



# Bergvesenet

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## Rapportarkivet

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## TRANSIENT EM SURVEY OF THE LØKKEN AREA IN 1985

This is a preliminary report of the geophysical survey supervised by Outokumpu Oy Exploration Dept. with its EM 37 transient or time domain (TDEM) system. The survey was carried out during the 7th of August to the 20th of September. The purpose of the survey was to be a follow-up method for the new information obtained by the litogeochemical sampling undertaken in the previous year. TDEM was used to locate possible big massive sulfide ore bodies down to the depths of 300 - 400 m.

## SUMMARY

The survey succeeded well if thinking of instruments, men and data acquisition. The weather was mostly favourable and rough terrain did not bother too much. More or less continuous area of about 26 km<sup>2</sup>, 15 km from west to east, 46 line kilometres with 429 points were surveyed. The area can be divided to ten subareas, three of which were more like test areas. Power lines and culture restricted the survey area somewhat and one power line was cut off for the survey. All the known conductors were found, but no new more interesting anomalies by just superficial examination. Further interpretations will show more exactly what the data really includes. No special extra expenses were met.

## INTRODUCTION

EM 37 was transported from Finland to the Løkken area by the Finnish technician, Jouko Longi, who participated and supervised the survey all the time present. Geophysicist Ensio Lakanen visited Løkken on the 15th to 23rd of August. He checked the test profiles and negotiated the final follow-up program.

Measurements were conducted in a fixed loop mode, which means that the transmitter is located in a fixed position feeding a large loop (1 - 2 kW power). Survey line crosses the loop (desirably through the middle of it) and continues outside of it as far as the loop's field is strong enough; this equals the perpendicular side of the loop. There were in many cases only one survey line across the loop, but in some cases two, e.g. when the line spacing was 250 m. Mostly used loop size was 400 x 400 m<sup>2</sup> (18 in number), but one double sized and two with indefinite shape. The length of the survey lines (30) varies from 0.9 to 2.6 km totalling 46.35 km. Point spacing was normally 100 m,

totalling 429 points altogether. When using a smaller loop size the next loop was laid beforehand by two extra men; measuring needed also two men. The average of 13 points per working day is satisfactory in this terrain and long carrying distances of 60 kg generator. Two components Z and X (directed towards the center axis of the loop) were measured, except in one profile also Y. Gain of 7 was used all the way, which speaks about high resistivity.

High frequency mode (25 Hz) was mainly used so that the measured 20 channels correspond time range from 0.09 to 7.2 ms, which is an equivalent of frequencies from 140 to 1100 Hz and skin depth is more than one km for 1000  $\Omega$ m environment. The eighteenth channel was lost at the last profile in Moen, and that was the only instrumental failure; it was caused by moisture.

The method can indicate good conductors to the depth of 400 - 500 m and also a few hundred metres sideways so that we can estimate the effective coverage about 26 km<sup>2</sup> encountered and volume of 13 km<sup>3</sup>. Power lines and settled areas caused troubles and some places had to be even left aside. One power line coming from the west side to the Astrup shaft was tamed by shutting the galvanic contacts from its ends till the measurements close to it were finished. This gives more hope for the further use of AMT in locating a possible continuation of the Løkken ore body.

#### SURVEY AREAS (Appendix)

Three test sites, three one profile reconnaissance and four more systematic surveys were carried out. Survey facts and some preliminary notes are presented of each site.

##### Björnli

This was the only possible site for testing the Løkken ore body at a reasonable depth of 400 - 500 m. Unfortunately there were many power lines crossing the site in different directions, and it was restricted by the Astrup shaft in west and dwellings in east. Transmitter loop was adjusted in the middle of power lines and crossing roads with an effective area of 275 x 525 m<sup>2</sup>. Two profiles in about southwest-northeast direction 1050 and 1100 m long were measured with 50 m point spacing. The easterly profile was chosen as a local zero (EW) and starting from southwestern end with a point coordinate -0.4 S (in km).

The second profile was 250 m west, so the coordinate is -0.25 W. The center of the loop is then -0.12 W; 0.15 N. One power line was disastrous for the results, because it caused an anomaly turnover just above the Lökken ore body in both profiles. X-component is still more sensitive to cultural noise. The end of the zero profile is on its behalf disturbed by dwellings. No clear indication of the orebody was obtained. More thorough interpretation will be dealt with the particular report to be written during the autumn 1985.

#### Svinsås

This was chosen for comparison to the AMT survey of 1984. The same profile, -0.6 W, south to north, from -0.7 S to 0.8 N was surveyed. Loop of 400 x 400 m<sup>2</sup> was located at -0.6 W; 0.15 N as a centre. Another line with its own transmitter loop was located to cross the strongest known "vaskis" anomaly (Genie, IP, VLF and magnetic). Profile's coordinates are -0.15 W from -0.8 S to 0.5 N now with 100 m point spacing. The centre of the loop is -0.05 W/-0.275 S. "Vaskis"-horizon outcrops at -.45 and -.65 S in the profiles -0.6 and -0.15 W respectively. It can be interpreted as a gently dipping dyke.

#### Damlia (southwest from Astrup shaft)

One profile over the well-conducting "vaskis"-horizon was deliberately included to see the shape of the anomaly. S-N oriented profile has regional coordinates Y = 31.75, X = 97.9 - 99.3. The centre of the loop was at Y = 31.85, X = 98.65. The strongest anomaly of the survey was obtained.

#### Blokkum-Marka (west of the Orkla-river)

Profile Y = 30.4, X = 99.3 - 100.8 was measured. The centre of the loop was at Y = 30.4, X = 100.05. No anomaly existed. X-component exhibits large distortion, which is caused by so resistive environment.

#### Högåsen (southeast from the Astrup shaft)

This is geochemically anomalous area. A large loop, 800 x 800 m<sup>2</sup> was used to cover the desired large survey area. Three profiles 2.2 - 2.6 km long, 500 m apart were measured. In the easternmost profile also the third (Y) component was observed to sense any indications eastward. The centre of the

loop was at  $Y = 33.0$ ,  $X = 98.95$  and profiles were  $Y = 32.5$ ,  $X = 97.7 - 99.9$ ;  $Y = 33.0$ ,  $X = 97.6 - 100.2$  and  $Y = 33.5$ ,  $X = 97.6 - 99.8$  with a variable point spacing of 100 or 200 m. The known "vaskis"-horizon gave a strong anomaly in the first profile at  $X = 98.15$  and a weaker one in the next profiles. A double anomaly, which may mean a parallel conductor can be seen. A power line in the northern part of the two easternmost profiles can be noticed. No other anomalies are located.

Mogset

The most northern profile is situated in the eastern shore of Orkla-river climbing onto a hill of 350 m. There were some geochemical marks, which wanted to be checked. Profile  $Y = 33.35$ ,  $X = 101.2 - 102.7$  with the loop of  $400 \times 400 \text{ m}^2$ , centre at  $Y = 33.25$ ,  $X = 102.05$  was measured. No anomalies were obtained.

Moen

This was the last profile to be surveyed and is situated in a difficult place, because of the high bank of Orkla-river and cultural effects. But it was very important having to do with the deepest part of the Løkken orebody and its possible continuation westward. This profile includes a part close to the AMT profile surveyed in 1984, by which the anomaly of the orebody could be seen in spite of a strong power line influence. Now the power line was shut off for the survey; the first time that this has been possible as to my knowledge. And it sure wiped out the power line anomaly. This profile was surveyed with the largest possible loop size, indefinite in shape about  $700 \times 900 \text{ m}$ , the centre at local coordinates 0,0. Profile goes from -1.3 S to 1.0 N twisting according to the shoreline of Orkla with 100 or 200 m point spacing. A possible continuation of the "vaskis"-horizon in Damlia and Högåsen causes a strong anomaly at -1.05, which is 200 - 300 m more to north than expected. No other clear indications exist.

Høydal (east from Løkken)

This is a large area with many geochemical anomalies even when the old mine is excluded. 9 profiles with 250 m spacing were surveyed and four loops had to be laid down. One power line in west and a new big one in east limited the area of two km long. The generator of 60 kg had to be carried all the way through this hilly area. Two westernmost profiles,  $Y = 36.75$  and  $37.0$  from  $X = 98.8 - 99.8$  and  $98.6 - 100.2$  respectively, have the same transmitter loop the centre at  $36.9$ ,  $99.35$ . One known

"vaskis"-horizon gave an anomaly at  $X = 98.95$ . There is again a double feature, which may mean a parallel conductive horizon. This needs further interpretation.

Next two profiles  $Y = 37.25$  and  $37.50$  from  $X = 98.6 - 100.1$  and  $98.5 - 100.1$  respectively, have the loop with its centre at  $37.4, 99.25$ . The same two conductive horizons can be traced here too, but the more northern one seems to be more unhomogeneous.

Profiles  $Y = 37.75$  and  $38.0$  go across the Høydal mine from  $X = 98.5 - 100.0$  both, the centre of the loop is at  $37.87, 99.25$ . The same anomaly horizons exist at  $X = 98.85$  and  $98.75$ . The former one is the strongest in the first profile and correlated well with the old mine and litogeochemical anomaly.

The next three profiles  $Y = 38.25, 38.5$  and  $38.75$  from  $X = 98.4 - 100.0$  or  $99.9$  each, have the same loop with the centre at  $38.5, 99.15$ . The same two anomalies are again clear trending more south.

#### Urvatnet (more east from Høydal)

This is a continuation east from Høydal area starting about 1 km east. It covers an area of 3.5 km long with 7 separate profiles 500 m apart with their own transmitter loops. Also this was selected because of promising geochemical anomalies. The westernmost profile  $Y = 40.0$  from  $X = 98.0 - 99.6$ , has the loop centred at  $40.0, 98.75$ . A prominent anomaly is located at  $X = 98.55$ .

The next profile  $Y = 40.5$  from  $X = 98.1 - 99.5$ , the loop centred at  $40.5, 98.85$ , has also an anomaly now at  $X = 98.75$ . Either this has been caused by another zone or the same zone has been slipped by a fault or it changes its dip from north to south. This has to be further interpreted.

The profile  $Y = 41.0$  from  $X = 97.9 - 99.2$ , the loop at  $41.0, 98.65$  repeats the same anomaly zone, but now it is broader. But in the next profile  $Y = 41.55$  from  $X = 98.0 - 99.4$ , the loop at  $41.55, 98.85$  has much weaker twofold anomaly shifted southward. In the profile  $Y = 42.0$  from  $X = 97.8 - 99.4$ , the loop at  $42.0, 98.65$ , the same anomaly zone is repeated as a strong one now at  $X = 98.15$  again much more south.

The easternmost two profiles Y = 42.5 and 43.0 from X = 97.7 - 99.3 and 97.6 - 99.1 and the loops at 42.5, 98.65 and 42.92, 98.45 respectively only repeat the weakening south-trending anomaly.

Åmot (north from Urvatnet)

This is an area of the old small Åmot mine. Three profiles with two loops were surveyed 500 m apart. The western profiles Y = 41.0 and 41.5 from X = 99.8 - 101.0 and 99.5 - 100.6 respectively, the loop at 41.25, 100.4, has again a known anomaly zone at X = 99.9 and 99.7 respectively.

The lonely profile Y = 42.0 from X = 99.5 - 101.0, the loop at 42.05, 100.35, has no clear anomalies; only some smaller variations. X-components of all three Åmot profiles are very variable, which could be caused by weaker conductivity contrasts (compare IP results).

#### EXPENCES OF THE SURVEY

Expences before reporting the survey till the 25th of September are:

Geophysicist	11 x 1500	=	16 500 FIM
Technician	51 x 1100	=	56 100 "
Trips and daily allowances	two trips and km of jeep	=	29 800 "
Rental of EM37	33 x 1800	=	59 400 "
Rental of HP45	70 x 160	=	11 200 "
Ata garnet and insurance		=	<u>3 200</u> "
Total			176 200 FIM =====
equals about			245 000 NOK =====

## RECOMMENDATIONS

So far no further geophysical work can be recommended to the surveyed areas. The results clearly demonstrate the emptiness of the area from the large massive conductors to the depth of at least 400 m (500). Only some structural and indirect information can be extracted from the "vaskis"-horizon anomalies and for this purpose the method is not very suitable.

The most interesting problem is to find out what the Orkla-river has to do with the westward continuation of the Løkken orebody. Because it is difficult to investigate so deep in the mine, one indirect way would be to use the "vaskis"-horizon as a guiding one. It is located at the surface in the Damlia and Moen profiles being so conductive that mise-à-la-masse could be used grounding at the "vaskis".

Another possibility is to use AMT in the Orkla-valley and west of it to locate possible deep conductors. This can be now better recommended knowing that the troublesome power line can be cut off.

If in other places the depth range is desired to increase, the only possibilities are AMT and Maxi-probe or similar surveys.

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ONE APPENDIX

Layout map

DISTRIBUTION

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