

# Midnorden Project, Geophysics Sub-Project: Introduction to Combined Geophysical Maps of Central and Northern Fennoscandia

Ruotoistenmäki, T.[1]

1. Geological Survey of Finland, Geophysics Department, Betonimiehenkuja 4, Espoo, Finland

## INTRODUCTION

The internordic Mid-Norden Project is a joint venture of the geological surveys of Finland, Norway and Sweden to provide regional geoscientific information of central Fennoscandia. The main goal of the Mid-Norden geophysics sub-project has been to prepare gravity and magnetic data matrixes and maps covering central Fennoscandia between latitudes 62°45' and 66°N (Ruotoistenmäki *et al.*, 1996 a,b) and combine these with the Nordkalott project data (Korhonen *et al.*, 1986 a,b). The location of the Mid-Norden (MN) and Nordkalott (NK) areas is shown in Figure 1.

The maps have been published in digital form and as paper maps at the scale 1:1 000 000. The digital maps can be used interactively with PCs and they can be correlated and combined with other Mid-Norden data. The data matrix behind the maps will be used in the surveys for scientific purposes. The paper maps contain general description of the data, statistics, index maps and national descriptions of Norway, Sweden and Finland separately given in English and 'national languages' (Norwegian, Swedish and Finnish).

The digital versions of the maps include an information file system by which vectors and point symbols can be displayed on or extracted from the maps. The information files distributed by the authors contain deep seismic sounding profiles, regional fractures (vectors) and ore indications (symbols) for the Mid-Norden area. New information files can also be created separately by the user from any location (x,y) data.

Other geophysical information available from the Geological Surveys includes regional and local scale gravity and magnetic maps (paper and digital maps) and grids, low-altitude gamma-radiation and electromagnetic response data and maps and ground profiles for various geophysical methods. The petrophysical databases for the Mid-Norden area contain information (mainly density, magnetic susceptibility, remanence and electrical conductivity) obtained from about 49 500 samples in Finland, 3800 in Norway and 16 000 in Sweden.

The poster gives a brief look at the existing Mid-Norden geophysical data and maps and their combinations with Nordkalott data and gives preliminary examples of data interpretation.

## GRAVITY MAPS AND DATA

The gravity anomaly map of the Mid-Norden area was prepared by the geological surveys of Finland, Norway and Sweden during the period 1989–1996. A Bouguer density of 2.670 g/cm$^3$ was used for onshore data. The water volume in offshore areas was replaced by a mass of the Bouguer density using a water density of 1027 kg/m$^3$ for the Norwegian Sea, and 1000 kg/m$^3$ for the Bothnian Bay. The International Gravity Standardization Net 1971 (IGSN-71) and the Gravity Formula 1980 for normal gravity were applied. The data were interpolated to a square grid of 2.5 km by 2.5 km. Anomaly gradients were emphasized by 'illuminating' them from northwest and northeast.

The combined gravity map of Mid-Norden and Nordkalott areas at 1:2 000 000 scale is given in Ruotoistenmäki *et al.* (1997). The interpreted gravity lineaments of the Mid-Norden area combined with the hillshaded gravity map are shown in Figure 2 as an example of use of the data. It can be seen that the main gravity minimum A–A' controlling the ore potential of Ladoga-Bothnian Bay zone (LBZ) on its northeastern side continues northwest to Sweden, where it coincides with the Archean paleoboundary defined by Öhlander *et al.* (1993) by Sm-Nd isotope analyses.

## MAGNETIC MAPS AND DATA

The magnetic data matrices were interpolated to a common net with a cell size of 1 km × 1 km, and the Definite International Geomagnetic Reference Field 1965.0 (DGRF-65) was subtracted. Anomaly gradients were emphasized by illuminating them from the northwest and northeast.

The combined magnetic map of the Mid-Norden and Nordkalott areas at 1:2 000 000 scale is given in Ruotoistenmäki *et al.* (1997). The interpreted magnetic lineaments and base metal showings of the Mid-Norden area combined with the hill-shaded magnetic map of the Mid-Norden and Nordkalott areas are shown in Figure 3 as an example of the usage of the data. The main gravity minimum A–A' shown above is included in the figure. It can be seen that the majority of Finnish ore showings in the Mid-Norden area are connected with the magnetic

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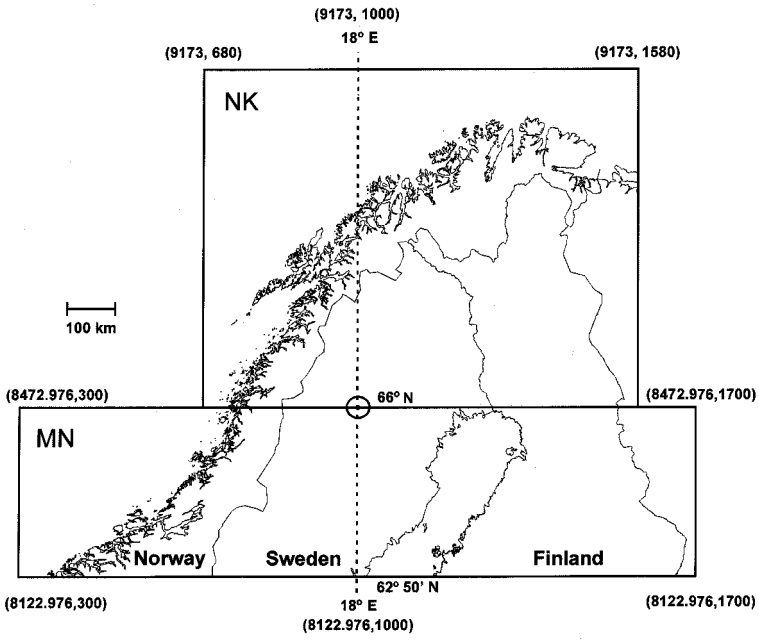


**Figure 1:** *The Mid-Norden (MN) and Nordkalott (NK) areas. The Lambert conformal conical projection is used. Standard parallels are 54°N and 68°N; the centre meridian is 18°E. Lat=66°N and long=18°E corresponding to x=8472.976; y=1000.000. The Lambert coordinates of the corner points are shown in parentheses.*

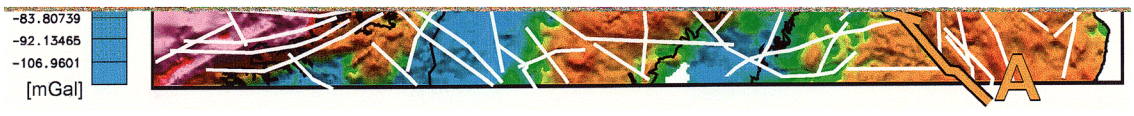


**Figure 2:** *The interpreted gravity lineaments of the Mid-Norden area combined with the hill-shaded gravity map of Mid-Norden and Nordkalott areas. A–A' indicates the main gravity minimum controlling the ore potential of Ladoga-Bothnian Bay zone (LBZ).*

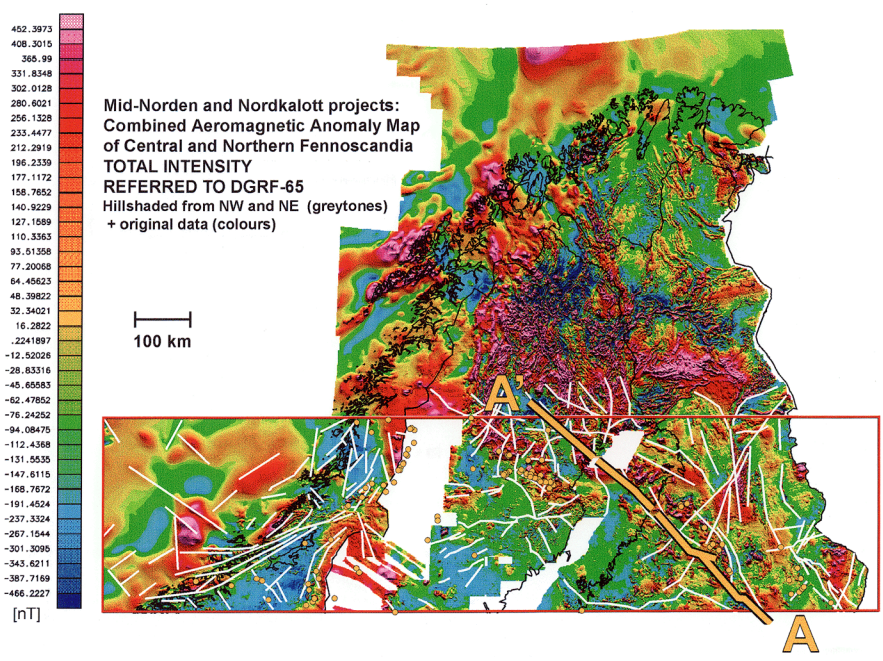


**Figure 3:** *The interpreted magnetic lineaments and base metal showings in the Mid-Norden area combined with the hill-shaded magnetic map of Mid-Norden and Nordkalott areas. A–A′ indicates the main gravity minimum controlling the ore potential of Ladoga-Bothnian Bay zone (LBZ).*

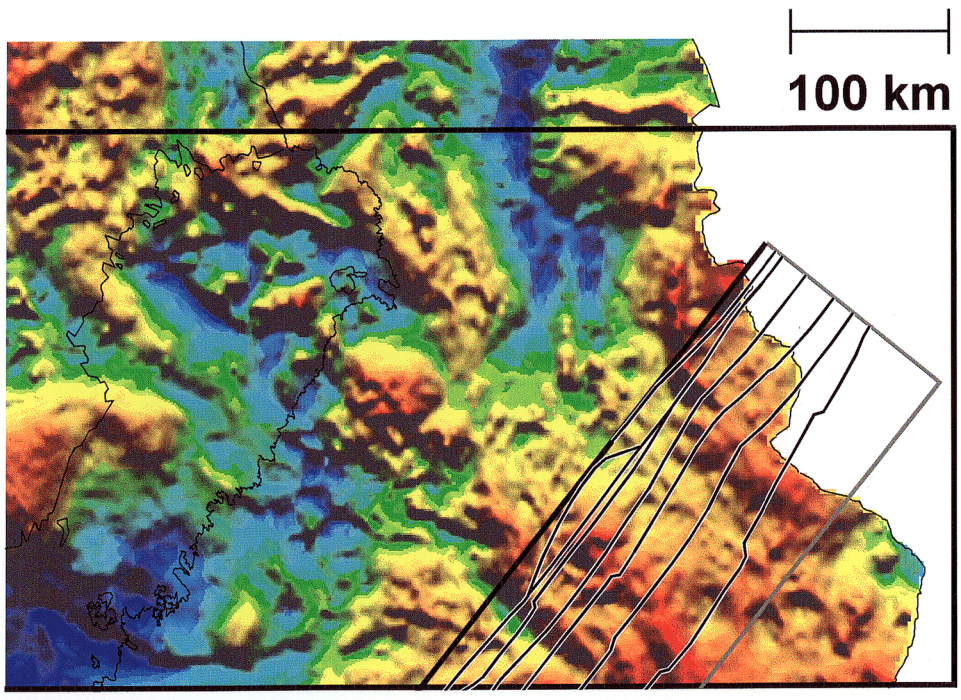


**Figure 4:** *The deep seismic sounding profile SVEKA connected with the gravity map of Finnish Mid-Norden areas.*

maximum zone northeast of the main gravity minimum A–A'. This magnetic maximum zone is also a regional gravity maximum referring to large amounts of mafic rocks in the upper crust (e.g., Elo *et al.*, 1978; Ruotoistenmäki, 1993, 1996).

## SEISMIC PROFILES

During the Mid-Norden project two deep seismic refraction profiles were digitized from the Norwegian Sea and two from onshore areas in Sweden and Finland. These profiles are included in the extra Info files of the digital map browser. As an example of these profiles Figure 4 depicts the deep seismic refraction profile SVEKA (e.g., Luosto *et al.*, 1982) in Mid-Finland.

The northeastern part of the SVEKA profile overlapping the Mid-Norden area was digitized along the shot points. In the figure the profile is projected along a straight line between the end points (heavy black line). The main reflectors were drawn with black lines. The profile is framed so that along the profile the scale is the same as that of the map. In vertical dimension, however, the scale factor is 2. The height of the frame is 70 km. Note that stretching in a vertical dimension makes the dips of the reflector surfaces steeper.

The figure shows that the ore potential area northeast of the gravity lineament A–A' in Figure 2 is characterized by very thick crust, c. 60 km, possibly due to tectonic thickening (e.g., Ruotoistenmäki, 1996) and/or introduction of mafic mantle melts in the lower crust (e.g., Lahtinen, 1994; Korja, 1995).

## CONCLUSIONS

The geophysical data on and maps of the Mid-Norden area supplemented with other geological and geophysical data provide valuable tools for analyzing the bedrock characteristics in central and northern Fennoscandia. The advantage of the combined maps is that the regional structures and lithology variations can be analyzed across national borders. This is necessary when considering and modelling the large-scale tectonic processes that created the Fennoscandian bedrock. An understanding of bedrock evolution is also needed for predicting and modelling the location of ore showings and changes in fracture zones around radioactive waste repositories.

## SUPPLY OF DATA AND MAPS

The data and maps (paper and digital PC versions) of the Mid-Norden and Nordkalott areas can be ordered from the geological surveys of Norway, Sweden and Finland:

- Geological Survey of Norway, Leiv Eirikssons vei 39, PO Box 3006 - Lade, N-7002 Trondheim, Norway
- Geological Survey of Sweden, PO Box 670, S-75128 Uppsala, Sweden
- Geological Survey of Finland, PO Box 96, Betonimiehenkuja 4, FIN-02151 Espoo, Finland

An Internet www page presenting the maps is on address: http://www.gsf.fi/midnord/

We emphasize that not all the data used for map production are readily available to persons outside the geological surveys. In such cases the surveys are ready to provide consultation assistance with the interpretation and production of special maps.

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