykes (129), and the orientation of lineation (38) and foliation (8).
Magnetic susceptibility	1239 measurements have been carried out.

Table 5-3. Summary of bedrock outcrop data from the area between the Forsmark and Singö deformation zones (including the candidate area).

Rock type, order 1- dominant rock type at 468 observation points	
Rock type	The main rock types are: 1. Granite (57%) 2. Tonalite (9%) 3. Tonalite-granodiorite (6%) 4. Felsic volcanic rock (5%) 5. Pegmatitic granite (4%) 6. Ultramafic rock (4%) 7. Granodiorite (4%) 8. Granodiorite-granite (4%) 9. Other rocks (7%) Among the group “other rocks” occur amphibolite, diorite, gabbro, unspecified granitoid and cataclastic rock.
Occurrence	Since most of the rock types judged to be dominant in an outcrop occur as parts of larger mappable rock units, the type of occurrence has generally not been documented.
Stratigraphic position	Svecofennian supracrustal rocks and early Svecokarelian intrusive rocks are present in the Forsmark area. The stratigraphic position of younger intrusive rocks has only in part been specified.
Texture	These data document the predominance of equigranular rocks in the Forsmark area.
Structure	Virtually all rocks are metamorphic in character. Both the Svecofennian supracrustal rocks and the early Svecokarelian intrusive rocks were affected by metamorphism under amphibolite-facies conditions. However, in most cases, the primary character of these rocks can still be recognised. The data document the importance of foliated, lineated, banded and folded rocks. The occurrence of mylonitic, highly fractured and cataclastic rocks, which formed under lower-grade metamorphic conditions (ductile or brittle), has also been documented.
Groundmass grain size	The groundmass grain-size data are variable. There is an important component of medium-grained rocks. Note that the grain size of pegmatites and pegmatitic granites has seldom been documented in this data set.
Megacryst grain size	There is very little documentation of this parameter. This reflects the generally equigranular character of the rocks (see texture).
Key minerals	Documentation of key minerals are few in this central area. Only a few occurrences of epidote and quartz as fracture filling as well as garnet in aggregates or as scattered occurrences in the groundmass have been noted.
Structure orientation	508 measurements have been carried out, predominantly foliation (236) and lineation (187).
Magnetic susceptibility	3455 measurements have been carried out.

Rock type, order > 1- subordinate rock types at 468 observation points	
Rock type	The main rock types are: 1. Pegmatite (38%) 2. Amphibolite (20%) 3. Granite (13%) 4. Felsic volcanic rock (5%) 5. Pegmatitic granite (5%) 6. Leucogranite (3%) 7. Granodiorite (2%) 8. Granodiorite-granite (2%) 9. Other rocks (12%) Among the group “other rocks” occur aplite, tonalite, tonalite-granodiorite, granitoid, diorite and calc-silicate (skarn) rock.
Occurrence	Various modes of occurrence have been documented for the subordinate rock types at the 468 observation points. The most common are dyke, inclusion and band.
Stratigraphic position	Svecofennian supracrustal rocks and early Svecokarelian intrusive rocks are present in the Forsmark area. The stratigraphic position of younger intrusive rocks has only in part been specified.
Texture	These data document the predominance of equigranular rocks in the Forsmark area.
Structure	Virtually all rocks are metamorphic in character. Both the Svecofennian supracrustal rocks and the early Svecokarelian intrusive rocks were affected by metamorphism under amphibolite-facies conditions. However, in most cases, the primary character of these rocks can still be recognised. The data document the importance of foliated, lineated, banded and folded rocks. The occurrence of mylonitic and highly fractured rocks, which formed under lower-grade metamorphic conditions (ductile or brittle), has also been presented. Locations where discordant relationships are present between younger and older intrusive rocks are also documented.
Groundmass grain size	The groundmass grain-size data are variable. There is an important component of medium-grained rocks. Note that the grain size of pegmatites and pegmatitic granites has seldom been documented in this data set.
Megacryst grain size	There is very little documentation of this parameter. This reflects the generally equigranular character of the rocks (see texture).
Key minerals	Documentation of key minerals are few in this central area and only a few occurrences of epidote as fracture filling as well as garnet and muscovite in metamorphosed, felsic volcanic rock have been noted.
Structure orientation	241 measurements have been carried out, predominantly the strike direction of dykes (170). The orientation of foliation (28), lineation (21), layering (17) and fold axis (5) have also been documented.
Magnetic susceptibility	1813 measurements have been carried out.

Table 5-4. Summary of bedrock outcrop data from the archipelago area northeast of the Singö deformation zone.

Rock type, order 1- dominant rock type at 246 observation points	
Rock type	The main rock types are: 1. Diorite-quartz diorite (22%) 2. Felsic volcanic rock (21%) 3. Granite (17%) 4. Granodiorite (11%) 5. Pegmatite (11%) 6. Gabbro (4%) 7. Tonalite-granodiorite (4%) 8. Granodiorite-granite (3%) 9. Other rocks (7%) Among the group “other rocks” occur unspecified granitoid, pegmatitic granite, sedimentary rock, tonalite and leucogranite.
Occurrence	Since most of the rock types judged to be dominant in an outcrop occur as parts of larger mappable rock units, the type of occurrence has generally not been documented.
Stratigraphic position	Svecofennian supracrustal rocks and early Svecokarelian intrusive rocks are present in the Forsmark area. The stratigraphic position of younger intrusive rocks has only in part been specified.
Texture	These data document the predominance of equigranular rocks in the Forsmark area.
Structure	Virtually all rocks are metamorphic in character. Both the Svecofennian supracrustal rocks and the early Svecokarelian intrusive rocks were affected by metamorphism under amphibolite-facies conditions. However, in most cases, the primary character of these rocks can still be recognised. The data document the importance of lineated, foliated, banded and folded rocks as well as the increased occurrence of veined (migmatitic) rocks in this area. The occurrence of highly fractured rocks has also been documented.
Groundmass grain size	The groundmass grain-size data are variable. However, there is a predominance of medium-grained and fine-grained rocks. The medium-grained rocks are generally linked to the dioritoids and granitoids and the fine-grained rocks are generally linked to the metamorphosed, felsic volcanic rocks. Note that the grain size of pegmatites and pegmatitic granites has seldom been documented in this data set.
Megacryst grain size	There is very little documentation of this parameter. This reflects the generally equigranular character of the rocks (see texture).
Key minerals	Various key minerals have been documented. Note especially the occurrence of mineral fillings in fractures that transect rock type, order 1. Epidote and quartz dominate these fracture fillings. The presence of muscovite as aggregates in the metamorphosed, felsic volcanic rocks is a typical feature of the area. This is possibly related to extensive syn-volcanic hydrothermal alteration.
Structure orientation	275 measurements have been carried out, predominantly lineation (100), foliation (76), fold axis (34), shear zone (28) and banding (22).
Magnetic susceptibility	1762 measurements have been carried out.

Rock type, order > 1- subordinate rock types at 246 observation points	
Rock type	The main rock types are: 1. Pegmatite (33%) 2. Amphibolite (16%) 3. Granite (11%) 4. Felsic volcanic rock (9%) 5. Leucogranite (6%) 6. Granodiorite (5%) 7. Tonalite (4%) 8. Gabbro (2%) 9. Tonalite-granodiorite (2%) 10. Other rocks (12%) Among the group “other rocks” occur diorite, ultramafic rock, pegmatitic granite, unspecified felsic intrusive rock and cataclastic rock.
Occurrence	Various modes of occurrence have been documented for the subordinate rock types at the 246 observation points. The most common occurrences are band, inclusion and dyke.
Stratigraphic position	Svecofennian supracrustal rocks and early Svecokarelian intrusive rocks are present in the Forsmark area. The stratigraphic position of younger intrusive rocks has only in part been specified.
Texture	These data document the predominance of equigranular rocks in the Forsmark area.
Structure	Virtually all rocks are metamorphic in character. Both the Svecofennian supracrustal rocks and the early Svecokarelian intrusive rocks were affected by metamorphism under amphibolite-facies conditions. However, in most cases, the primary character of these rocks can still be recognised. The data document the importance of lineated, foliated, banded and folded rocks as well as the increased occurrence of veined (migmatitic) rocks in this area. The occurrence of highly fractured and cataclastic rocks has also been documented. Locations where discordant relationships are present between younger and older intrusive rocks are also presented.
Groundmass grain size	The groundmass grain-size data are variable. The documentation of finer-grained rocks is more frequent in the subordinate rock types relative to that in rock type, order 1. Note that the grain size of pegmatites and pegmatitic granites has seldom been documented in this data set.
Megacryst grain size	There is very little documentation of this parameter. This reflects the generally equigranular character of the rocks (see texture).
Key minerals	Various key minerals have been documented. Note especially the occurrence of mineral fillings in fractures. Epidote and quartz dominate these fracture fillings. The presence of magnetite in visible amounts in the metamorphosed, felsic volcanic rocks is also typical for the area.
Structure orientation	259 measurements have been carried out, predominantly the strike direction of dykes (141) and the orientation of lineation (41), foliation (36) and fold axis (23).
Magnetic susceptibility	1695 measurements have been carried out.

5.3 Modified outcrop database 2002

The outcrop database for 2002 that is archived in SKB's SICADA database has been modified slightly and complemented with additional information during 2003. Following further inspection of reference samples and, in some examples, even complementary field work, one or more of the rock types and, in some cases, even the order of rock types have been modified at 15 observation points. These changes are listed in Table 5-5. Improvements in the free text part of the outcrop database have also been carried out. Finally, the database has been complemented with information concerning the observation points where reference rock samples were collected and where field photographs were taken during the field season 2002. This information was lacking when the database was submitted during the early part of 2003 /Stephens et al, 2003a/.

Table 5-5. Documentation of changes carried out in the order and character of rock type in the outcrop database 2002.

Observation point	Outcrop database 2002		Modified outcrop database 2002	
	Order	Rock type	Order	Rock type
PFM000656	Not present	Not present	4	Granitoid
PFM000666	Not present	Not present	5	Granitoid
PFM000677	1	Granite	1	Granodiorite-granite
PFM000677	2	Tonalite	2	Tonalite-granodiorite
PFM000686	2	Granitoid	2	Tonalite-granodiorite
PFM000693	2	Dioritoid	2	Diorit
PFM000703	2	Granitoid	2	Tonalite-granodiorite
PFM000703	5	Aplite	5	Granite
PFM000703	8	Quartzo-feldspathic supracrustal rock	8	Dioritoid
PFM000703	Not present	Not present	9	Quartzo-feldspathic supracrustal rock
PFM000712	1	Granitoid	1	Tonalite-granodiorite
PFM000714	6	Quartzo-feldspathic supracrustal rock	6	Felsic rock
PFM000718	3	Granitoid	3	Tonalite-granodiorite
PFM000718	Not present	Not present	7	Mylonite
PFM000720	3	Granitoid	3	Tonalite-granodiorite
PFM000742	2	Granitoid	2	Tonalite-granodiorite
PFM000767	3	Granitoid	3	Granodiorite
PFM000803	1	Tonalite	1	Tonalite-granodiorite
PFM000811	Not present	Not present	4	Leucogranite
PFM001874	1	Felsic volcanic rock	1	Tonalite-granodiorite

5.4 Outcrop data from the base of temporary trenches through the Quaternary cover

The bedrock outcrop data from the base of eight temporary trenches that were excavated in connection with the mapping of Quaternary deposits /Sundh et al, 2004/ are listed in Table 5-6.

Table 5-6. Bedrock data from the temporary outcrops at the base of eight trenches through the Quaternary cover. Only rock types order 1 and order 2 are shown in the table. Note also PFM002585, rock type order 3, pegmatite, dyke; PFM002586, rock type order 3, granite, fine-grained, band; PFM002586, rock type order 4, pegmatite, band; PFM002587, rock type order 3, pegmatite, dyke.

Rock type, order 1

Observation point	Northing in RT 90, 2.5 gon V (metres)	Easting in RT 90, 2.5 gon V (metres)	Rock type	Structure	Grain size	Magnetic susceptibility, range
PFM002582	6698865	1630391	Granite	Metamorphic, foliated	Fine- to finely medium-grained	5–25x10^{-5} SI units
PFM002583	6697440	1632010	Granite	Metamorphic, foliated	Medium-grained	200–5000x10^{-5} SI units
PFM002584	6697296	1631630	Granite	Metamorphic, foliated	Medium-grained	
PFM002585	6697290	1631640	Granite	Metamorphic, foliated	Medium-grained	10–300x10^{-5} SI units
PFM002586	6696515	1631084	Tonalite	Metamorphic, banded	Fine-grained	30–60x10^{-5} SI units
PFM002587	6696764	1630497	Granitoid	Metamorphic, foliated	Finely medium-grained	5–30x10^{-5} SI units
PFM002588	6698220	1633947	Pegmatite	Metamorphic		5–25x10^{-5} SI units
PFM002595	6696563	1633931	Granodiorite	Metamorphic, lineated	Finely medium-grained	400–1000x10^{-5} SI units

Rock type, order 2

Observation point	Northing in RT 90, 2.5 gon V (metres)	Easting in RT 90, 2.5 gon V (metres)	Rock type	Structure	Grain size	Magnetic susceptibility, range
PFM002582	6698865	1630391	Amphibolite	Foliated	Fine-grained	10–30x10^{-5} SI units
PFM002584	6697296	1631630	Amphibolite			
PFM002585	6697290	1631640	Amphibolite		Fine-grained	
PFM002586	6696515	1631084	Amphibolite			60–70x10^{-5} SI units
PFM002587	6696764	1630497	Granitoid	Metamorphic	Fine-grained	
PFM002588	6698220	1633947	Tonalite-granodiorite		Medium-grained	40–60x10^{-5} SI units
PFM002595	6696563	1633931	Pegmatite	Metamorphic		

5.5 Data from drill cuttings from the base of shallow boreholes through the Quaternary cover

The bedrock data from the drill cuttings that were obtained at the base of 21 shallow boreholes through the Quaternary cover /Johansson, 2003/ are presented in Appendix 1.

6 References

Bergman T, Isaksson H, 1996. Förstudie Östhammar. Sammanställning av befintlig geoinformation vid Forsmarksverket. SKB PR D-96-025, del 2, Svensk Kärnbränslehantering AB.

Bergman S, Isaksson H, Johansson R, Lindén A, Persson C, Stephens M, 1996. Förstudie Östhammar. Jordarter, bergarter och deformationszoner. SKB PR D-96-016, Svensk Kärnbränslehantering AB.

Bergman S, Bergman T, Johansson R, Stephens M, Isaksson H, 1998. Förstudie Östhammar. Delprojekt jordarter, bergarter och deformationszoner. Kompletterandearbeten 1998. Del 1: Fältkontroll av berggrunden inom Forsmarks- och Hargshamnsområdena. SKB R-98-57, Svensk Kärnbränslehantering AB.

Carlsson A, Christiansson R, 1987. Geology and tectonics at Forsmark. SKB Progress Report SFR 87-04, Svensk Kärnbränslehantering AB.

Hansen L, 1989. Bedrock of the Forsmark area. Technical Report, Swedish State Power Board, Stockholm.

Isaksson H, Thunehed H, Keisu M, 2004a. Interpretation of airborne geophysics and integration with topography. Stage 1 (2002). SKB P-04-29, Svensk Kärnbränslehantering AB.

Isaksson H, Mattsson H, Thunehed H, Keisu M, 2004b. Interpretation of petrophysical surface data. Stage 1 (2002). SKB P-03-102, Svensk Kärnbränslehantering AB.

Johansson P-O, 2003. Drilling and sampling in soil. Installation of groundwater monitoring wells and surface water level gauges. SKB P-03-09, Svensk Kärnbränslehantering AB.

Lindroos H, 1996. Förstudie Östhammar. Malmer och mineral inom Östhammars kommun. SKB PR D-96-012, Svensk Kärnbränslehantering AB.

Mattsson H, Isaksson H, Thunehed H, 2003. Petrophysical rock sampling, measurements of petrophysical rock parameters and in situ gamma-ray spectrometry measurements on outcrops carried out 2002. SKB P-03-26, Svensk Kärnbränslehantering AB.

SKB, 2002. Forsmark-site descriptive model version 0. SKB R-02-32, Svensk Kärnbränslehantering AB.

Sohlenius G, Rudmark L, Hedenström A, 2003. Forsmark. Mapping of unconsolidated Quaternary deposits. Field data 2002. SKB P-03-11, Svensk Kärnbränslehantering AB.

Sohlenius G, Hedenström A, Rudmark R, 2004. Forsmark site investigation: Mapping of unconsolidated Quaternary deposits 2002-2003. Map description. SKB R-04-xx (in progress), Svensk Kärnbränslehantering AB.

Stephens M B, Isaksson H, 2000. Förstudie Östhammar. Kommunens yttrande över den preliminära slutrapporten samt kompletterande utredningar. Del 4: Nya utredningar, kompletteringar och tillägg. Flik 2: Tredimensionell tolkning av de geologiska förhållandena i området Forsmark-Bolundsfjärden. SKB R-00-24, Svensk Kärnbränslehantering AB.

Stephens M B, Bergman T, Andersson J, Hermansson T, Wahlgren C-H, Albrecht L, Mikko H, 2003a. Forsmark. Bedrock mapping. Stage 1 (2002) – Outcrop data including fracture data. SKB P-03-09, Svensk Kärnbränslehantering AB.

Stephens M B, Lundqvist S, Ekström M, Bergman T, Andersson J, 2003b. Forsmark site investigation: Rock types, their petrographic and geochemical characteristics, and a structural analysis of the bedrock based on stage 1 (2002) surface data. SKB P-03-75, Svensk Kärnbränslehantering AB.

Stålhös G, 1991. Beskrivning till berggrundskartorna Östhammar NV, NO, SV, SO. Sveriges geologiska undersökning Af 161, 166, 169 och 172.

Sundh M, Sohlenius G, Hedenström A, 2004. Forsmark site investigation: Stratigraphical investigation of till in machine-cut trenches. SKB P-04-34, Svensk Kärnbränslehantering AB.

Bedrock data from drill cuttings that were obtained at the base of 21 shallow boreholes through the Quaternary cover

Drill cuttings Date: 2003-10-16 Sign.: Christin Nordman

Hole	Sample	from	to	Untreated drill cuttings sample				Washed and sieved drill cuttings sample				Rock type A	Rock type B	Min-1	Min-2	Min-3	Min-4	Min-5	Distr.	Comment
				Lightn.	Chrom.	Hue	Grain size	Lightn.	Chrom.	Hue	Grain size									
PFM2463	11	11,00	- 11,40	100; Light	0;	8; Grey	1; Aphanitic (grains not visible with naked eye)													Not bedrock.
PFM2463	12	10,10	- 10,80	100; Light	0;	8; Grey	1; Aphanitic (grains not visible with naked eye)													Not bedrock.
PFM2463	13	11,90	- 12,60	0;	80; Greyish	2; Red	8; Medium to coarse grained	100; Light	80; Greyish	2; Red	9; Medium-grained (1-5 mm)	101057; Granite to granodiorite, metamorphic, medium grained		49; Plagioclase	32; Potash Feldspar	36; Quartz	10; Biotite	30; Calcite	100; 100 %	With rounded to smoothly angular limestone fragments. Probably contamination. Sample looks otherwise pure. Traces of purple quartz?
PFM2572	5	4,00	- 4,40	100; Light	0;	8; Grey	1; Aphanitic (grains not visible with naked eye)													Not bedrock.
PFM2572	6	5,10	- 5,70	100; Light	0;	8; Grey	1; Aphanitic (grains not visible with naked eye)													Not bedrock.
PFM2572	7	7,20	- 7,50	0;	80; Greyish	2; Red	8; Medium to coarse grained	100; Light	80; Greyish	2; Red	9; Medium-grained (1-5 mm)	101057; Granite to granodiorite, metamorphic, medium grained		49; Plagioclase	32; Potash Feldspar	36; Quartz	10; Biotite	107; Prehnite	100; 100 %	
PFM2572	8	7,70	- 8,20	100; Light	10; Pinkish	8; Grey	8; Medium to coarse grained	100; Light	0;	8; Grey	9; Medium-grained (1-5 mm)	101057; Granite to granodiorite, metamorphic, medium grained		49; Plagioclase	32; Potash Feldspar	36; Quartz	10; Biotite	30; Calcite	100; 100 %	Calcite probably from fracture filling.
PFM2573	6	5,30	- 5,60	0;	0;	2; Red	8; Medium to coarse grained	100; Light	0;	2; Red	8; Medium to coarse grained	101061; Pegmatite, pegmatitic granite		49; Plagioclase	32; Potash Feldspar	36; Quartz	10; Biotite	30; Calcite	100; 100 %	Calcite as contamination from moraine (limestone, rounded). Otherwise fresh sample. Angular, slightly rusty fragment, also contamination.
PFM2573	7	5,60	- 6,00	100; Light	80; Greyish	1; Pink	9; Medium-grained (1-5 mm)	100; Light	80; Greyish	2; Red	8; Medium to coarse grained	101061; Pegmatite, pegmatitic granite		49; Plagioclase	32; Potash Feldspar	36; Quartz	10; Biotite	30; Calcite	100; 100 %	Calcite as contamination from moraine (limestone, rounded to angular).
PFM2574	3	2,00	- 2,50	0;	40; Brownish	2; Red	9; Medium-grained (1-5 mm)	100; Light	0;	2; Red	8; Medium to coarse grained	101061; Pegmatite, pegmatitic granite		49; Plagioclase	32; Potash Feldspar	36; Quartz	10; Biotite	30; Calcite	100; 100 %	Calcite as contamination from moraine (limestone, rounded). Rounded rusty fragment, also contamination. Otherwise fresh sample.
SFM0009	4	2,70	- 3,00	100; Light	80; Greyish	2; Red	8; Medium to coarse grained	100; Light	80; Greyish	2; Red	9; Medium-grained (1-5 mm)	101057; Granite to granodiorite, metamorphic, medium grained		49; Plagioclase	32; Potash Feldspar	36; Quartz	10; Biotite	30; Calcite	100; 100 %	Calcite as contamination (rounded, limestone, whitish or red), traces of amphibolite. Otherwise fresh bedrock sample.
SFM0009	5	3,20	- 3,50	0;	80; Greyish	2; Red	8; Medium to coarse grained	100; Light	80; Greyish	2; Red	9; Medium-grained (1-5 mm)	101057; Granite to granodiorite, metamorphic, medium grained		49; Plagioclase	32; Potash Feldspar	36; Quartz	10; Biotite	30; Calcite	100; 100 %	Traces of rounded calcite/limestone (contamination). Bedrock sample.

Drill cuttings

Date: 2003-10-16 Sign.: Christin Nordman

Hole	Sample	from	to	Untreated drill cuttings sample				Washed and sieved drill cuttings sample				Rock type A	Rock type B	Min-1	Min-2	Min-3	Min-4	Min-5	Distr.	Comment
				Lightn.	Chrom.	Hue	Grain size	Lightn.	Chrom.	Hue	Grain size									
SFM0010	2	2,00	2,20	0;	20; Reddish	9; Black	8; Medium to coarse grained	0;	20; Reddish	9; Black	6; Fine-to medium grained	102017; Amphibolite	111058; Granite, fine to medium grained	3; Amphibole	49; Plagioclase	32; Potash Feldspar	36; Quartz	30; Calcite	80; 80/20	Calcite in amphibolite (not as veins or contamination). 111058 leucocratic, red. Some rounded 111058 fragments. Could be contamination from moraine.
SFM0010	3	2,20	2,70	0;	50; Greenish	9; Black	8; Medium to coarse grained	0;	0;	9; Black	6; Fine-to medium grained	102017; Amphibolite		3; Amphibole	49; Plagioclase	30; Calcite	36; Quartz	32; Potash Feldspar	100; 100 %	Calcite as constituent in amphibolite. Quartz grains - could be contamination from moraine. Also fresh quartz probably from fracture filling or possible pegmatite - less than 10%
SFM0011	5	4,50	5,00	0;	80; Greyish	2; Red	9; Medium-grained (1-5 mm)	0;	80; Greyish	2; Red	6; Fine-to medium grained	111058; Granite, fine to medium grained	101054; Tonalite to granodiorite, metamorphic	49; Plagioclase	32; Potash Feldspar	36; Quartz	10; Biotite	3; Amphibole	90; 90/10	Granite leucocratic, red.
SFM0013	5	5,00	5,20	0;	80; Greyish	2; Red	8; Medium to coarse grained	0;	80; Greyish	2; Red	6; Fine-to medium grained	101057; Granite to granodiorite, metamorphic, medium grained	102017; Amphibolite	49; Plagioclase	32; Potash Feldspar	36; Quartz	10; Biotite	50; Pyrite	90; 90/10	Some angular, yellowish fragments, probably close to surface or moraine material. One rounded fragment. Slight contamination - most fresh bedrock material.
SFM0013	6	5,30	5,60	0;	80; Greyish	2; Red	8; Medium to coarse grained	0;	80; Greyish	2; Red	6; Fine-to medium grained	101057; Granite to granodiorite, metamorphic, medium grained	101054; Tonalite to granodiorite, metamorphic	49; Plagioclase	32; Potash Feldspar	36; Quartz	10; Biotite	3; Amphibole	90; 90/10	Some contamination from moraine (rounded limestone, orange coloured fragments).Traces of pyrite. Calcite also from fracture filling.
SFM0014	3	1,95	2,67	0;	0;	4; Brown	8; Medium to coarse grained	0;	80; Greyish	2; Red	8; Medium to coarse grained	101061; Pegmatite, pegmatitic granite	101051; Granite, granodiorite and tonalite, metamorphic, fine to medium grained	49; Plagioclase	32; Potash Feldspar	36; Quartz	10; Biotite	16; Epidote	90; 90/10	Traces of rounded to angular calcite/limestone (contamination). Bedrock sample. Some amphibole.
SFM0014	4	2,80	3,25	0;	20; Reddish	4; Brown	9; Medium-grained (1-5 mm)	0;	40; Brownish	2; Red	2; Fine-grained (<1 mm)	101051; Granite, granodiorite and tonalite, metamorphic, fine to medium grained	101061; Pegmatite, pegmatitic granite	49; Plagioclase	32; Potash Feldspar	36; Quartz	10; Biotite	16; Epidote	70; 70/30	C-type granitoid (in samples 3 and 4) or grain-size reduced 101057 - uncertain. Traces of green calcite (limestone from moraine?).

Drill cuttings

Date: 2003-10-16 Sign.: Christin Nordman

Hole	Sample	from	to	Untreated drill cuttings sample				Washed and sieved drill cuttings sample				Rock type A	Rock type B	Min-1	Min-2	Min-3	Min-4	Min-5	Distr.	Comment
				Lightn.	Chrom.	Hue	Grain size	Lightn.	Chrom.	Hue	Grain size									
SFM0016	9	7,20	7,60	200; Dark	0;	2; Red	8; Medium to coarse grained	0;	80; Greyish	2; Red	1; Aphanitic (grains not visible with naked eye)	103076; Felsic to intermediate volcanic rock, metamorphic	108019; Calc-silicate rock (skarn)	49; Plagioclase	32; Potash Feldspar	36; Quartz	33; Chlorite	30; Calcite	60; 60/40	Some rounded fragments of granite-granodiorite. Probably also some amphibole. Strongly deformed. Very uncertain volcanic rock - could be a cataclasite (red, almost aphanitic).
SFM0016	10	7,60	8,60	200; Dark	20; Reddish	5; Green	8; Medium to coarse grained	200; Dark	20; Reddish	5; Green	1; Aphanitic (grains not visible with naked eye)	108019; Calc-silicate rock (skarn)		3; Amphibole	30; Calcite				100; 100 %	Strongly deformed rock type. Could be an altered amphibolite? Red network-like oxidation.
SFM0017	5	4,20	4,40	200; Dark	0;	4; Brown	6; Fine-to medium grained	200; Dark	0;	8; Grey	2; Fine-grained (<1 mm)	102017; Amphibolite	101057; Granite to granodiorite, metamorphic, medium grained	3; Amphibole	49; Plagioclase	36; Quartz	10; Biotite	32; Potash Feldspar	90; 90/10	Oxidized and deformed (cataclastic?). Quartz and calcite, probably from fracture fillings. Some contamination from moraine (red limestone, roundish fragments). Biotite.
SFM0017	6	4,50	5,00	200; Dark	20; Reddish	4; Brown	6; Fine-to medium grained	200; Dark	0;	4; Brown	2; Fine-grained (<1 mm)	102017; Amphibolite		10; Biotite	49; Plagioclase	11091; X1	30; Calcite		100; 100 %	Strongly oxidized and foliated. Brittle-ductile shear zone? Uncertain amphibolite - hardly recognisable.
SFM0017	7	5,00	5,40	200; Dark	20; Reddish	4; Brown	6; Fine-to medium grained	200; Dark	80; Greyish	4; Brown	2; Fine-grained (<1 mm)	102017; Amphibolite	101057; Granite to granodiorite, metamorphic, medium grained	10; Biotite	49; Plagioclase	30; Calcite			90; 90/10	Strongly oxidized and foliated. Brittle-ductile shear zone? Uncertain granite-granodiorite - more granitic, fine grained. Amphibolite or possibly skarn?
SFM0018	3	4,70	4,85	100; Light	10; Pinkish	4; Brown	8; Medium to coarse grained	0;	80; Greyish	7; White	8; Medium to coarse grained	101061; Pegmatite, pegmatitic granite	101054; Tonalite to granodiorite, metamorphic	32; Potash Feldspar	49; Plagioclase	36; Quartz	10; Biotite		70; 70/30	Tonalite to granodiorite light grey, almost aphanitic (fine grained), foliated.
SFM0018	4	4,90	5,50	100; Light	0;	4; Brown	6; Fine-to medium grained	0;	10; Pinkish	7; White	8; Medium to coarse grained	101061; Pegmatite, pegmatitic granite		32; Potash Feldspar	49; Plagioclase	36; Quartz	10; Biotite	3; Amphibole	100; 100 %	Traces of pyrite. Traces of amphibolite and tonalite.
SFM0019	10	5,20	5,50	0;	0;	7; White	6; Fine-to medium grained	0;	0;	2; Red	6; Fine-to medium grained	101061; Pegmatite, pegmatitic granite		32; Potash Feldspar	49; Plagioclase	36; Quartz	10; Biotite	30; Calcite	100; 100 %	Probably deformed pegmatitic granite. Grain size reduced, foliated. Traces of dark red limestone (contamination from moraine)

Drill cuttings

Date: 2003-10-16 Sign.: Christin Nordman

Hole	Sample	from	to	Untreated drill cuttings sample				Washed and sieved drill cuttings sample				Rock type A	Rock type B	Min-1	Min-2	Min-3	Min-4	Min-5	Distr.	Comment
				Lightn.	Chrom.	Hue	Grain size	Lightn.	Chrom.	Hue	Grain size									
SFM0020	4	3,30	- 3,60	100; Light	0;	8; Grey	8; Medium to coarse grained	100; Light	80; Greyish	2; Red	9; Medium-grained (1-5 mm)	101057; Granite to granodiorite, metamorphic, medium grained	101061; Pegmatite, pegmatitic granite	32; Potash Feldspar	49; Plagioclase	36; Quartz	10; Biotite		90; 90/10	Contaminated by moraine: Rounded fragments and limestone. Pegmatite slightly foliated or lineated. Medium grain size dominates. Also tonalite and amphibolite fragments (contamination?)
SFM0020	5	3,60	- 4,40	100; Light	10; Pinkish	8; Grey	8; Medium to coarse grained	100; Light	80; Greyish	2; Red	9; Medium-grained (1-5 mm)	101057; Granite to granodiorite, metamorphic, medium grained		32; Potash Feldspar	49; Plagioclase	36; Quartz	10; Biotite		100; 100 %	
SFM0021	3	2,40	- 2,70	0;	0;	2; Red	8; Medium to coarse grained	0;	0;	2; Red	6; Fine-to medium grained	111058; Granite, fine to medium grained		32; Potash Feldspar	49; Plagioclase	36; Quartz	10; Biotite	33; Chlorite	100; 100 %	Relatively leucocratic. Biotite somewhat chlorite altered.
SFM0021	4	2,80	- 3,10	0;	0;	2; Red	8; Medium to coarse grained	0;	0;	2; Red	6; Fine-to medium grained	111058; Granite, fine to medium grained		32; Potash Feldspar	49; Plagioclase	36; Quartz	10; Biotite	33; Chlorite	100; 100 %	Relatively leucocratic. Biotite somewhat chlorite altered.
SFM0021	5	3,10	- 3,60	0;	0;	2; Red	8; Medium to coarse grained	0;	0;	2; Red	6; Fine-to medium grained	111058; Granite, fine to medium grained		32; Potash Feldspar	49; Plagioclase	36; Quartz	10; Biotite	33; Chlorite	100; 100 %	Relatively leucocratic but has more biotite than samples 3 and 4. Biotite somewhat chlorite altered.
SFM0026	7	16,80	- 17,50	0;	20; Reddish	4; Brown	8; Medium to coarse grained	0;	80; Greyish	2; Red	9; Medium-grained (1-5 mm)	101061; Pegmatite, pegmatitic granite	101054; Tonalite to granodiorite, metamorphic	32; Potash Feldspar	49; Plagioclase	36; Quartz	10; Biotite	11091; X1	80; 80/20	Probably relatively strong contamination from moraine. Rounded fragments, also limestone. Pegmatite and tonalite deformed - some fragments are mylonitic. Chlorite.
SFM0028	7	7,20	- 8,00	0;	80; Greyish	2; Red	8; Medium to coarse grained	0;	80; Greyish	2; Red	9; Medium-grained (1-5 mm)	101057; Granite to granodiorite, metamorphic, medium grained		32; Potash Feldspar	49; Plagioclase	36; Quartz	10; Biotite	30; Calcite	100; 100 %	Some contamination from moraine (rounded fragments, limestone).
SFM0030	4	3,70	- 4,00	0;	10; Pinkish	7; White	6; Fine-to medium grained	0;	0;	2; Red	2; Fine-grained (<1 mm)	101057; Granite to granodiorite, metamorphic, medium grained		32; Potash Feldspar	49; Plagioclase	36; Quartz	10; Biotite		100; 100 %	Probably grain size reduction due to deformation. Foliated. Some larger quartz grains probably from fracture filling. Some contamination from moraine (limestone, amphibolite)
SFM0030	5	4,00	- 4,80	100; Light	0;	8; Grey	8; Medium to coarse grained	0;	80; Greyish	2; Red	6; Fine-to medium grained	101057; Granite to granodiorite, metamorphic, medium grained		32; Potash Feldspar	49; Plagioclase	36; Quartz	10; Biotite		100; 100 %	Foliatedl/lineated. Traces of moraine (limestone, rounded yellowish fragments).

Drill cuttings

Date: 2003-10-16 Sign.: Christin Nordman

Hole	Sample	from	to	Untreated drill cuttings sample				Washed and sieved drill cuttings sample				Rock type A	Rock type B	Min-1	Min-2	Min-3	Min-4	Min-5	Distr.	Comment
				Lightn.	Chrom.	Hue	Grain size	Lightn.	Chrom.	Hue	Grain size									
SFM0032/33	2	2,90	3,50	0;	0;	4; Brown	6; Fine-to medium grained	0;	80; Greyish	2; Red	6; Fine-to medium grained	101057; Granite to granodiorite, metamorphic, medium grained		32; Potash Feldspar	49; Plagioclase	36; Quartz	10; Biotite	16; Epidote	100; 100 %	Possible grain size reduction - foliated/lineated. Traces of epidote. Traces of contamination from moraine (limestone, amphibolite)
SFM0032/33	3	2,50	4,20	0;	0;	4; Brown	6; Fine-to medium grained	100; Light	80; Greyish	2; Red	2; Fine-grained (<1 mm)	101057; Granite to granodiorite, metamorphic, medium grained	102017; Amphibolite	32; Potash Feldspar	49; Plagioclase	36; Quartz	10; Biotite	3; Amphibole	80; 80/20	Possible grain size reduction - strongly foliated.
SFM0036	2	2,10	2,60	0;	0;	4; Brown	8; Medium to coarse grained	100; Light	0;	8; Grey	9; Medium-grained (1-5 mm)	101057; Granite to granodiorite, metamorphic, medium grained		32; Potash Feldspar	49; Plagioclase	36; Quartz	10; Biotite		100; 100 %	Probably some contamination from moraine (somewhat rounded fragments, a few pegmatite grains).
SFM0036	3	2,60	3,20	0;	0;	8; Grey	8; Medium to coarse grained	100; Light	0;	8; Grey	6; Fine-to medium grained	101057; Granite to granodiorite, metamorphic, medium grained		32; Potash Feldspar	49; Plagioclase	36; Quartz	10; Biotite	33; Chlorite	100; 100 %	Only traces of chlorite.
SFM0049	2	4,00	4,50	100; Light	80; Greyish	2; Red	8; Medium to coarse grained	100; Light	10; Pinkish	8; Grey	9; Medium-grained (1-5 mm)	101057; Granite to granodiorite, metamorphic, medium grained		32; Potash Feldspar	49; Plagioclase	36; Quartz	10; Biotite		100; 100 %	Foliatedl/lineated.
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