P-04-105

Forsmark site investigation

Ground penetrating radar (GPR) and resistivity (CVES) surveys – interpretation of new and previous measurements

Johan Nissen, Malå Geoscience AB, Raycon

July 2004

Svensk Kärnbränslehantering AB
Swedish Nuclear Fuel
and Waste Management Co
Box 5864
SE-102 40 Stockholm Sweden
Tel 08-459 84 00
+46 8 459 84 00
Fax 08-661 57 19
+46 8 661 57 19

ISSN 1651-4416
SKB P-04-105

Forsmark site investigation

Ground penetrating radar (GPR) and resistivity (CVES) surveys – interpretation of new and previous measurements

Johan Nissen, Malå Geoscience AB, Raycon

July 2004

Keywords: GPR, CVES, Soil thickness, AP PF 400-03-86, Field note no Forsmark 210.

Abstract

Ground Penetrating Radar (GPR) data have been collected with a recently developed 50 MHz heavy-duty antenna. This data have been interpreted and a re-interpretation has been made of data from an earlier Continuous Vertical Electrical Sounding (CVES). In both cases, soil thickness reported from nearby boreholes has been taken into account.

The results from the radar measurements have been delivered as raw data files on CD-ROM to SKB. The interpretation results are delivered in pdf-format. All radar interpretations (soil thickness and fracture zones) are furthermore delivered in ASCII files (*.pck).

Finally, Excel-files containing co-ordinates (X,Y in RT90) and soil depths for both the radar and the CVES interpretations have been delivered to be inserted in the SKB SICADA data base.

Sammanfattning

Markradarmätningar (GPR) har utförts med en nyligen utvecklad 50 MHz-antenn avsedd före mätning i svår terräng. Den insamlade informationen har tolkats och dessutom har tidigare insamlade CVES (Continuous Vertical Electrical Sounding)-data omtolkats. I bägge fallen har information om jorddjup från närbelägna borrhål nyttjats.

Resultaten från radarmätningarna har levererats till SKB som rådatafiler på CD. Tolkningsresultaten (jorddjup och sprickzoner) har leverereats i pdf-format samt som ASCII-filer (*.pck).

Slutligen har Excel-filer innehållande koordinater (X,Y i RT90) och jorddjup i diskreta punkter längs mätlinjerna, både GPR och CVES, levererats för inmatning i SKB:s databas SICADA.

Contents

1 Introduction

This document reports the data gained according to activity plan AP-PF-400-03-86 (SKB internal controlling document), which is one of the activities performed within the site investigation at Forsmark.

Ground Penetrating Radar (GPR) data have been collected with a recently developed 50 MHz heavy-duty antenna. The new GPR data have been interpreted and a re-interpretation has been made of data from previous Continuous Vertical Electrical Sounding (CVES) measurements reported in /1/. In both cases, soil thickness reported from nearby boreholes has been taken into account. The location of the measured profiles is shown in Figure 1-1.

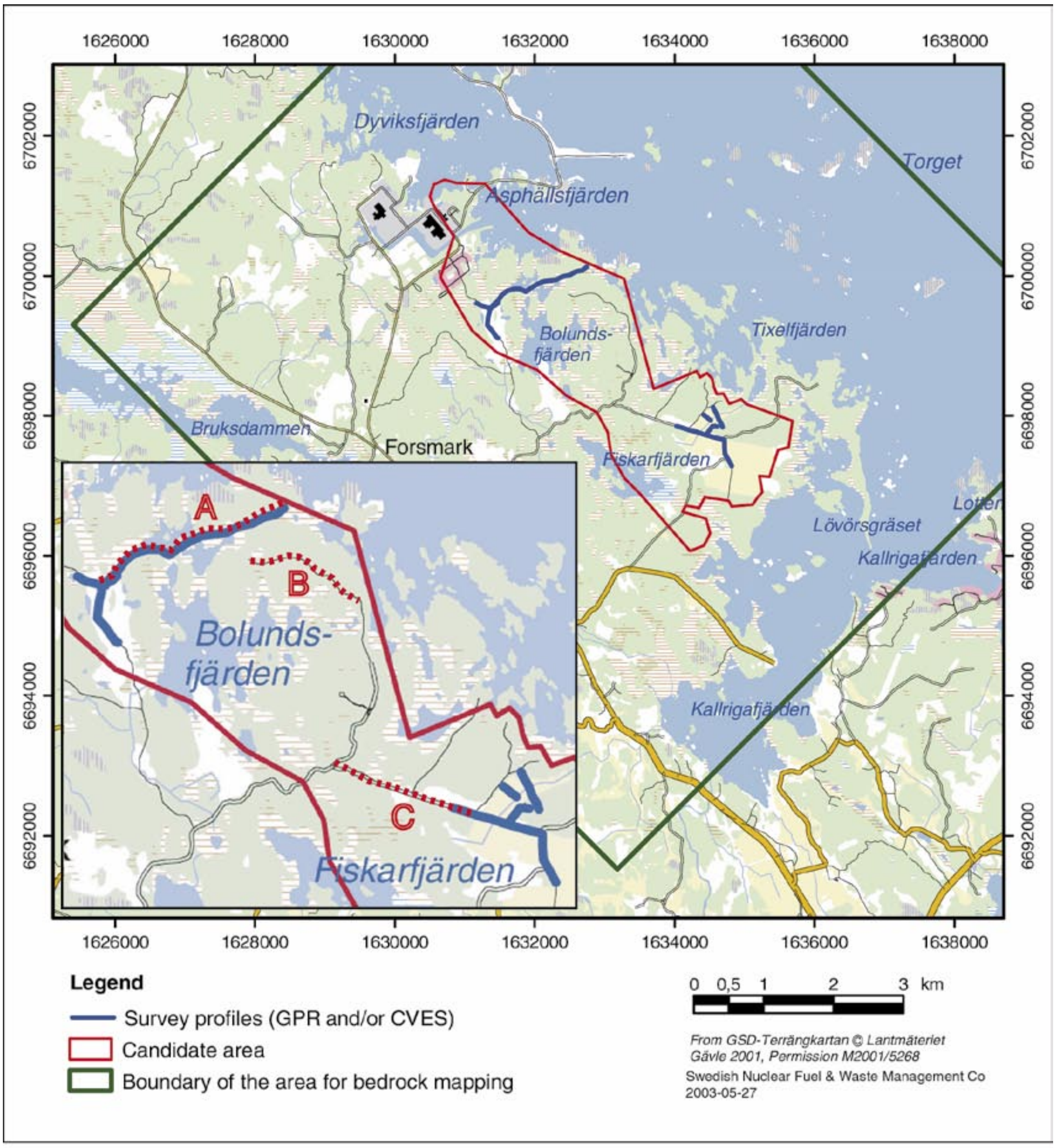


Figure 1-1. *Previous radar (GPR) and resistivity (CVES) measurements (blue lines). New GPR measurements have been carried out along the profiles showed by red dotted lines on the insert map.*

2 Objective and equipment

One of the goals of the ongoing site investigation at Forsmark, is to establish a model describing the soil thickness in the area. Combined with information about the surface topography, a model of the bedrock surface can then be established.

In order to estimate the soil thickness, several methods are applicable. Drilling and digging give direct observations, while geophysical methods like seismics, ground probing radar and geoelectrical measurements give indirect observations. For the interpretation of indirect methods it is important to use available direct observations in order to establish a reliable model.

The present study includes new radar (GPR) measurements and re-interpretation of previous geoelectrical (CVES) measurements /1/, taking new information from drillings into account.

The new GPR measurements are conducted with a recently developed 50 MHz antenna, specially designed for rough terrain. The antenna elements are in-line configured, and the whole system is build into a tube. Only one field operator is required.

A description of the instrument is found in Appendix 1.

3 Execution of radar measurements

The radar measurements were conducted in accordance with the method description SKB MD 251.003, version 1.0 (“Metodbeskrivning för markradar”). Figures 3-1 and 3-2 below show the location of the three profiles measured (Profile A–C), see also Figure 1-1. Table 3-1 shows the settings of the control unit for data collection.

Measurements along Profiles A and B were conducted while walking, whereas Profile C was measured by pulling the antenna by a car along the road. The maximum speed was 10 km/h.

The profiles have been denoted Profile A–C and Profile 2–4 (at Storskäret), names which are also used in the raw data files. The corresponding SKB ID-codes are as follows:

Profile A LFM000568 (previous measurements /1/), LFM000839 (new measurements)

Profile B LFM000657 (new measurements)

Profile C LFM000658 (new measurements)

Profile 2 LFM000569 (previous measurements /1/)

Profile 3 LFM000570 (previous measurements /1/)

Profile 4 LFM000571 (previous measurements /1/)

Table 3-1. Control unit settings during data collection.

Number of samples	408
Sampling frequency	702 MHz (14 times oversampling)
Trace interval	0.10 m
Antenna separation	4 m
Time window	581 ns
Number of stacks	2

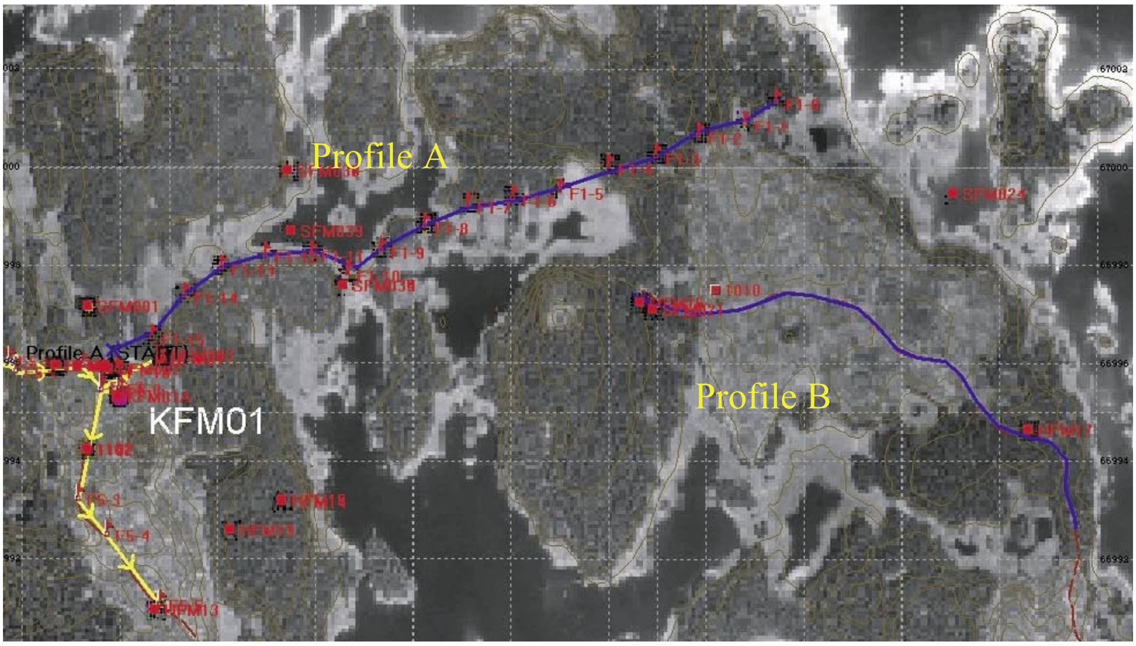


Figure 3-1. *Profiles A and B, both measured from west to east.*

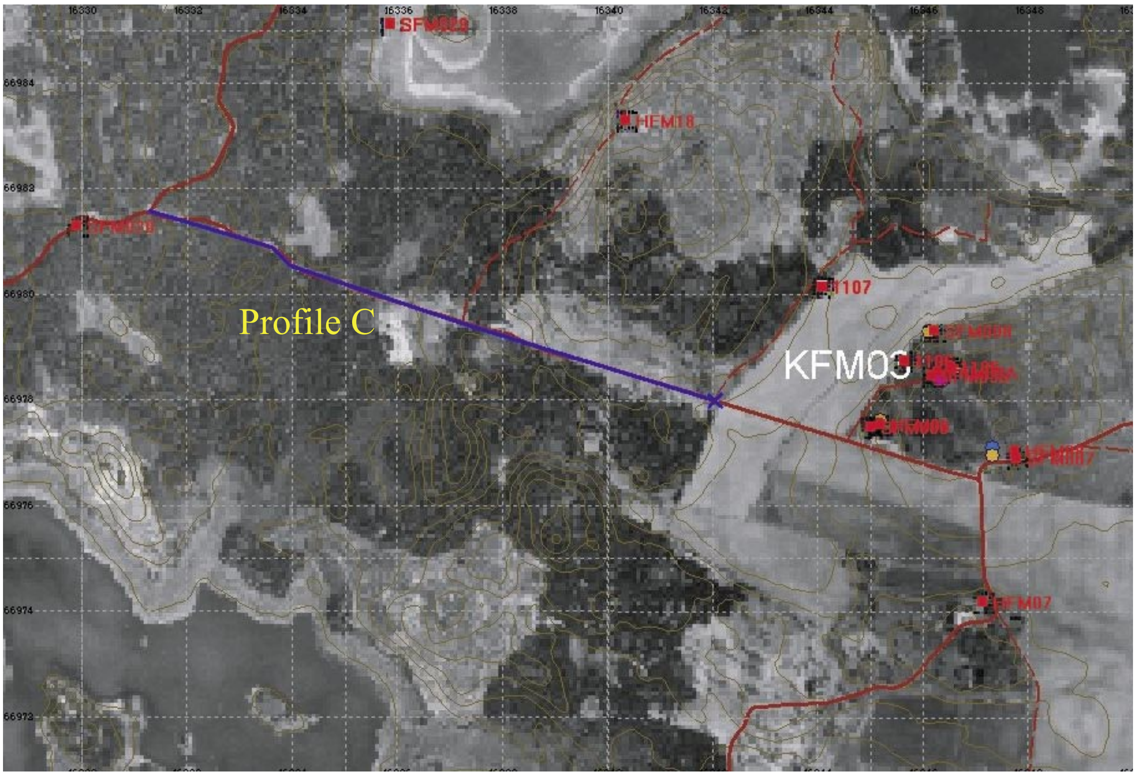


Figure 3-2. *Profile C, measured from east to west.*

4 Interpretation results

4.1 Radar data

The radar data were processed using the REFLEXW software package. The following filter steps were applied for all three profiles:

- Removal of DC shift.
- Adjustment of zero time.
- Gain function (start time 55 ns, linear gain 12, exponential gain 0.02).
- Bandpass filtering (Butterworth 25 MHz to 100 MHz).

Were appropriate, known fix points etc were added into REFLEXW. Along Profile A, a large number of marks from a seismic survey along the same line were added.

The three profiles showed different characteristics:

Profile A (LFM000839): Interpretation possible only along minor parts of the profile. The reason for this is bad penetration of the radar signal due to low electrical resistivity in the ground.

Profile B (LFM000657): Interpretation possible along almost the entire profile. Rather shallow (a few metres) soil cover. Good penetration down to approximately 10 m depth into the bedrock. Normally, very good penetration (down to approximately 25 m) into the bedrock would be expected. The limited penetration in this case might be caused by saline water in the bedrock.

Profile C (LFM000658): Very poor penetration.

Along Profile B, information about soil thickness was available from three boreholes. Attempts have been made to make the radar interpretation in accordance with this information. An example of a section of Profile B is shown in the Figure 4-1 below.

Interpretations for all three profiles, in 100 m sections, are found in Appendix 5–7.

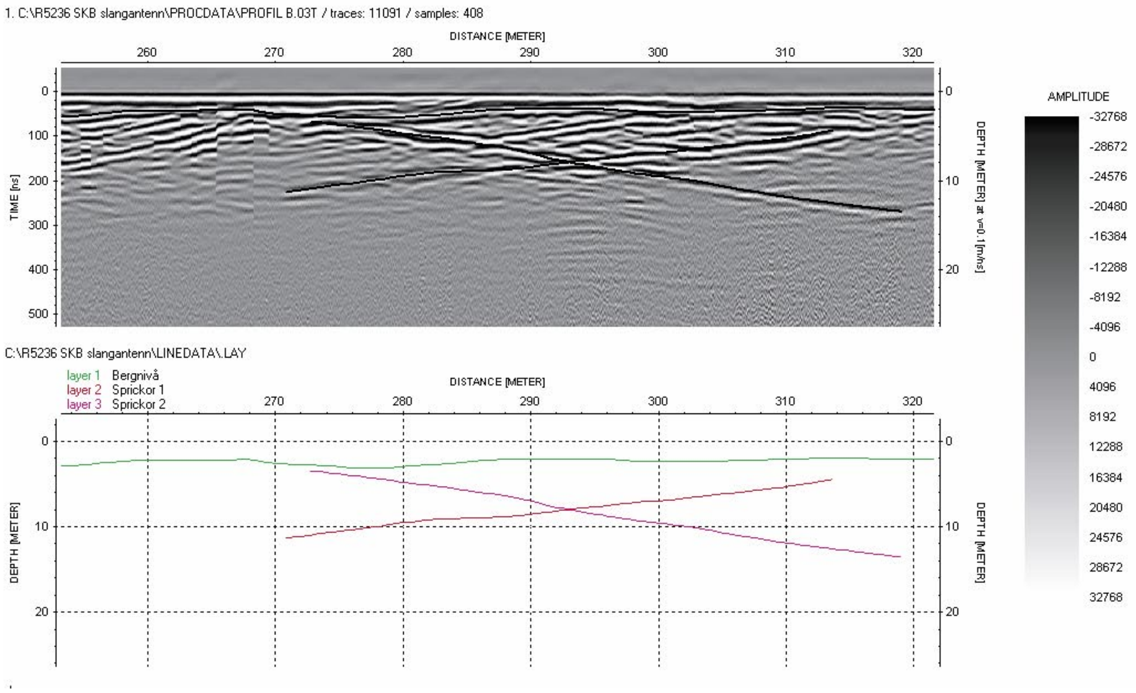


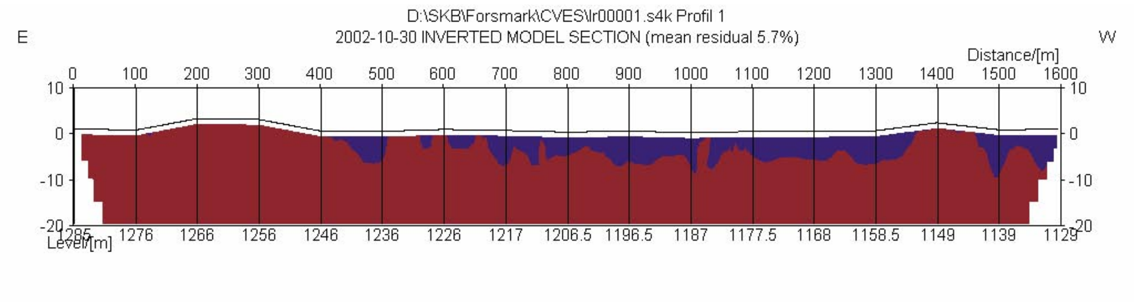
Figure 4-1. A 100 m section of Profle B, measured from west to east. Original data (upper diagram) and interpretation (lower diagram). The green interface corresponds to the interpreted bedrock surface. In the figure is also shown the interpretation of two fracture zones, detected down to approximately 15 metres depth.

4.2 CVES data

The CVES data were inverted using the program RES2DINV. For details of the resistivity method and data analysis, the reader is referred to /1/.

In the three CVES profiles, earlier reported in /1/, information of soil thickness were incorporated. It was found that the best agreement with the soil depths reported from the boreholes was established by selecting a treshold resistivity of 300 Ωm.

4.2.1 Profile A (LFM00568)



In Profile A (see Figure 3-1) information from the boreholes SFM034 and SFM035, both located very close to position 1000 m (point #1187), was used. Also information from KFM01 and the nearby SFM-holes was used. Detailed plots of soil thickness are shown in Appendix 2.

4.2.2 The Storskäret profiles

The location of Profiles 2, 3 and 4 at Storskäret is documented in /1/ and shown in Figure 4-2.

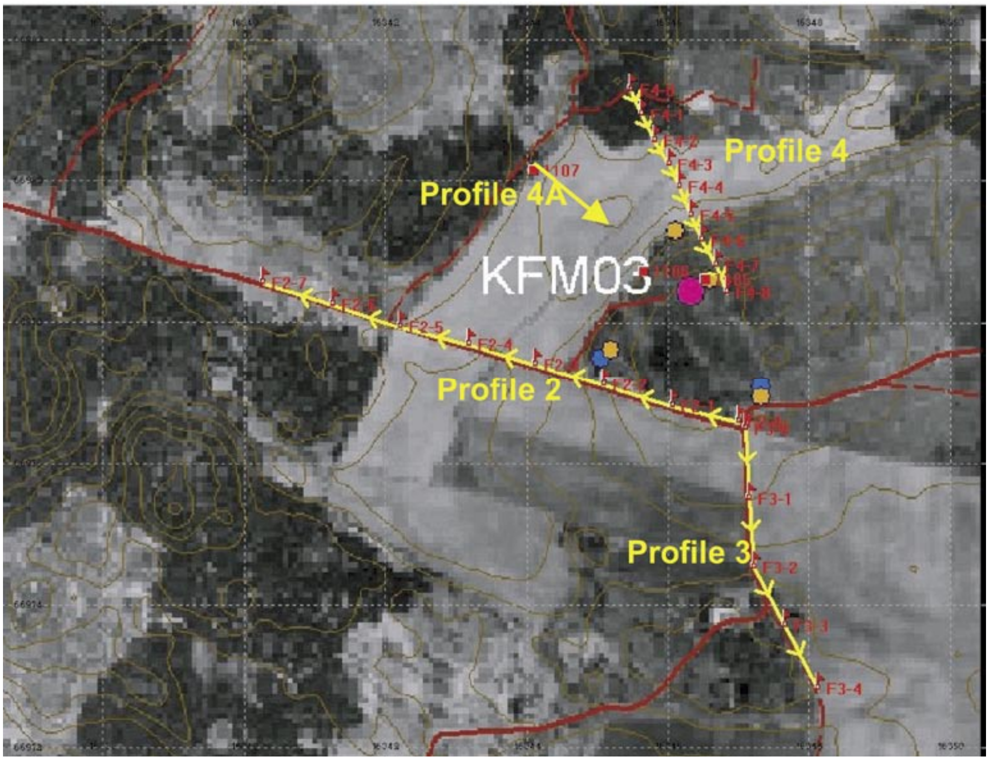
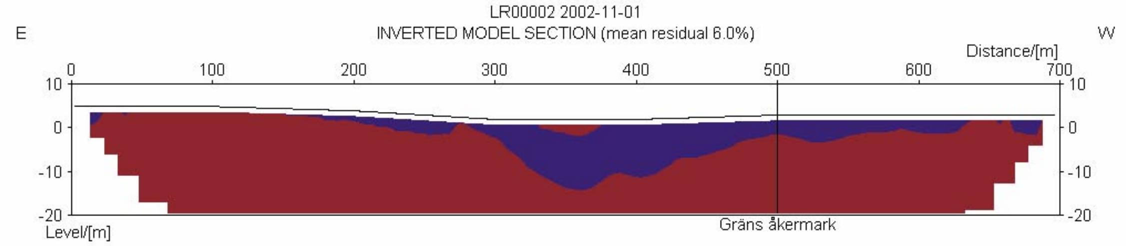


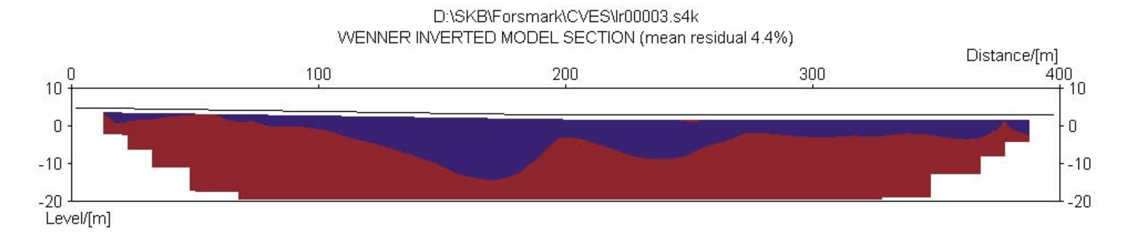
Figure 4-2. Profiles 2, 3 and 4 at Storskäret. From /1/.

Profile 2 (LFM000569)



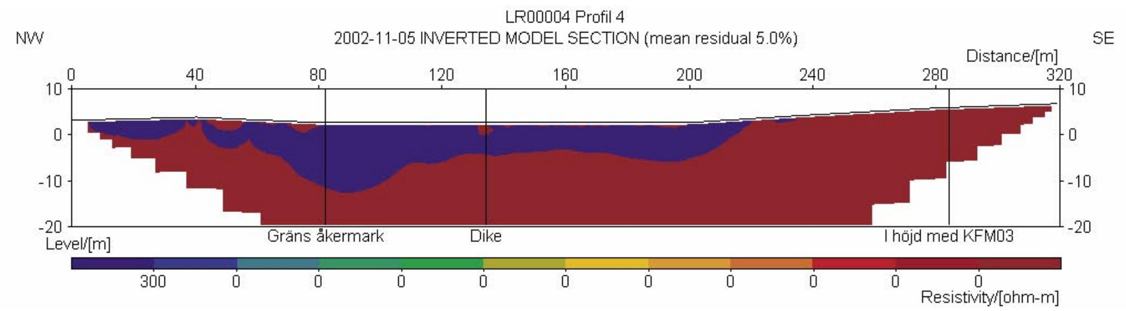
In the display above, a threshold resistivity of 300 Ωm was used. There are no nearby boreholes for calibrating the display. Detailed plots of soil thickness are shown in Appendix 3.

Profile 3 (LFM000570)



In the display above, a threshold resistivity of 300 Ωm was used. There are no nearby boreholes for calibrating the display. A detailed plot of soil thickness is shown in Appendix 4.

Profile 4 (LFM000571)



In the display above, a threshold resistivity of 300 Ωm was used. There are no nearby boreholes for calibrating the display. A detailed plot of soil thickness is shown in Appendix 4.

4.3 Soil depth at discrete points

Interpreted soil depths from the radar and resistivity measurements have been picked at approximately every 5 metres along the profiles and the results are documented in EXCEL-files. The tables contain the co-ordinates (in RT90) together with the interpreted depth, ready to be inserted in SICADA.

Figure 4-3 presents a comparison of the CVES and GPR depth interpretation along Profile A. To a large extent, the interpretations are in agreement. However, there are disagreements also. The main error sources for the two methods applied are discussed in Section 4.4.

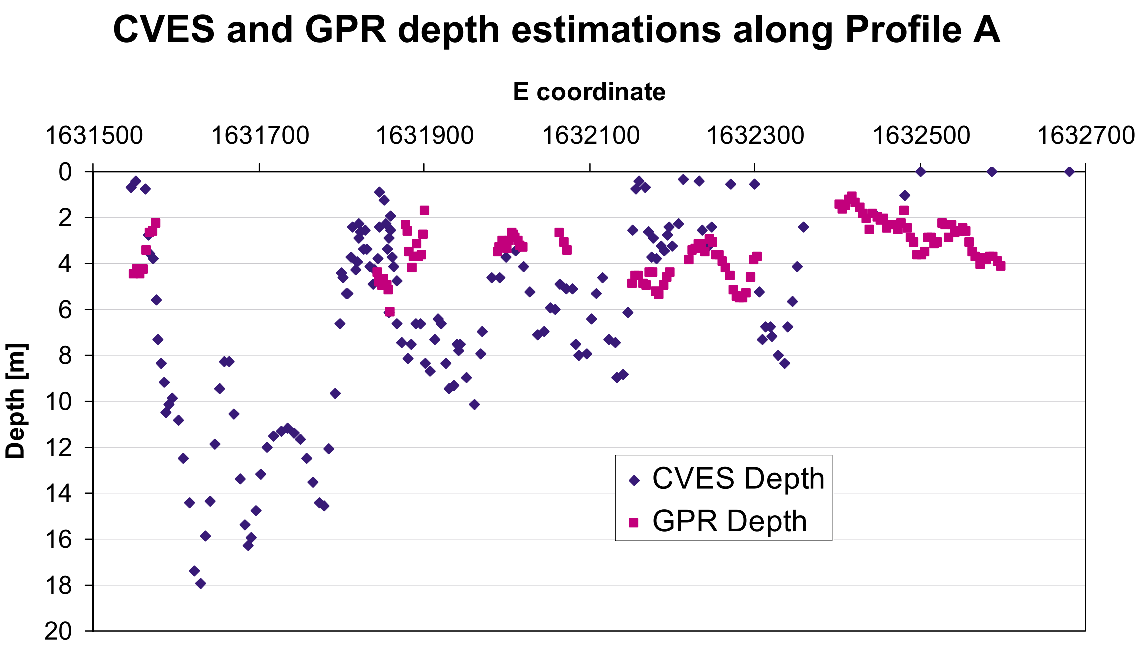


Figure 4-3. Comparison of CVES and GPR depth interpretation.

4.4 Discussion

The RTC antenna showed up to work very well. The data was collected at normal walking speed, and even in case of dense forest, the antenna could be handled without serious problems.

In the following is given a short description of some possible error sources for both methods applied it the present study.

Error sources in the CVES interpretation:

- In geological conditions with a highly resistive substratum, the resistivity method gives a unique determination of the longitudinal conductance, which is the sum of the thickness/resistivity ratios of the overlying layers. However, the independent estimation of the thickness and resistivity values is less accurate. This phenomenon is called equivalence.
- When interpreting the CVES data, a treshold resistivity of 300 ohm-m was selected for defining the transition from soil to bedrock. This value was selected in order to make the interpretation in agreement with the (very few) known depth values from boreholes. By using a larger number of “calibration boreholes” a more refined interpretation could be achieved.
- The interpretation is based upon the assumption that 3D effects can be neglected. Obviously, there exist strong 3D effects in the area, which can cause misinterpretation.

Error sources in the GPR interpretation:

- The most probable error is misinterpretation of the reflectors in the radargram (e.g. a reflector within the overburden could be misinterpreted as the bedrock surface). This source of error can only be eliminated by adding supportive information from e.g. nearby drillings.
- Wrong velocity estimation gives wrong depth estimates. In the actual interpretation, a velocity of 100 m/μsec was used. This value is based upon estimates from hyperbolic diffractions from the present and earlier radar measurements in the area.

For both methods it is of outmost importance with accurate positioning. The CVES profiles were positioned using GPS at all cable joints during the data collection. The co-ordinates along the CVES profiles were calculated by interpolation between the cable joints. The overall accuracy of the CVES co-ordinates is better than 5 metres. The GPR profiles are positioned at regular intervals using the detailed maps, see e.g. Figure 3-1 and 3-2. The depth interpretations are then exported together with interpolated co-ordinates. The overall accuracy is better than 5 metres, but the relative accuracy (from point to point) is of the order 0.5–1 metre.

5 Data delivery

The results from the radar measurements have been delivered as raw data files on CD-ROM to SKB. The raw data consists of two file types: *.rd3 containing the binary radar data and *.rad containing information about the settings etc in ASCII format.

The interpretation results are delivered in pdf-format. All radar interpretations (soil thickness and fracture zones) are furthermore delivered in ASCII files (*.pck).

EXCEL files containing co-ordinates (X,Y in RT90) and soil depths for both the radar and the CVES interpretations have been delivered to SKB.

The SICADA reference is field note no Forsmark 210.

6 References

/1/ **Nissen J, 2003.** Test of methods. Ground penetrating radar and resistivity measurements for overburden investigations. SKB P-03-43, Svensk kärnbränslehantering AB.

Appendix 1

The RAMAC Rough Terrain Concept RTA50

Photography of the RAMAC Rough Terrain Concept RTA50 antenna in field operation. The antenna is operated by one operator (in contrast to traditional systems, in which two operators are required). The total length of the antenna is approximately 9m.

The antenna is controlled by a RAMAC CUII control unit, and a RAMAC XV Monitor.

All equipment are manufactured by Malå Geoscience AB.

The RTC offers a number of advantages over standard unshielded low-frequency Systems

- Minimal site preparation since the RTA articulated/ flexible design curves and bends around and over obstacles such as fallen trees, rocks and ditches.
- One-person design for easy handling.
- Capable of mounting to a vehicle.
- Ruggedized for extreme environments and terrains.
- Optimum ground coupling due to the articulated/flexible design results in deeper profiling.
- Low power consumption results in extended operation time.

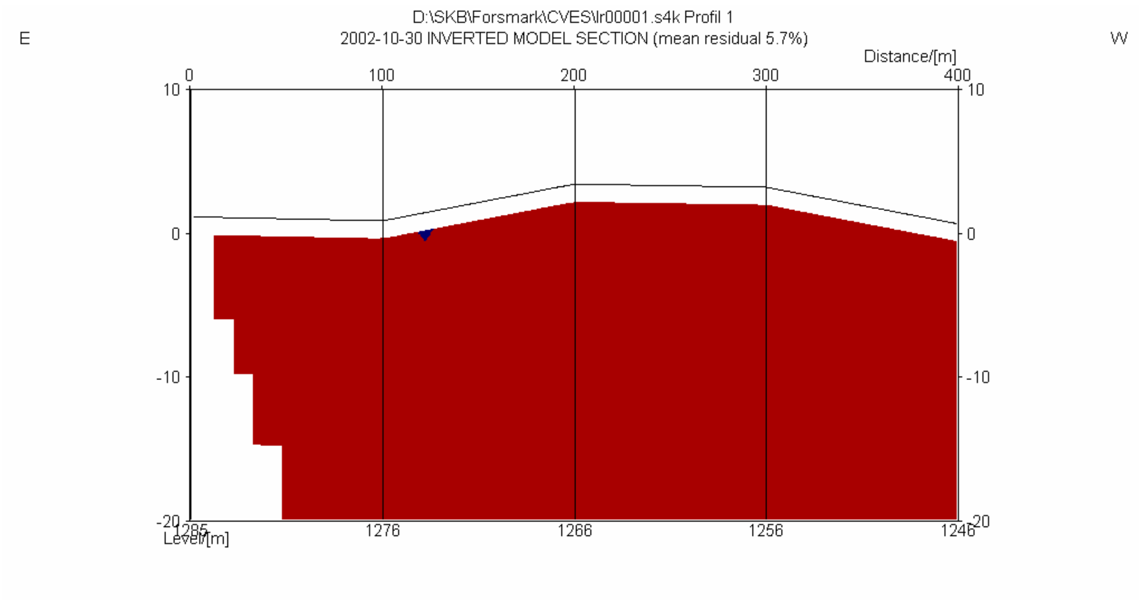
Technical Specifications

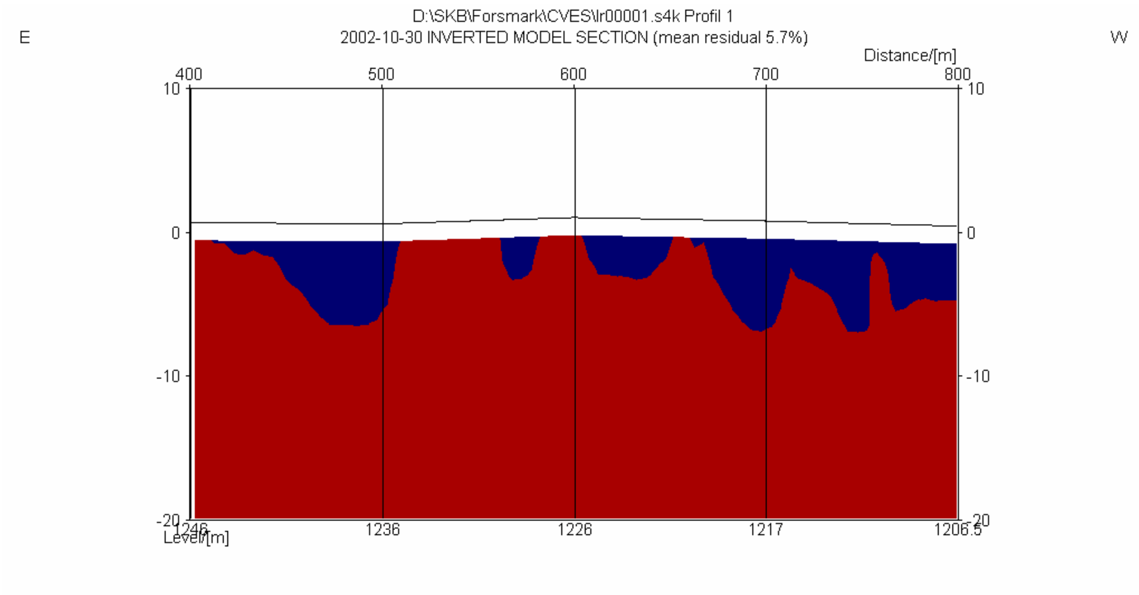
Total weight incl. Batteries	7 kg (15.5 lbs)
Total length	9.25 m (30 ft)
Distance Tx-Rx	4 m (13 ft)
Center frequency	50 MHz
Power source	12V Li-Ion rechargeable
Operating time	6 hours
Environmental	Shock and water proof

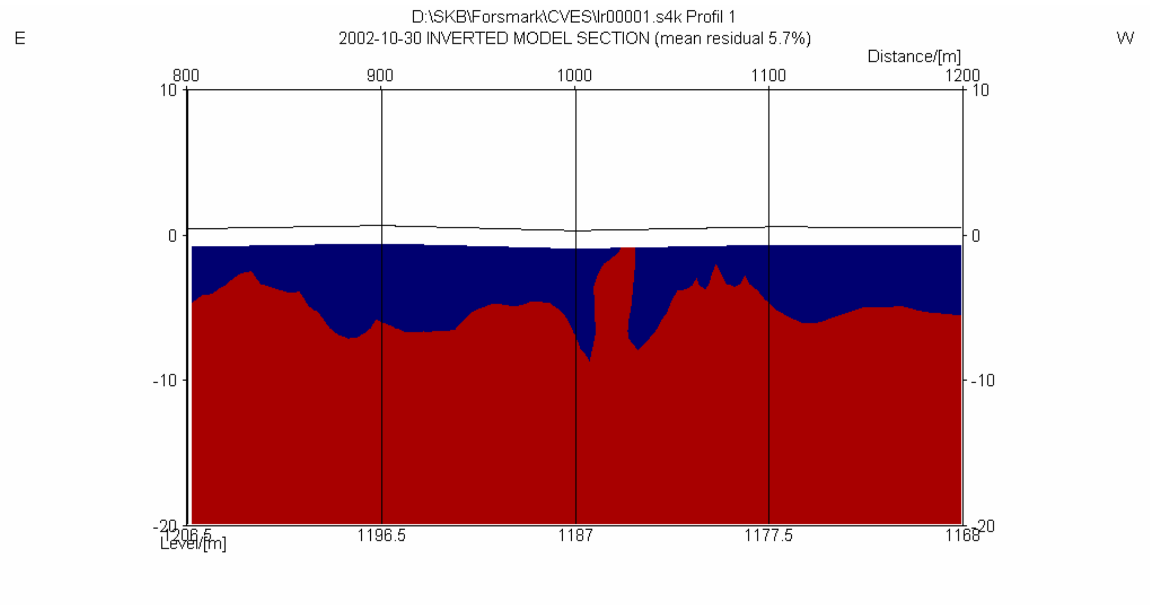
Appendix 2

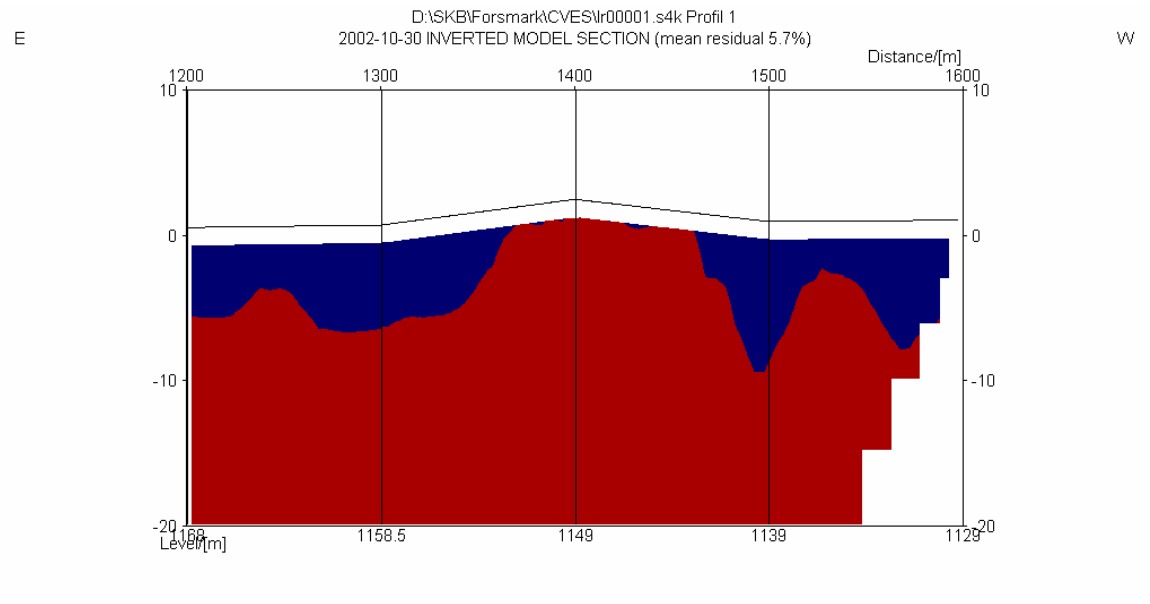
Detailed plots of soil thickness from CVES measurements, Profile A

The following diagrams shows 400m-sections of Profile A. The threshold resistivity between bedrock and soil is 300 Ωm. The vertical exaggeration is 10 times.





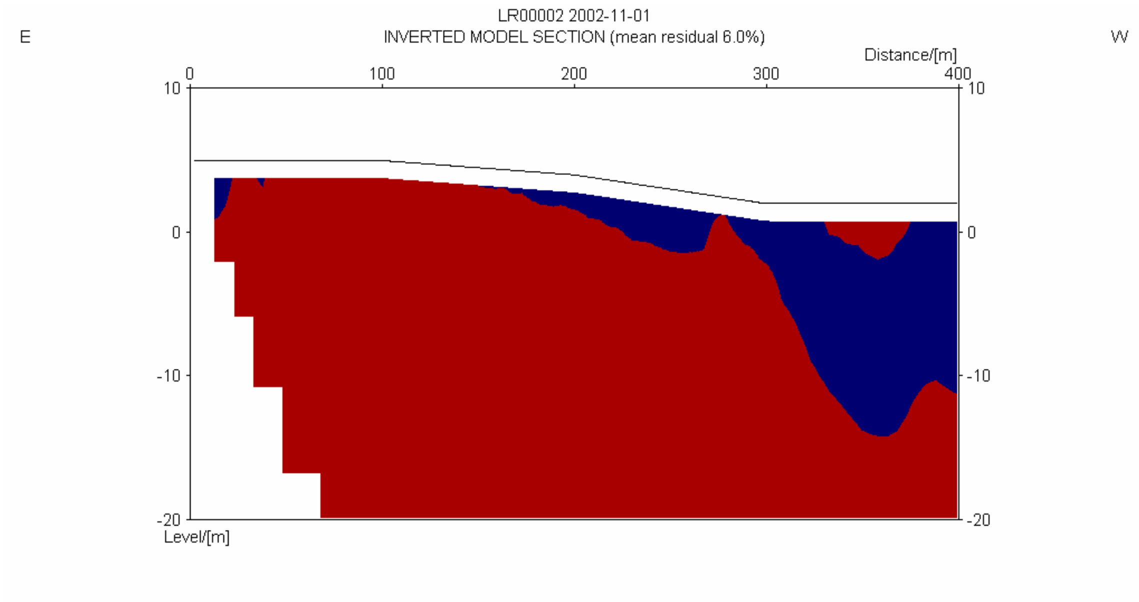

E
D:\SKB\Forsmark\CVES\lr00001.s4k Profil 1
2002-10-30 INVERTED MODEL SECTION (mean residual 5.7%)
W
Distance/[m]
800
900
1000
1100
1200
10
0
-10
-20
1206.5
1196.5
1187
1177.5
1168
Level/[m]

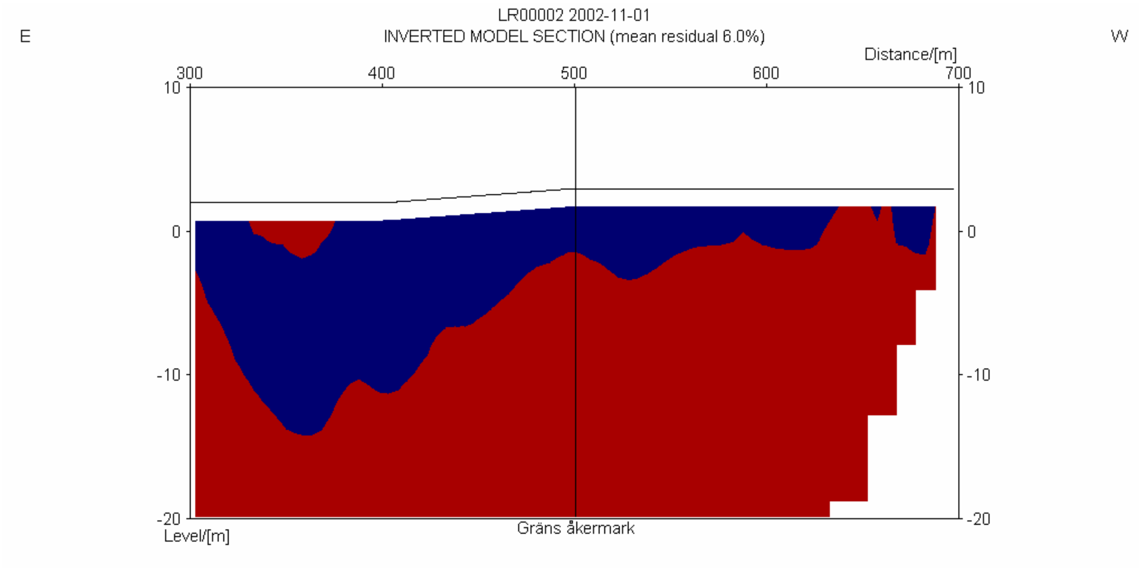

E
D:\SKB\Forsmark\CVES\lr00001.s4k Profil 1
2002-10-30 INVERTED MODEL SECTION (mean residual 5.7%)
W
Distance/[m]
1200
1300
1400
1500
1600
10
0
-10
-20
1168
1158.5
1149
1139
1129
Level/[m]

Appendix 3

Detailed plots of soil thickness from CVES measurements, Profile 2

The following diagrams shows 400m-sections of Profile 2. The threshold resistivity between bedrock and soil is 300 Ωm. The vertical exaggeration is 10 times.



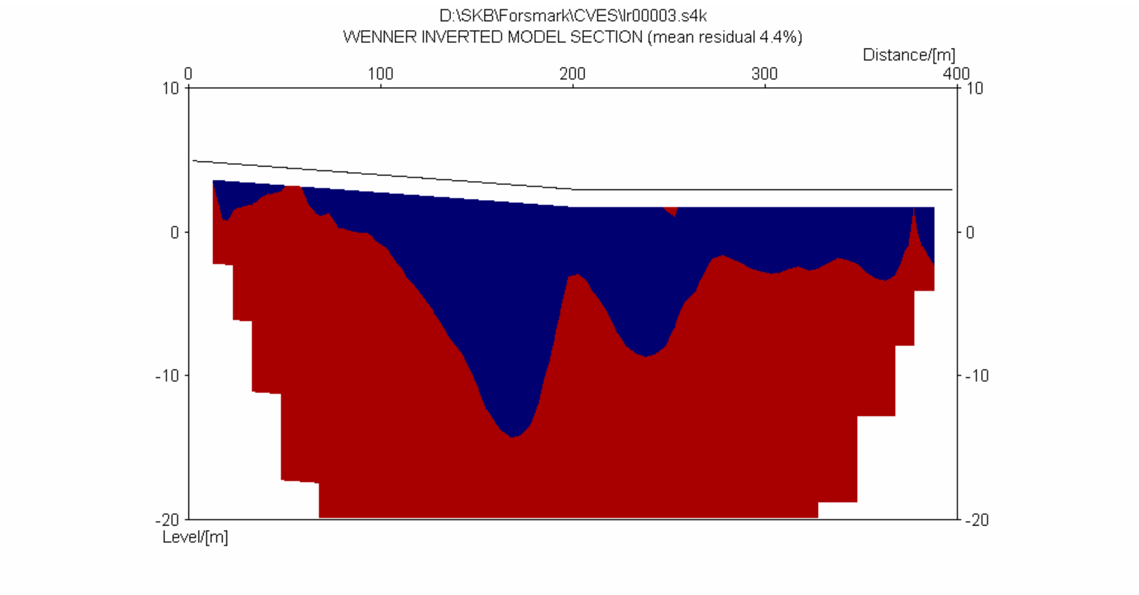


Appendix 4

Detailed plots of soil thickness from CVES measurements, Profiles 3 and 4

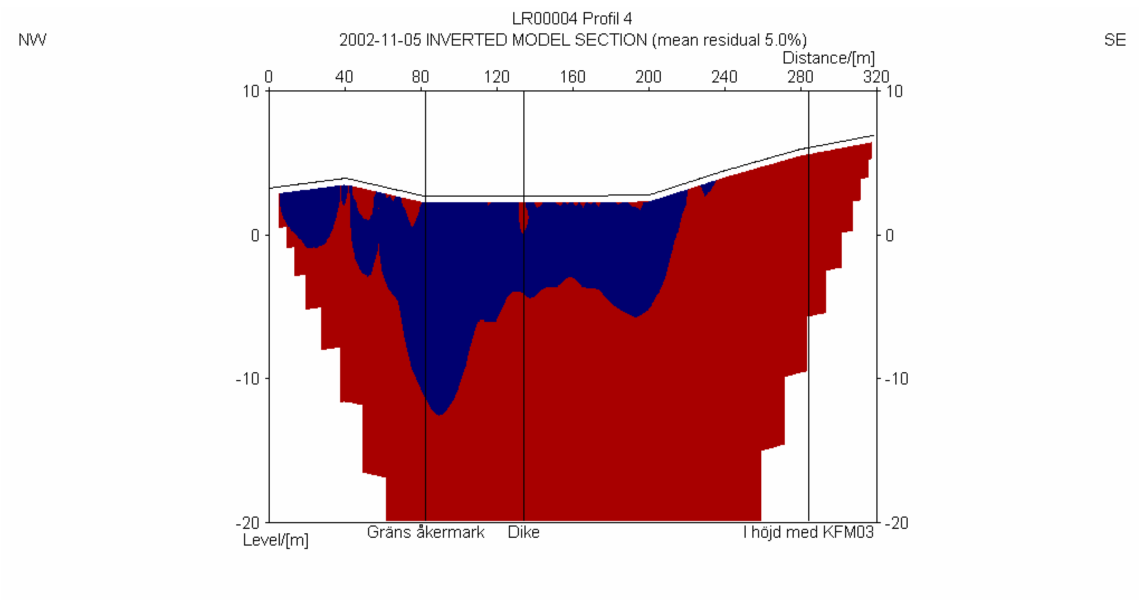
Profile 3

The following diagram shows Profile 3. The threshold resistivity between bedrock and soil is 300 Ωm. The vertical exaggeration is 10 times.



Profile 4

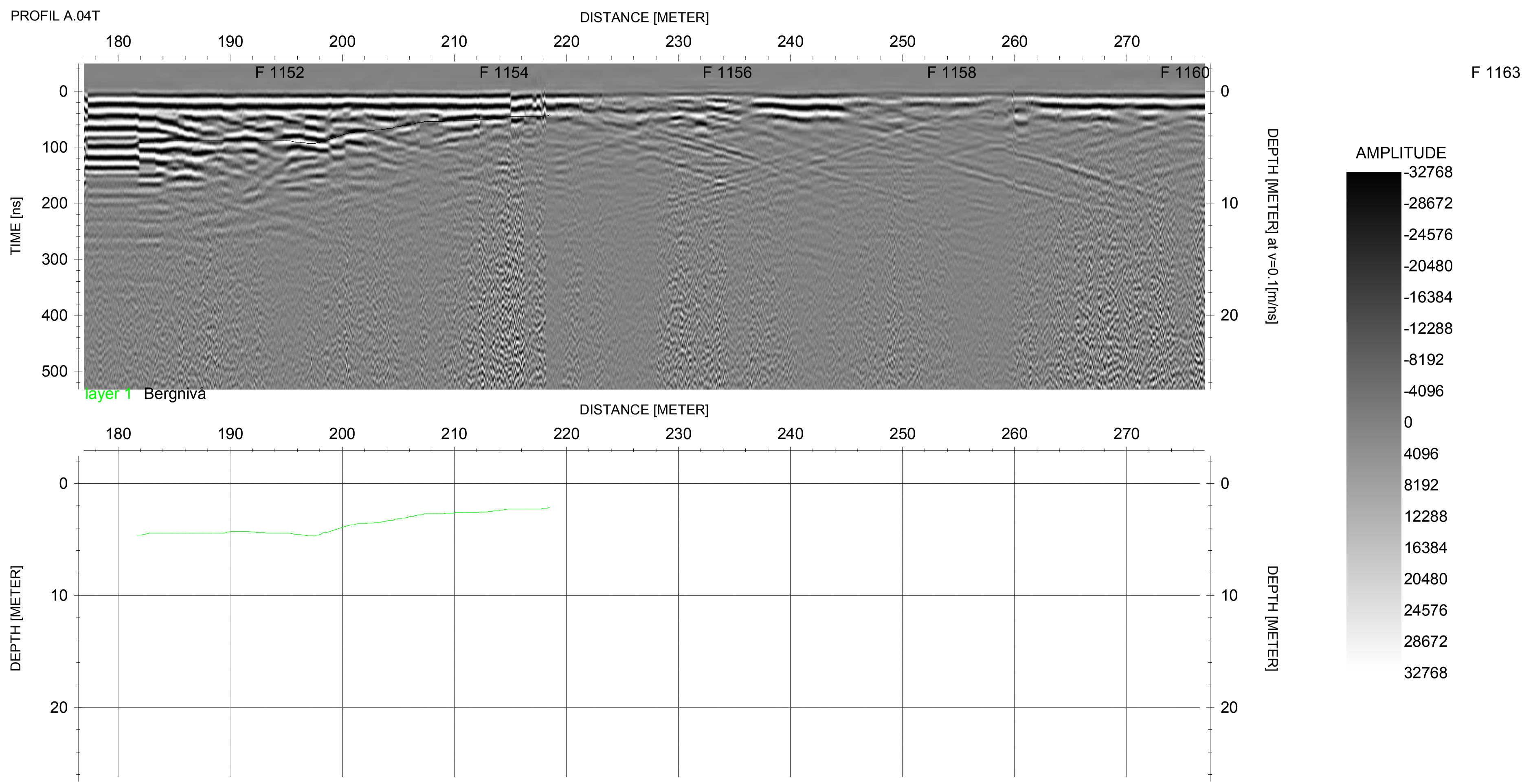
The following diagram shows Profile 4. The threshold resistivity between bedrock and soil is 300 Ωm. The vertical exaggeration is 10 times.



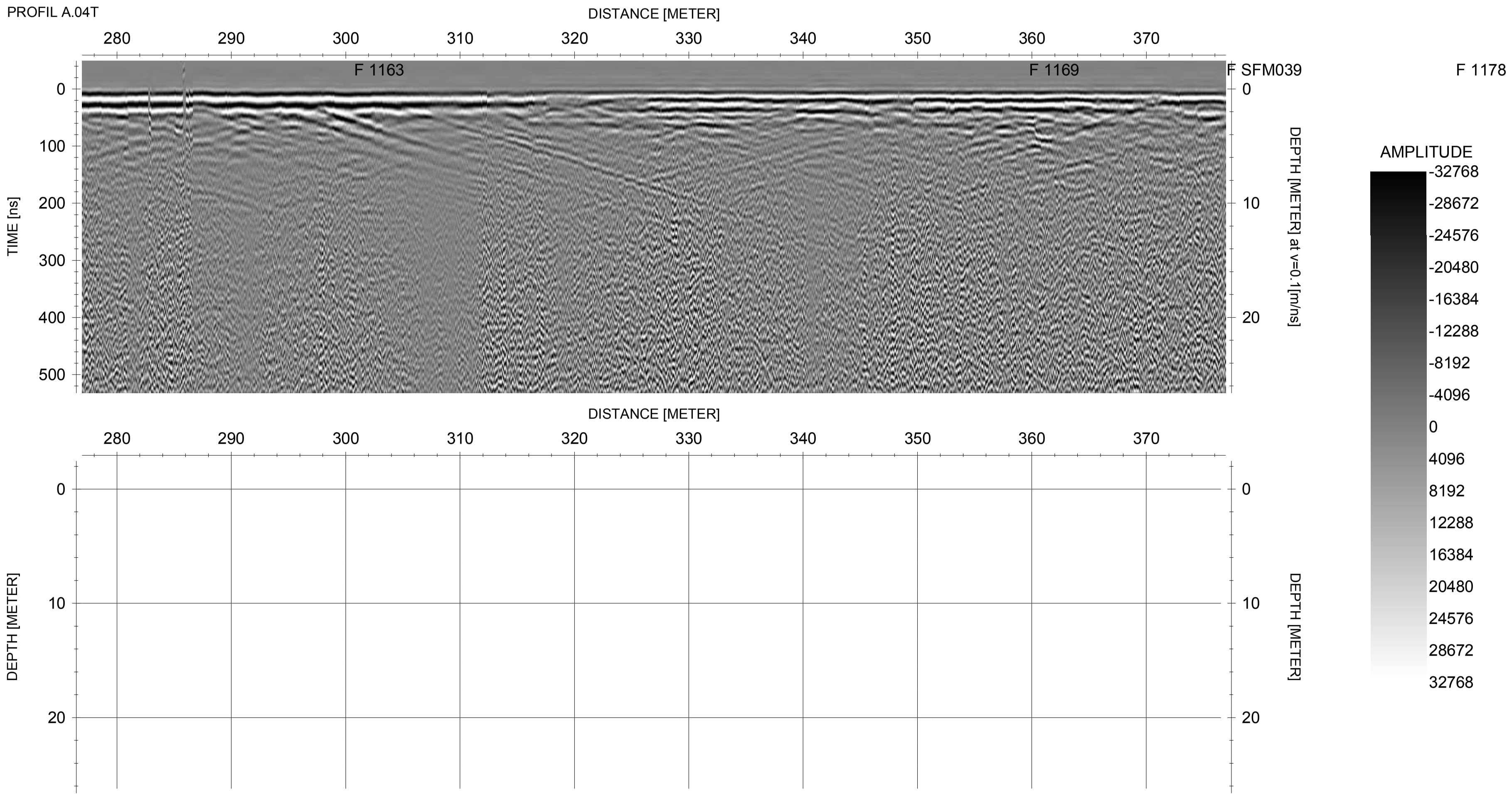
Appendix 5

Radar data from Profile A in 100 m sections

Profil A

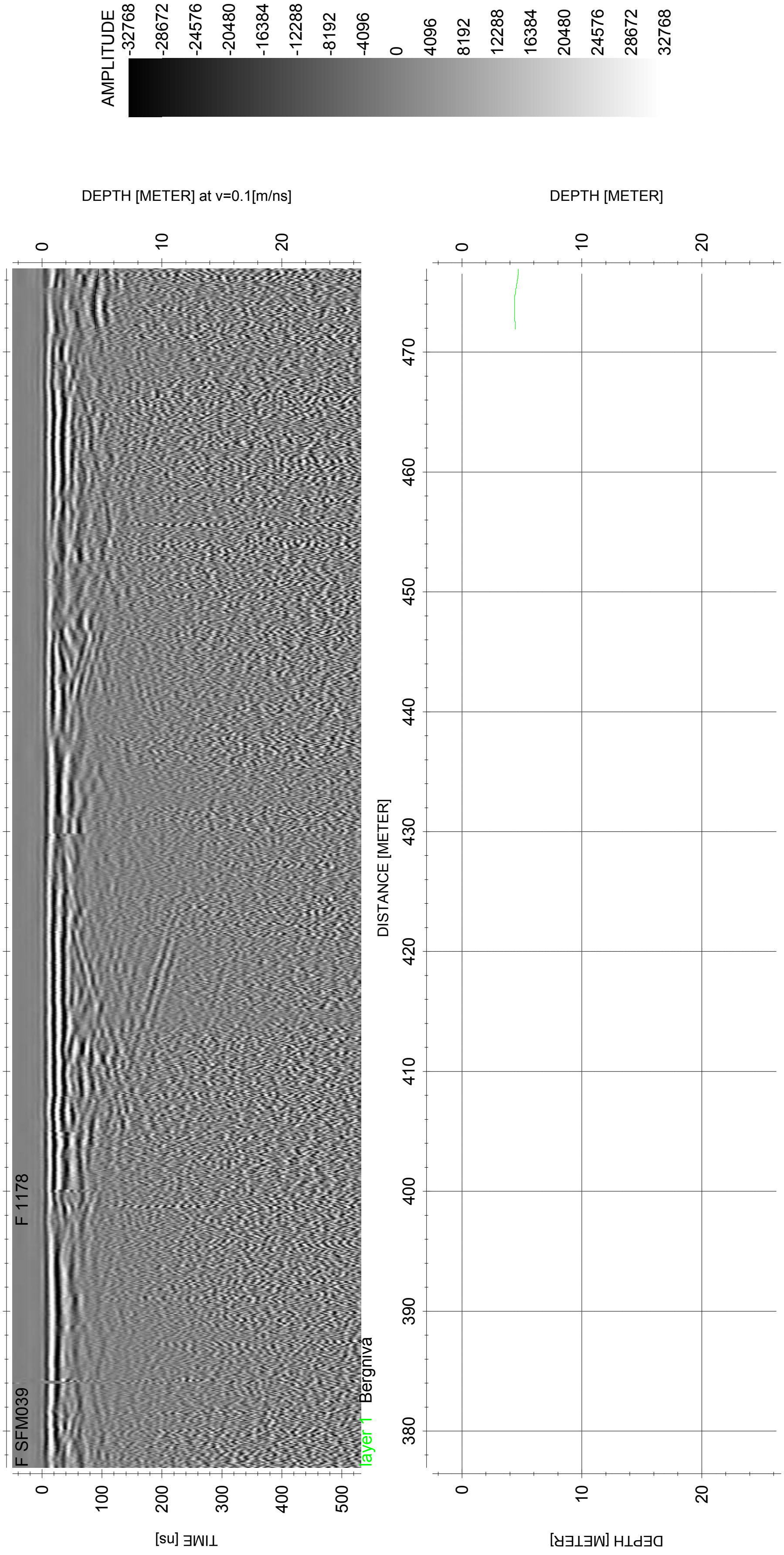


Profil A

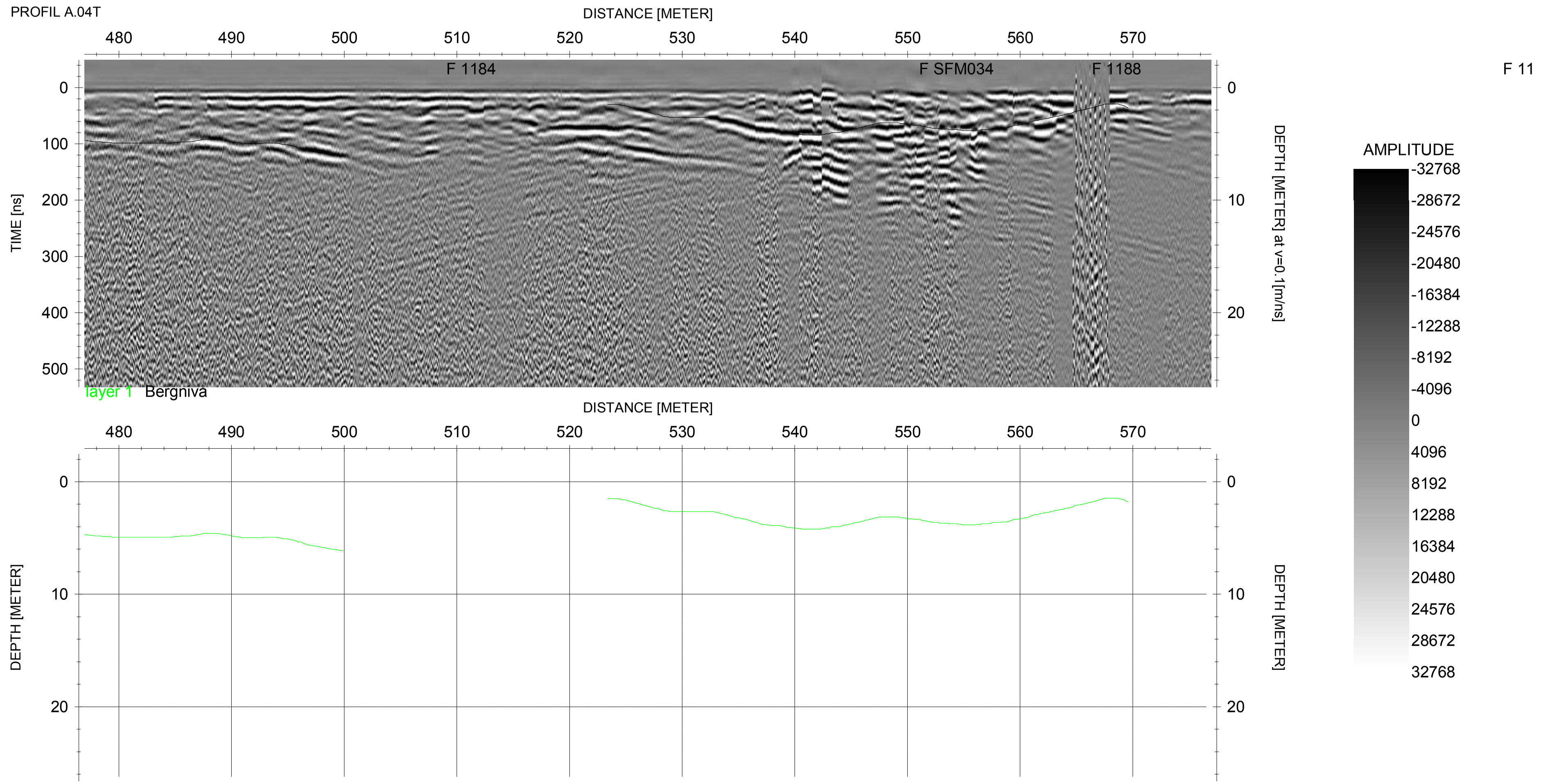

PROFIL A.04T
DISTANCE [METER]
280
290
300
310
320
330
340
350
360
370
F 1163
F 1169
F SFM039
F 1178
TIME [ns]
0
100
200
300
400
500
DEPTH [METER] at v=0.1[m/ns]
0
10
20
AMPLITUDE
-32768
-28672
-24576
-20480
-16384
-12288
-8192
-4096
0
4096
8192
12288
16384
20480
24576
28672
32768
DISTANCE [METER]
DEPTH [METER]

Profil A

PROFIL A.04T



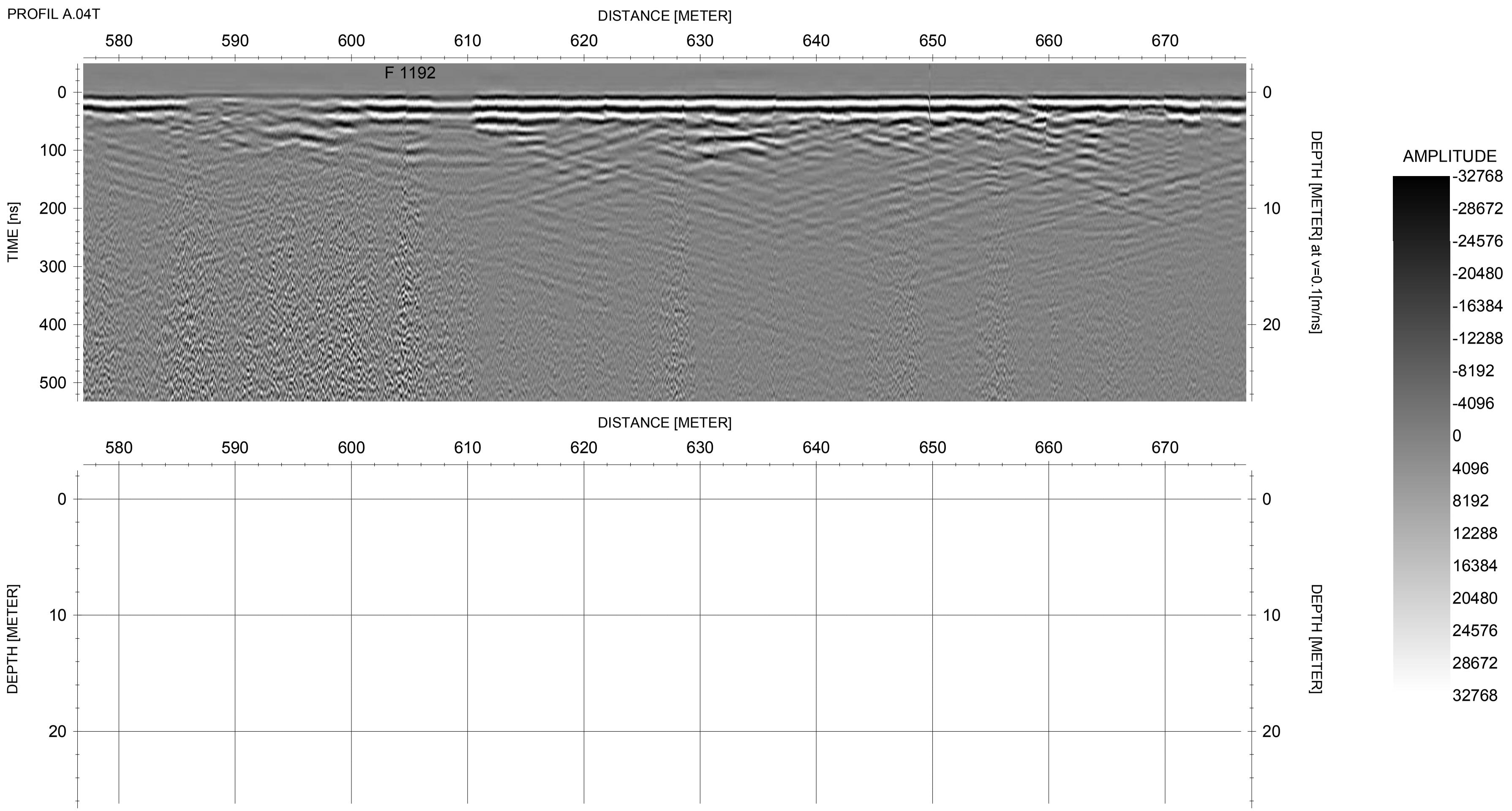
Profil A

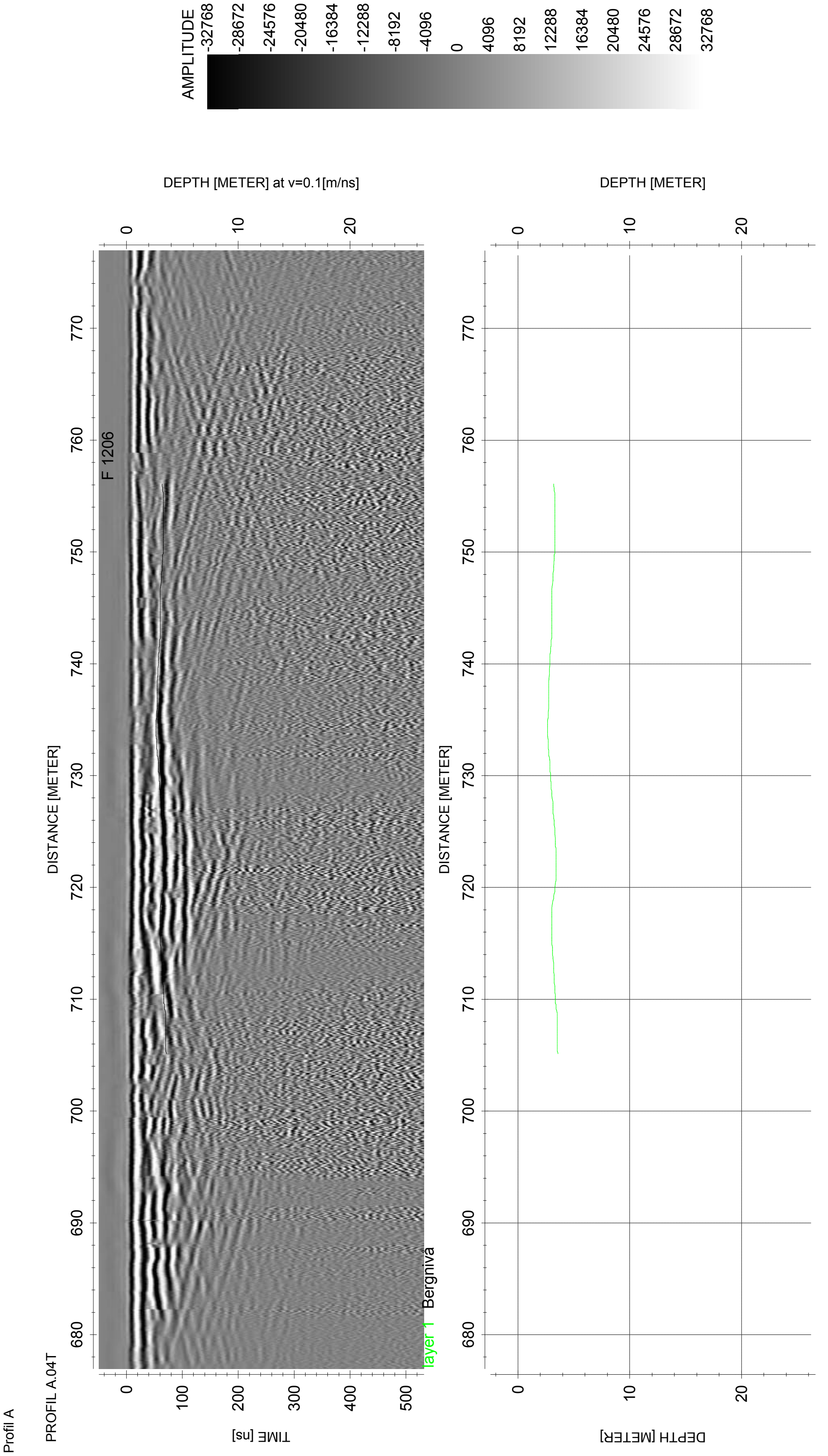


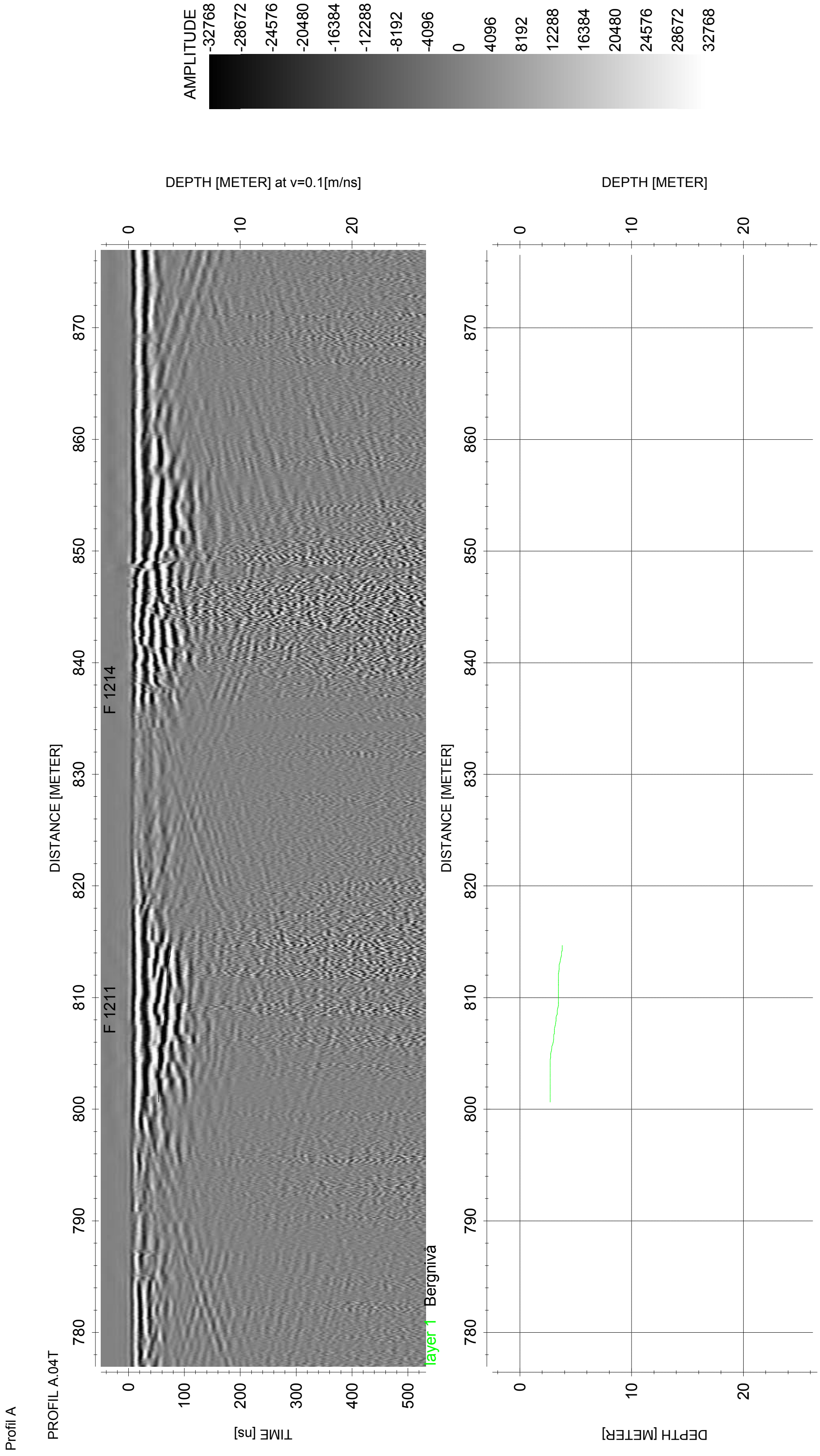
PROFIL A.04T
DISTANCE [METER]
480
490
500
510
520
530
540
550
560
570
F 1184
F SFM034
F 1188
TIME [ns]
0
100
200
300
400
500
DEPTH [METER] at v=0.1[m/ns]
0
10
20
layer 1
Bergnivå
DISTANCE [METER]
DEPTH [METER]
DEPTH [METER]
AMPLITUDE
-32768
-28672
-24576
-20480
-16384
-12288
-8192
-4096
0
4096
8192
12288
16384
20480
24576
28672
32768

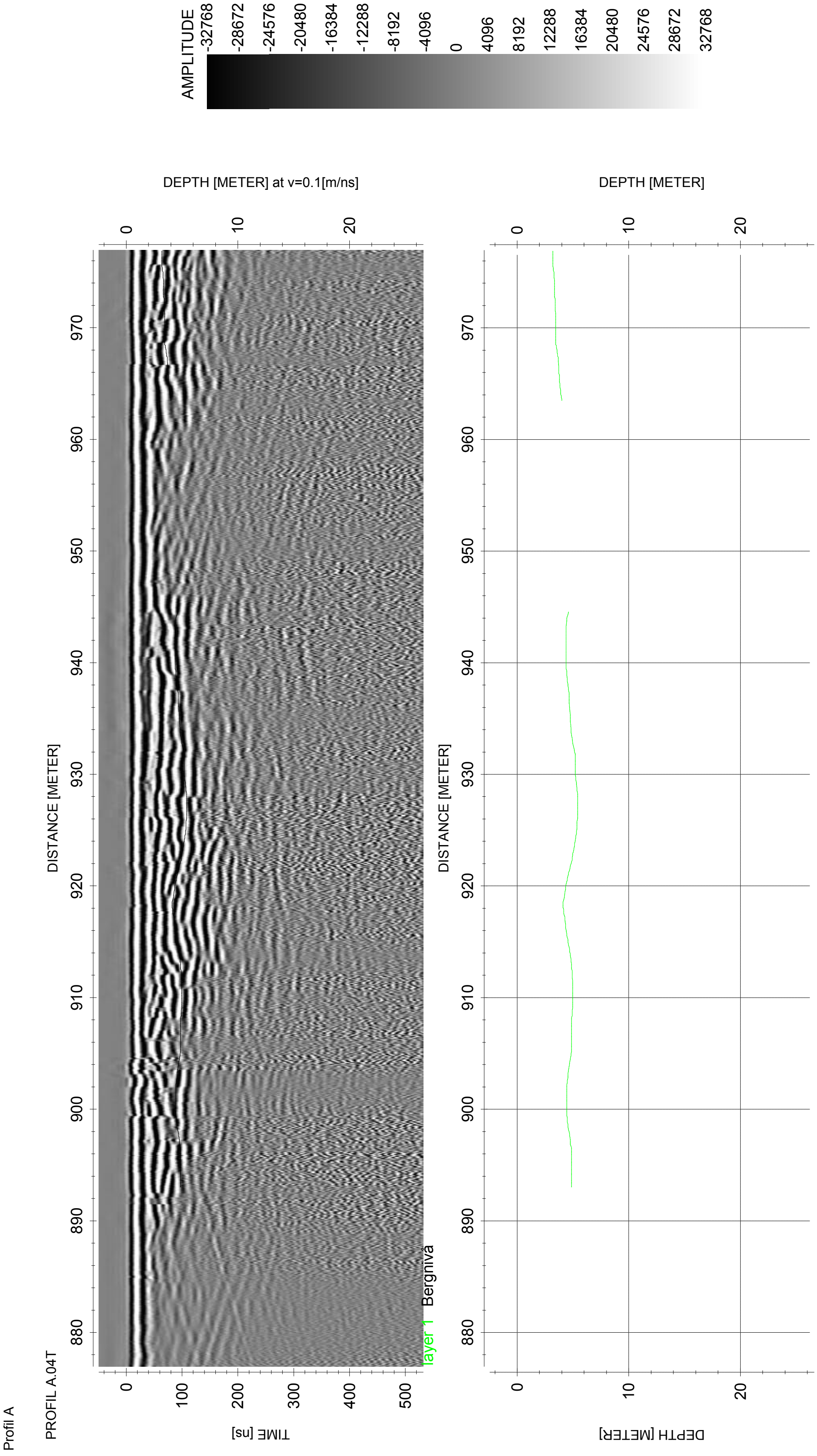
F 11

Profil A

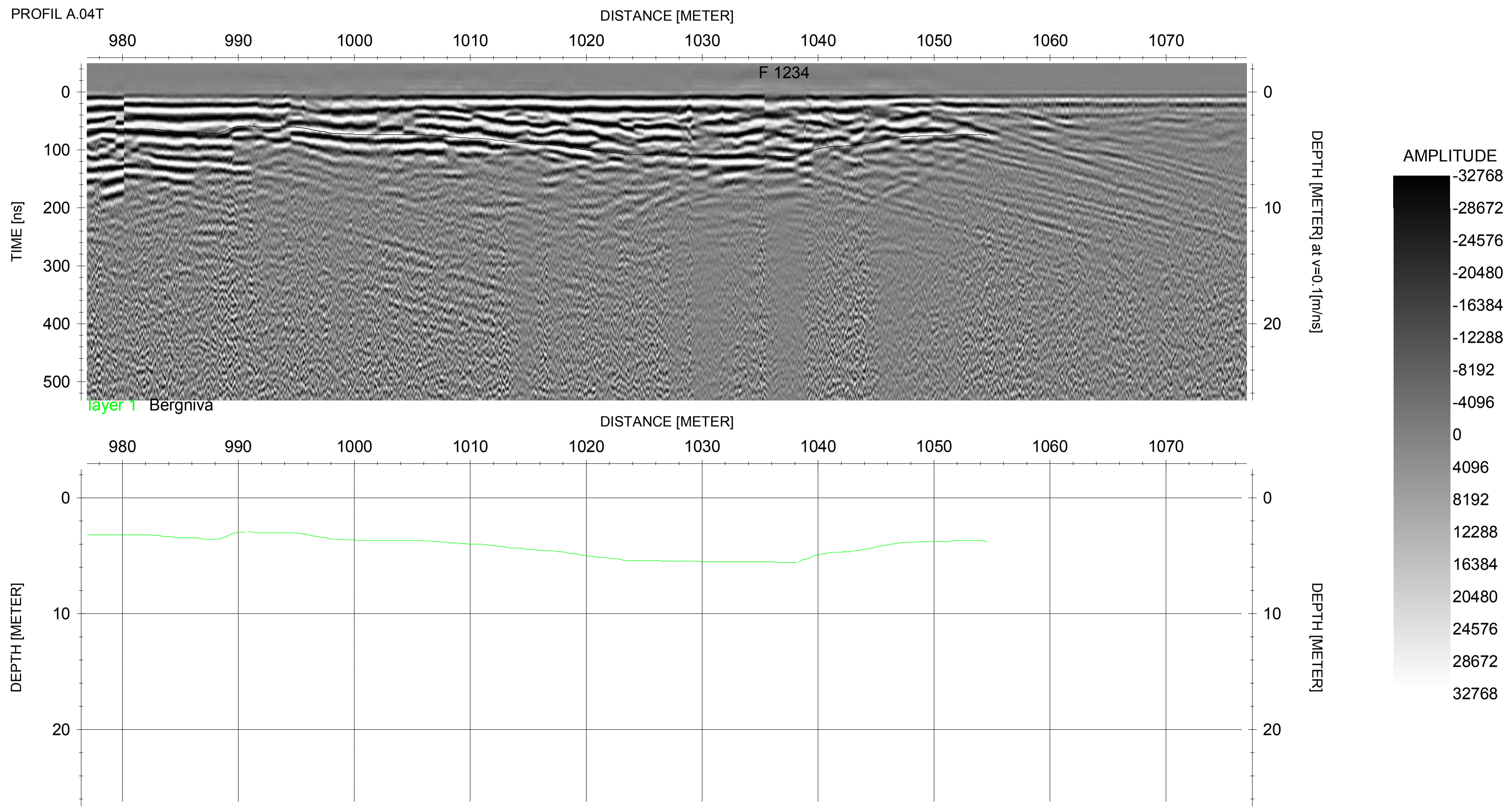

PROFIL A.04T
DISTANCE [METER]
580
590
600
610
620
630
640
650
660
670
F 1192
TIME [ns]
0
100
200
300
400
500
DEPTH [METER] at v=0.1[m/ns]
0
10
20
DISTANCE [METER]
DEPTH [METER]
DEPTH [METER]
AMPLITUDE
-32768
-28672
-24576
-20480
-16384
-12288
-8192
-4096
0
4096
8192
12288
16384
20480
24576
28672
32768


Profil A
PROFIL A.04T
AMPLITUDE
-32768
-28672
-24576
-20480
-16384
-12288
-8192
-4096
0
4096
8192
12288
16384
20480
24576
28672
32768
DEPTH [METER] at v=0.1[m/ns]
DISTANCE [METER]
TIME [ns]
F 1206
layer 1
Bergnivå
DEPTH [METER]

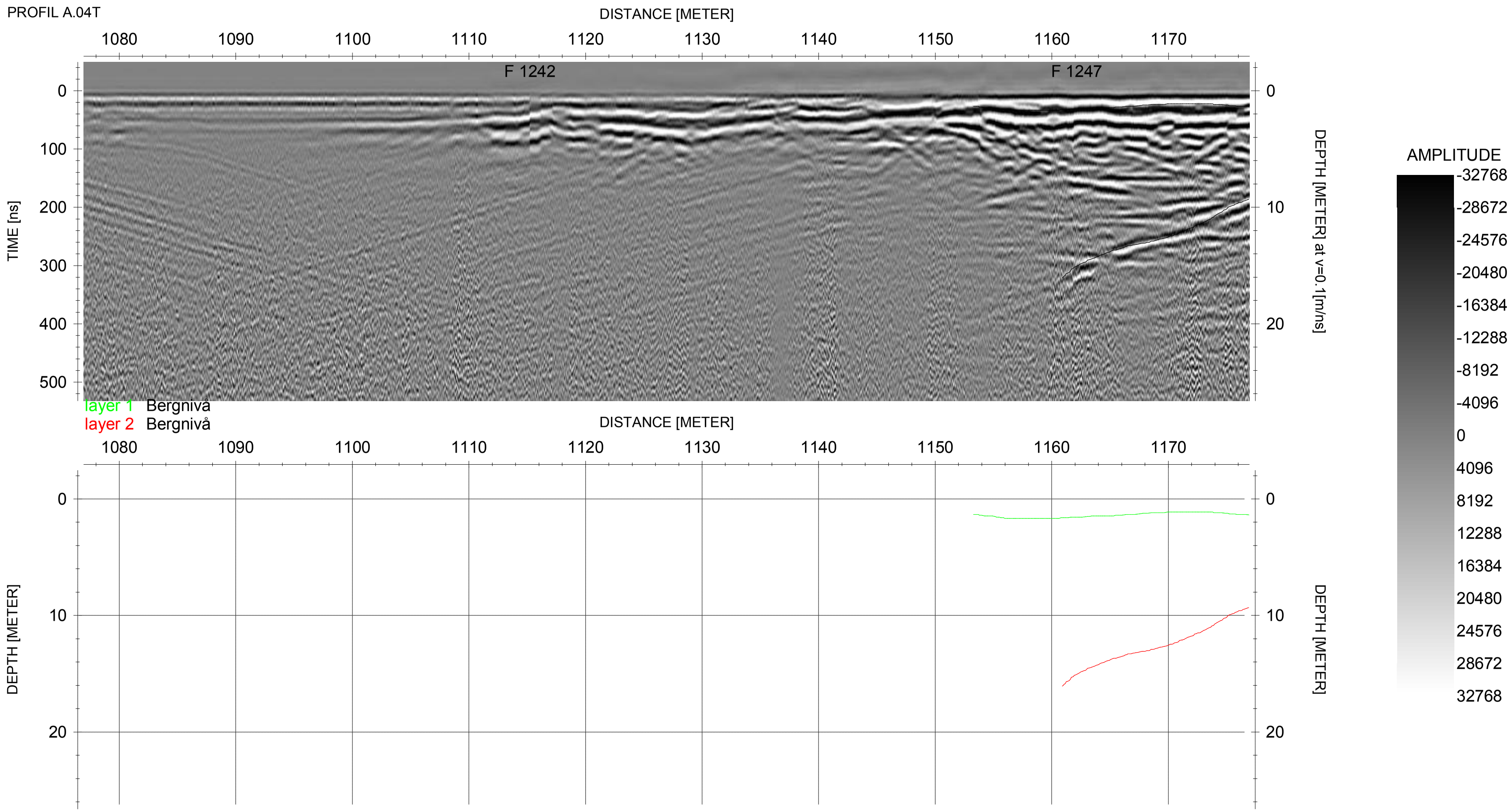

Profil A
PROFIL A.04T
AMPLITUDE
-32768
-28672
-24576
-20480
-16384
-12288
-8192
-4096
0
4096
8192
12288
16384
20480
24576
28672
32768
DEPTH [METER] at v=0.1[m/ns]
DEPTH [METER]
DISTANCE [METER]
TIME [ns]
F 1214
F 1211
layer 1
Bergnivå


Profil A
PROFIL A.04T
AMPLITUDE
-32768
-28672
-24576
-20480
-16384
-12288
-8192
-4096
0
4096
8192
12288
16384
20480
24576
28672
32768
DEPTH [METER] at v=0.1[m/ns]
DISTANCE [METER]
TIME [ns]
layer 1 Bergnivå
DEPTH [METER]
DISTANCE [METER]
DEPTH [METER]

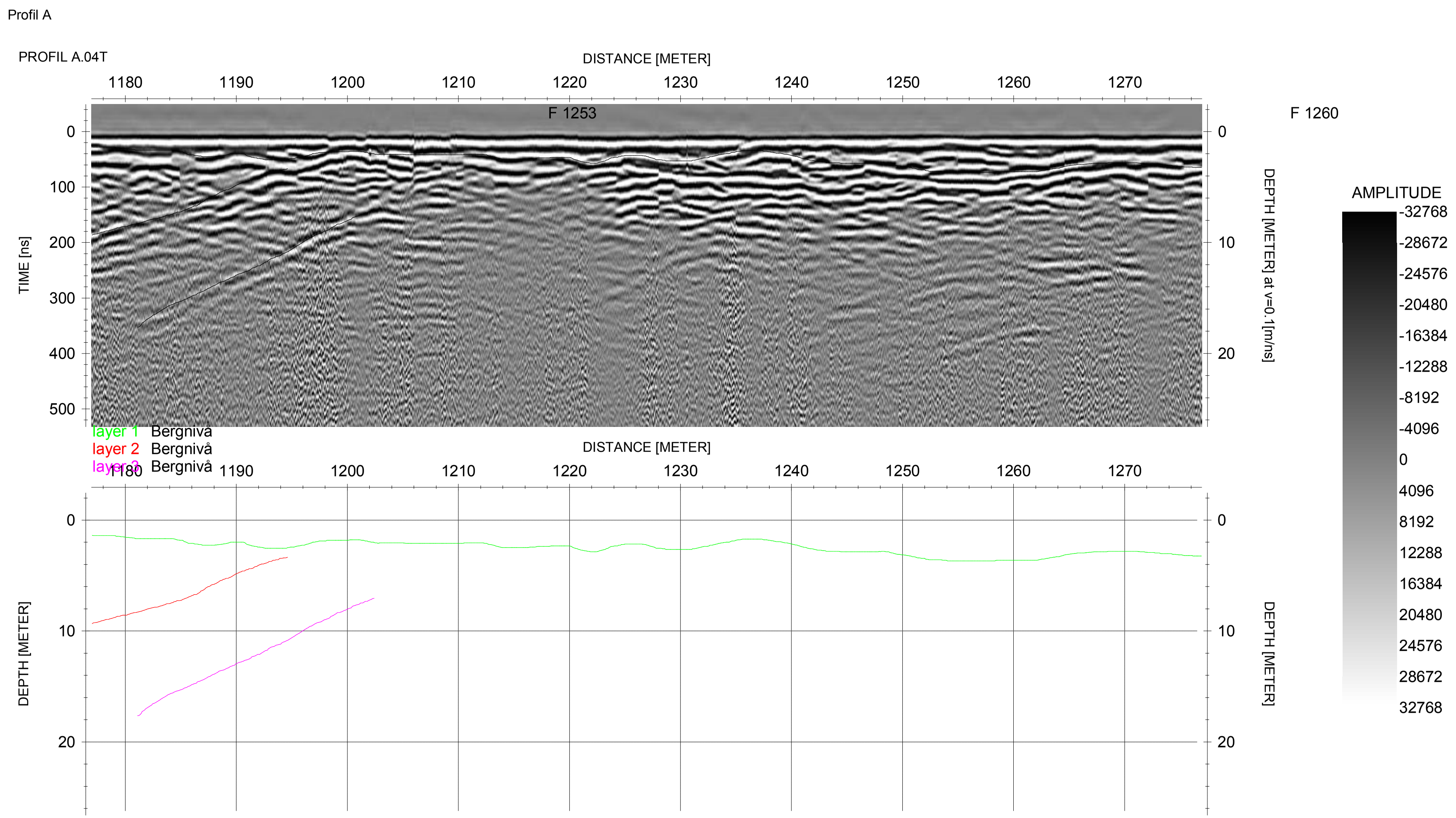
Profil A

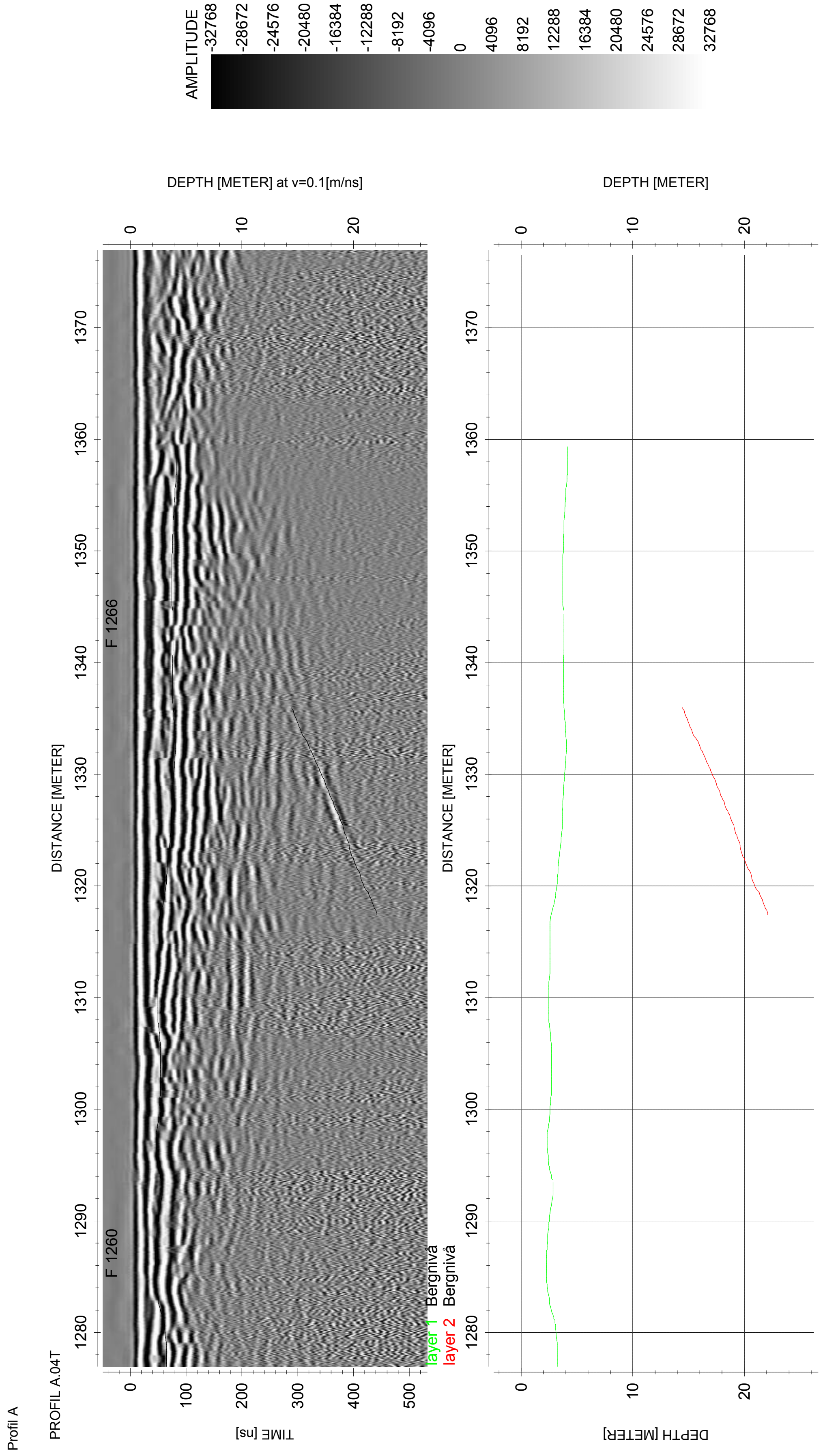

PROFIL A.04T
DISTANCE [METER]
980
990
1000
1010
1020
1030
1040
1050
1060
1070
F 1234
TIME [ns]
0
100
200
300
400
500
DEPTH [METER] at v=0.1[m/ns]
0
10
20
layer 1
Bergniva
DISTANCE [METER]
DEPTH [METER]
AMPLITUDE
-32768
-28672
-24576
-20480
-16384
-12288
-8192
-4096
0
4096
8192
12288
16384
20480
24576
28672
32768

Profil A

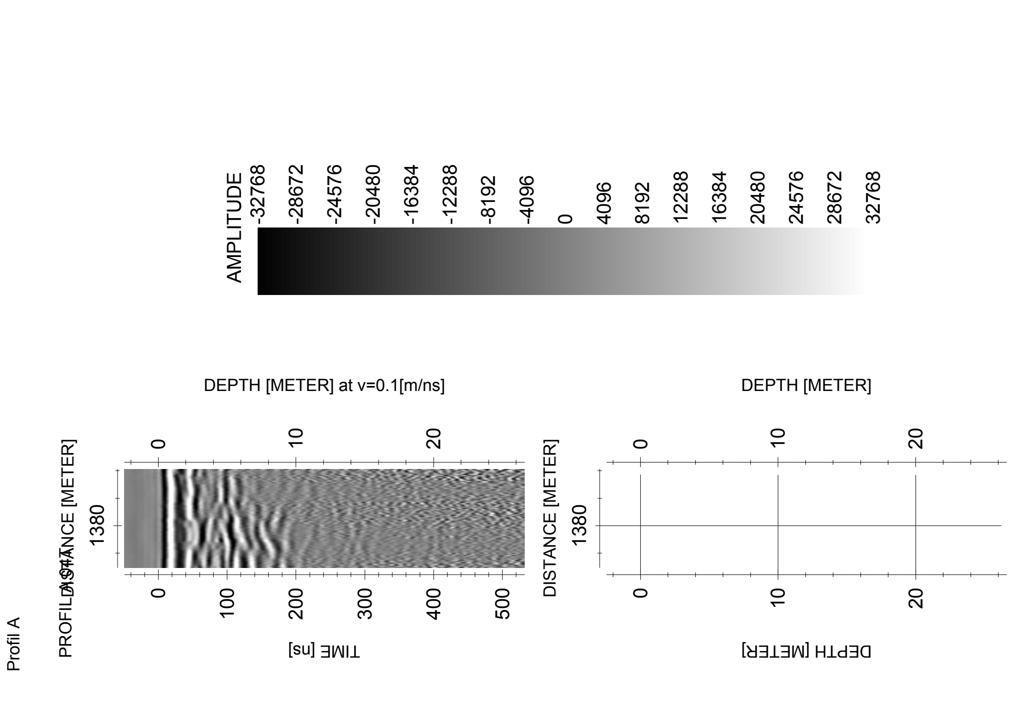


PROFIL A.04T
DISTANCE [METER]
1080
1090
1100
1110
1120
1130
1140
1150
1160
1170
F 1242
F 1247
TIME [ns]
DEPTH [METER] at v=0.1[m/ns]
layer 1 Bergnivå
layer 2 Bergnivå
DEPTH [METER]
AMPLITUDE
-32768
-28672
-24576
-20480
-16384
-12288
-8192
-4096
0
4096
8192
12288
16384
20480
24576
28672
32768


Profil A
PROFIL A.04T
DISTANCE [METER]
F 1253
F 1260
TIME [ns]
DEPTH [METER] at v=0.1[m/ns]
AMPLITUDE
layer 1 Bergnivå
layer 2 Bergnivå
layer 3 Bergnivå
DISTANCE [METER]
DEPTH [METER]
DEPTH [METER]



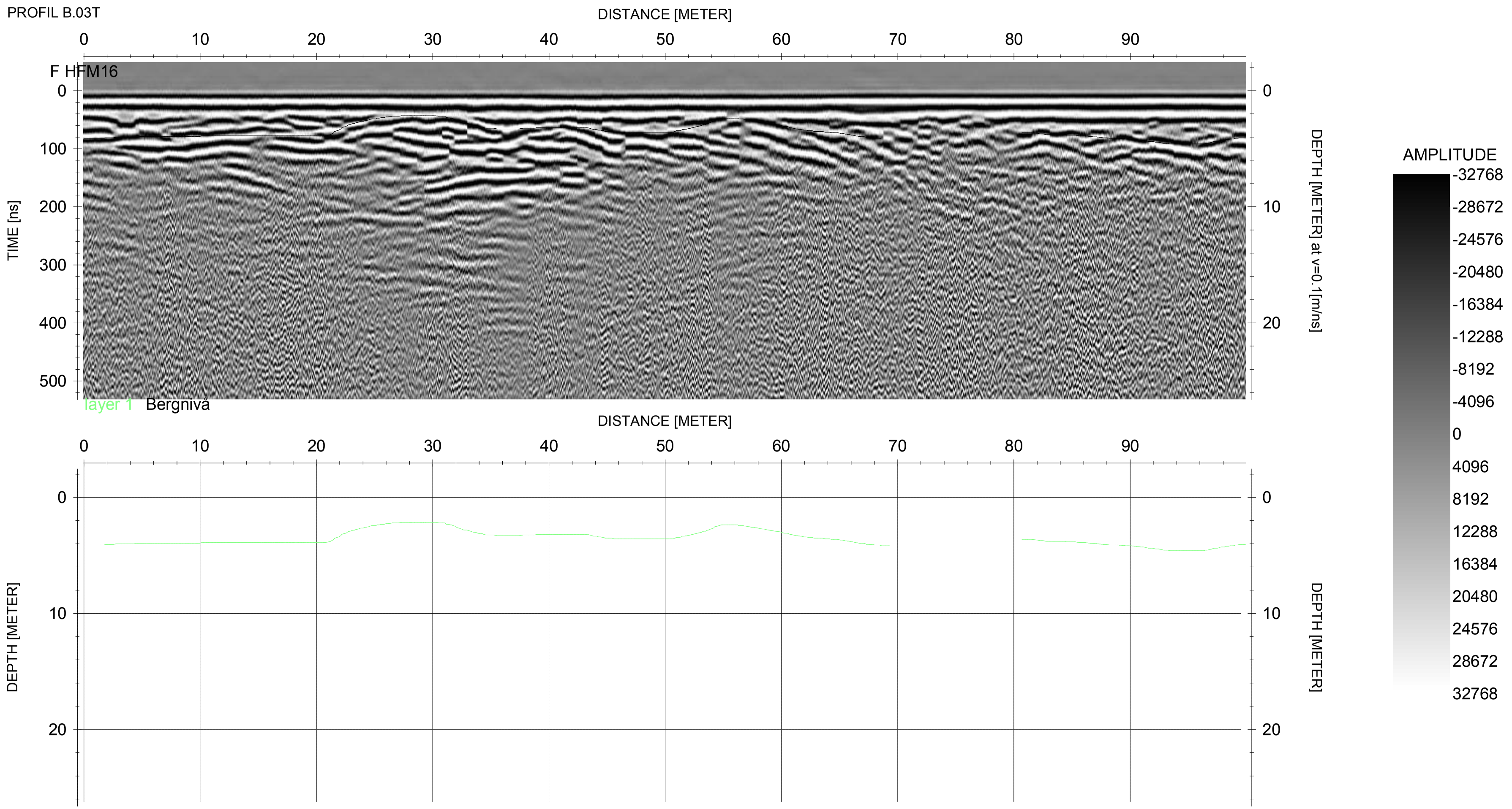
Profil A
PROFIL A.04T
AMPLITUDE
-32768
-28672
-24576
-20480
-16384
-12288
-8192
-4096
0
4096
8192
12288
16384
20480
24576
28672
32768
DEPTH [METER] at v=0.1[m/ns]
DISTANCE [METER]
TIME [ns]
F 1260
F 1266
layer 1 Bergnivå
layer 2 Bergnivå
DEPTH [METER]


Profil A
DISTANCE [METER]
1380
TIME [ns]
DEPTH [METER] at v=0.1[m/ns]
DEPTH [METER]
AMPLITUDE
-32768
-28672
-24576
-20480
-16384
-12288
-8192
-4096
0
4096
8192
12288
16384
20480
24576
28672
32768

Appendix 6

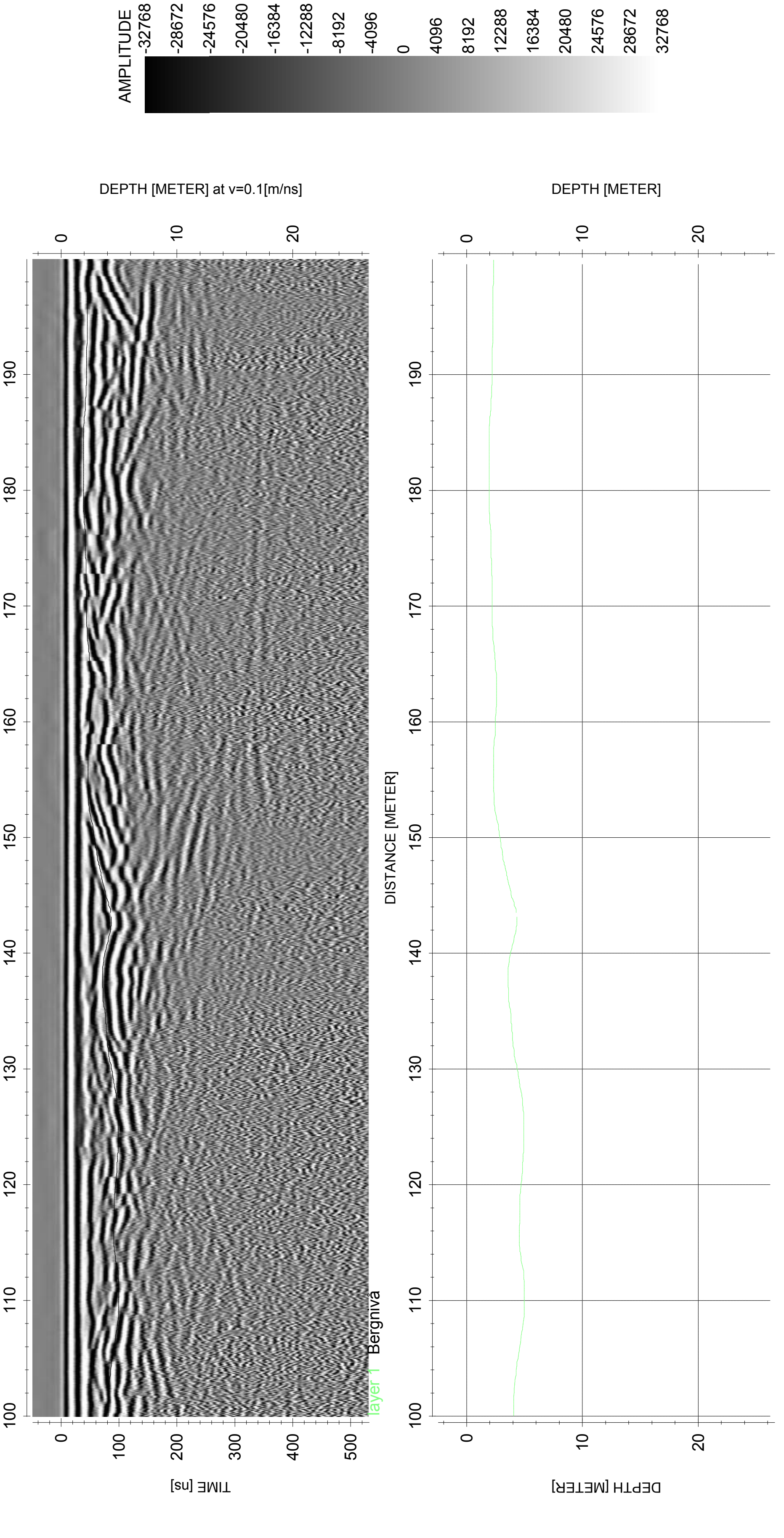
Radar data from Profile B in 100 m sections

Profil B

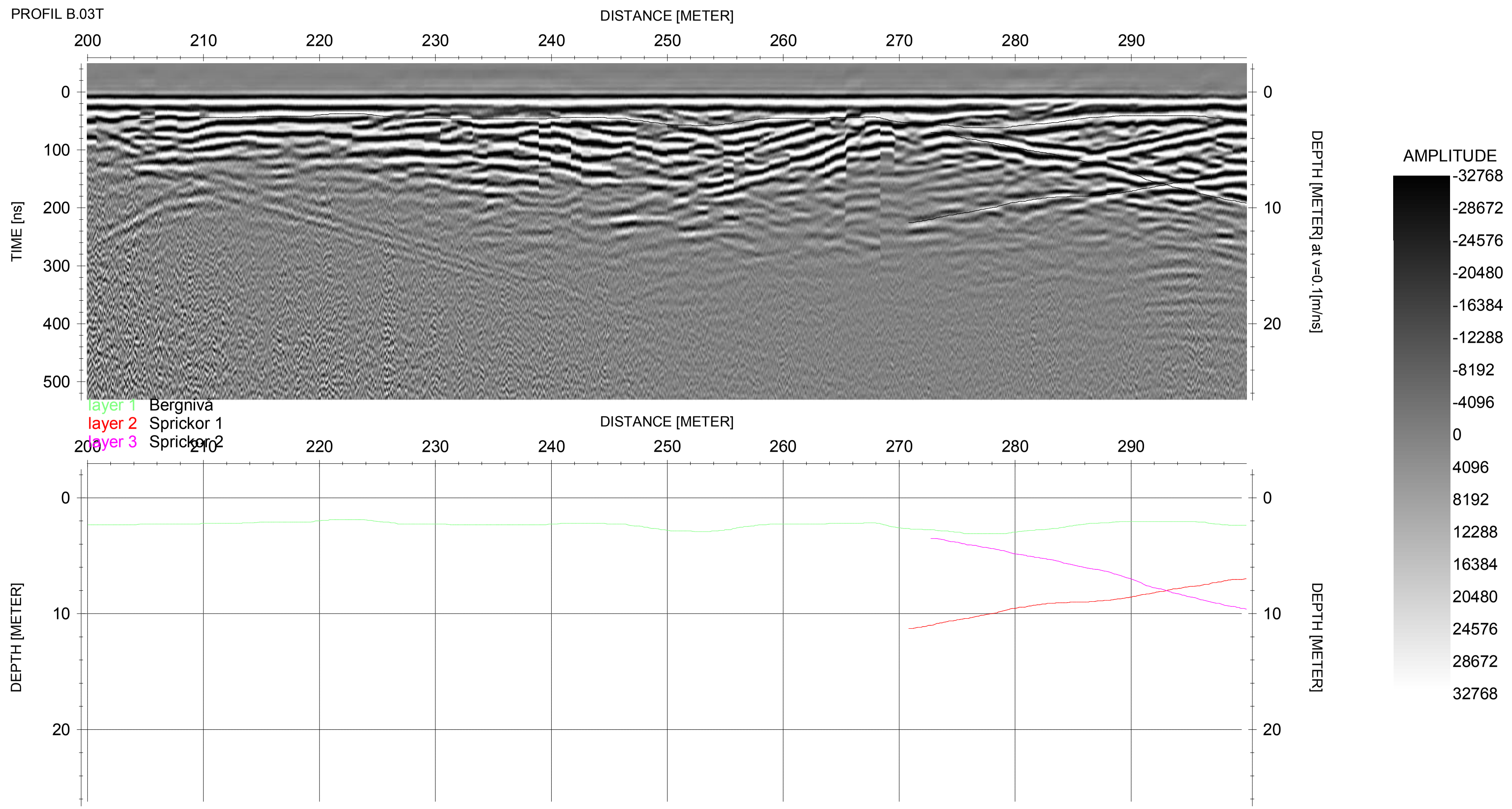


Profil B

PROFIL B.03T

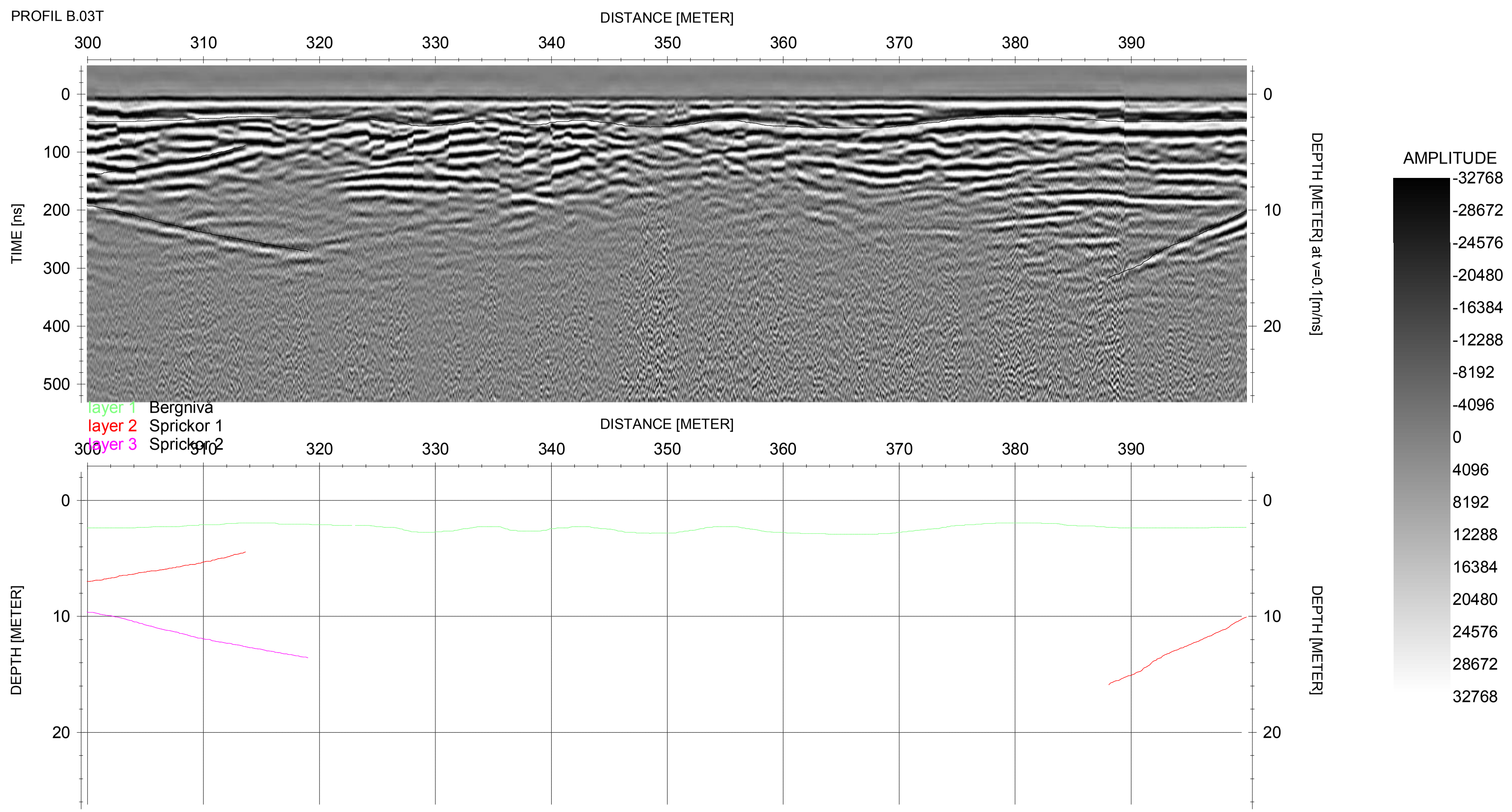


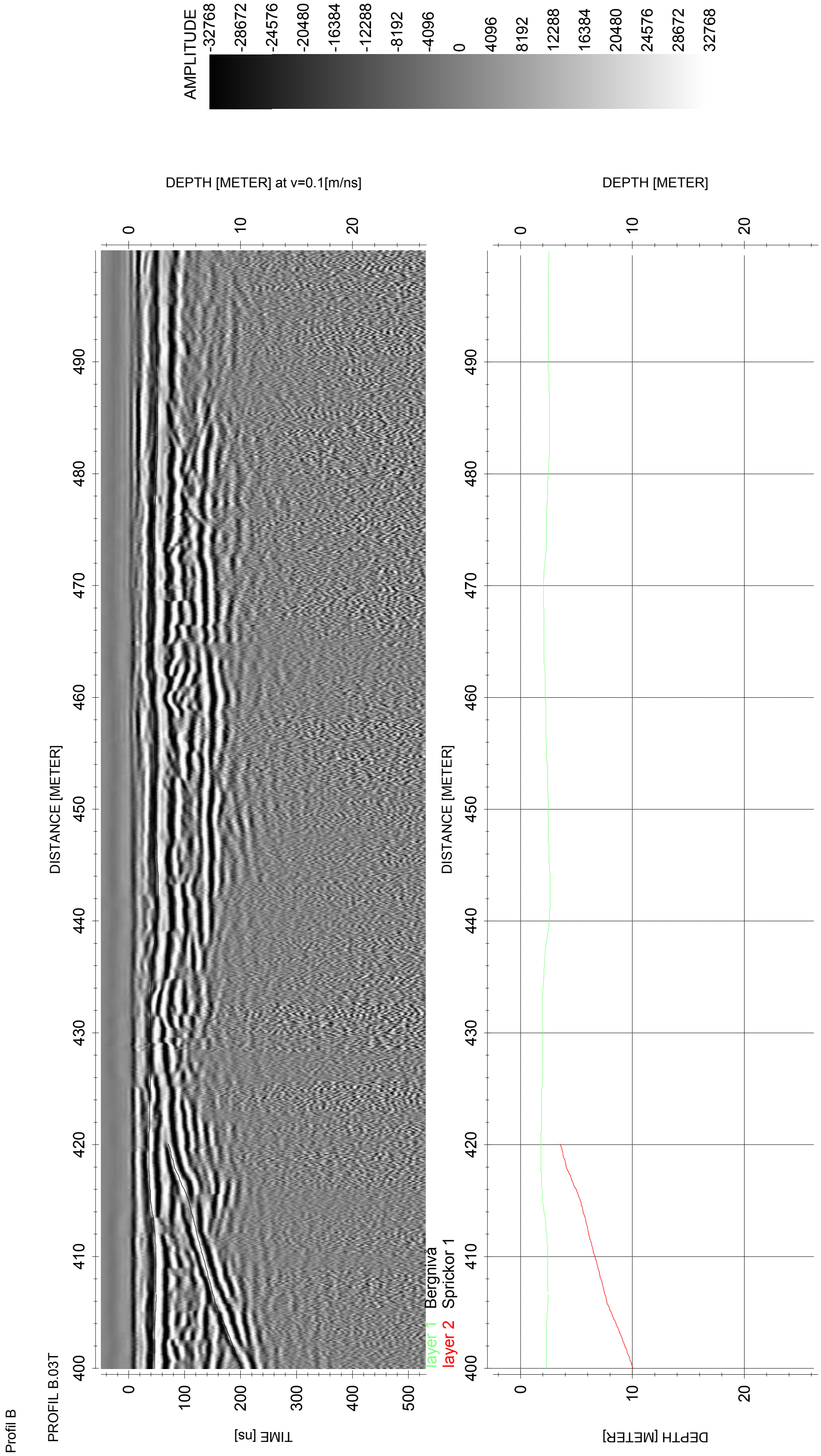
Profil B

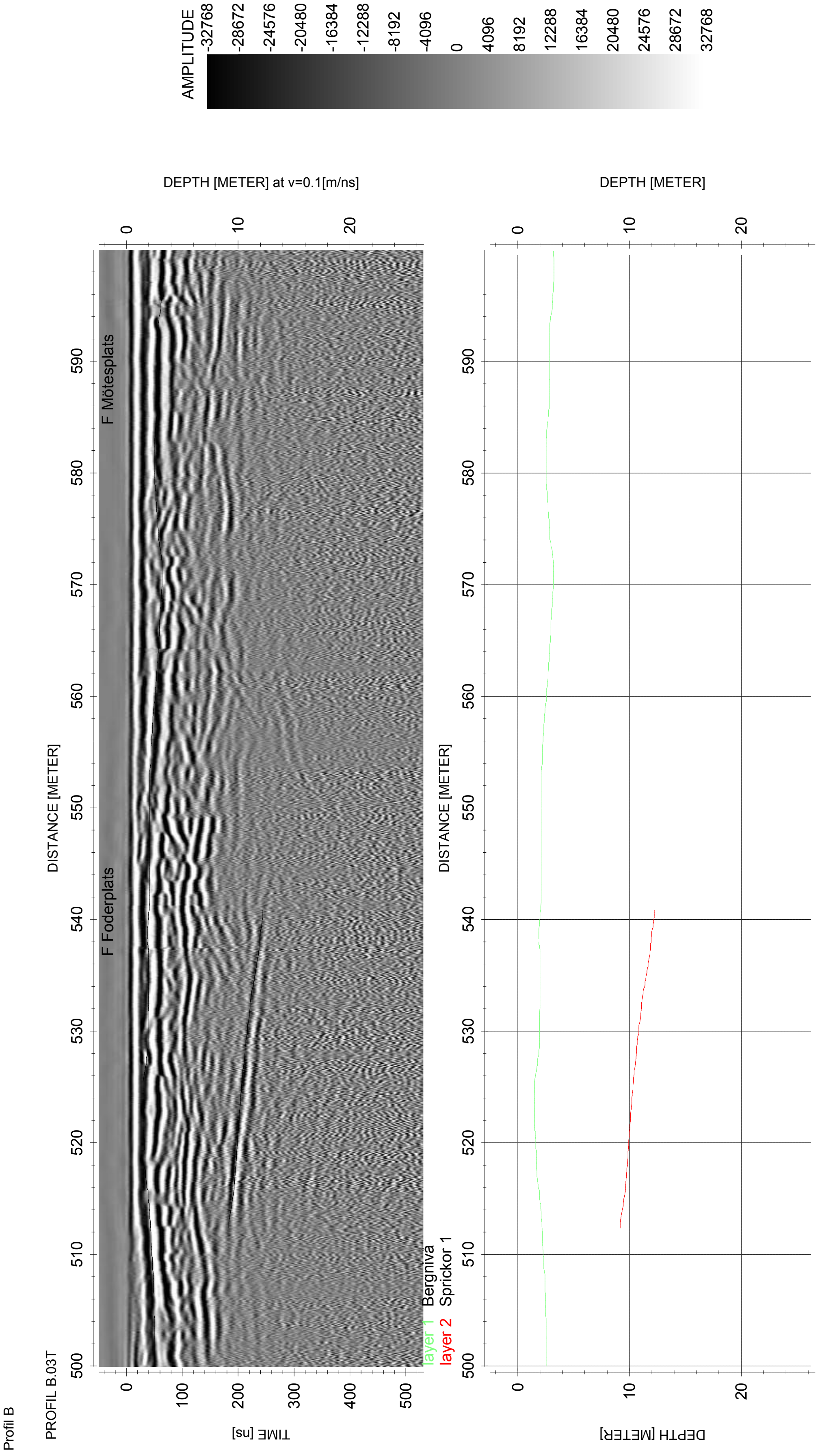


PROFIL B.03T
DISTANCE [METER]
TIME [ns]
DEPTH [METER] at v=0.1[m/ns]
layer 1 Bergnivå
layer 2 Sprickor 1
layer 3 Sprickor 2
DEPTH [METER]
AMPLITUDE

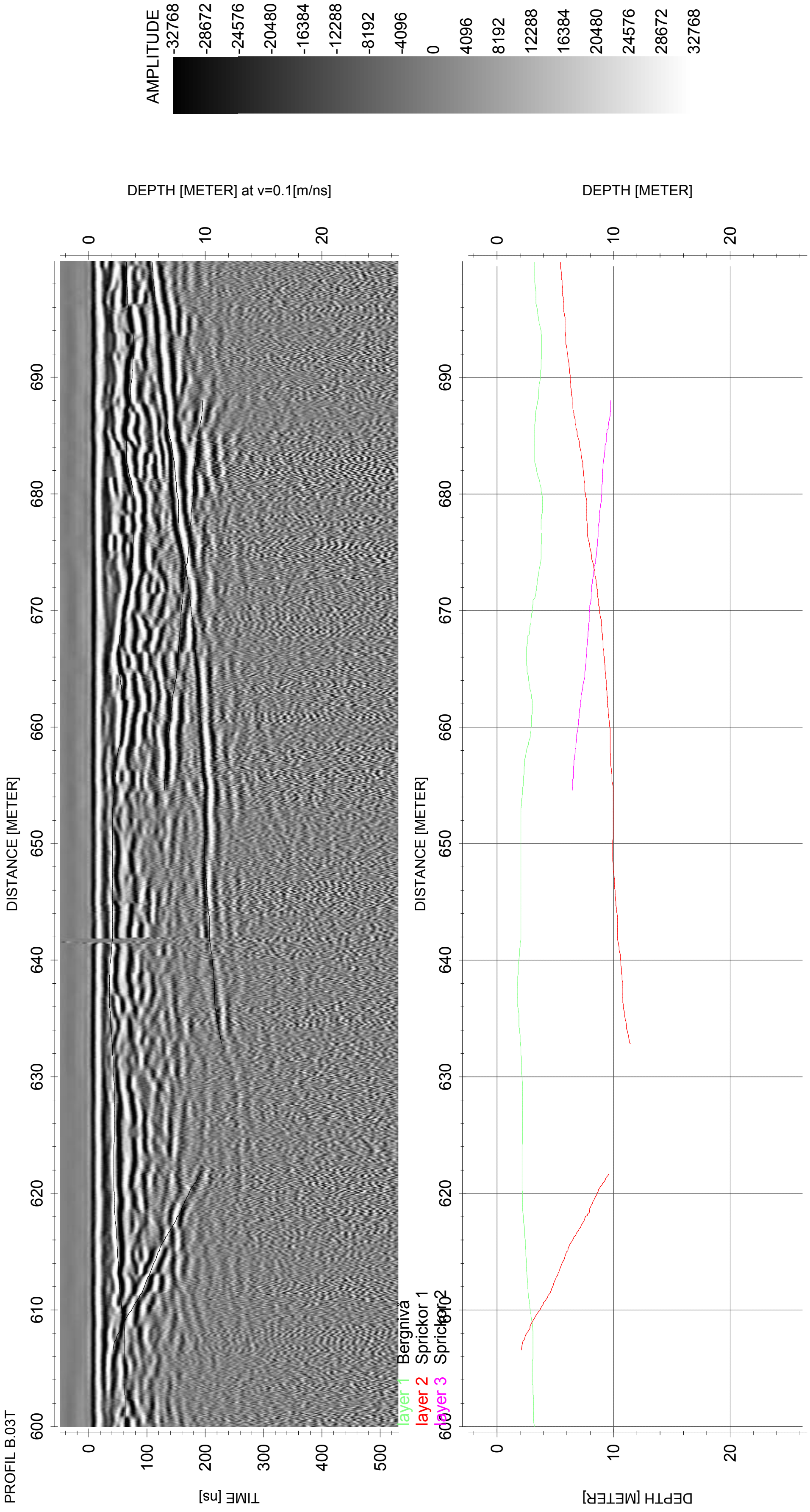
Profil B

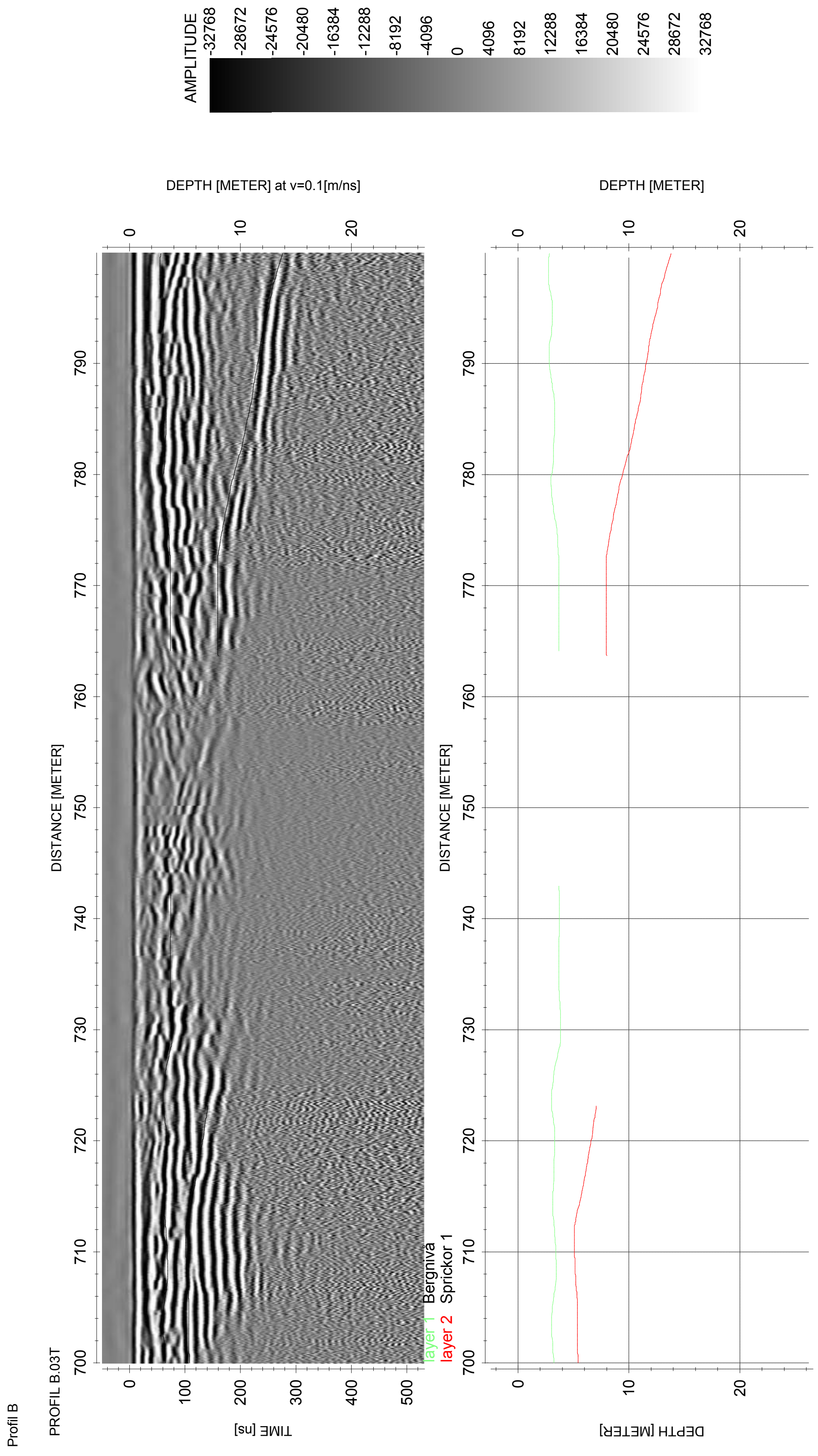

PROFIL B.03T
DISTANCE [METER]
300
310
320
330
340
350
360
370
380
390
TIME [ns]
0
100
200
300
400
500
DEPTH [METER] at v=0.1[m/ns]
0
10
20
layer 1 Bergnivå
layer 2 Sprickor 1
layer 3 Sprickor 2
DEPTH [METER]
AMPLITUDE
-32768
-28672
-24576
-20480
-16384
-12288
-8192
-4096
0
4096
8192
12288
16384
20480
24576
28672
32768


Profil B
PROFIL B.03T
AMPLITUDE
-32768
-28672
-24576
-20480
-16384
-12288
-8192
-4096
0
4096
8192
12288
16384
20480
24576
28672
32768
DEPTH [METER] at v=0.1[m/ns]
DISTANCE [METER]
TIME [ns]
layer 1 Bergniva
layer 2 Sprickor 1
DEPTH [METER]


Profil B
PROFIL B.03T
AMPLITUDE
-32768
-28672
-24576
-20480
-16384
-12288
-8192
-4096
0
4096
8192
12288
16384
20480
24576
28672
32768
DEPTH [METER] at v=0.1[m/ns]
DISTANCE [METER]
TIME [ns]
F Mötesplats
F Foderplats
layer 1 Bergnivå
layer 2 Sprickor 1
DEPTH [METER]
DISTANCE [METER]
DEPTH [METER]

Profil B

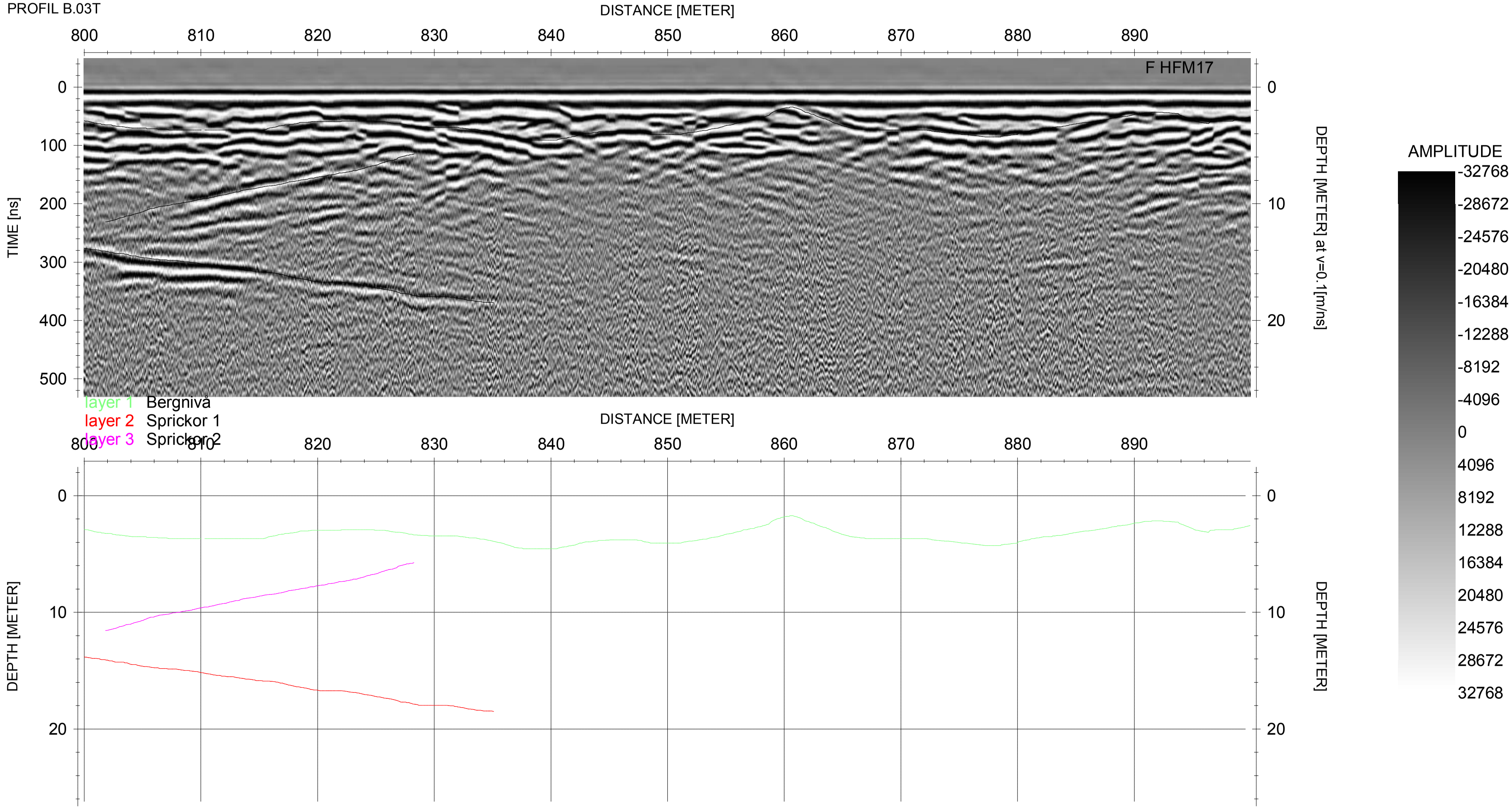

PROFIL B.03T
AMPLITUDE
-32768
-28672
-24576
-20480
-16384
-12288
-8192
-4096
0
4096
8192
12288
16384
20480
24576
28672
32768
DEPTH [METER] at v=0.1[m/ns]
DISTANCE [METER]
TIME [ns]
layer 1 Bergniva
layer 2 Sprickor 1
layer 3 Sprickor 2
DEPTH [METER]



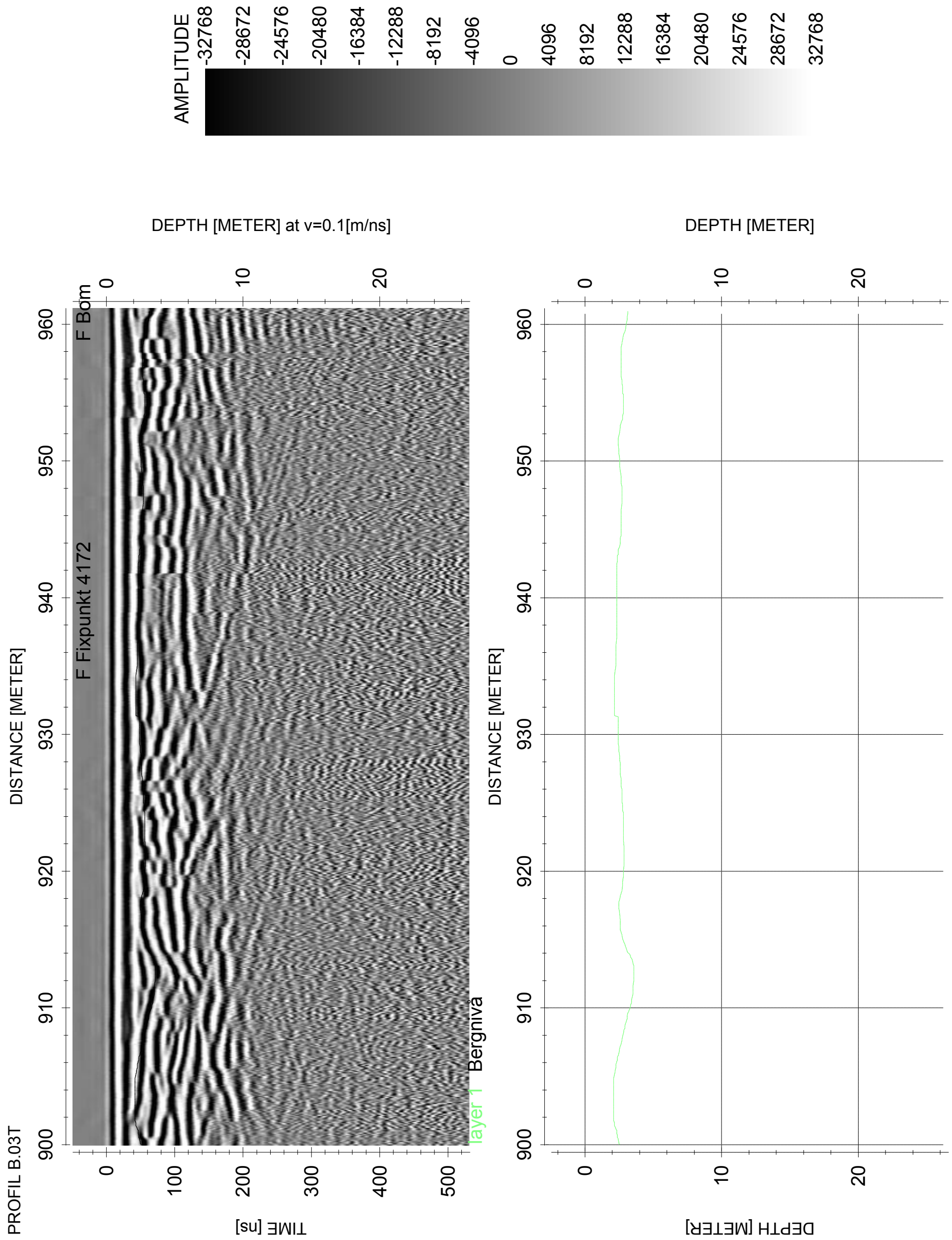
Profil B
PROFIL B.03T
AMPLITUDE
-32768
-28672
-24576
-20480
-16384
-12288
-8192
-4096
0
4096
8192
12288
16384
20480
24576
28672
32768
DEPTH [METER] at v=0.1[m/ns]
DEPTH [METER]
DISTANCE [METER]
TIME [ns]
layer 1 Bergnivå
layer 2 Sprickor 1

Profil B

PROFIL B.03T

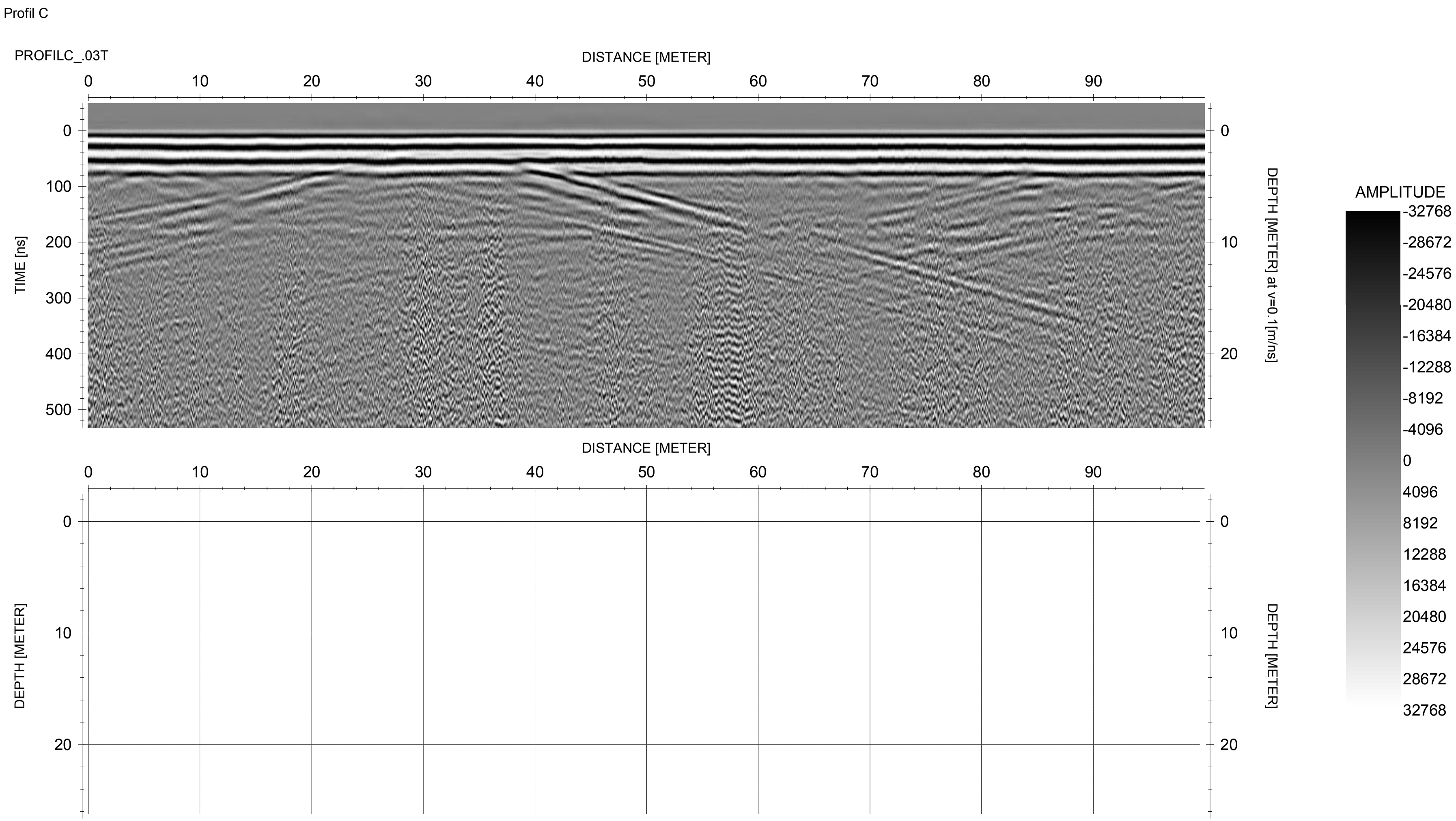


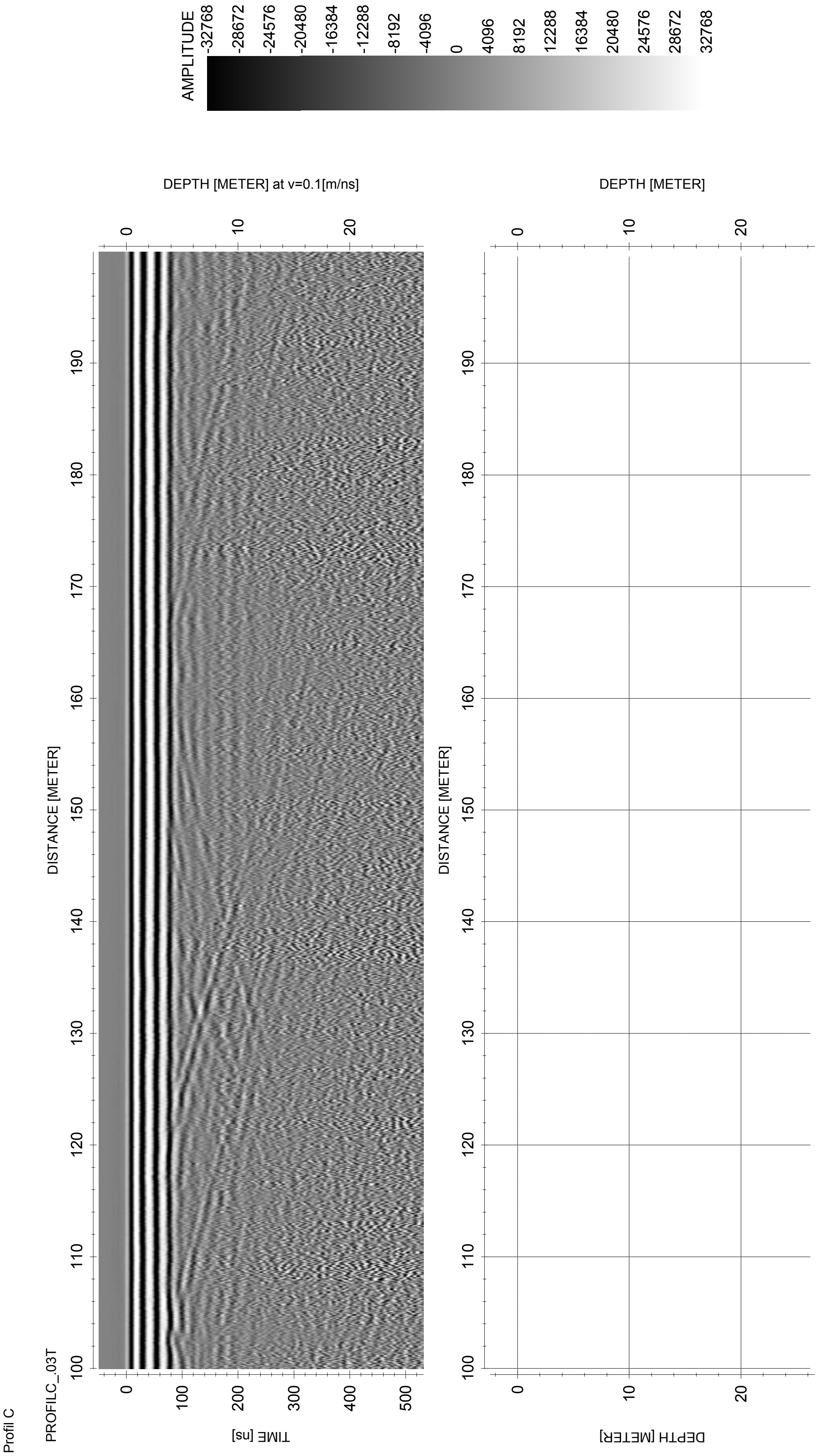
Profil B

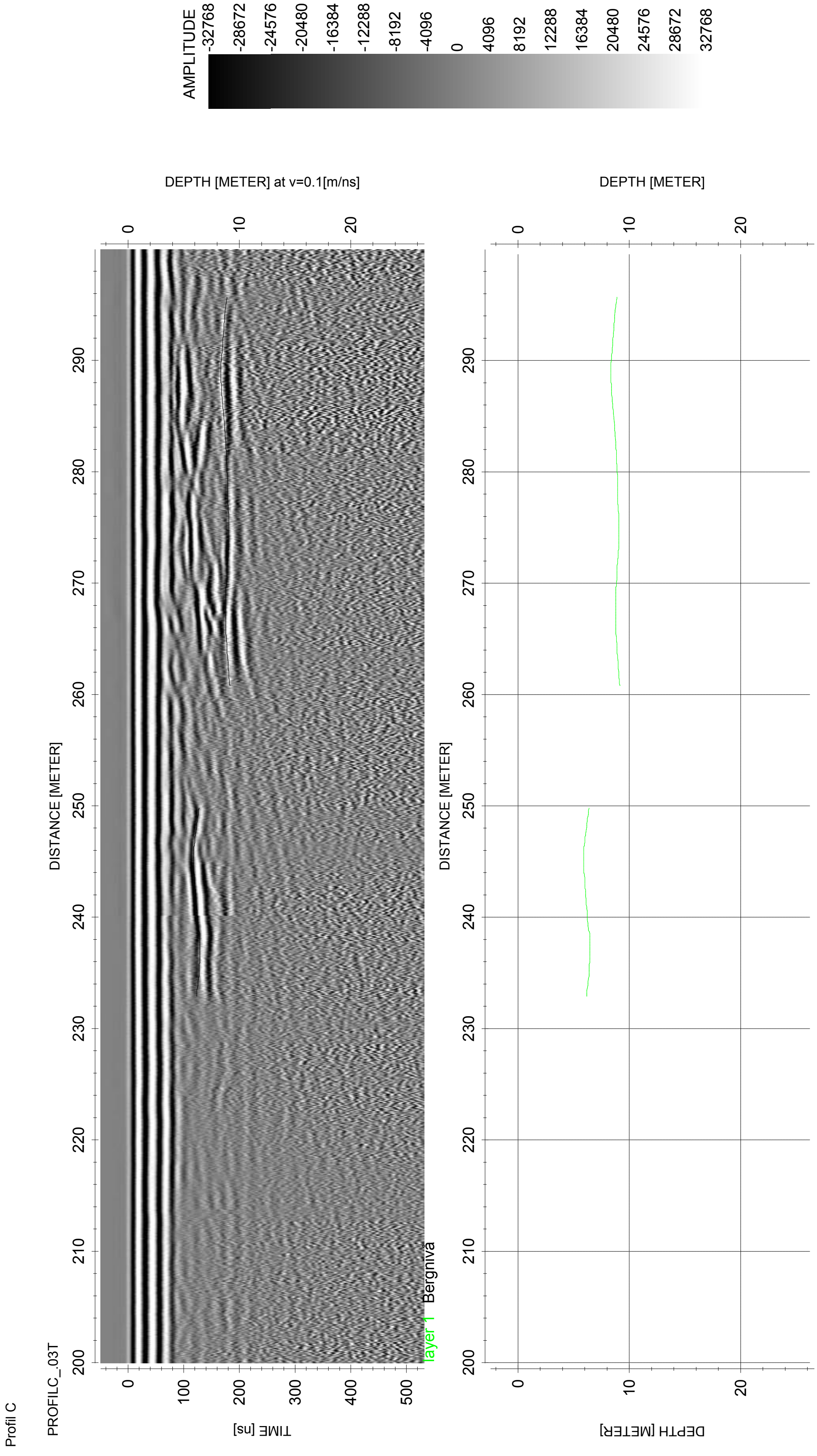

PROFIL B.03T
AMPLITUDE
-32768
-28672
-24576
-20480
-16384
-12288
-8192
-4096
0
4096
8192
12288
16384
20480
24576
28672
32768
DEPTH [METER] at v=0.1[m/ns]
DEPTH [METER]
DISTANCE [METER]
TIME [ns]
F Bom
F Fixpunkt 4172
layer 1
Bergnivå

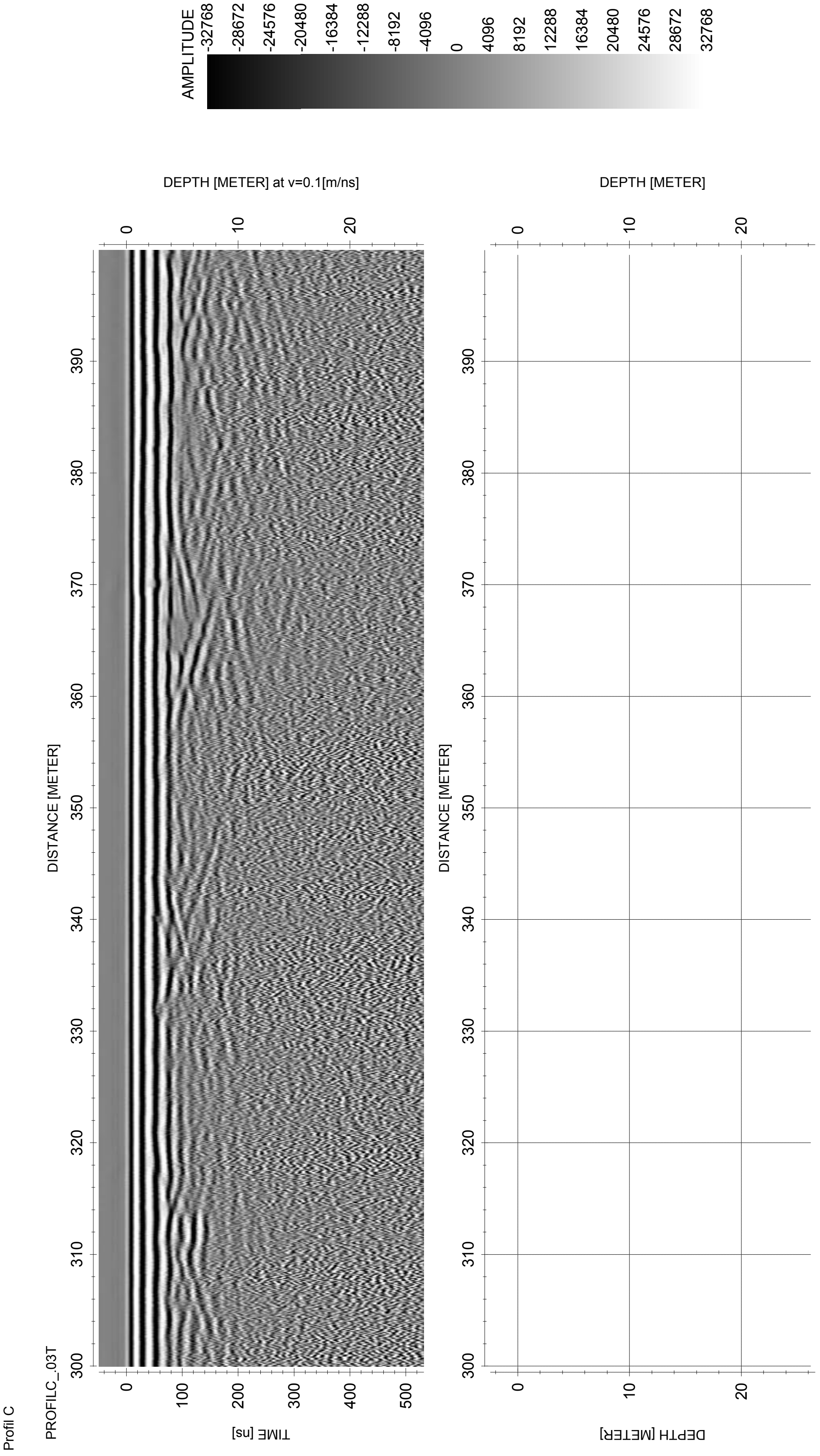
Appendix 7

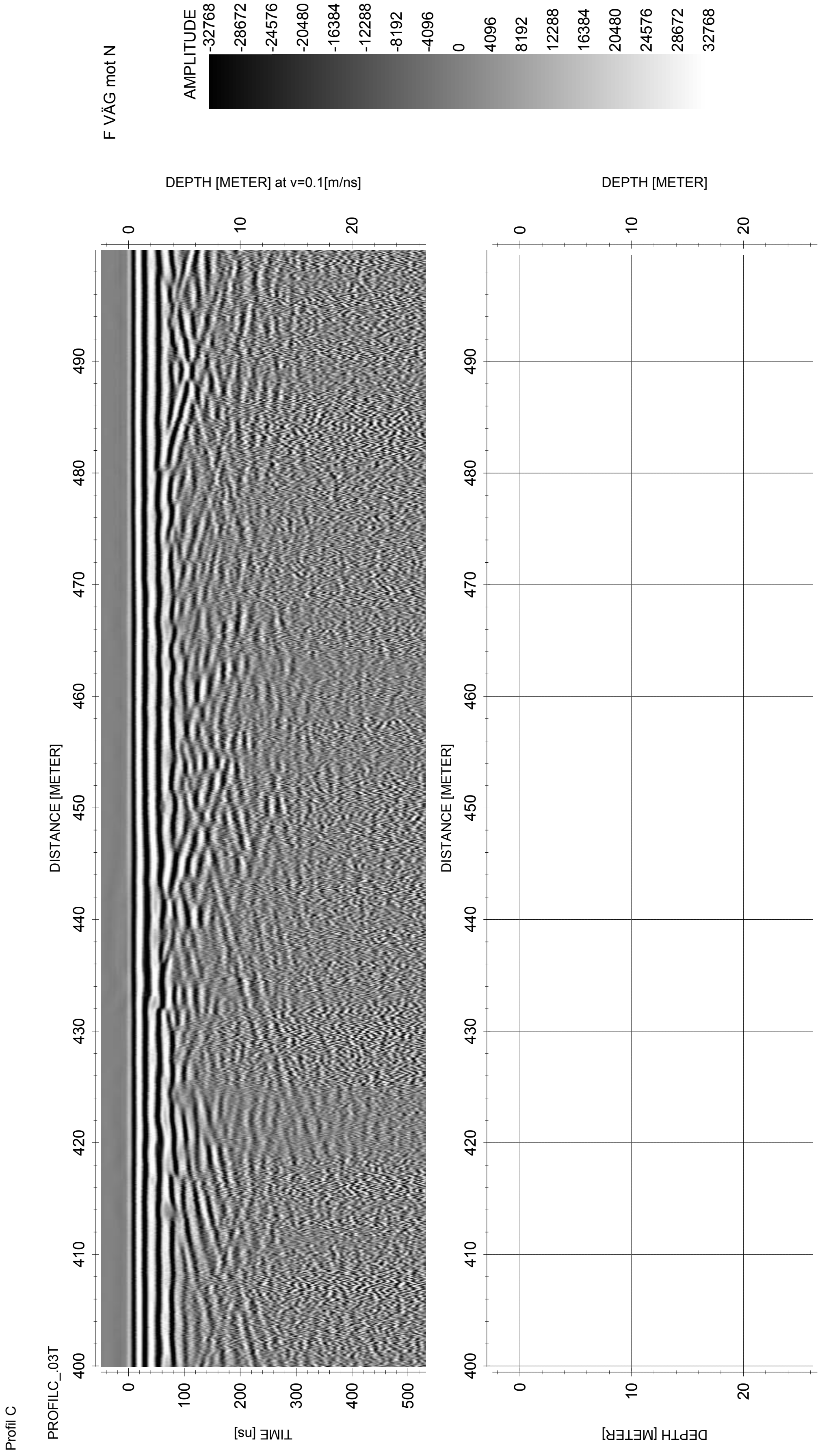
Radar data from Profile C in 100 m sections



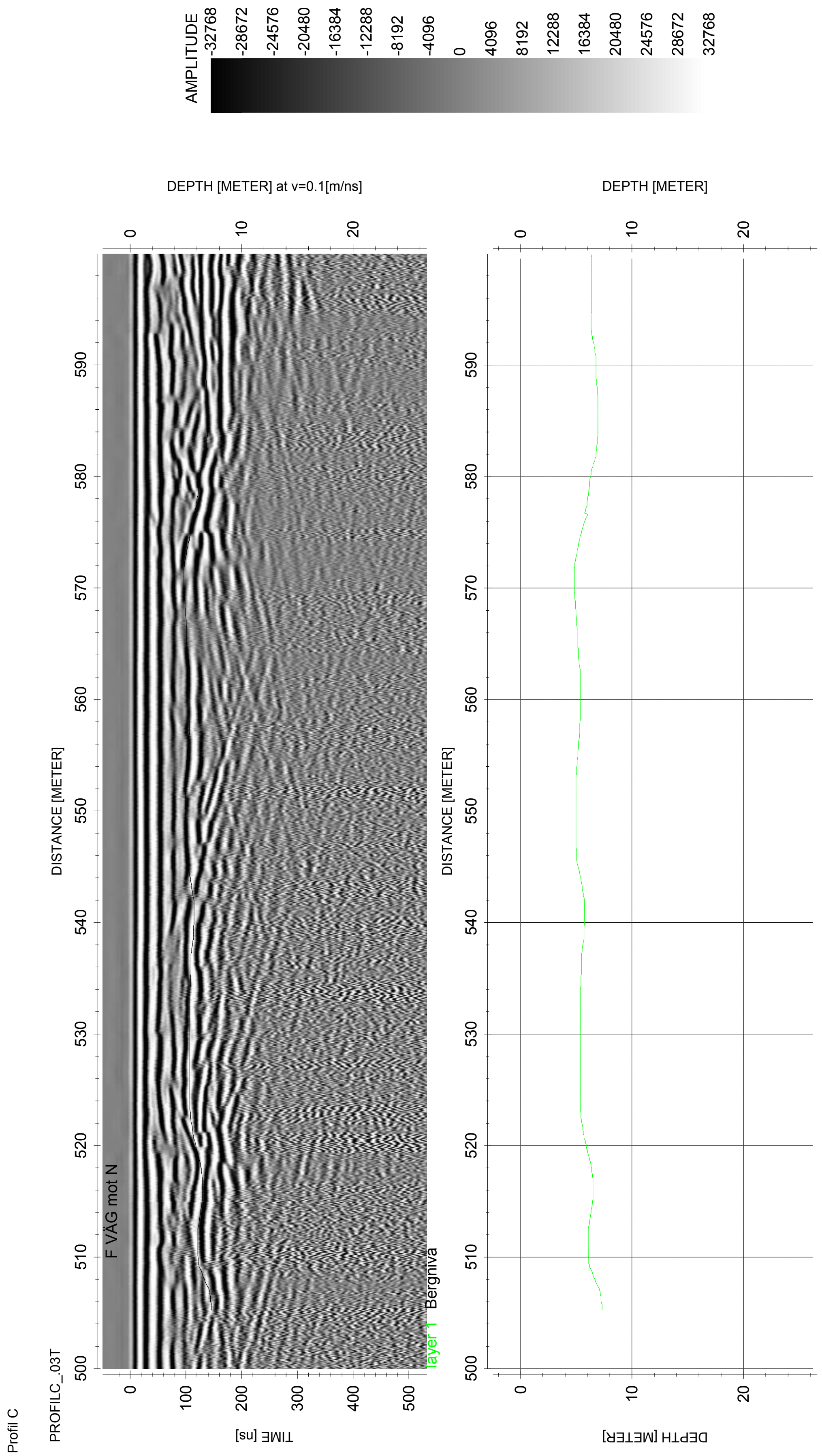

Profil C
PROFILC_.03T
AMPLITUDE
-32768
-28672
-24576
-20480
-16384
-12288
-8192
-4096
0
4096
8192
12288
16384
20480
24576
28672
32768
DEPTH [METER] at v=0.1[m/ns]
DEPTH [METER]
DISTANCE [METER]
TIME [ns]

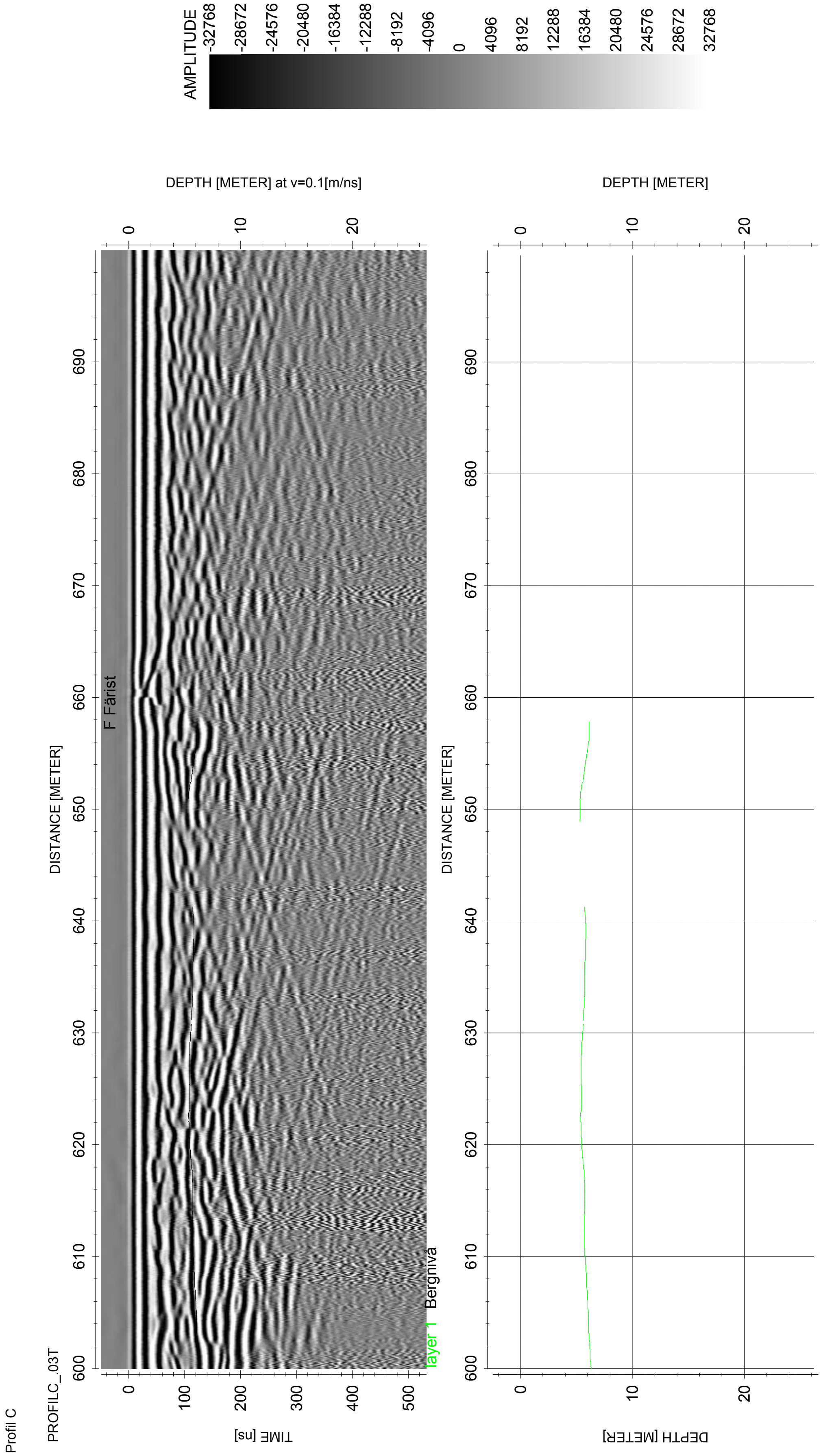

Profil C
PROFILC_03T
AMPLITUDE
-32768
-28672
-24576
-20480
-16384
-12288
-8192
-4096
0
4096
8192
12288
16384
20480
24576
28672
32768
DEPTH [METER] at v=0.1[m/ns]
DEPTH [METER]
DISTANCE [METER]
TIME [ns]
layer 1
Bergniva
200
210
220
230
240
250
260
270
280
290
0
100
200
300
400
500
0
10
20

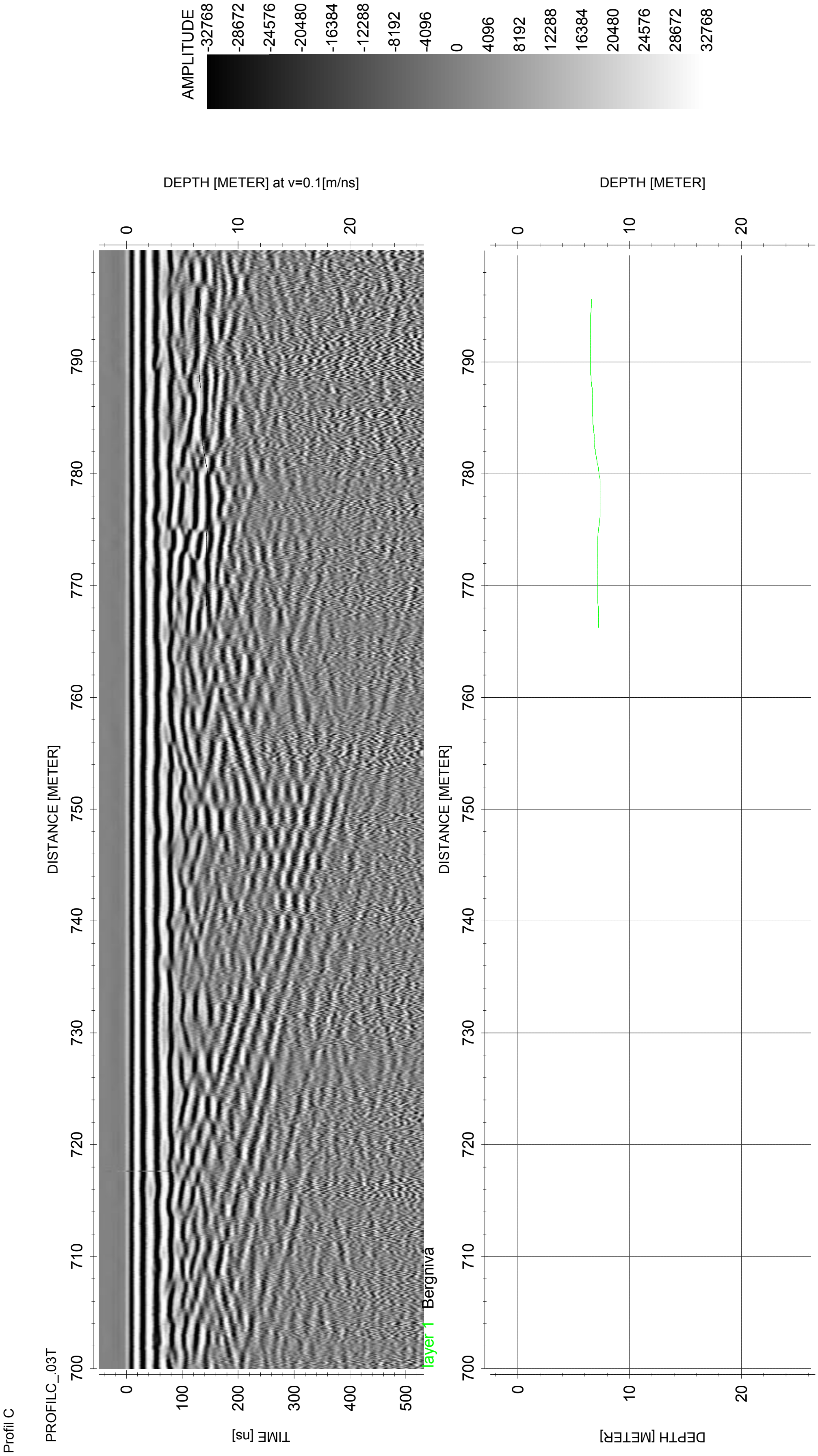

Profil C
PROFILC_03T
AMPLITUDE
-32768
-28672
-24576
-20480
-16384
-12288
-8192
-4096
0
4096
8192
12288
16384
20480
24576
28672
32768
DEPTH [METER] at v=0.1[m/ns]
DEPTH [METER]
DISTANCE [METER]
TIME [ns]
300
310
320
330
340
350
360
370
380
390
0
10
20
100
200
300
400
500



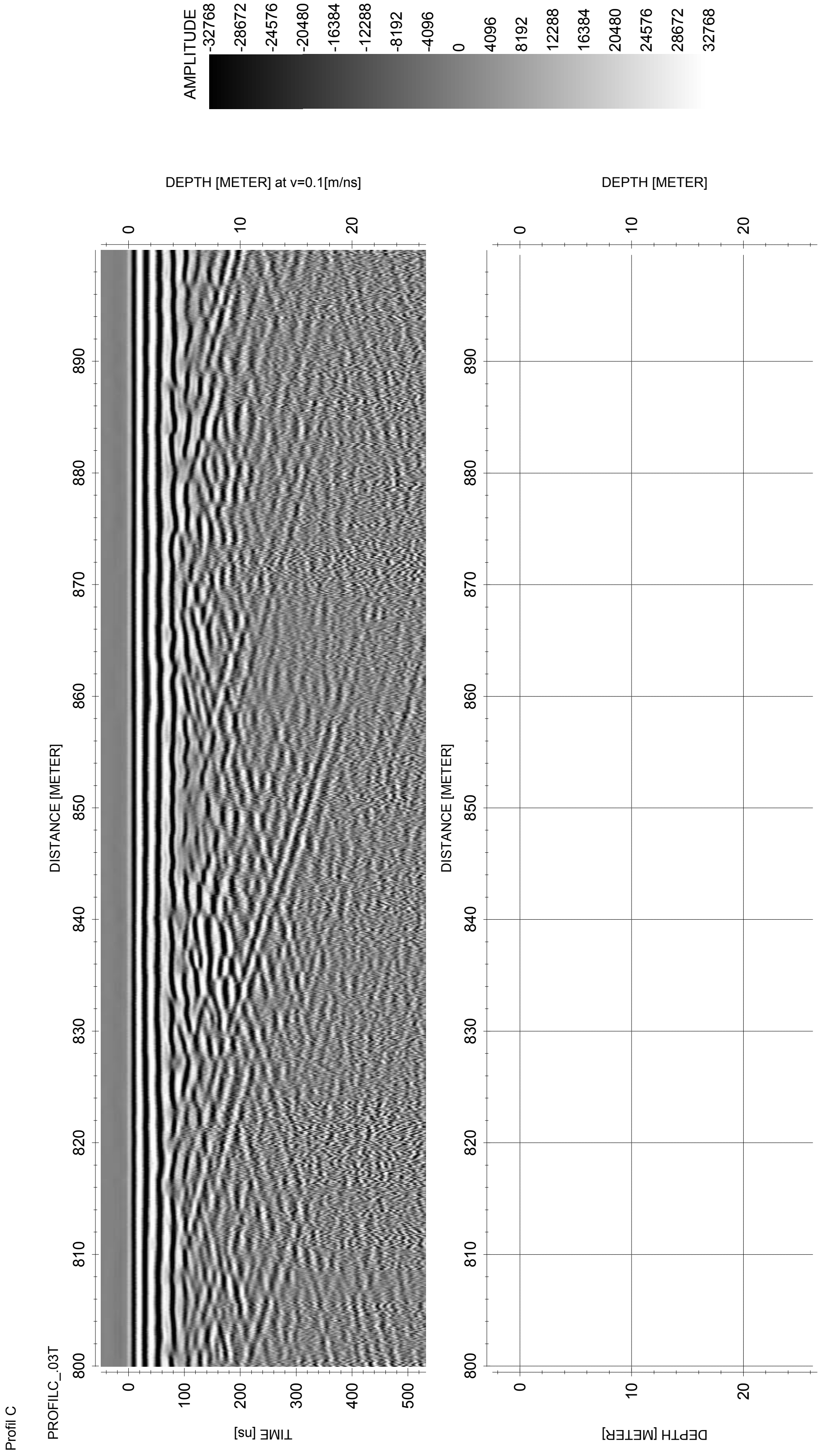
Profil C
PROFILC_03T
F VÄG mot N
AMPLITUDE
-32768
-28672
-24576
-20480
-16384
-12288
-8192
-4096
0
4096
8192
12288
16384
20480
24576
28672
32768
DEPTH [METER] at v=0.1[m/ns]
DEPTH [METER]
DISTANCE [METER]
TIME [ns]


Profil C
PROFILC_03T
AMPLITUDE
-32768
-28672
-24576
-20480
-16384
-12288
-8192
-4096
0
4096
8192
12288
16384
20480
24576
28672
32768
DEPTH [METER] at v=0.1[m/ns]
DISTANCE [METER]
TIME [ns]
F VÄG mot N
layer 1 Bergnivå
DEPTH [METER]
DISTANCE [METER]
DEPTH [METER]

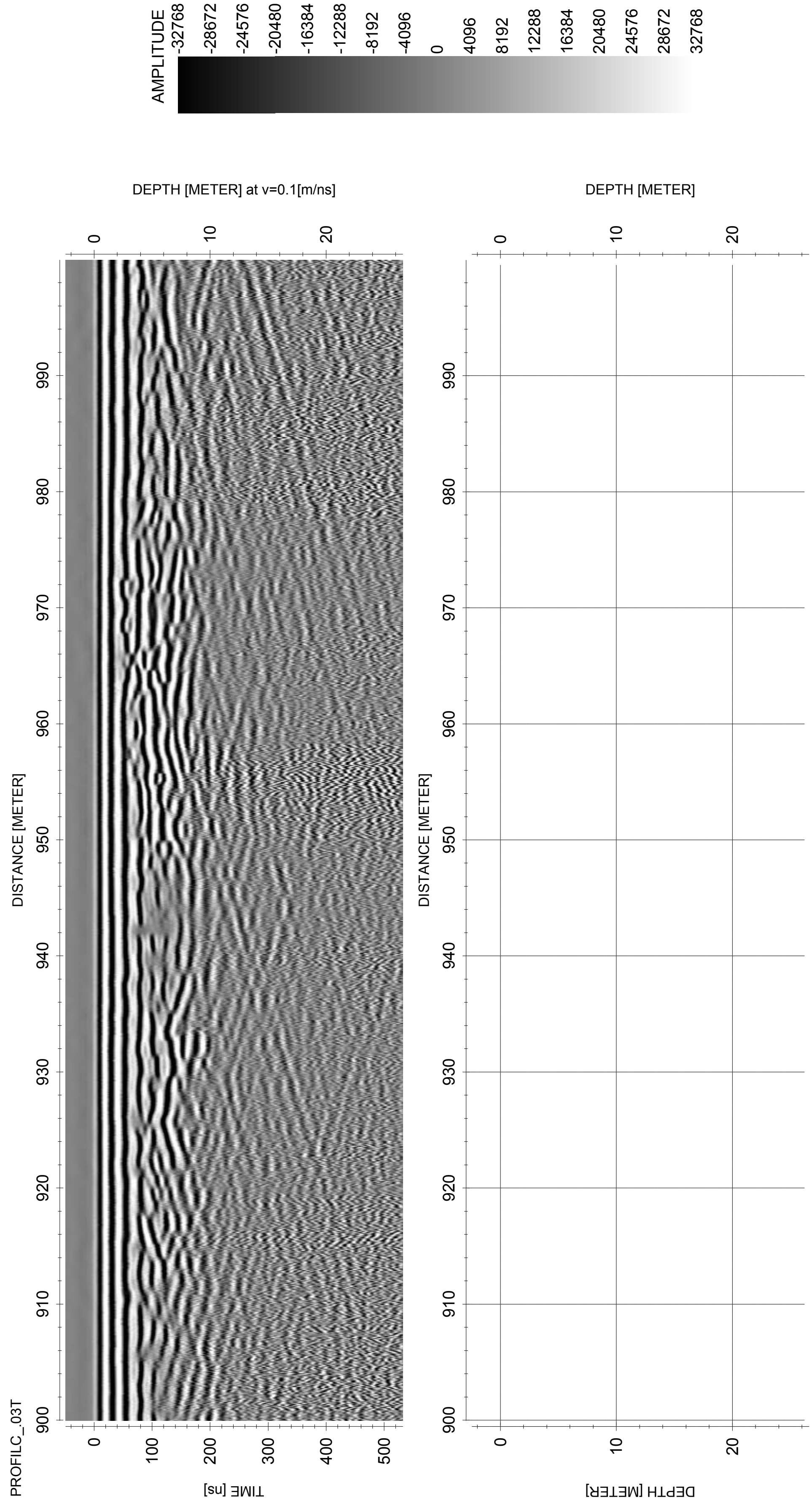

Profil C
PROFILC_03T
AMPLITUDE
DEPTH [METER] at v=0.1[m/ns]
DEPTH [METER]
DISTANCE [METER]
TIME [ns]
F Färist
layer 1
Bergniva



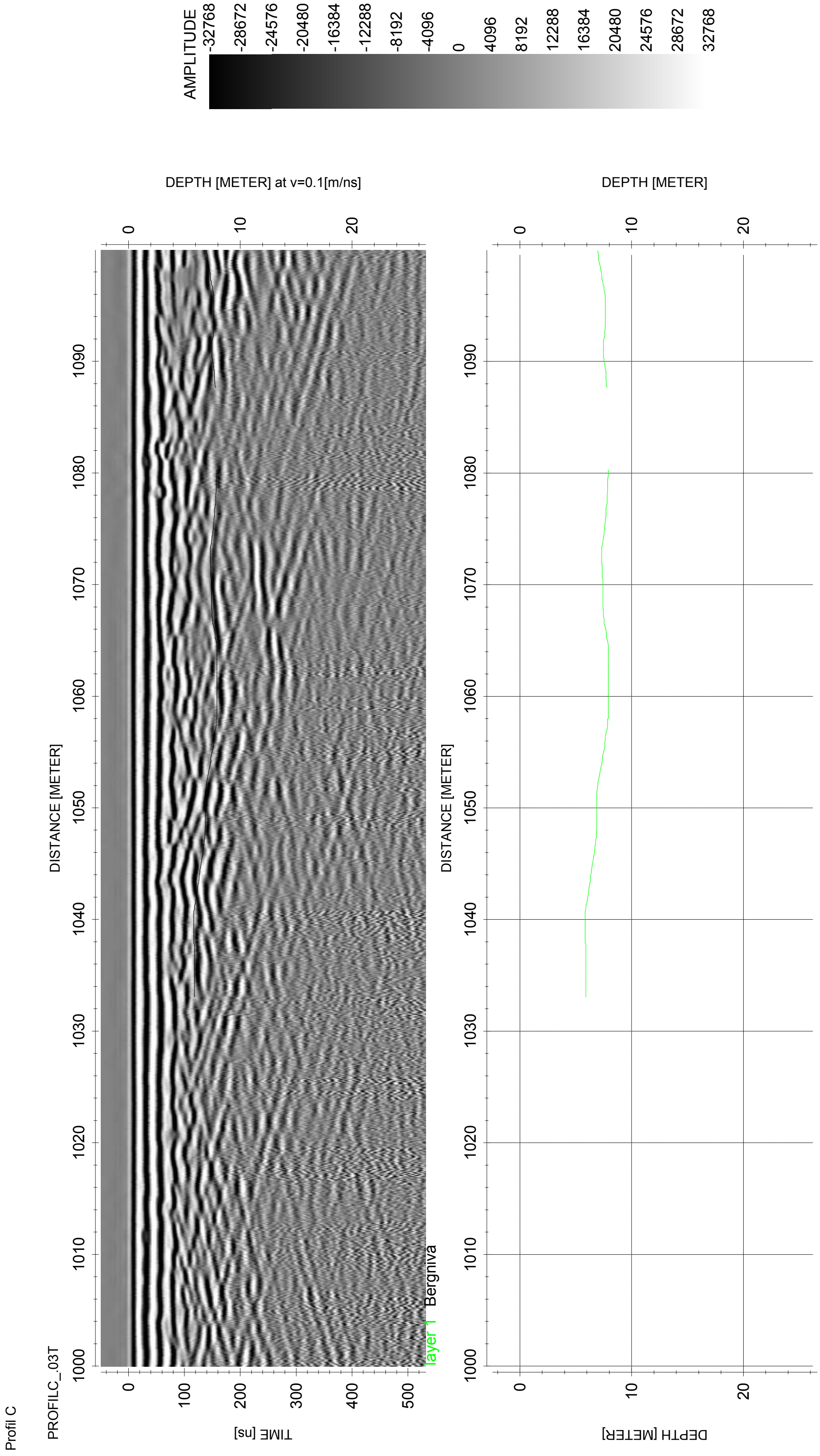
Profil C
PROFILC_.03T
AMPLITUDE
-32768
-28672
-24576
-20480
-16384
-12288
-8192
-4096
0
4096
8192
12288
16384
20480
24576
28672
32768
DEPTH [METER] at v=0.1[m/ns]
DISTANCE [METER]
TIME [ns]
layer 1
Bergnivå
DEPTH [METER]

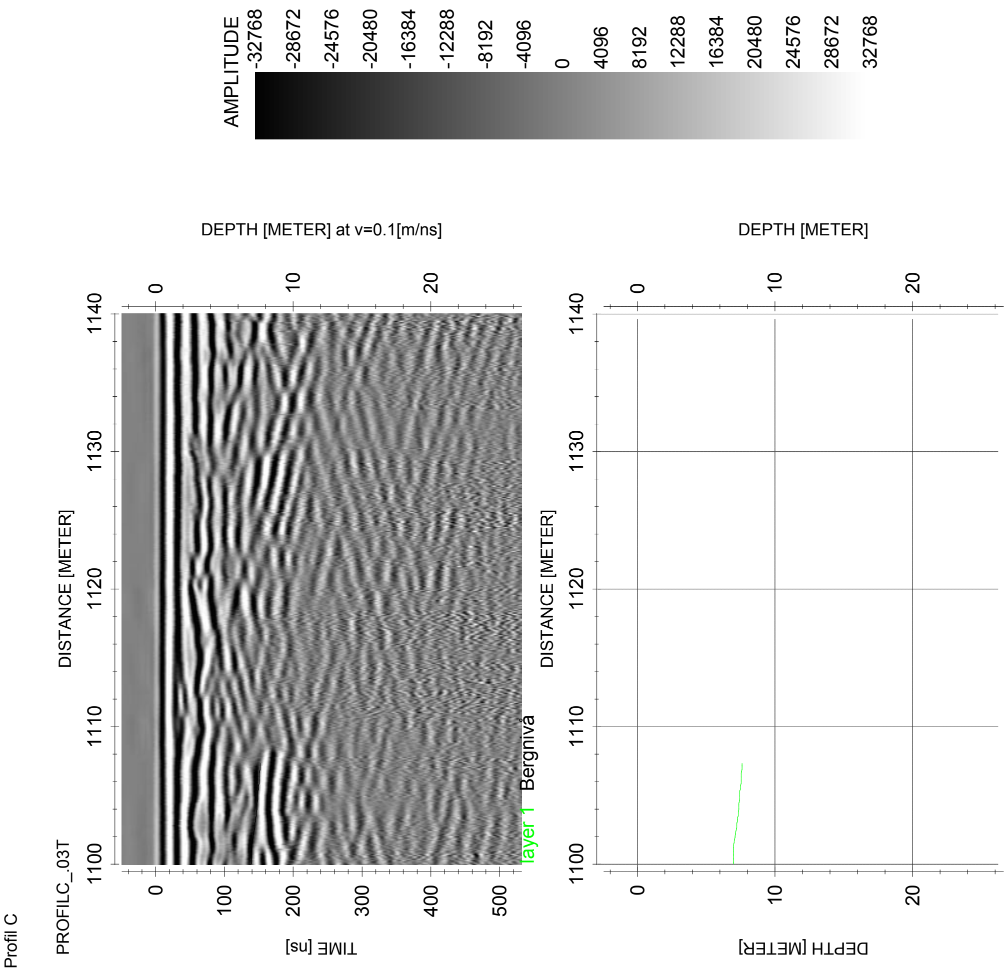


Profil C
PROFILC_03T
AMPLITUDE
-32768
-28672
-24576
-20480
-16384
-12288
-8192
-4096
0
4096
8192
12288
16384
20480
24576
28672
32768
DEPTH [METER] at v=0.1[m/ns]
DEPTH [METER]
DISTANCE [METER]
TIME [ns]


PROFILC_.03T
AMPLITUDE
-32768
-28672
-24576
-20480
-16384
-12288
-8192
-4096
0
4096
8192
12288
16384
20480
24576
28672
32768
DEPTH [METER] at v=0.1[m/ns]
DEPTH [METER]
DISTANCE [METER]
TIME [ns]
900
910
920
930
940
950
960
970
980
990
0
100
200
300
400
500
10
20

Profil C


Profil C
PROFILC_03T
AMPLITUDE
-32768
-28672
-24576
-20480
-16384
-12288
-8192
-4096
0
4096
8192
12288
16384
20480
24576
28672
32768
DEPTH [METER] at v=0.1[m/ns]
DEPTH [METER]
DISTANCE [METER]
TIME [ns]
layer 1
Bergniva


Profil C
PROFILC_.03T
AMPLITUDE
-32768
-28672
-24576
-20480
-16384
-12288
-8192
-4096
0
4096
8192
12288
16384
20480
24576
28672
32768
DEPTH [METER] at v=0.1[m/ns]
DISTANCE [METER]
TIME [ns]
layer 1
Bergnivå
DEPTH [METER]
DISTANCE [METER]
DEPTH [METER]