

Oskarshamn site investigation

Compilation of structural geological data covering the Simpevarp peninsula, Ävrö and Hålö

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All Appendices is available on the enclosed CD-ROM-disc.
The printed version contains only the main text and a list of the Appendices.

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

A pdf version of this document can be downloaded from www.skb.se

Summary

The aim of the current project is the compilation of structural geological data covering the Simpevarp Peninsula, Hålö and Ävrö. The work has been based on information contained in existing reports and documents of diverse origin: SKB published and unpublished reports; site investigation records; construction and 'as built' drawings from the major infrastructure projects on the peninsula.

By means of scanning, digitising, georeferencing and cataloguing, the two dimensional geometry of the interpreted lineaments and structures, contained in the reference documents, has been included in a GIS database. All information available in the reports, relevant to the engineering geological character of each lineament or structure, has been systematically compiled in a data table. The data table together with the digitised graphics constitute the complete GIS database.

This written report includes relevant information from the references that did not lend itself to GIS presentation; it describes the content of the GIS database and how the work was carried out and aims to provide a link to the regional Version 0 framework.

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Appendix A Boreholes

Appendix B Fracture data

Appendix C Data Inventory based on SKB reference list: Format and Coding

Appendix D Selected scanned figures from the references used for the generation of the compilation drawings

Appendix E O1 to O3 Selected structures

Appendix F CLAB Selected structures

Appendix G Ävrö and Hålö selected structures

Appendix H Complete data inventory

Appendix I Traceability of original reference numbers

1 Introduction

Swedish Nuclear Fuels and Waste Management Company (Svensk Kärnbränslehantering AB) is currently investigating two potential sites for a deep repository. Forsmark and Simpevarp. An important part of the necessary preparations concerns site descriptive modelling. This entailed the establishment of the first version ('version 0') of the site descriptive model of the two sites. An essential part of this work was the compilation of existing data and interpretations for each site at a regional scale. The existing Simpevarp – site descriptive model version 0 report /SKB, 2002/ summarises all the data available that is considered relevant to modelling work on the regional scale. As a supporting activity to this modelling work the role of the current report is to compile available structural geological data on a more local scale, centred on the Simpevarp Peninsula.

1.1 Project area

The project area is shown below and encompasses the Simpevarp peninsula and the islands of Hålö and Ävrö.

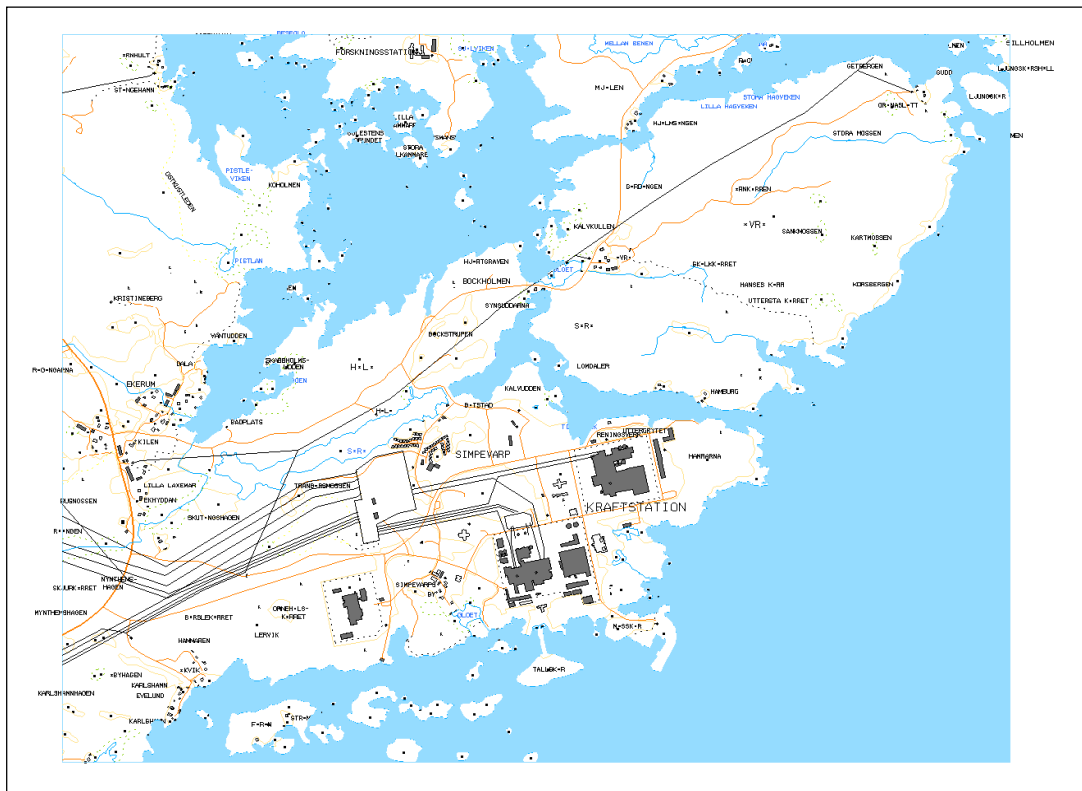
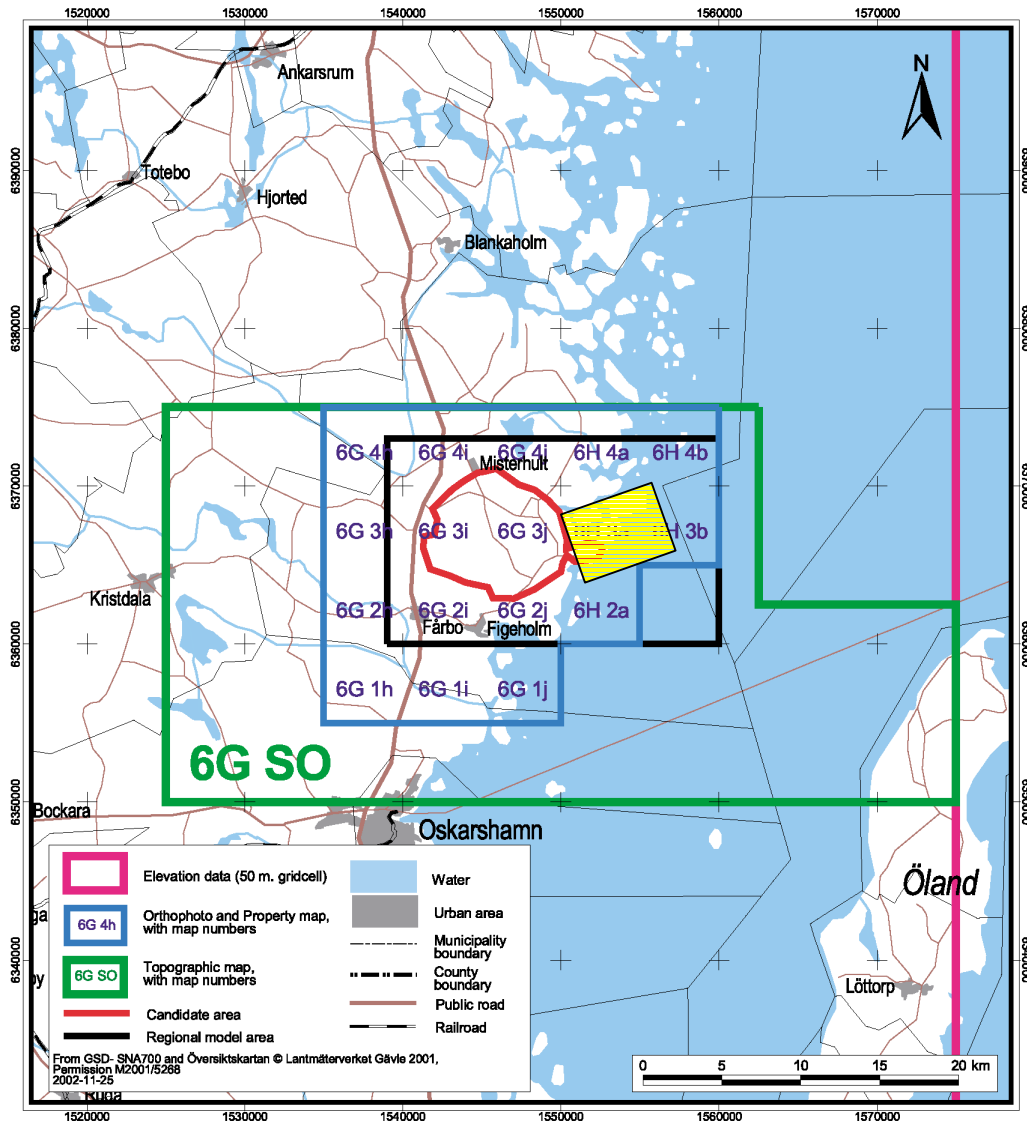


Figure 1-1. The Project Area: Simpevarp Peninsula, Ävrö and Hålö. The relationship between the current project area, Version 0 study area and existing GIS data coverage is presented in Appendix J.




 = current project area

Figure 1-2. The relationship between the current project area, Version 0 study area and existing GIS data coverage. The distribution of maps, orthophotos and elevation data available in the GIS database of SKB over the northern part of the province of Småland and the Simpevarp regional model area (ref: Figure 2-1, /SKB, 2002/ Simpevarp – site descriptive model version 0).

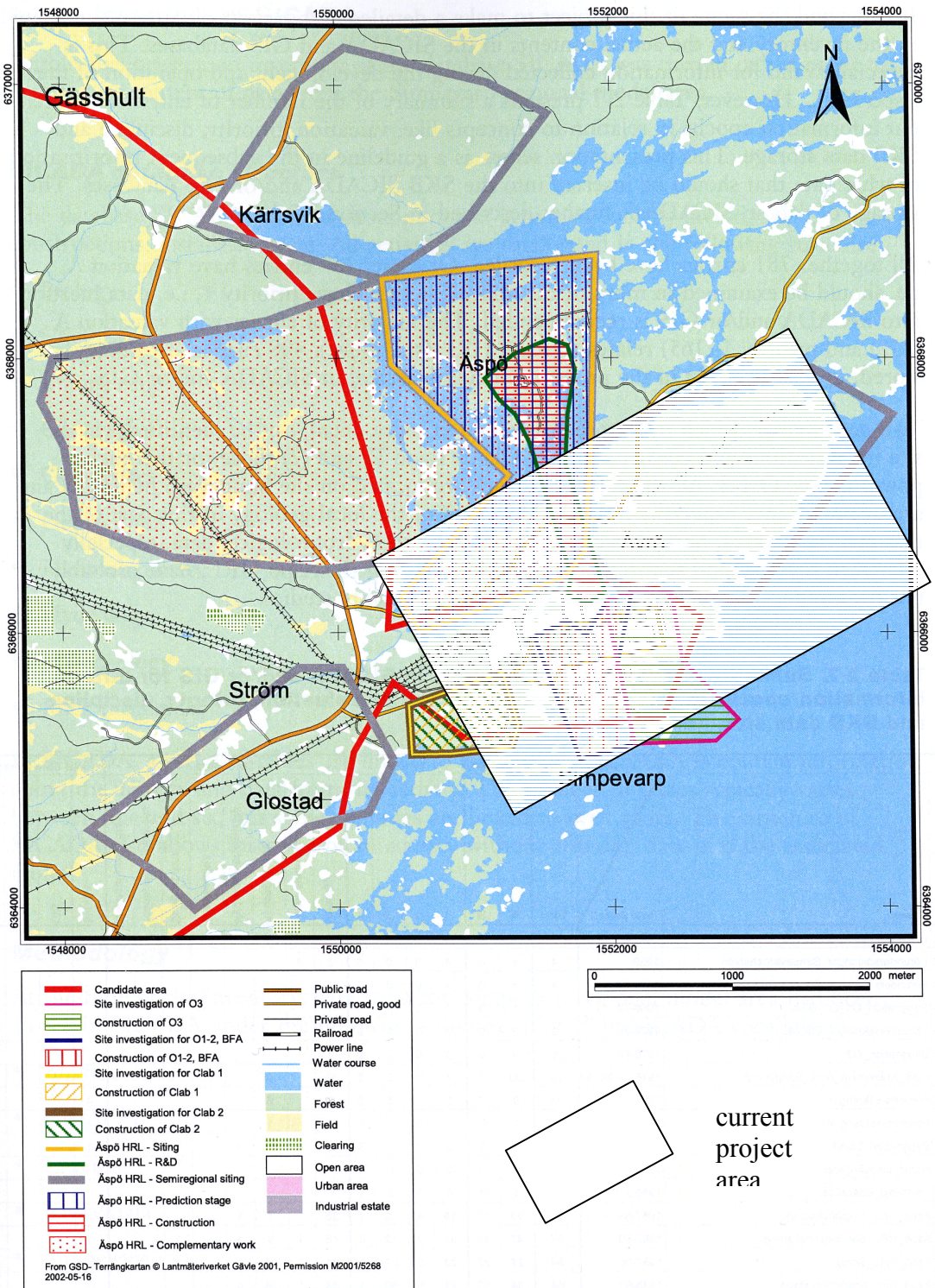


Figure 1-3. Geographical areas in the vicinity of the Oskarshamn nuclear power station and CLAB, linked to information epochs in the (V0) data inventory (ref: Figure 2-3, /SKB, 2002/ Simpevarp – site descriptive model version 0).

1.2 Aim

This report contains no new data and no new interpretations of existing data. The aim of the current report is to provide a systematic compilation of available structural geological information that is relevant to the project area. The project area has been the subject of intense studies, from the 1960's to the present day, associated with the identification, investigation and construction of Oskarhamn Nuclear Power Station (Reactors 1, 2 and 3), the Central Interim Storage Facility for Spent Nuclear Fuel (CLAB 1 and 2) and the access tunnel to SKB's Underground Hard Rock Laboratory beneath Äspö. Only the initial section of the access tunnel is geographically relevant to the present study. The data has been compiled and integrated but no new interpretations have been made.

The current project has relied on the results of geological mapping of the various excavations, to supply primary information on the character of tectonic structures present in the project area and give indications of local orientation. The interpreted results of geophysical surveys, primarily seismic refraction, supplied information on the persistence of the structures and their larger scale orientations. More general information on fracture orientations was available from both local and regional joint statistic compilation surveys.

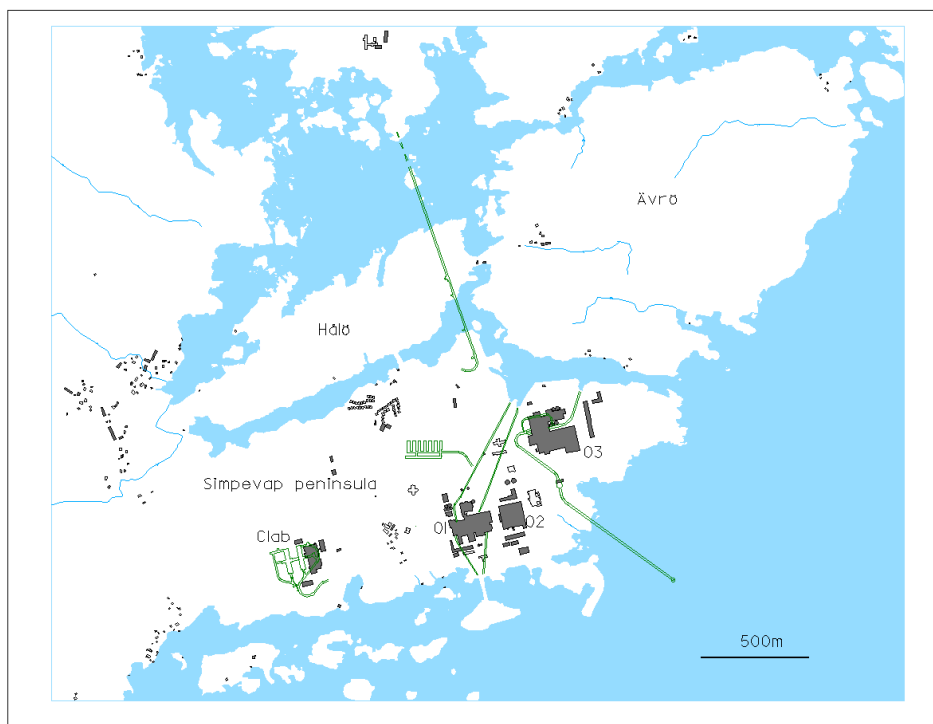


Figure 1-4. Plan view of the project area showing the major infrastructure (underground works shown in green).

Geological rock type mapping has been carried out across the project area at various scales. The results of Regional scale mapping, included in the present report, are based on selected text and figures from SKB's recent site descriptive modelling work and have been extracted from the Simpevarp – site descriptive model version 0 report /SKB, 2002/.

The results of lithological mapping at a local scale, covering the island Ävrö and the Simpevarp peninsula, are based on original work by /Kornfält and Wikman, 1987a,b/.

Lithological mapping has been carried out at a more detailed site scale. For example, mapping of the excavated caverns and tunnels of the power plants and storage site. Whilst this mapping work provides an incomplete coverage of the project area, it does provide an indication of the variability within the rock mass that is inevitably masked when only considering the regional scale. The graphical results from lithological mapping of CLAB 2 cavern are included in the present report as an example. Complete mapping results from CLAB 2 can be found in TP-01-02 (ID14).

2 Existing infrastructure in the project area

Figure 1-2 shows the major infrastructure, relevant to the current project, present in the project area. The footprint of surface structures are shown in grey and the underground excavations shown in green.

Approximately 5 km of tunnels and two major rock caverns with a total volume of ca 325,000 m³ have been excavated. In addition, there has been approximately 900,000 m³ of surface blasting.

2.1 Oskarshamn power station

The power station consists of three nuclear reactors, referred to in this report as O1, O2 and O3, and an underground storage site for medium and low grade radioactive waste, BFA (Bergrum För Avfall). The facilities are owned by Oskarshamns Power Group (OKG). Generation capacity is in the order of 2,270 MW. The plant area as a whole has a surface footprint of ca 1.5 km².

By the end of the 1950's the coastal area around Simpevarp was judged to be a suitable location for a nuclear power plant for the following reasons:

- Strategic location for supply.
- Space exists for at least four reactors.
- Easy access to cooling water (sea) and suitable topography for intake and tailrace facilities.
- Suitable foundation conditions for the reactor buildings.
- Potential deep water harbour location.
- Sparsely populated area.

Construction for O1 began in 1966 and was commissioned in 1972. Construction of O2 began in 1970 and was commissioned in 1974. O3 was commissioned in 1985.

Each reactor has an intake tunnel and a tailrace tunnel. The intakes for O1 and O2 are situated on the southern coast of the peninsula. O3 has its intake located 500 m from the coast towards the SE. The outfall from all three tailraces is in Hamnefjärden on the northern coast. The total length of the tunnels is ca 4,000 m with an excavated rock volume of ca 215,000 m³.

2.2 CLAB

Central Interim Storage Facility for Spent Nuclear Fuel (CLAB 1 and 2). CLAB 1 was commissioned in 1985 and has a current capacity of 5,000 tonnes of spent fuel. CLAB 2, currently under construction, will provide additional capacity for a further 3,000 tonnes of waste and hard components.

Siting studies for CLAB 1 were carried out during the latter part of the 1970's. In the final phase Forsmark and Simpevarp, judged to have similar rock conditions, were favoured. An area on Simpevarp peninsula, ca 800 m west of O1 and O2 was selected in 1978 for further investigations. Simpevarps' advantages were judged to be:

- Geographic suitability, close to O1 and O2.
- A suitable harbour location, essentially ice-free.

Preliminary investigations were carried out during 1978 and 1979. Rock excavation started in 1980, was completed in 1982 and the facility was commissioned in 1985.

CLAB 1 consists of an above ground facility for handling of the spent fuel and an underground cavern facility for storage of the spent fuel in concrete water filled cooling tanks. The cavern is connected to the surface by an elevator shaft, transport shaft and tunnel. The underground excavation work for CLAB 2 is now complete and is connected to CLAB 1 with a geometry that is essentially a mirror image of CLAB 1.

The cavern length is 117 m, with a width of 21 m and a height of 27 m. The total excavated rock volume for CLAB 1 is ca 180,000 m³, with ca 100,000 m³ from underground. CLAB 2 has a similar underground excavation volume.

2.3 Äspö Hard Rock Laboratory – access tunnel

The access tunnel to the underground facility begins on the northern side of Simpevarp peninsula. The tunnel has an area of ca 25 m² on the straight sections and ca 40 m² on the curves. The total length is ca 3,500 m with the initial 300 m on the peninsula.

3 Overview of old data – ambition levels for geological investigations and excavation records

The majority of the geological information available covering the Simpevarp peninsula originates from the ground investigation and excavation records that were produced in connection with the excavation of the various tunnels, caverns and foundations during the years 1965–2000.

It is clear from the available data that different ambition levels have been applied at different times to the works themselves carried out for different structures. In addition, the ambition level as regarding the nature and extent of the presentation and documentation of results has varied greatly over the years and, therefore, varies for different structures.

3.1 O1 and O2

The construction phase of O1 and O2 was preceded by investigations including outcrop mapping, seismic refraction surveying and drilling. No comprehensive site investigation report was ever produced. Documentation regarding the cooling water tunnels is rather superficial when compared with current standards of required documentation for such important structures.

3.2 BFA

There exists no geological documentation from investigations or the construction of BFA. BFA consists of a number of caverns with a transport tunnel to the ground surface.

3.3 O3

Construction of O3 was preceded by an investigation phase including, outcrop mapping, geophysical surveying, hammer drilling with permeability testing and borehole camera surveys. The reactor foundation area was further investigated by core drilling. No comprehensive site investigation report was ever produced.

For the construction phase geological documentation and rock condition descriptions showed a great improvement in scope when compared with those of the previous facilities. Geological mapping was carried out of all the tunnels and major foundations.

3.4 CLAB

The ambition level as regards investigation work and documentation during the excavation phase was very high for both CLAB 1 and CLAB 2.

3.4.1 CLAB 1

Investigation of rock conditions for CLAB 1 was carried out during 1978 and 1979. The investigations included seismic refraction surveys, outcrop mapping, 11 core drill holes with mapping and permeability testing, in situ stress measurements and soil/rock soundings.

During the excavation phase the following work was carried out:

- Advance investigative drilling ahead of the tunnel face.
- Geological documentation of rock types, fractures and other rock structures.
- Documentation of groundwater conditions in the caverns and monitoring of the wells in the surrounding area.
- Measurements of rock deformation (convergence measurements).
- Investigation of the cavern floors including 16 core drillholes, for foundation analysis for the cooling tanks.
- Documentation of rock support and grouting works.

All documentation is available in reports. Borehole data from the investigations are available in SICADA.

3.4.2 CLAB 2

The geological investigations for CLAB 2 were undertaken from 1995–1997. The investigations included seismic refraction, geological mapping and drilling with permeability testing, BIPS and in situ stress measurements. Documentation of the tunnels and cavern was maintained throughout the excavation phase. Data from the seismic and drillhole investigations are available in SICADA. Other data is available in reports. Mapping data from the tunnels and cavern exists in digital format in the Stenograf system format.

3.5 Ävrö

No rock excavation for major infrastructure has been carried out on Ävrö. Geological investigations have included outcrop mapping, fracture mapping, geophysical surveying and drilling. Data from drilling and seismic reflection surveying exists in SICADA. Other data are well documented and available in reports. A high ambition level was applied to both the investigations and the documentation work.

3.6 Hålö

The Äspö tunnel penetrates Hålö. Extensive geological and geophysical investigations as well as drilling in association with the design of the Äspö tunnel were carried out. Continual documentation was maintained throughout both the investigation and excavation phases. All data is available in SICADA and reports. A very high ambition level was applied to the documentation of both the investigation and excavation work.

4 Evaluation of uncertainty of the presented data

Evaluation of uncertainty first needs to be applied when considering location, for example of boreholes, measurement profiles and structures.

For those structures (lineaments), which were defined in the Simpevarp site descriptive model – version 0 as being ‘regional’ or ‘local major’, the positional uncertainty is judged to be 50–100 m. In those sections where a structure is verified in an underground excavation, borehole or by surface geophysics, positional uncertainty is judged to be 5–10 m.

For those observations that originate from tunnels and caverns, such as fracture zones and dykes, the positional uncertainty is judged to be 0.5–1 m, with the exception of the O1 cooling water tunnels where positional uncertainty is judged to be 5–10 m.

Positional uncertainty of the interpreted tectonic structures, e.g. fracture zones, based on surface geophysical measurements is judged to be 5–10 m.

Positional uncertainty on the ground surface of boreholes and measurement profiles is judged to be of the order of 0.01–0.1 m.

5 Summary of earlier investigations and available data

Site investigations for O1, O2 and O3 for the main part consisted of seismic surveys and drilling to primarily investigate the rock conditions along the intake tunnels /Stanfors, 1981/.

During the period 1976–79 investigations centred on the CLAB site. Extensive seismic survey investigations, mapping and 11 cored drillholes and a number of hammer holes were completed. Permeability testing, borehole camera with fracture orientation and in situ stress testing were carried out in certain holes /Hagkonsult 1976; Moberg, 1978, 1979/. Excavation documentation from CLAB 1 is compiled in /Eriksson, 1982/.

Extensive ground investigations commenced in 1987 for the siting of the underground rock laboratory in the Simpevarp area. It was in connection with this work that the more detailed geological mapping of the Simpevarp peninsula was carried out /Kornfält and Wikman, 1987a,b/.

During the period 1995–1997 further investigations have been carried out in the CLAB area. These were to provide information for the planning of CLAB 2. The investigations consisted of seismic surveys, detailed geological mapping, 5 cored drillholes and 5 hammer holes with permeability testing. Additional testing has included BIPS mapping and in situ stress measurements /Stanfors et al, 1998/.