NGU Report 97.190

Geophysical modelling of aeromagnetic anomalies in Altermark, northern Norway

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REPORT

Report no.: 97.190	ISSN 0800-3416	Grading: ÅPEN

Title:
Geophysical modelling of aeromagnetic anomalies in Altermark, northern Norway

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County: Nordland		Commune: Mo i Rana	
Map-sheet name (M=1:250.000) Mo i Rana		Map-sheet no. and -name (M=1:50.000) 1927 I Mo i Rana	
Deposit name and grid-reference: Nakkan (Centre coordinates: UTM 4515/73575)		Number of pages: 11 Price (NOK): kr. 59,- Map enclosures:	
Fieldwork carried out:	Date of report: 20.11.1997	Project no.: 2734.00	Person responsible: [signature]

Summary:

In connection with investigations of the talc deposit «Nakkan» in Altermark, surrounding magnetic anomalies have been modelled and interpreted. The goal of this work is to get more knowledge about the possibility of finding additional resources of talc in the vicinity of the the Nakkan deposit.

Two magnetic profiles have been modelled; the first crosses the exposed ultramafite termed «Lille Esjeklumpen», while the second crosses a very weak positive magnetic anomaly west of the Nakkan deposit.

The modelling of the Lille Esjeklumpen ultramafite indicates that it extends no more than 150 metres below surface. The modelling of the weak anomaly to the west indicates that it is caused by a relatively low magnetic rock which is exposed at the surface - most likely a granet-mica schist.

Keywords: geofysikk	petrofysikk	magnetometer
industrimineraler	talk	
		fagrapport

CONTENTS

1. INTRODUCTION

The talc deposit at Nakkan, Altermark (Fig. 1), just west of Mo i Rana was discovered in 1992 using aeromagnetic measurements (Mogaard & Walker 1991), modelling (Karlsen & Olesen 1991) and subsequent drilling. Previous investigations are summarised by Karlsen (1995) and Karlsen & Olesen (1996) and by E. Rian and one of the present authors (TAK) in internal reports. When evaluating the area as a future mining area it is important to consider the potential for discovering additional deposits nearby. In this report two magnetic profiles, measured in 1990, have been modelled. One of them crosses the exposed ultramafite termed «Lille Esjeklumpen» (Profile 2140 in Fig. 2), while the other crosses a weak anomaly 700 metres further west (Profile 2050 in Fig. 2). The present report is a supplement to previous work by Karlsen & Olesen (1991, 1996), and the reader is referred to these reports for detailed information about the geology, geomagnetic field and petrophysics.

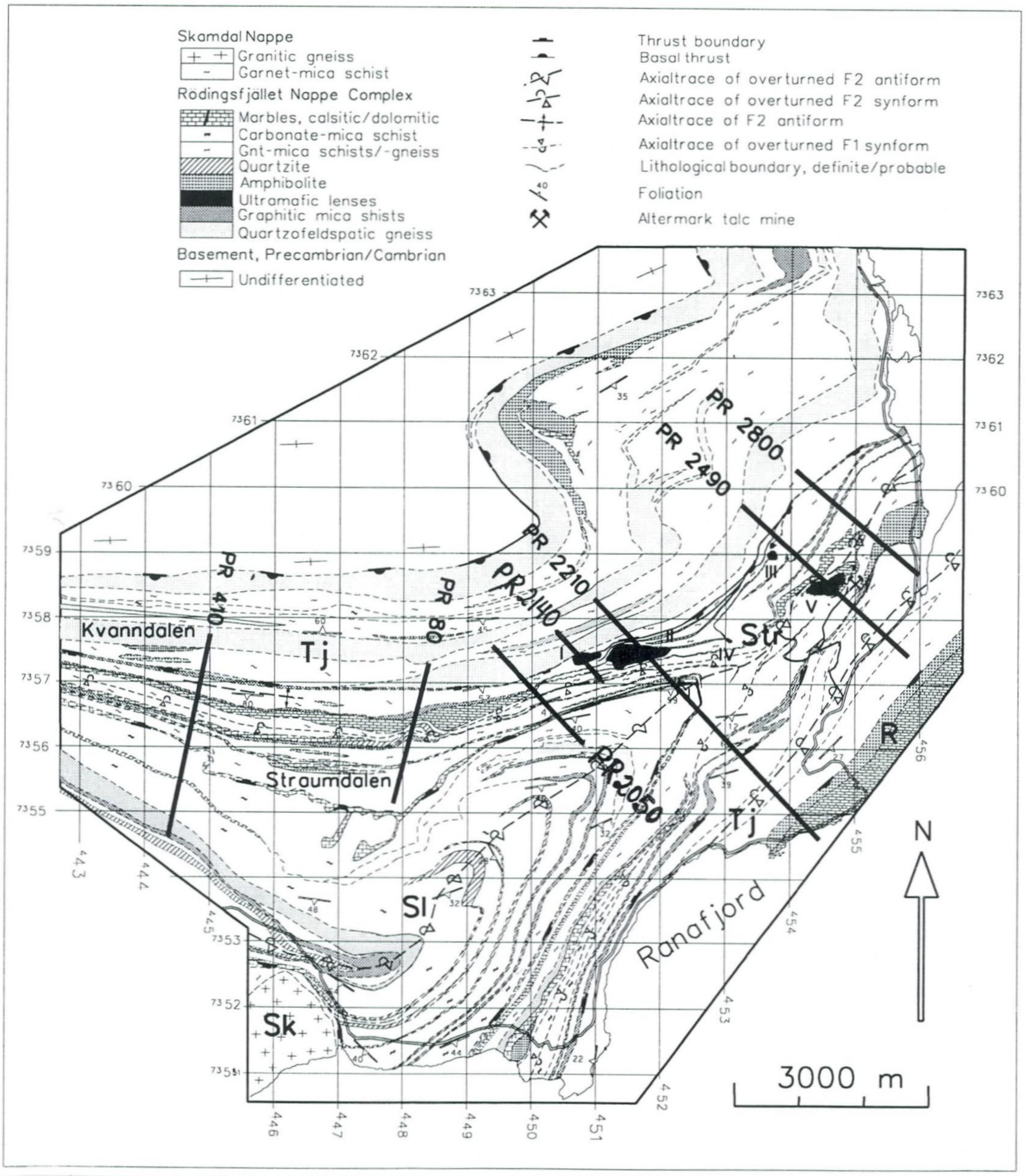

Figure 1. Simplified geological map showing the location of talc deposits in Altermark.

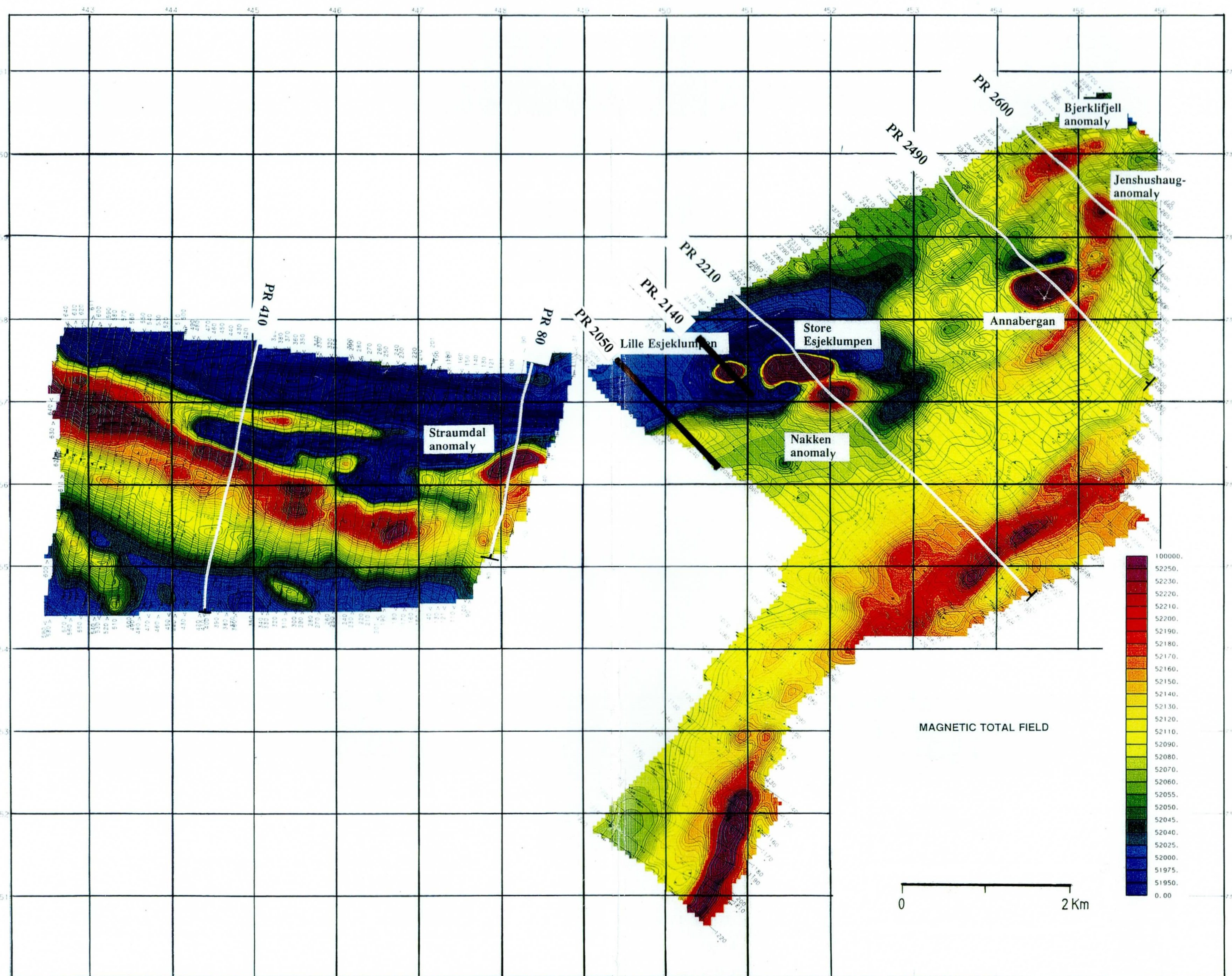

Figure 2. Aeromagnetic map of the Altermark area. The investigated profiles (Figs. 4-5) in the present study are outlined in black, while profiles interpreted by Karlsen & Olesen (1991, 1996) are outlined in white.

2. GEOLOGY OF THE ULTRAMAFIC LENSES

The ultramafites in Altermark are mineralogically zoned, having a core of serpentinite including remnants of primary ultramafic rocks, and a rim consisting of talc-rich rocks (Fig. 3). At the contact between the ultramafites and the country rocks occurs thin layers of monomineralic rocks like chloritite and biotitite. Commonly, such rocks are termed «blackwall rocks».

The serpentinite core consists primarily of serpentine and magnetite. The talc rich rim consists of two types of talc rocks: 1) talc-carbonate rock containing talc and carbonate in about equal amounts and magnetite and chlorite in smaller amounts.

Of primary importance in magnetic modelling is of course the distribution of magnetite in the rocks since this is the mineral with highest magnetic susceptibility. Magnetite is formed during the process of serpentinisation due to the following reaction:

1) Forsterite + H_2O ⇨ serpentine + magnetite

In the talc rich rim magnetite also occurs, but commonly in smaller amounts. The magnetite is, however, absent in extreme alteration cases. The explanation of this behaviour is that magnetite is broken down in the steatitisation process, and the iron enters breunnerite:

2) Serpentine + magnetite ⇨ talc + breunnerite

The stronger deformation and alteration, the less magnetite occurs in the talc rocks (Fig. 3).

Talc-carbonate lenses lacking a core of serpentinite might be impossible to detect when applying the magnetic exploration method.

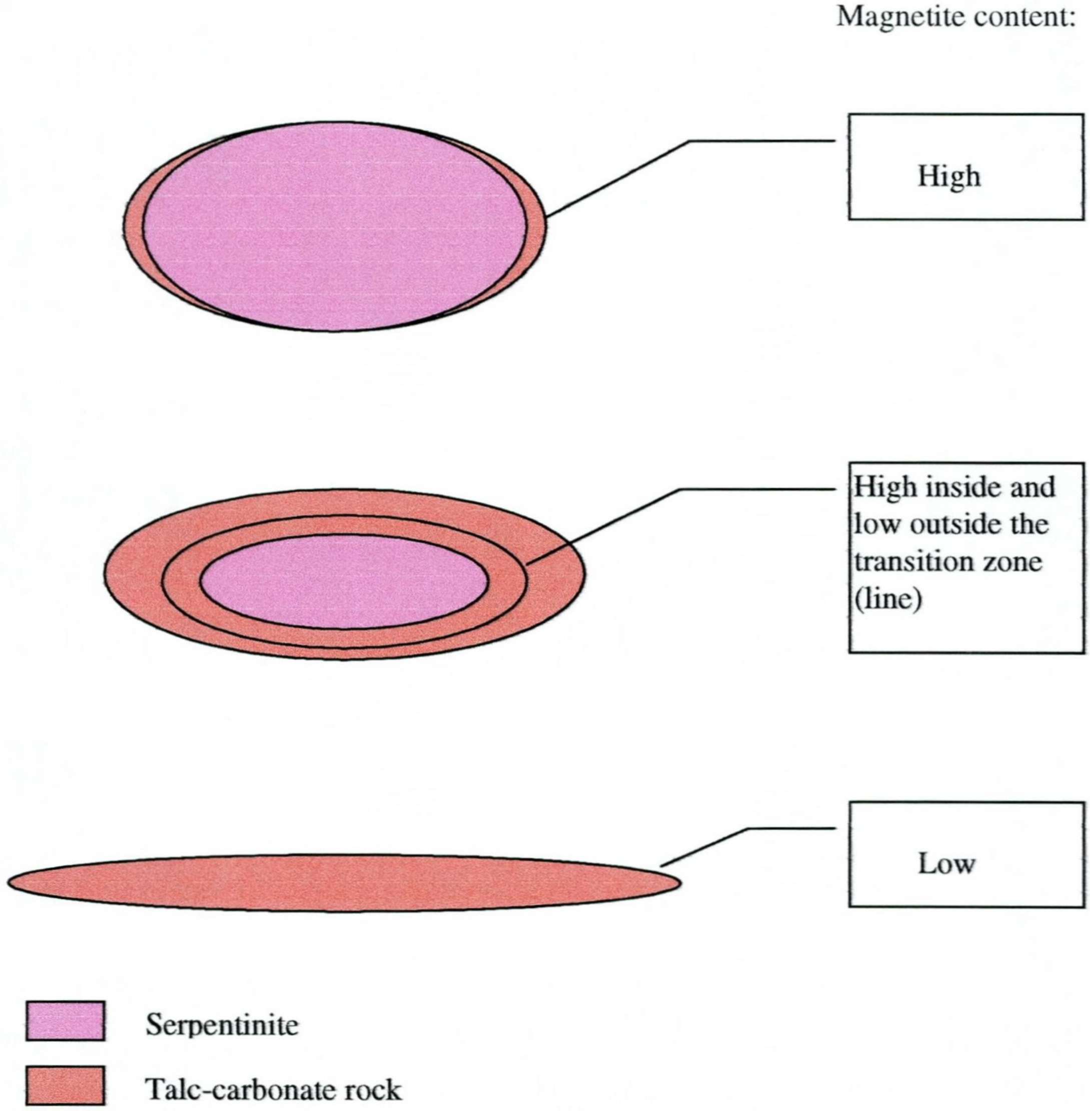

Figure 3. Sketch illustrating the general zoning pattern of the ultramafites and the relationship between the degree of alteration and the content of magnetite.

3. APPLIED PETROPHYSICAL PARAMETERS

The petrophysics of the rocks of the Altermark area as well as the procedure for the data acquisition and magnetic modelling is given by Mogaard & Walker (1991) and Karlsen & Olesen (1991), respectively. A summary of the applied geophysical/petrophysical values for the modelled bodies in the present work is given in Table 1.

Table 1: Petrophysical values used in the modelling in Figs. 4 and 5.

	Profile 2140 Lille Esjeklumpen	Profile 2050
Intensity, present earth field	51600 nT	51600 nT
Declination, present earth field	0°	0°
Inclination, present earth field	76°	76°
XY-rotation of magnetic body	40°	35°
Y1/2	0.15 km	1 km
Susceptibility	120000×10^{-6} SI	6900×10^{-6} SI
Remanence intensity	1460 mA/m	109 mA/m
Q-value	0.30	0.39
NRM declination	354°	354°
NRM inclination	87°	87°
Total Declination	359.6°	358.6°
Total Inclination	78.5°	79.3°

4. MODELLING OF MAGNETIC ANOMALIES

We have carried out forward modelling of the magnetic field along two profiles in the Lille Esjeklumpen area (Profiles 2050 and 2140 in Fig.2). When computing the response from the model we have used the new Windows NT/95 version of the IMP computer program of Torsvik (1992). The basic model in this program comprises 2½ dimensional bodies, i.e. bodies of polygonal cross-section of finite length in the strike direction.

Profile 2140 - Lille Esjeklumpen:

A model of the Lille Esjeklumpen ultramafite along profile 2140 (Fig. 2) is presented in Fig. 4. The amplitude of the anomaly is 2400 nT. The applied petrophysical values are similar to those used by Karlsen & Olesen (1996, Fig. 11) for the Nakkan ultramafite model which proved to fit quite well with results obtained from drilling.

When utilising these values it is likely that the deepest parts of the Lille Esjeklumpen ultramafite is situated maximum 150 metres below surface and possibly closer to the surface. The magnetic body is dipping steeply towards south-east.

Profile 2050:

A model of the strongest magnetic anomaly in this profile is given in Fig. 5. The amplitude of the anomaly is 100 nT, which is significantly lower than the amplitude of the anomaly in Profile 2140 (see previous section). To be able to fit the measured magnetic curve, a rather low magnetic susceptibility must be applied. Such low susceptibility is not commonly found for the serpentinite-bearing ultramafites in the area.

The weak magnetic anomaly in this profile can, in fact, be caused by most other rocks than the strongly magnetic serpentine-bearing ultramafites. It is important, however, to be aware that such rocks also includes low-magnetic talc-lenses. Since no such rock has been detected during field mapping it seems, however, unlikely to be present. Mica-garnet schist has been mapped in the area of the anomaly and according to petrophysical measurements on samples of this rock type (Karlsen & Olesen 1991, 1996), it may possibly also be the source of the anomaly. The large length of the anomaly also lend support to this hypothesis.

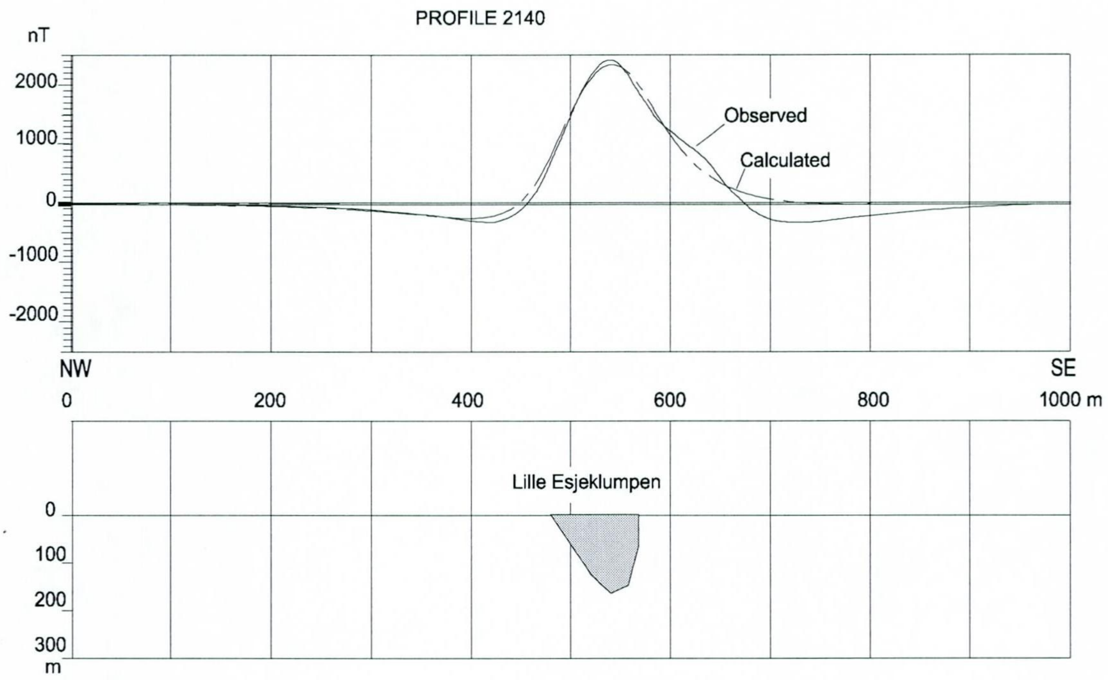

Figure 4. Part of cross section PR2140, Lille Esjeklumpen. Petrophysical properties are shown in Table 1. The location of the cross section is shown in Fig. 2.

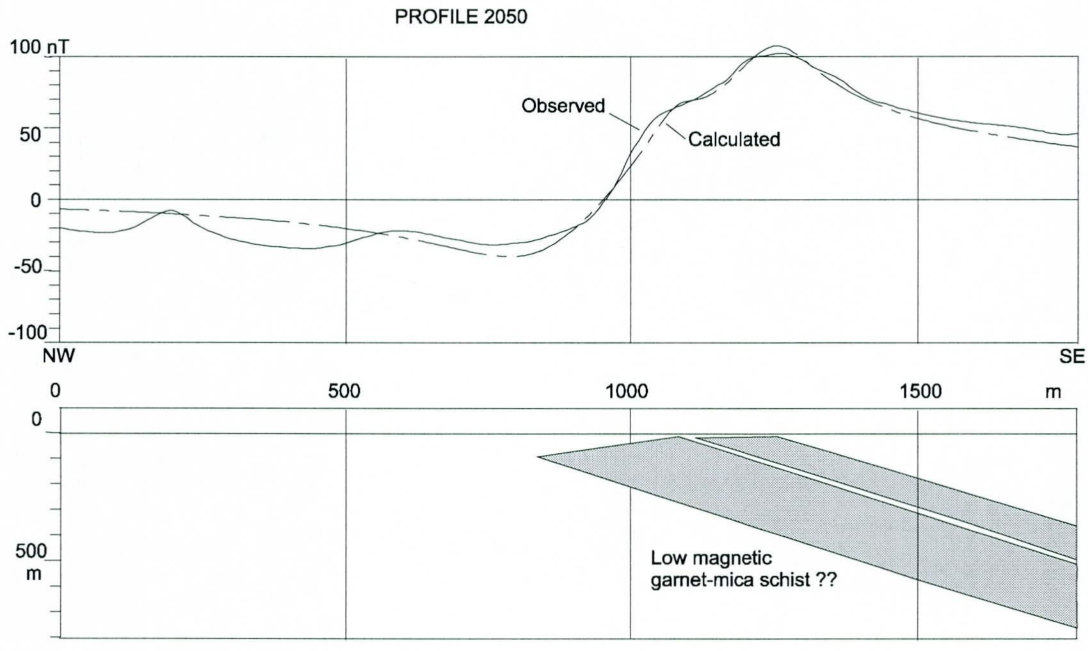

Figure 5. Cross section PR2050, to the west of the Nakkan anomaly. Petrophysical properties are shown in Table 1. The location of the profile is shown in Fig. 2.

5. CONCLUSIONS

Modelling of magnetic data indicate that the deepest magnetic part of the Lille Esjeklumpen ultramafite is situated no more than 150 metres below surface or possibly at even shallower levels. A weak magnetic anomaly along profile 2050 is not caused by deep-seated serpentine-bearing ultramafites, but a rock with lower contents of magnetite, most like a garnet-mica schist.

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