

REPUBLIC OF BOPHUTHATSWANA
DEPARTMENT OF WATER AFFAIRS

**BODIBE VILLAGE
DITSOBOTLA DISTRICT
REPORT ON
HYDROGEOPHYSICAL SURVEY
RUN IN BODIBE WEST**

PARTRIDGE MAUD AND ASSOCIATES

in association with

E. MARTINELLI AND ASSOCIATES

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1. INTRODUCTION

This report deals with a hydrogeophysical survey carried out in and around the western portions of the village of Bodibe, Ditsobotla District. The survey was concentrated in 4 main target areas, designated A, B, C and D, as shown on Fig 1. Areas C and D are respectively 1,5 Km East North East and 1,1 Km S of the village itself.

The objective of the survey was to find sites for the drilling of boreholes which are required to supply up to 17 l/s of water to a planned reticulation scheme for Bodibe Village. This work was undertaken in order to find alternative site to those previously selected in the Matlabes Compartment to the east of Bodibe; (ref. "Bodibe Village, Ditsobotla District, Report on Hydrogeophysical Survey" of October 1991.) The work dealt with in this report was carried out once it became clear that the existing boreholes in Bodibe were unable to satisfy the water demand, (ref. "Bodibe Village, Ditsobobtla District, Report on Controlled Testing of Existing Boreholes" of November 1991). The survey was carried out in November 1991 under the auspices of the ongoing Rural Water Supply Programme of Bophuthatswana.

This report describes the hydrogeophysical survey carried out and discusses the results obtained. Recommendations are given based on the interpretation of the survey data. Supporting tables, diagrams, and Appendices are included.

2. GENERAL GEOLOGY AND HYDROGEOLOGY

Bodibe village is underlain by chert-poor dolomite of the Oaktree Formation. The dolomite is capped by calcrete which forms an east west trending ridge through the village. The dolomite of the Oaktree Formation has not been subjected to extensive karst development and solutional weathering and for this reason is known to be a relatively poor aquifer. Boreholes recently tested in Bodibe yield between 0,3 l/s (10-77029) and 0,5 l/s (10-77260), as detailed in the testing report of November 1991. A limited water bearing horizon(s) is probably present at the contact between the calcrete and the solid dolomite.

A regional dyke trending SW-NE crosses the village. All the dykes and fractures indicated on Fig. 1 have been identified by means of photointerpretation and areomagnetic maps.

The four areas where the survey was concentrated are briefly described below. The areas were selected on the basis of the photo interpretation as representing target areas where the groundwater development potential appeared to be more favourable than in the surrounding areas.

2.1 AREA A

This is an elongated pan or depression to the north of the village with its long axis in a NW-SE direction. The floor of the pan comprises solid outcrops of Oaktree dolomite. A permanent spring is present in the northern part of the pan where water on the shallow contact between the calcrete and underlying solid dolomite emerges.

Testing of borehole 10-77261, situated on the northern edge of the pan, shows that the aquifer comprises surface weathering only. The borehole, although capable of being pumped at a high yield, cannot sustain any reasonable yield in the long term due to dewatering.

2.2. AREA B

This area is situated along the dry course of the Polfontein river south of the village (Fig. 1). Here the river has cut through the calcrete capping to the dolomite. The main SW-NE trending dyke crosses the river in this area.

2.3. AREA C

This is situated approximately 1,5 Km East North East of the village. Here again the Polfontein river has cut through the calcrete (5-6m thick) to the underlying dolomite. A N-S trending dyke crosses this area and runs parallel to the river here. An old borehole, T17000, reported to have a good water supply, is present. (Fig. 1).

2.4. AREA D

This area is located 1,1 Km south of the central part of the village. The main NE-SW trending dyke crosses this area. A significant SSW- NNE trending fracture is seen on the air photographs crossing the dyke.

3. HYDROGEOPHYSICAL SURVEY

The survey comprised the running of magnetic traverses (MT), electromagnetic traverses (EM) and electrical resistivity soundings (VES).

The combined application of these techniques is important in identifying potential aquifers and avoiding the ambiguities inherently present in the interpretation of each technique on an individual basis. In particular, the running of EM traverses helps in the detection of zones of conductivity in areas where there are no clear targets, for example, where dykes and fracture are covered with thick calcrete as is the case in Bodibe. The position of all geophysical work carried out is shown on the sketch plan of Fig. 2.

Gravity profiling was not undertaken due to the limited time available and the fact that the Oaktree Formation is known to be chert poor and lacking in karst features.

3.1. MAGNETIC TRAVERSING (MT)

All magnetic traversing has been carried out using a Chemtron Proton Magnetometer. Readings with an accuracy of ± 1 nanotesla were taken at 10m intervals along each traverse. Plots of the magnetic traverses are included in Appendix I. The positions of VES run on these traverses are indicated on the plots.

3.1.1. Bodibe Village area

Two magnetic traverses (designated MT1 with a length of 550m and MT2 with a length of 500m) were run perpendicular to the NE-SW trending regional dyke.

The position of the dyke could not be clearly detected due to the effect of nearby fences which caused background noise. It appears, however, that the centre of dyke is at approximately 140m along MT1 and 330m along MT2.

3.1.2. Area B

One traverse (MT3 with a length of 700m) was run along the course of the Polfontein Spruit in a NW-SE direction perpendicular to the regional dyke (Fig 2).

The dyke was detected at about 460m along this traverse (ref: plot in Appendix I). Interpretation of the magnetic response shows the dyke is approximately vertical here.

3.1.3. Area C

Two magnetic traverses were run almost perpendicular to the dyke (MT6 over a distance of 800m and MT5 over 250m) in a W-E direction (Fig. 2).

The dyke has been detected at 185m along MT4 and at 100m along MT5. The dyke is approximately vertical.

3.1.3. Area D

Two magnetic traverses were run at right angles to the dyke (these are designated MT6 with a of length 300m and MT7 with a length of 250m). These traverses were run in a NW-SE direction. (Fig. 2).

The regional dyke has been detected at 155m along profile MT6 and at 130m along profile MT7. The dyke is vertical.

3.2. ELECTROMAGNETIC TRAVERSING (EM)

The use of this technique assists in the detection of conductive zones in areas where no obvious targets are present. Furthermore, the technique can confirm the presence of conductive zones already detected by magnetic traversing or VES, for example, along dykes.

The EM profiles were carried out using an Apex Max-Min machine. The separation between the transmitter and receiver was 100m. In phase and Quadrature readings at four different frequencies (444Hz-888Hz-1777Hz and 3555Hz) were taken at 25m intervals along each profile.

Each reading obtained is a percentage expressing the ratio:-

$$\frac{\text{secondary field induced in the conductive layer/body}}{\text{primary field applied}}$$

Plots of the EM traverses are given in Appendix II. Where VES were run on traverses their position is indicated on the plots.

3.2.1. AREA A

Two EM traverses were run in this area to cover the entire length of the pan. EM 1 was run over 900m in a SSE-NNW direction. EM 2 is also 900m in length and was run in a SE-NW direction (Fig. 2).

No deep conductive zones of fracturing have been identified along the profiles. The noise on the quadrature response at higher frequencies seen on the profiles represents surface effects only and are of no significance to groundwater occurrence. The EM profiles confirm the floor of the

pan is characterized by solid unweathered and unfractured massive dolomite.

3.2.2. AREA B

Two EM traverses were run as indicated on Fig. 2. EM4 (350m) in a NW-SE direction, and EM5 (700m) in a SE-NW direction were run at right angles to the main NE-SW trending dyke. A limited zone of conductivity is detected on profile EM 4 at 155m, but this could not be confirmed by the 3 VES (VES 14, 19 and 20) subsequently run to investigate this feature.

A more pronounced conductive zone occurs on EM5 at 210m. This confirms the presence of the dyke detected along MT3 and is (probably) the expression of the fractured dyke/dolomite contact.

3.2.3. AREA C

A 300m long traverse, EM3, was run in an E-W direction perpendicular to the N-S trending dyke (Fig 2).

A shallow conductive zone centred 150m along the profile was detected. This zone coincides with the dyke identified on MT4 and MT5 run respectively 160m and 450m south of EM3.

3.2.4 AREA D

Traverse EM6 was run in a NW-SE direction at right angles to the dyke and parallel to MT6, over a distance of 300m (Fig 2).

A pronounced conductive zone is identified by the quadrature profile on all four frequencies. The centre of this zone is at 145m on the profile. The width of the zone is of the order of 25m and is approximately 20m deep. This matches the position and depth of the dyke as identified on MT6 and MT7

3.3. GEOELECTRICAL SURVEY

Initially 3 calibration VES and 17 exploratory VES were carried out. Subsequent to the running of the EM traverses, a further 9 exploratory VES were run to better define the conductive zones located. These zones all coincided with dykes and their contact zones. All the VES were run according to the Schlumberger electrode configuration. This enables the data obtained to be interpreted in terms of layers of different thickness and true resistivity.

The positions of all the VES run are shown on Fig. 2.

3.3.1. Bodibe village area

Exploratory VES 9, 10 and 11 were run in a gentle depression just north of the village and east of Area A (Fig. 2). Interpretation of the data show a 2 or 3 layer "A" type curve, with a first layer of weathered calcrete (between 1 and 3m thick with a resistivity of 80-100 ohm-metres), covering solid dolomite. The area has no groundwater potential and is unsuitable for drilling.

Exploratory VES 7 and 22 were run adjacent to the dyke on MT1 and VES 8 was run adjacent to the same dyke on MT2 (Fig 2). All three soundings are characterized by a 4 layer "HA" curve. Interpretation of

the data indicates the presence of a surface layer of calcrete (7-12m thick) overlying a deeper zone of fractured/weathered dolomite ranging from 25m at 160 ohm-metres (VES 22) to 40m at 200 ohm-metres (VES 7). This zone overlies solid dolomite.

Calibration VES 2 was run at borehole 10-77029. The geo-electrical response is similar to VES 7, but with a conductive intermediate layer of higher resistivity (260 ohm-metres). Controlled testing of borehole 10-77029 showed the aquifer intersected by this borehole is very poor.

The interpretation of VES 7 indicates that this could be selected as a low priority drilling site to intersect the dyke contact zone.

3.3.2. AREA A

A total of 8 VES were run in the pan to probe the subsurface conditions. VES 1, 2 and 12 show a 2 layer type curve with a surface layer of overburden material 1-2m thick, (resistivity 15-40 ohm-metres) overlying solid dolomite.

VES 3, 4, 5, 6 and 13 show 3 layer 'A' and 'Q' type curves with surface overburden material 0,5-3m thick with a resistivity of 60-70 ohm-metres overlying a thin zone with a resistivity 200-500 ohm-metres with solid dolomite below.

A calibration VES 1 was executed at WP 10-77261. This sounding shows a surface layer of calcrete 3m thick overlying solid dolomite. This confirms the results of the testing which showed the aquifer present in the pan to be very shallow.

The pan area has no groundwater development potential and is not suitable for drilling.

3.3.3. AREA B

Three exploratory VES, (VES 14, 19 and 20) have been carried out along EM4 profile close to the Polfontein Spruit. The soundings show a surface layer of calcrete, 2-4m thick, with a resistivity of 40-100 ohm-metres, overlying a shallow intermediate layer of probably fractured dolomite (thickness 3-8m, with a resistivity of 400 ohm-metres). Below solid dolomite occurs, and the conductive zone detected by the EM profiling is merely shallow surface weathering not suitable for drilling.

Three exploratory VES (VES 15, 21 and 24) were run in the eastern part of Area B, to probe the contact zone of the dyke detected on MT3 and EM5. These VES are all adjacent to the Polfontein Spruit (Fig. 2). They show a surface layer of weathered calcrete, (3-5m in thickness with resistivity of 65-100 ohm-metres) overlying an intermediate layer (possibly fractured dolomite) with a depth ranging between 5 and 20m and with a resistivity ranging from 250-800 ohm-metres. Solid dolomite is present below this layer in VES 14 and 24. However, the resistivity values in VES 21 tend to 350ohm-metres at depth. This could possibly represent deep fracturing associated with the dyke contact.

The hydrogeological potential of this site is enhanced by the proximity of the dyke to the Polfontein Spruit. VES 21 is suitable for drilling.

3.3.4 AREA C

Exploratory VES 16 and 23 have been carried out in the vicinity of the dyke detected on MT4, MT5 and EM3..

VES 16 is approximately in the middle of the conductive zone identified on EM3 profile. The sounding shows a 4 layer "QH" type curve, with a first layer of calcrete, 3,5m thick and resistivity of 300-1000 ohm-metres, overlying a thick layer of fractured/weathered dolomite (interpreted as 63m in thickness with a resistivity of 120 ohm-metres). Solid dolomite occurs below this depth.

VES 23 shows similar characteristics to VES 16 but the fractured/weathered dolomite layer is only about 30m thick.

Calibration VES 03 was executed at borehole T17000 300m south of VES 16. The sounding shows similar characteristics to VES 16 although here the fractured/weathered dolomite layer is only 35m thick.

These data indicate that VES 16 is favourable to groundwater occurrence and the site is selected for drilling. The potential of this site is enhanced by the proximity of the Polfontein Spruit.

3.3.5. AREA D

Four exploratory VES have been run in this area. VES 25 is positioned 145m along EM6 in the middle of the conductive zone and 10m SE of the centre of the dyke as seen on MT6. VES 26 has been carried out

40m NW of the centre of the dyke and VES 17 20m SE of the centre of the dyke, (Fig. 2.)

All three VES show a 4 layer "HA" type curve with a surface layer of calcrete (7-10m thick, with a resistivity of 100-1400 ohm-metres) overlying an intermediate layer of fractured dolomite (10-30m thick, with a resistivity of 400-1000 ohm-metres). At a greater depth the resistivity of the substratum is measured on each curve as 400 ohm-metres. The significance of this resistivity at depth cannot be determined without drilling data.

Exploratory VES 18 was run in the area 400m north of the dyke as a control. The sounding shows a surface layer of calcrete 11m thick with a resistivity of 130 ohm-metres, overlying a 10m thick intermediate layer with a resistivity of 450 ohm-metres. Dolomite with a resistivity of 1000ohm -metres forms the bedrock.

The area is not as topographically favourable as Area B. However, VES 25 could be selected for drilling as an alternative site.

4. CONCLUSIONS AND RECOMMENDATIONS

The photogeological and hydrogeophysical surveys, combined with the earlier testing carried out, have shown that the groundwater development potential of Bodibe Village West is generally poor to marginal. However, four areas and a dyke contact were considered worthy of field surveying where the potential for groundwater occurrence appeared to be more favourably developed. On the basis of the combined magnetic, electromagnetic and electrical resistivity survey 2 priority sites and 2

alternative sites have been selected for drilling. It is also recommended that one hole be rehabilitated.

VES 16 in Area C is selected as the priority drilling site. The site is approximately 1,5 Km East North East of Bodibe West adjacent to the Polfontein spruit. The topographic and geological position appear favourable and the geophysical survey data are promising. A higher than average yield for the Oaktree Formation is anticipated here. Should the borehole be successful the reported good yielding T17000 300m to the south should be rehabilitated and the two boreholes used together.






The second priority site is VES 21 in Area B. The topographic position is also favourable, being adjacent to the Polfontein Spruit, and the geological position appears favourable with the NE-SW trending dyke crossing the river course at this point. The borehole is sited to intersect the dyke contact zone on the upstream side.








VES 7 in Bodibe village area is selected as the third site on the NE-SW trending dyke. The position appears more favourable than the nearest calibration borehole, 10-77029. However, a yield in excess of 1-2 l/s cannot realistically be expected.

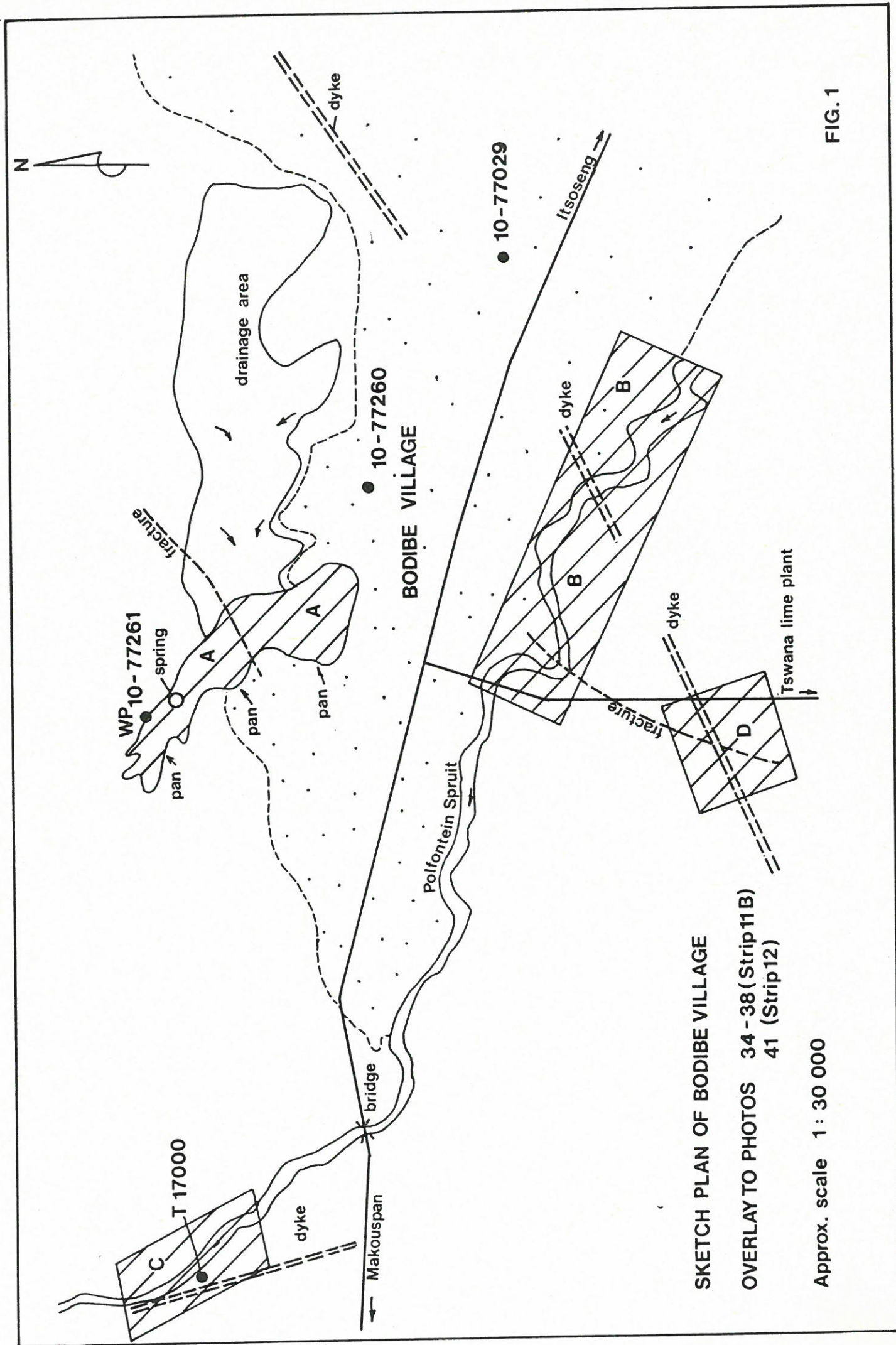
VES 25 in Area D should be regarded as an alternative to VES 21. The topographic position is not as favourable but the geological data appear reasonable.

The survey has therefore shown that the area is not without some groundwater development potential. However, in terms of the original requirement for 17 l/s, and for a borehole to yield 12 l/s, the area must be regarded as marginal.

LEGEND

-  Main roads
-  Tracks
-  Rivers
-  Dams
-  Fence

-  × 2 Position and number of Vertical Electrical Sounding
-  ○ Cal3 Position and number of Calibration Vertical Electric Sounding
-  1/01-50131 Position and number of Vertical Electrical Sounding and borehole number
-  ● Position and number of borehole drilled during present contract
-  • WP Position of existing borehole equipped with windpump
-  MT 2 Position and number of Magnetic Traverse
-  EM 2 Position and number of Electromagnetic Traverse

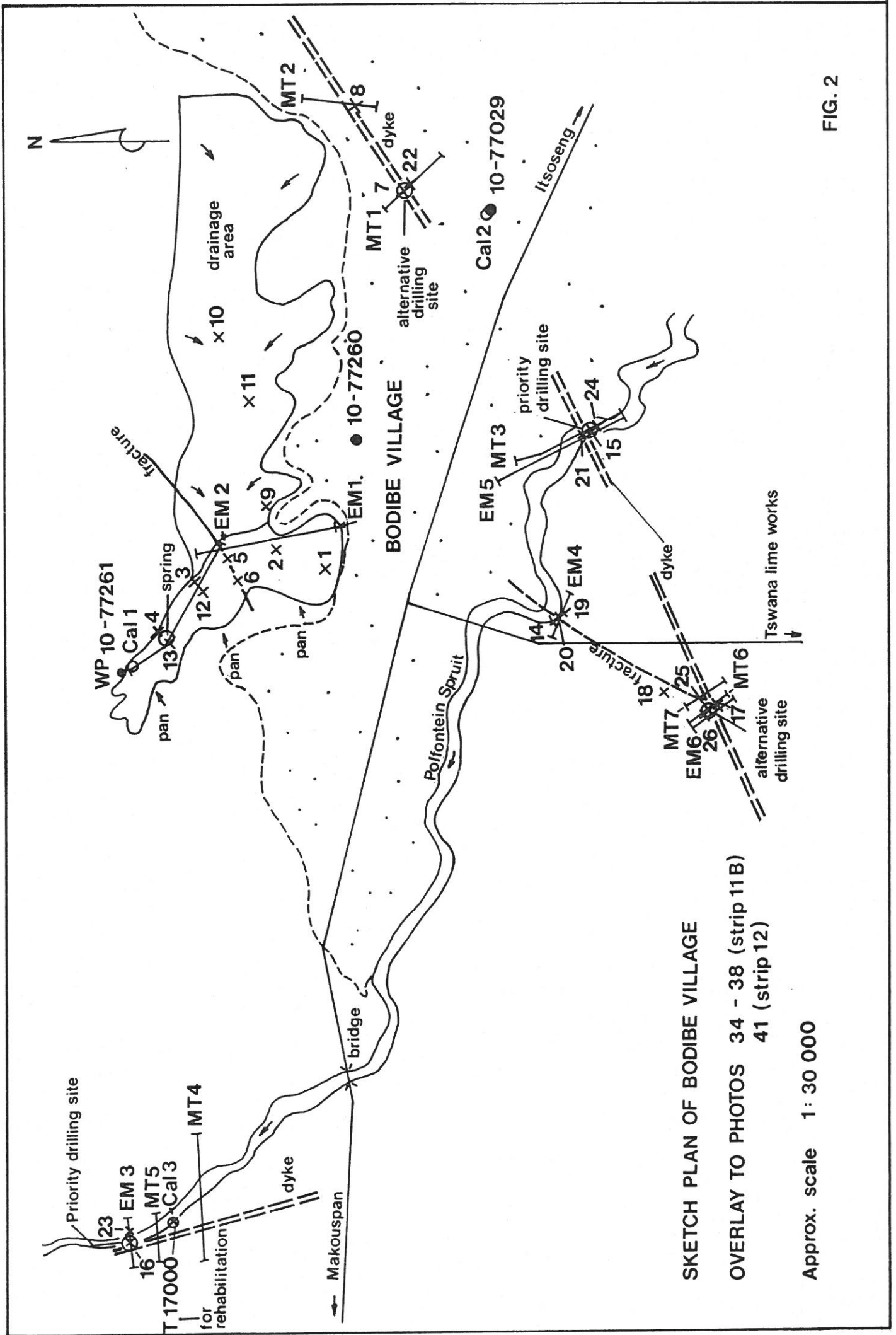


SKETCH PLAN OF BODIBE VILLAGE

OVERLAY TO PHOTOS 34-38 (Strip 11B)
41 (Strip 12)

Approx. scale 1 : 30 000

FIG. 1



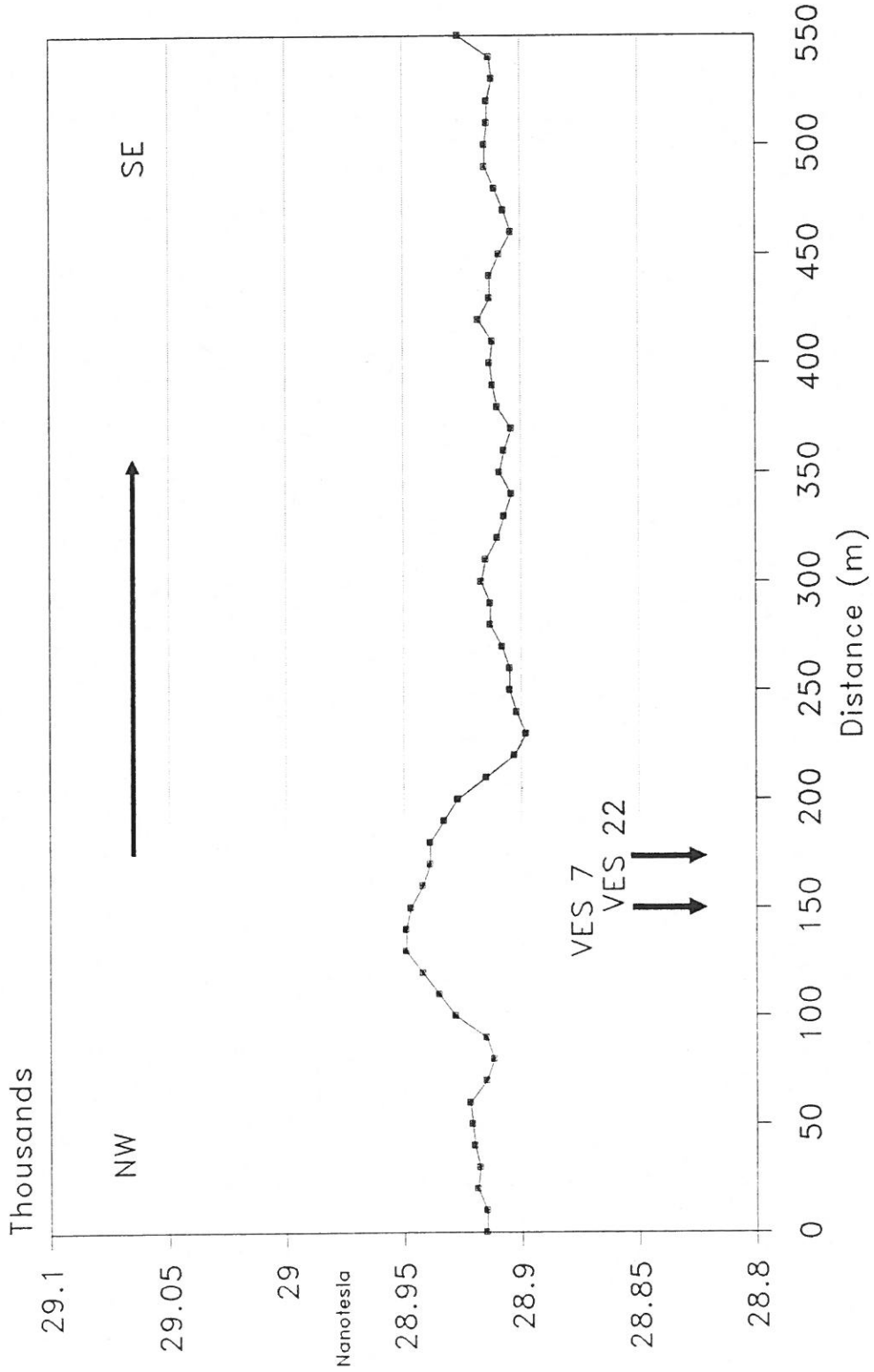
SKETCH PLAN OF BODIBE VILLAGE
 OVERLAY TO PHOTOS 34 - 38 (strip 11B)
 41 (strip 12)

Approx. scale 1 : 30 000

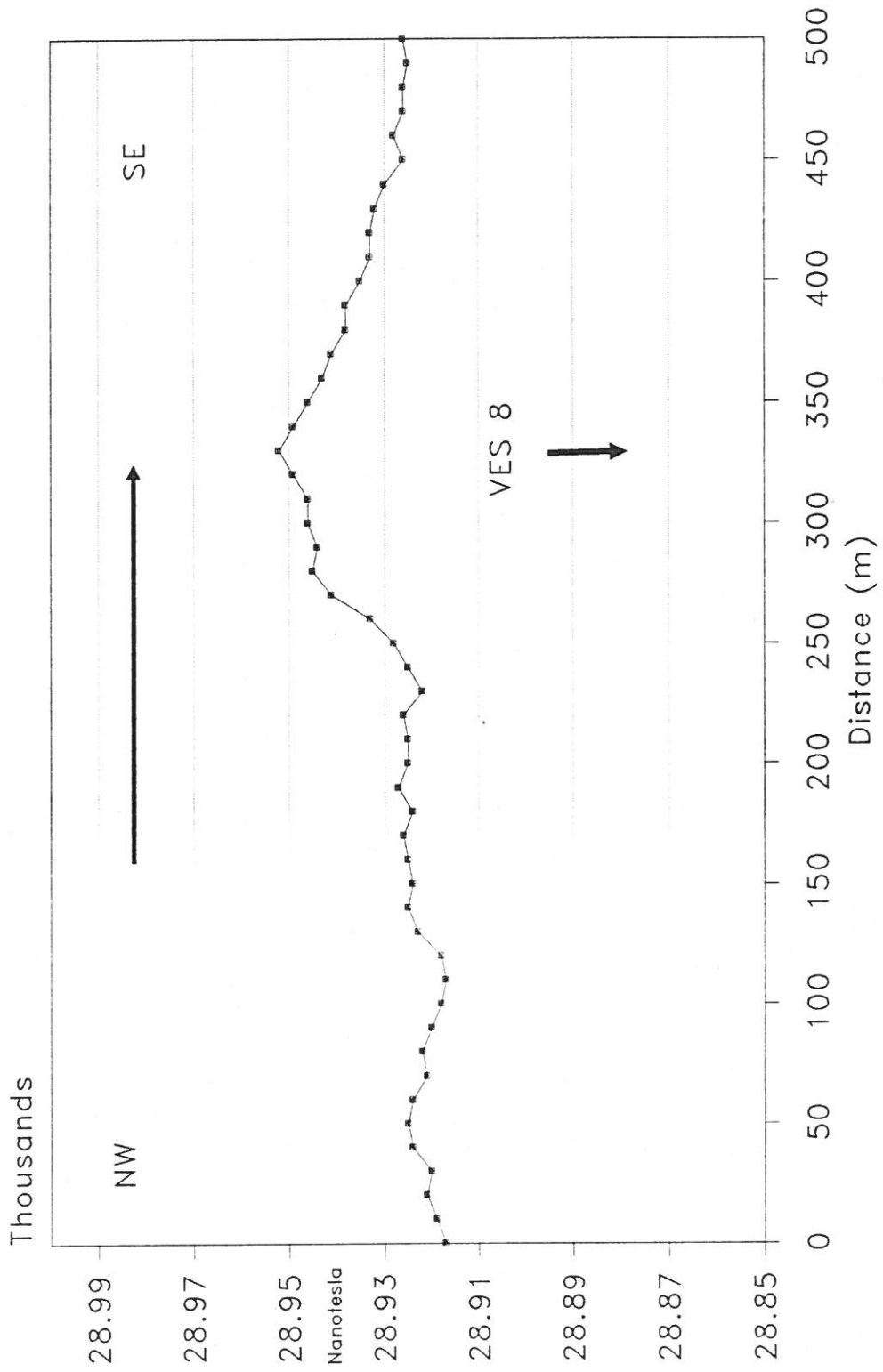
FIG. 2

APPENDIX I
MAGNETIC TRAVERSES

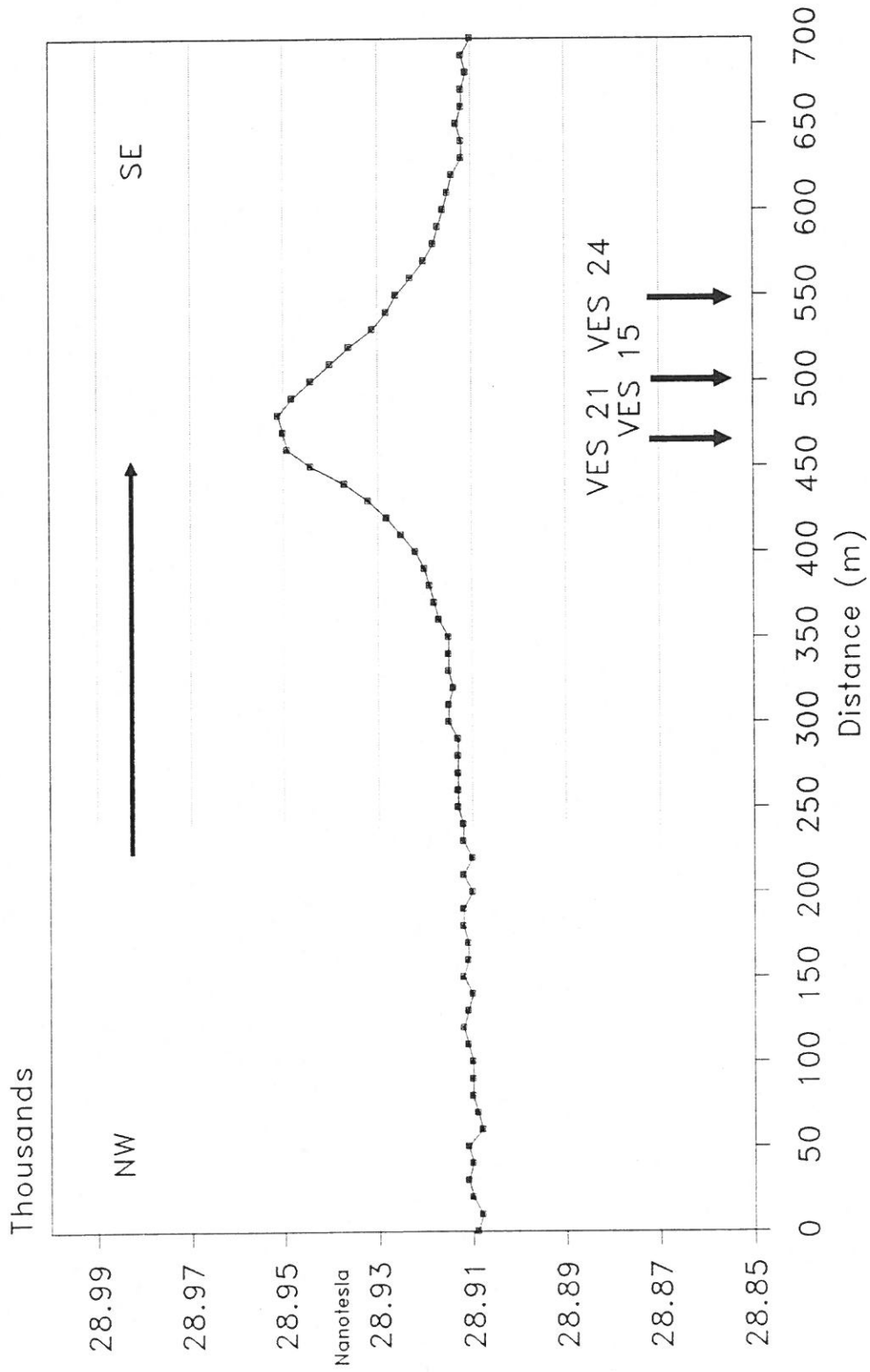
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District: DITSOBOTLA
Locality: BODIBE



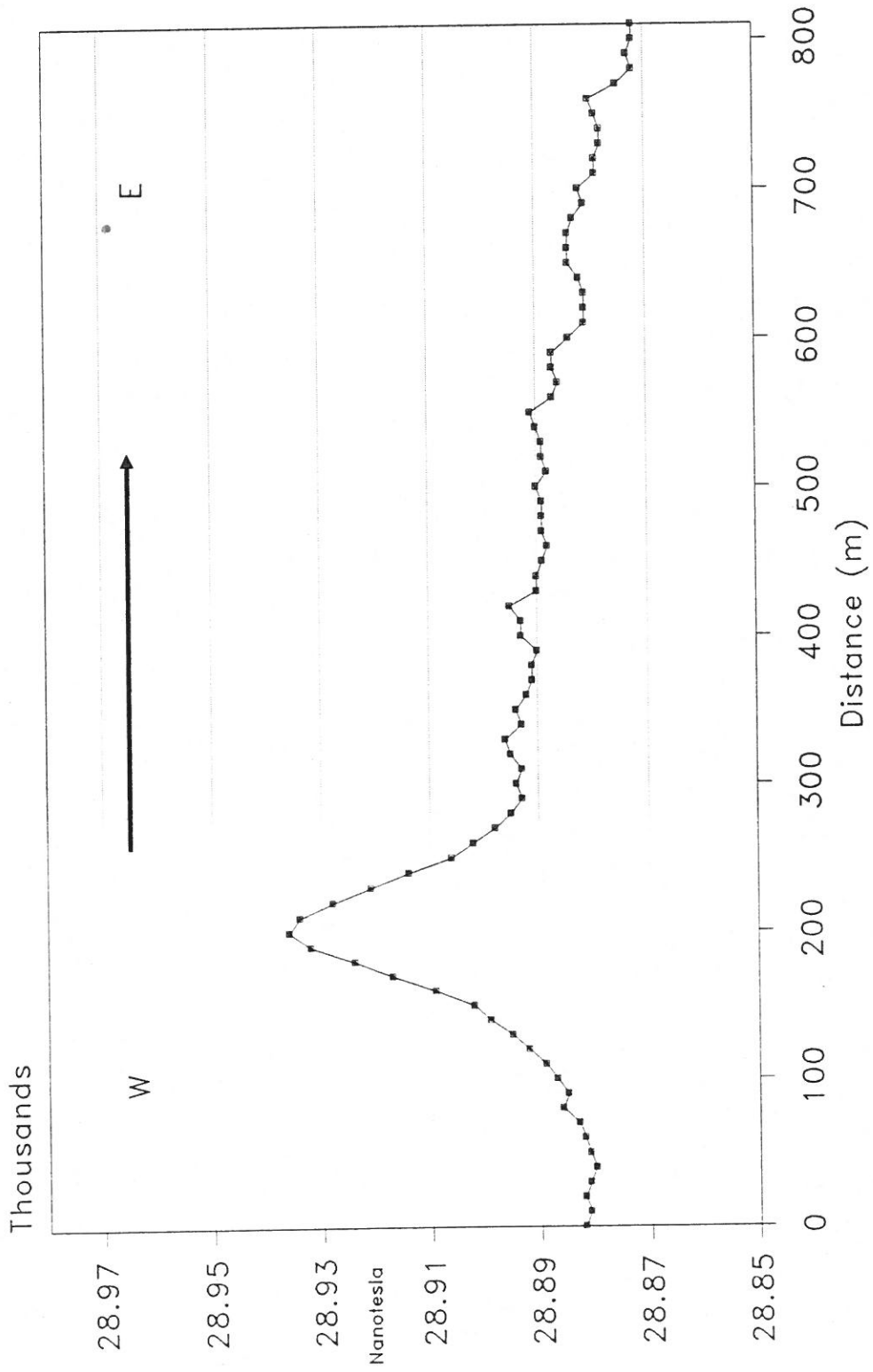
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District: DITSOBOTLA
Locality: BODIBE



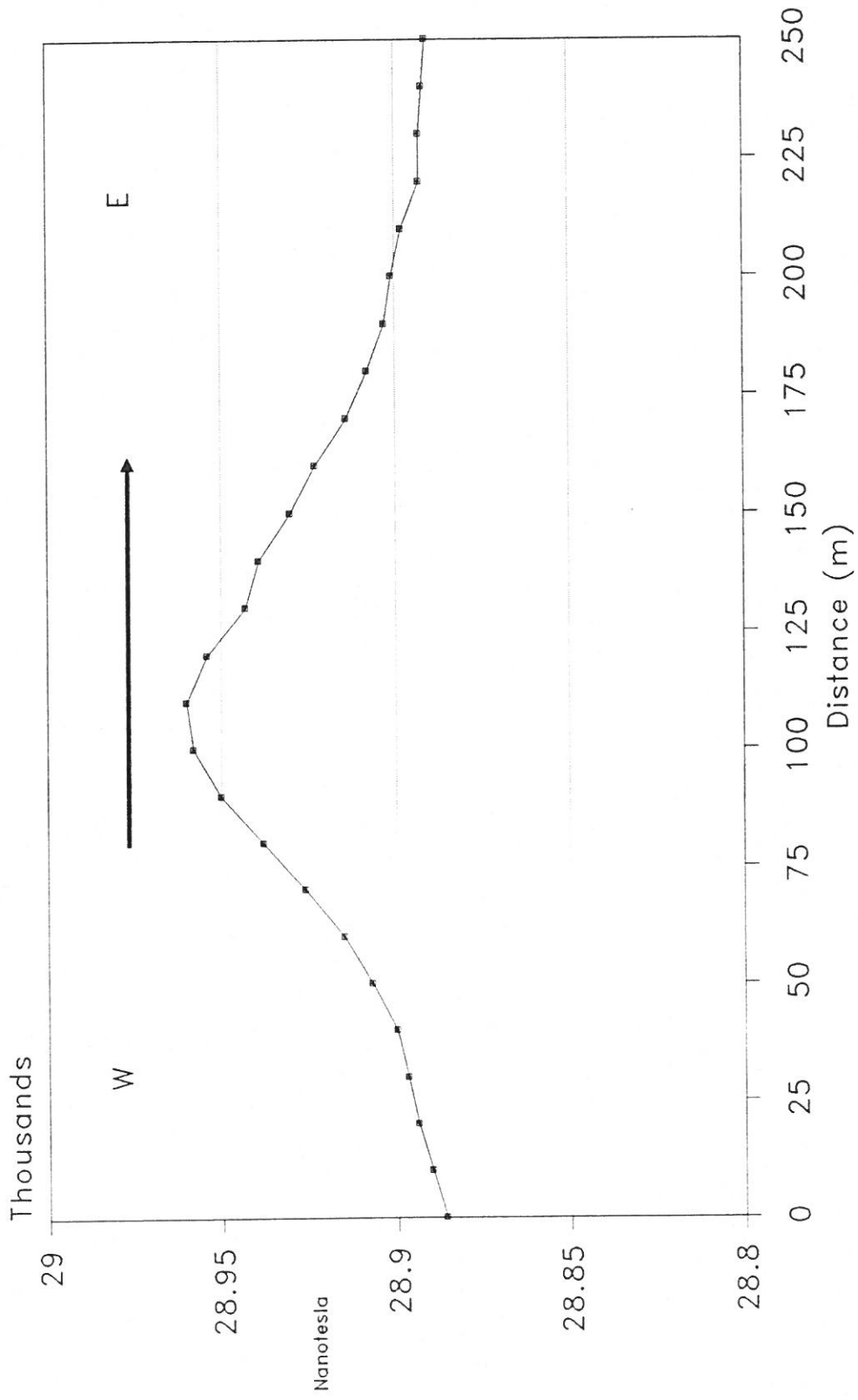
Magnetic Traverse T#3
District: DITSOBOTLA
Locality: BODIBE



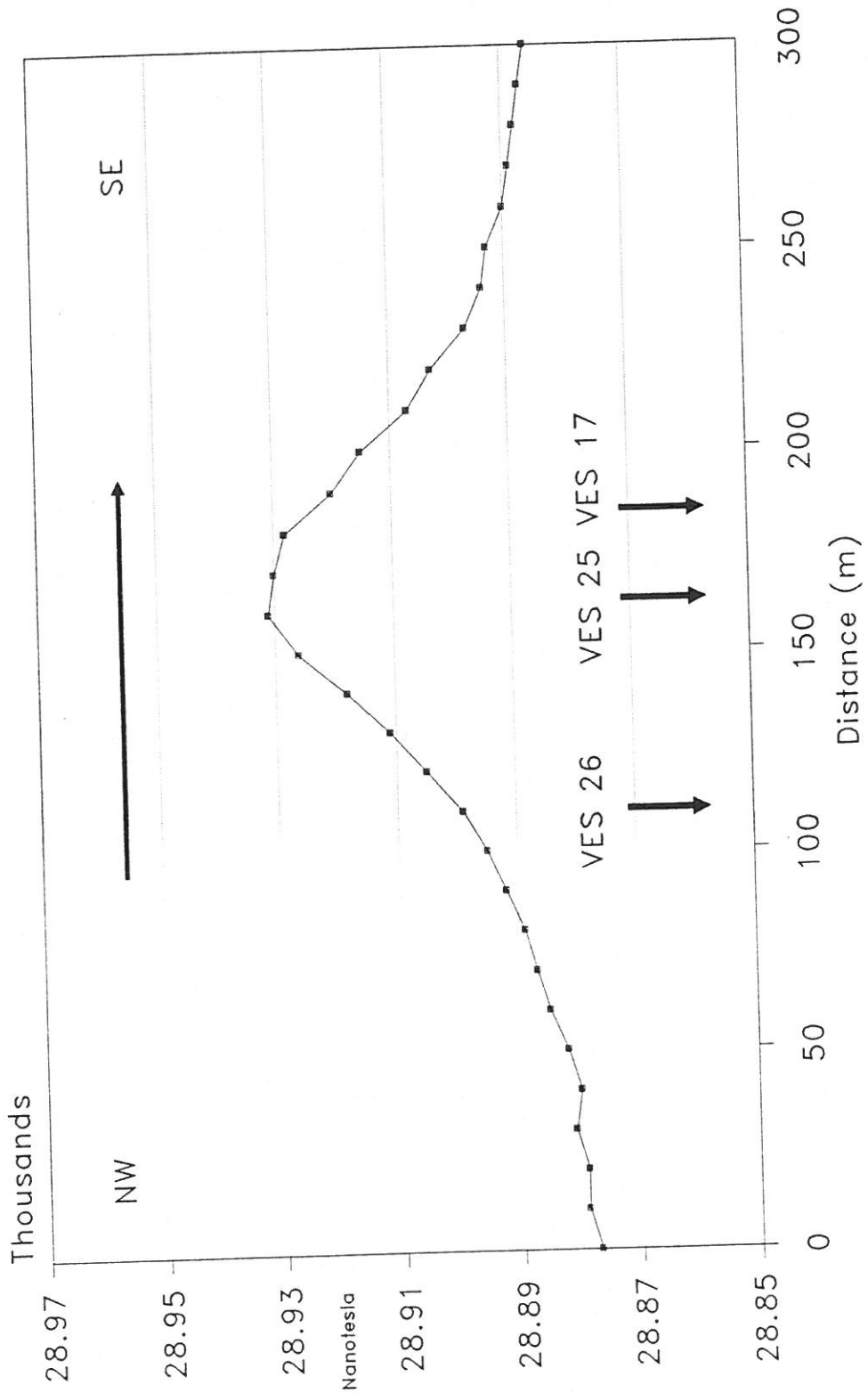
Magnetic Traverse T#4
District: DITSOBOTLA
Locality: BODIBE



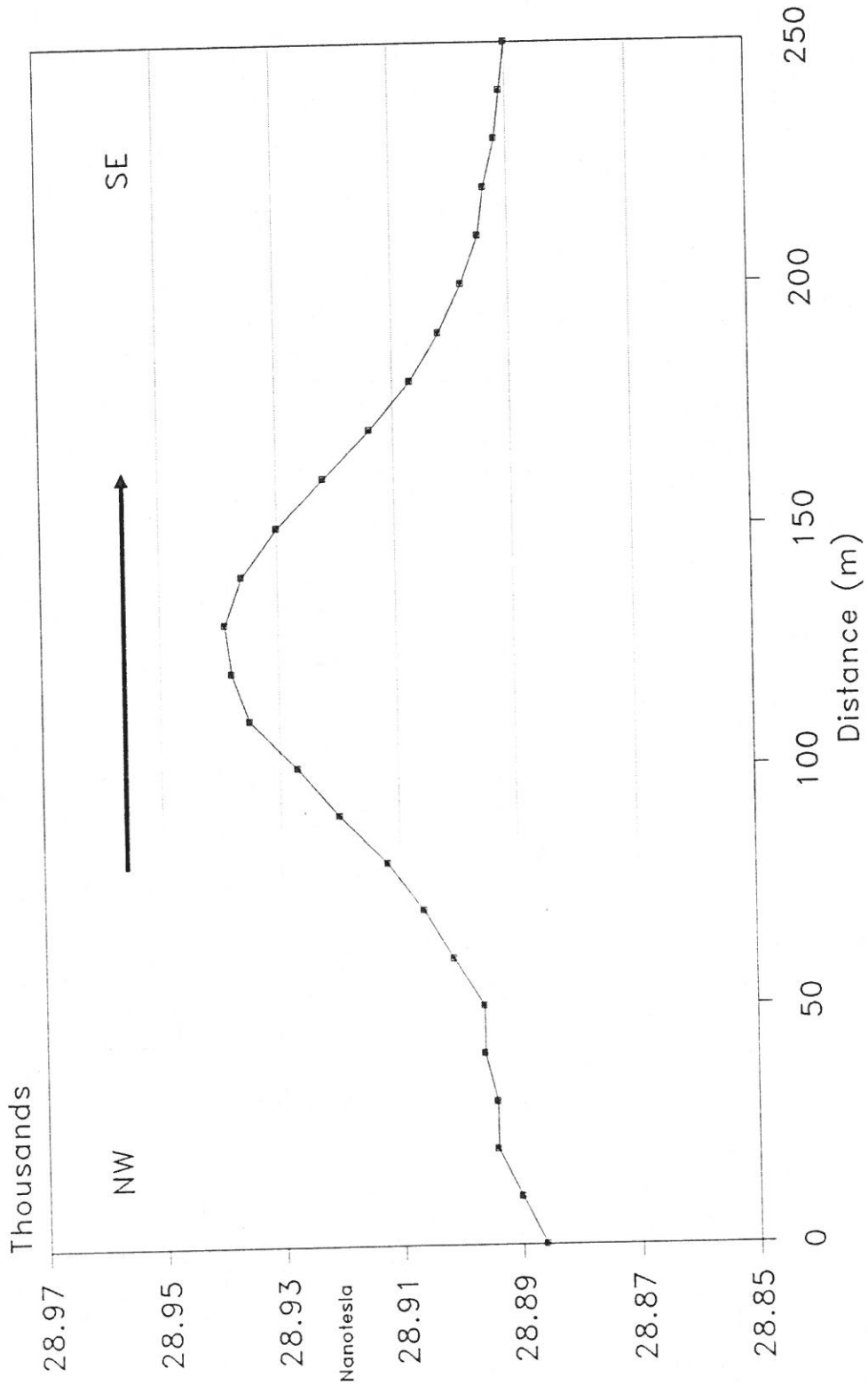
Magnetic Traverse T#5
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Locality: BODIBE



Magnetic Traverse T#6
District: DITSOBOTLA
Locality: BODIBE



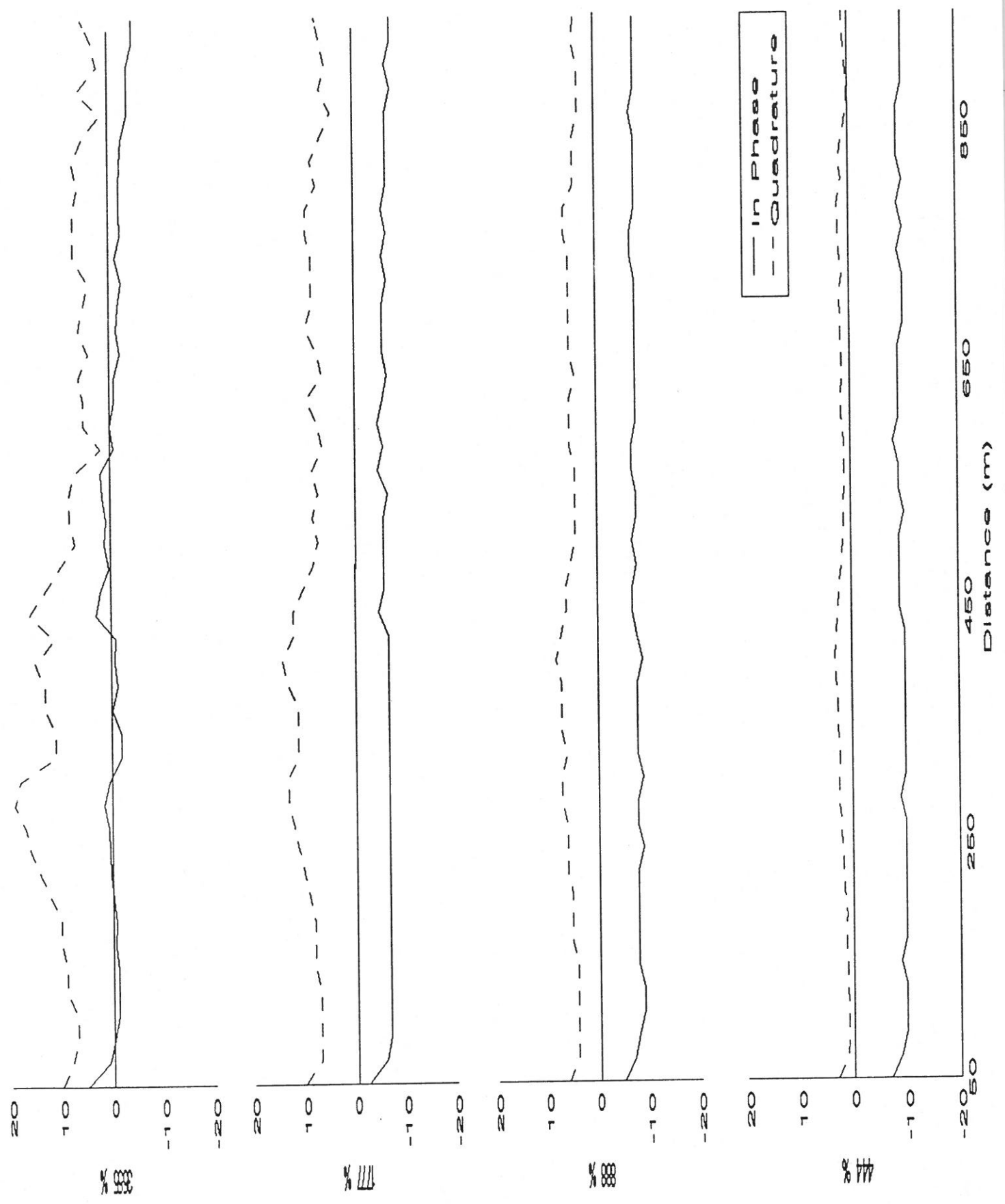
Magnetic Traverse T#7
District: DITSOBOTLA
Locality: BODIBE



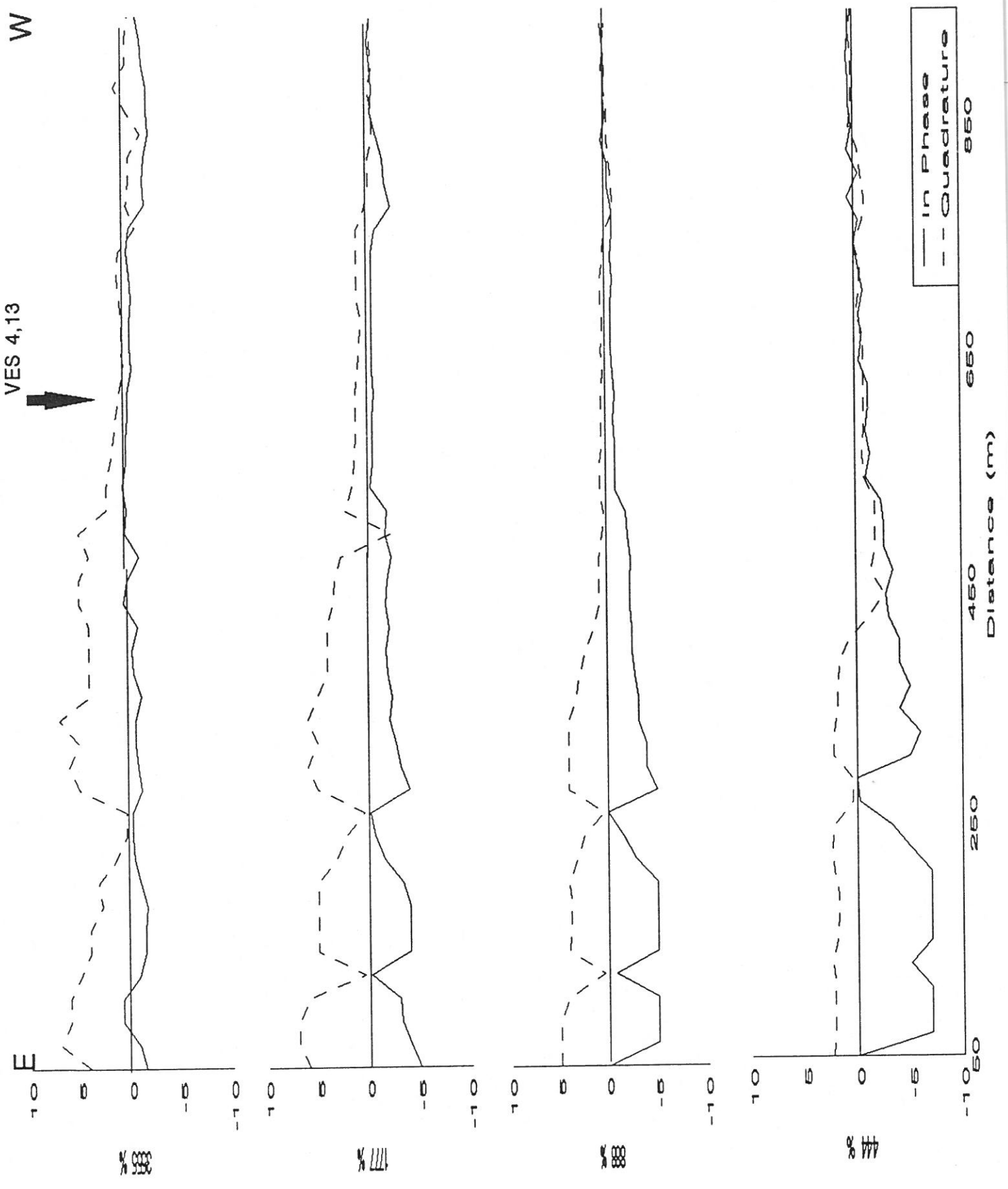
APPENDIX II

ELECTROMAGNETIC TRAVERSES

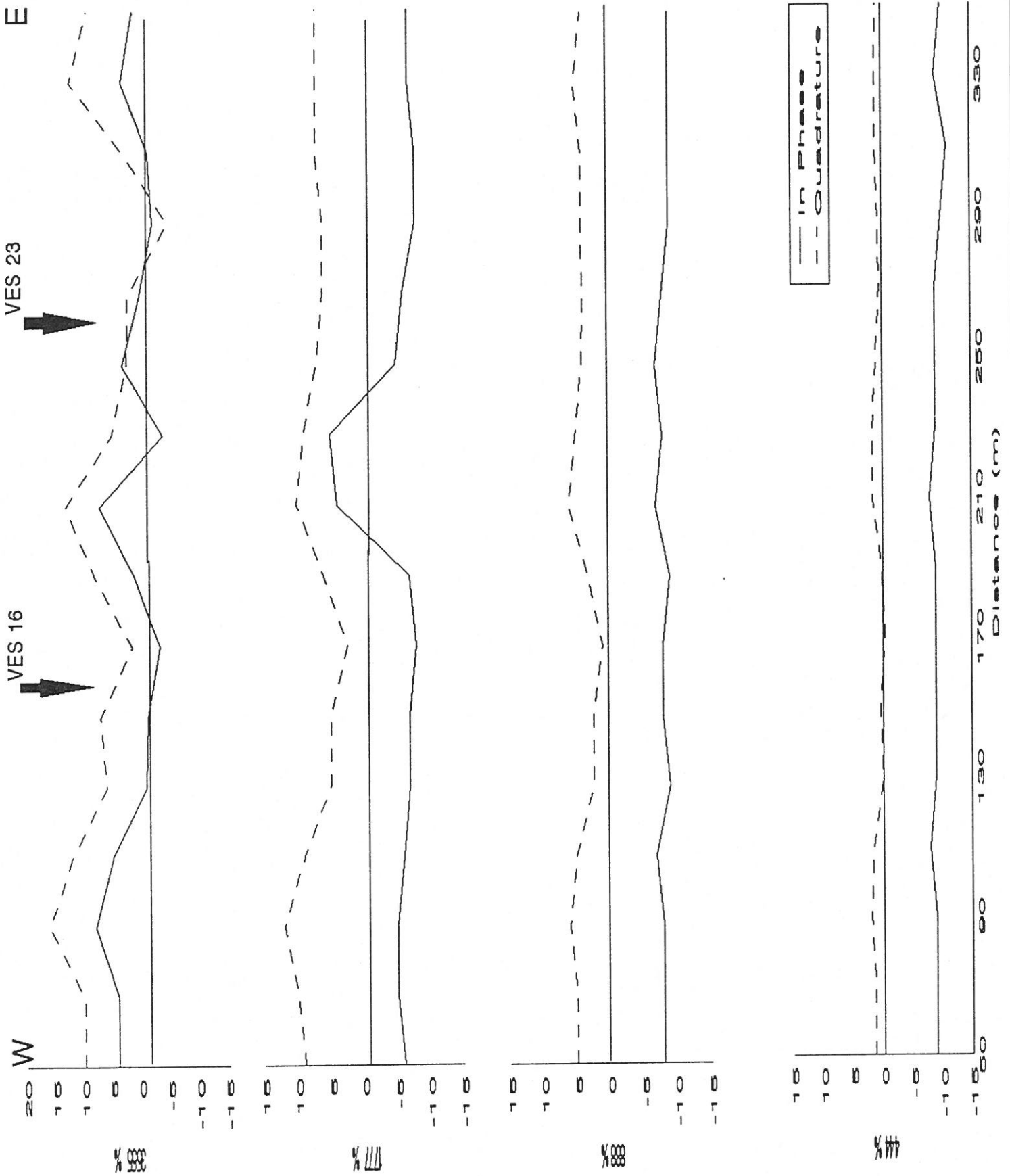
EM-1 Bodibe



EM-2 Bodibe



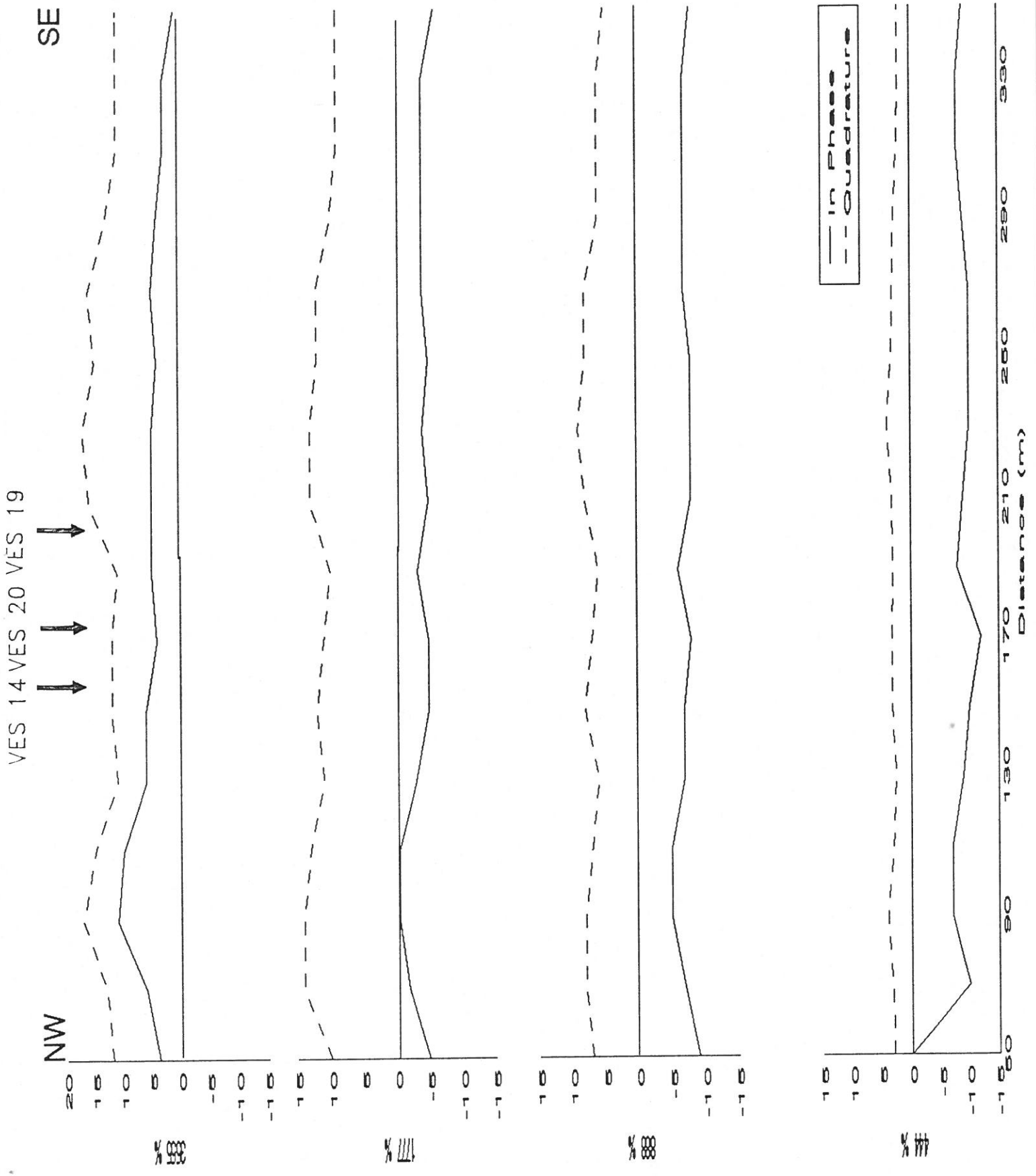
EM-3 Bodibe



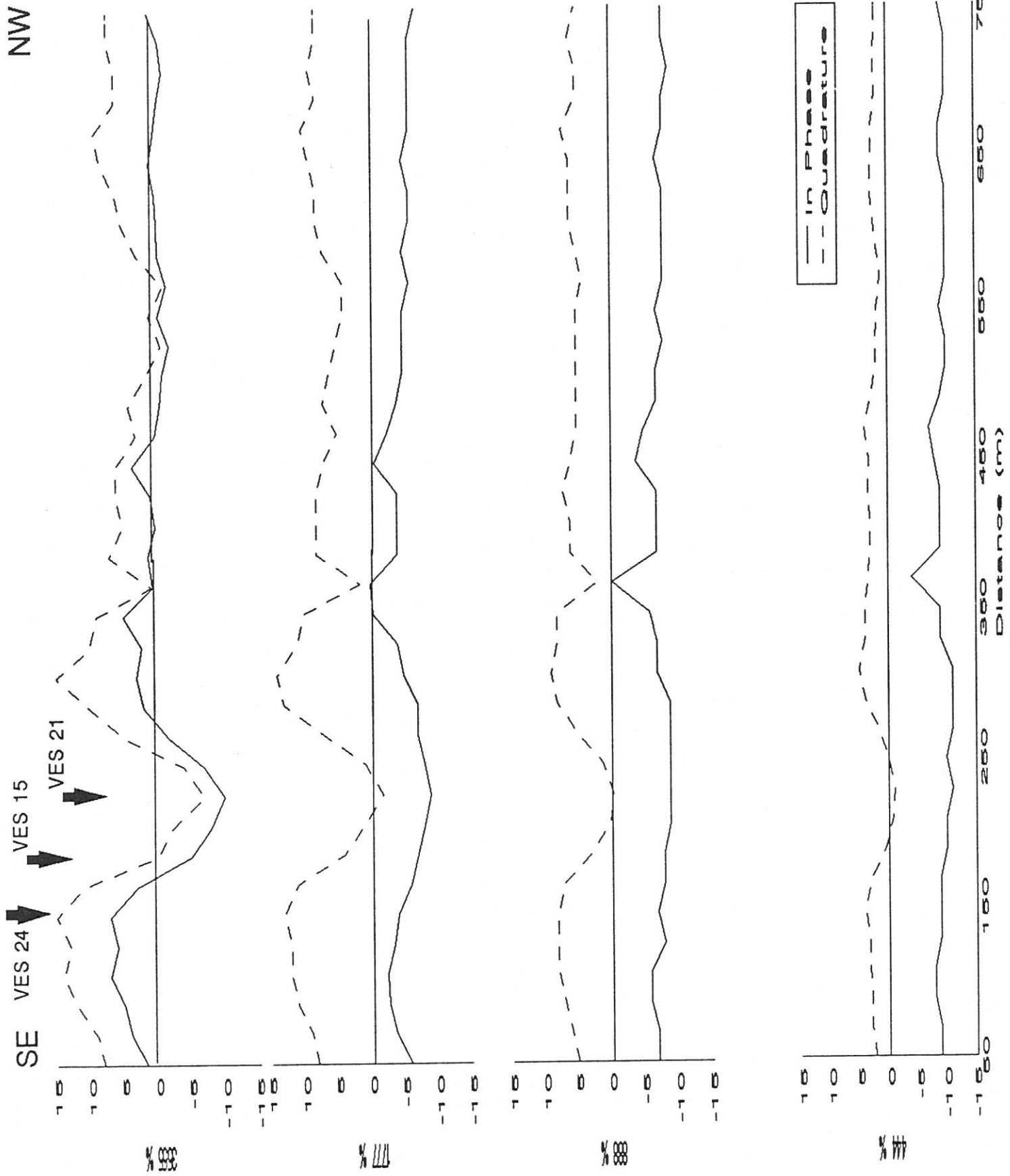
EM-4 Bodibe



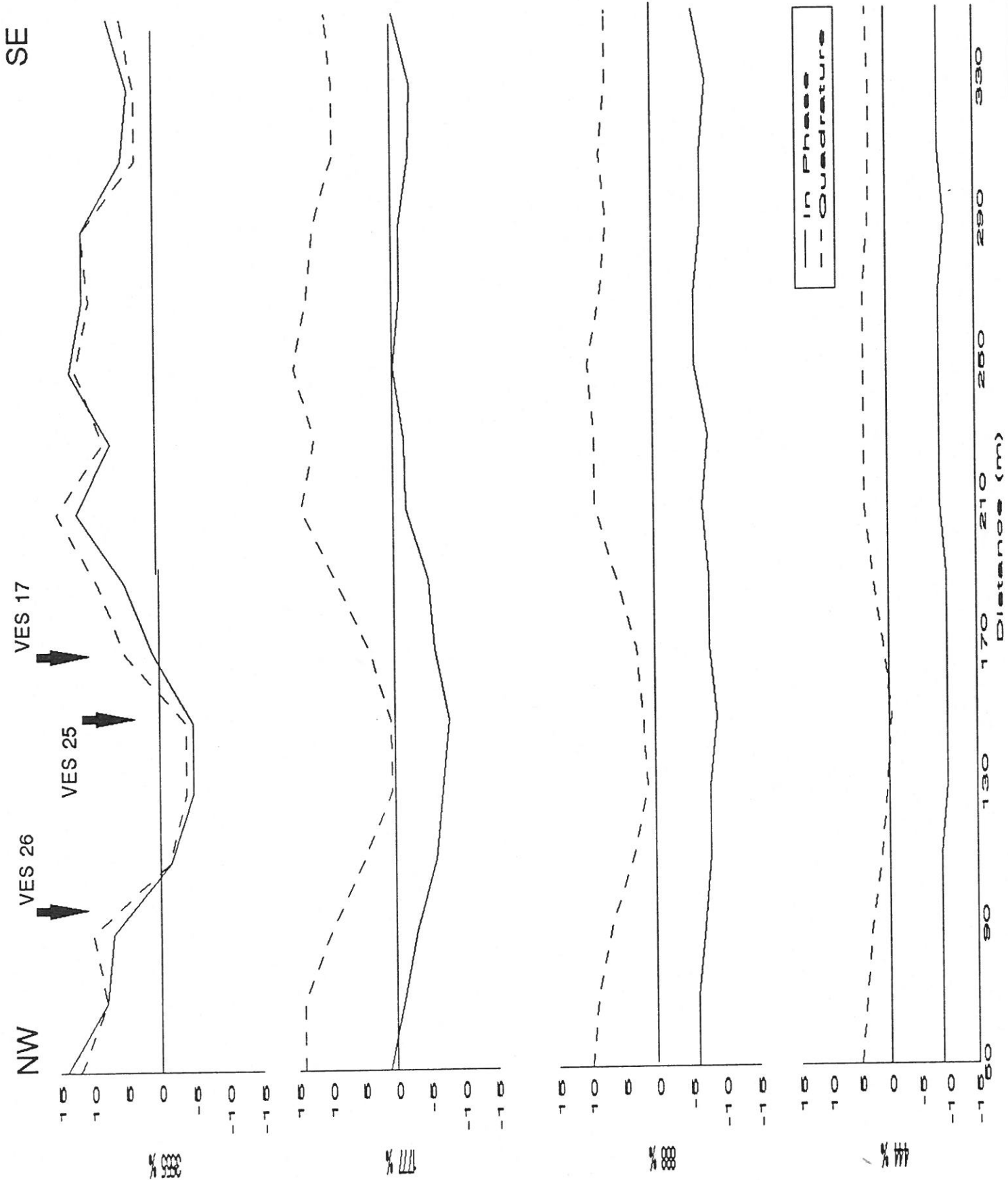
EM-4 Bodibe



EM-5 Bodibe



EM-6 Bodibe



APPENDIX III
VERTICAL ELECTRICAL SOUNDINGS

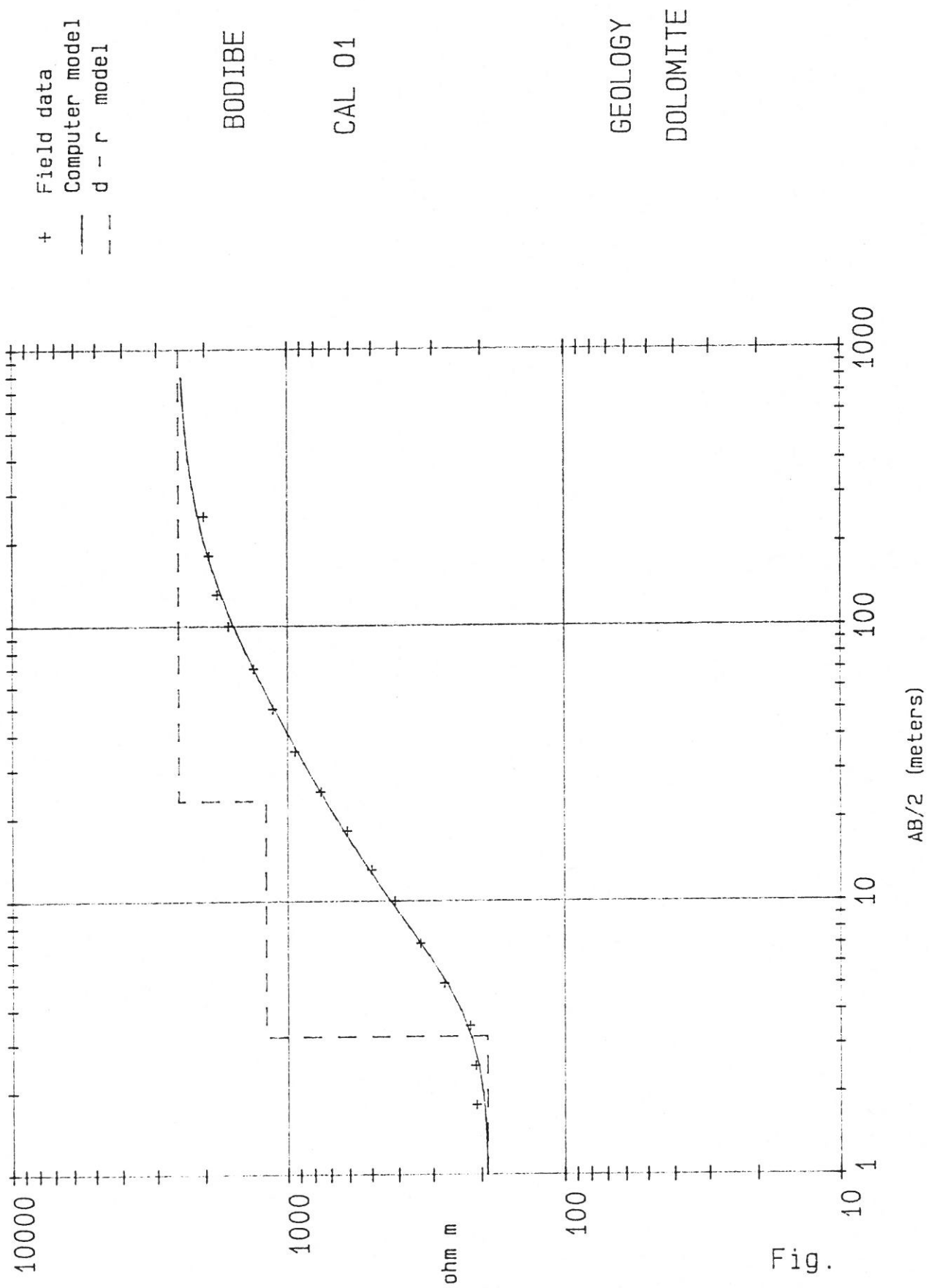
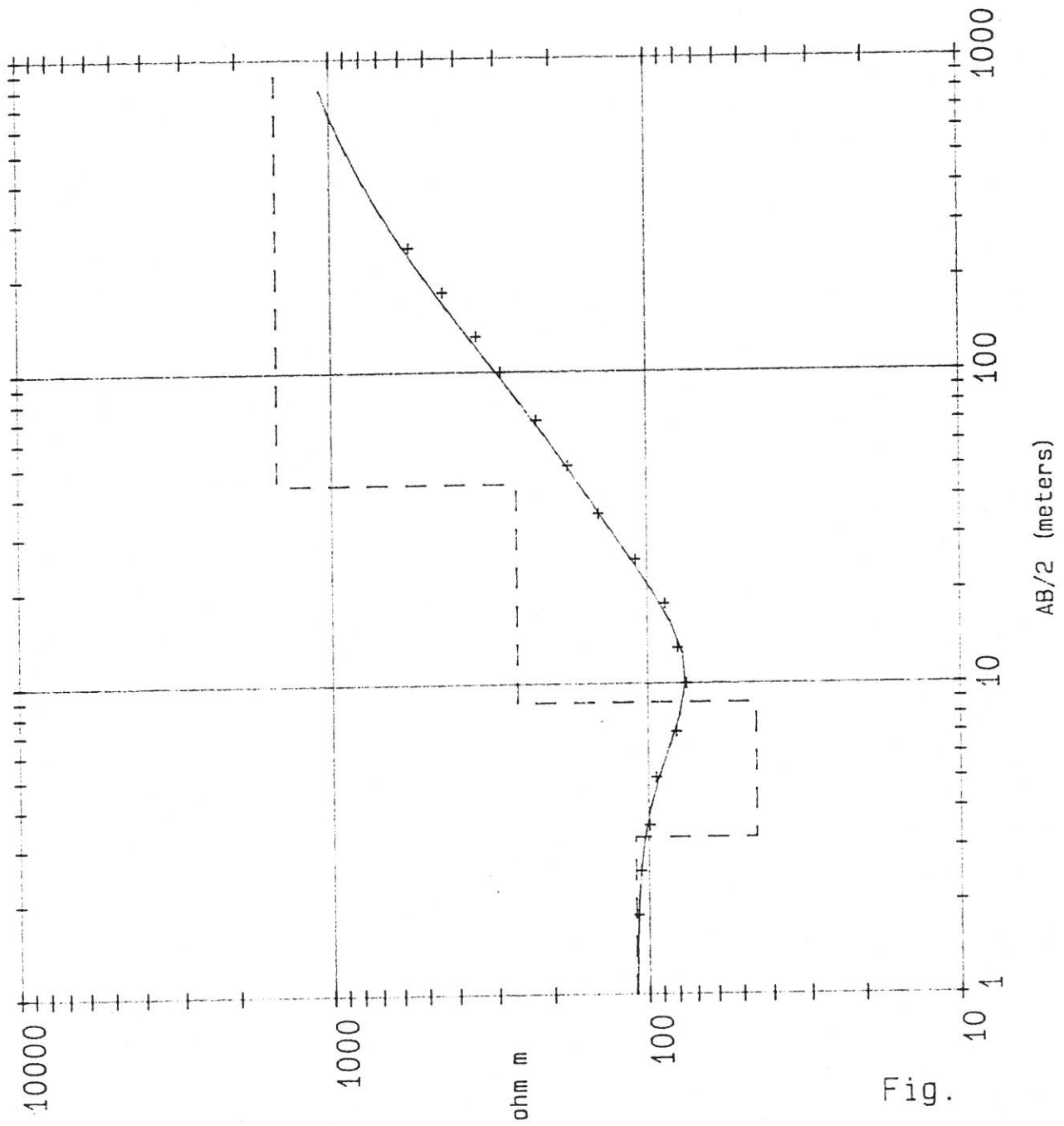


Fig.



+ Field data
 — Computer model
 - - - r model

BODIBE
 CAL 02

GEOLOGY
 DOLOMITE

Fig.

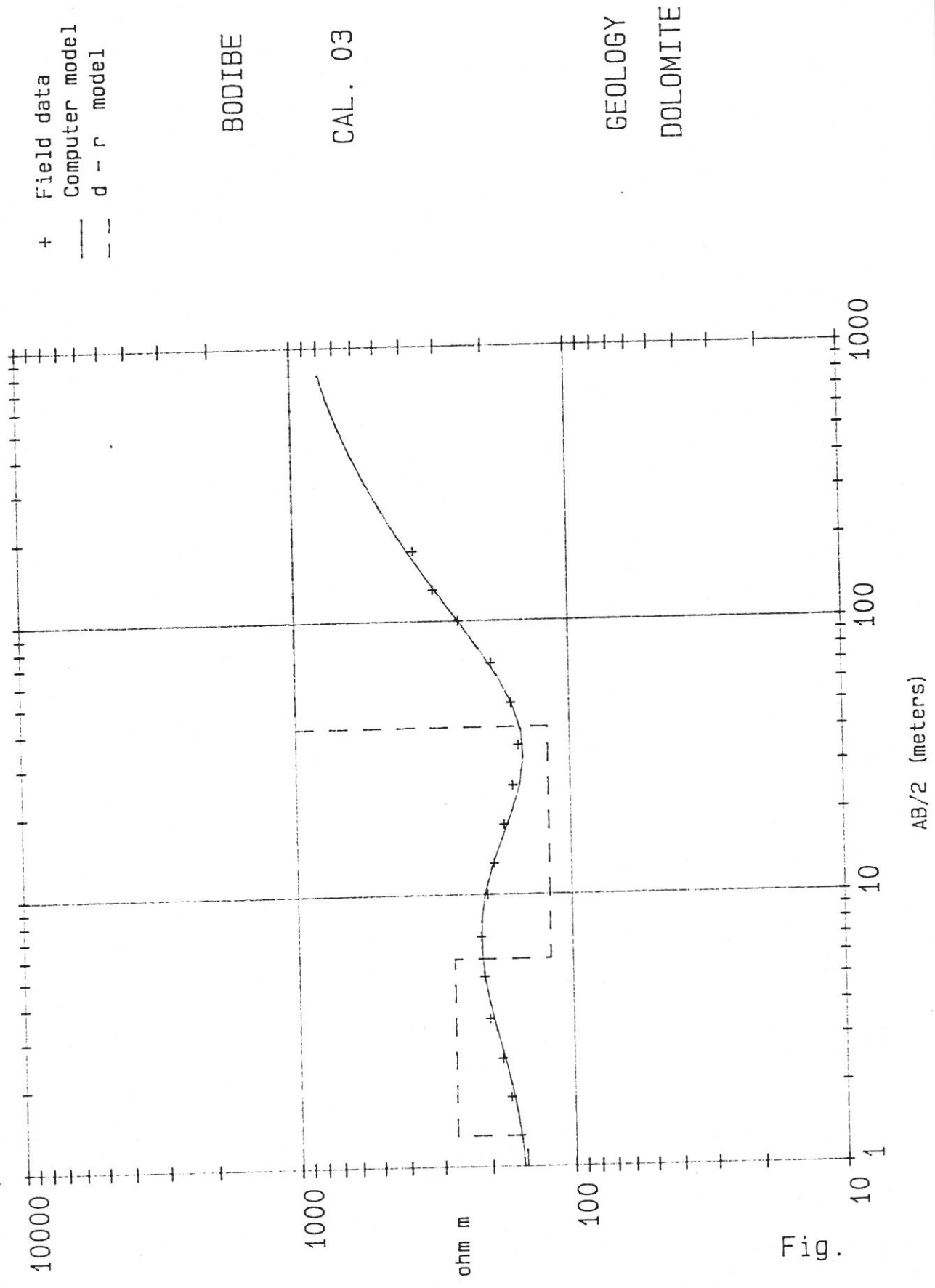


Fig.

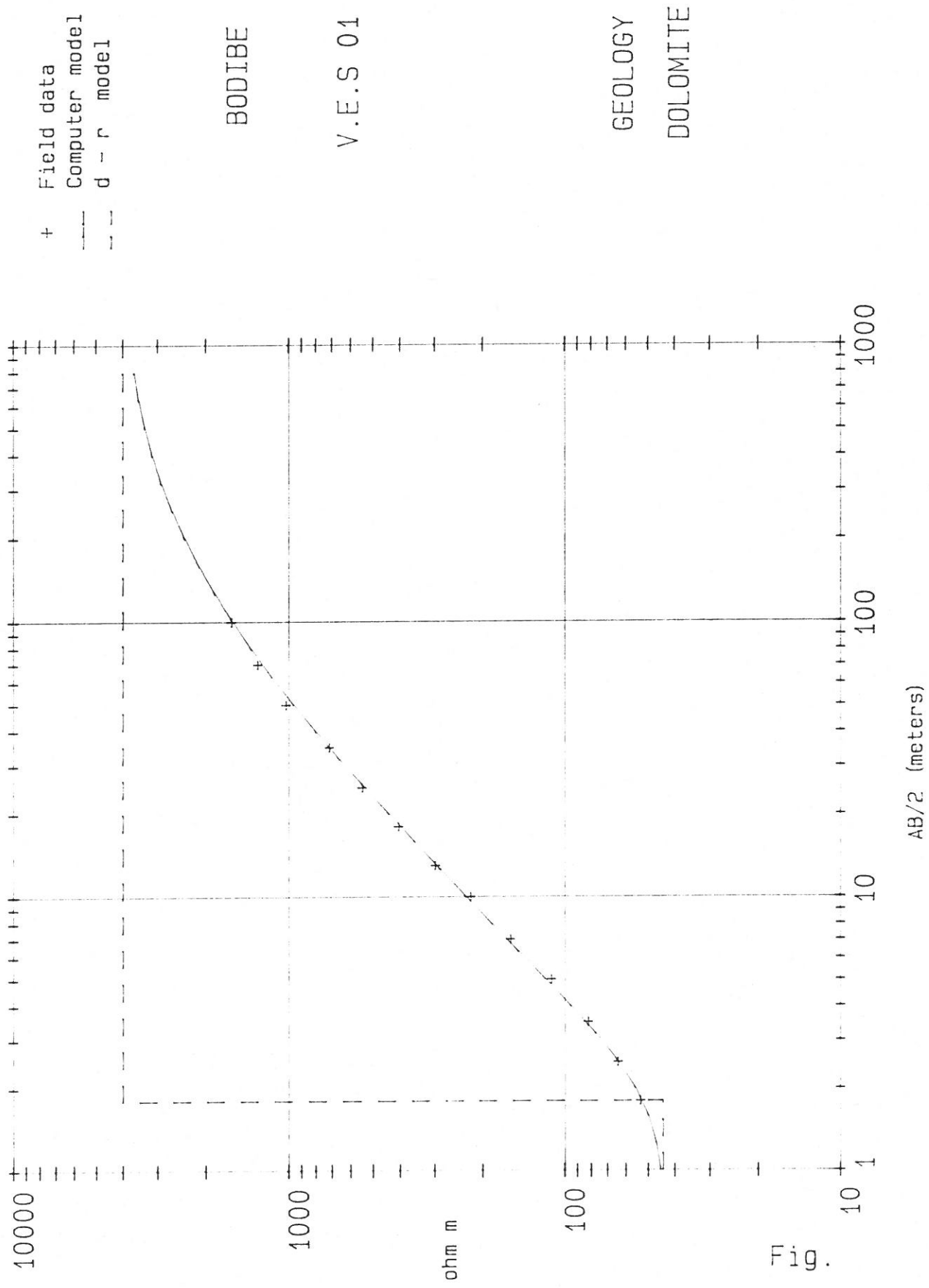
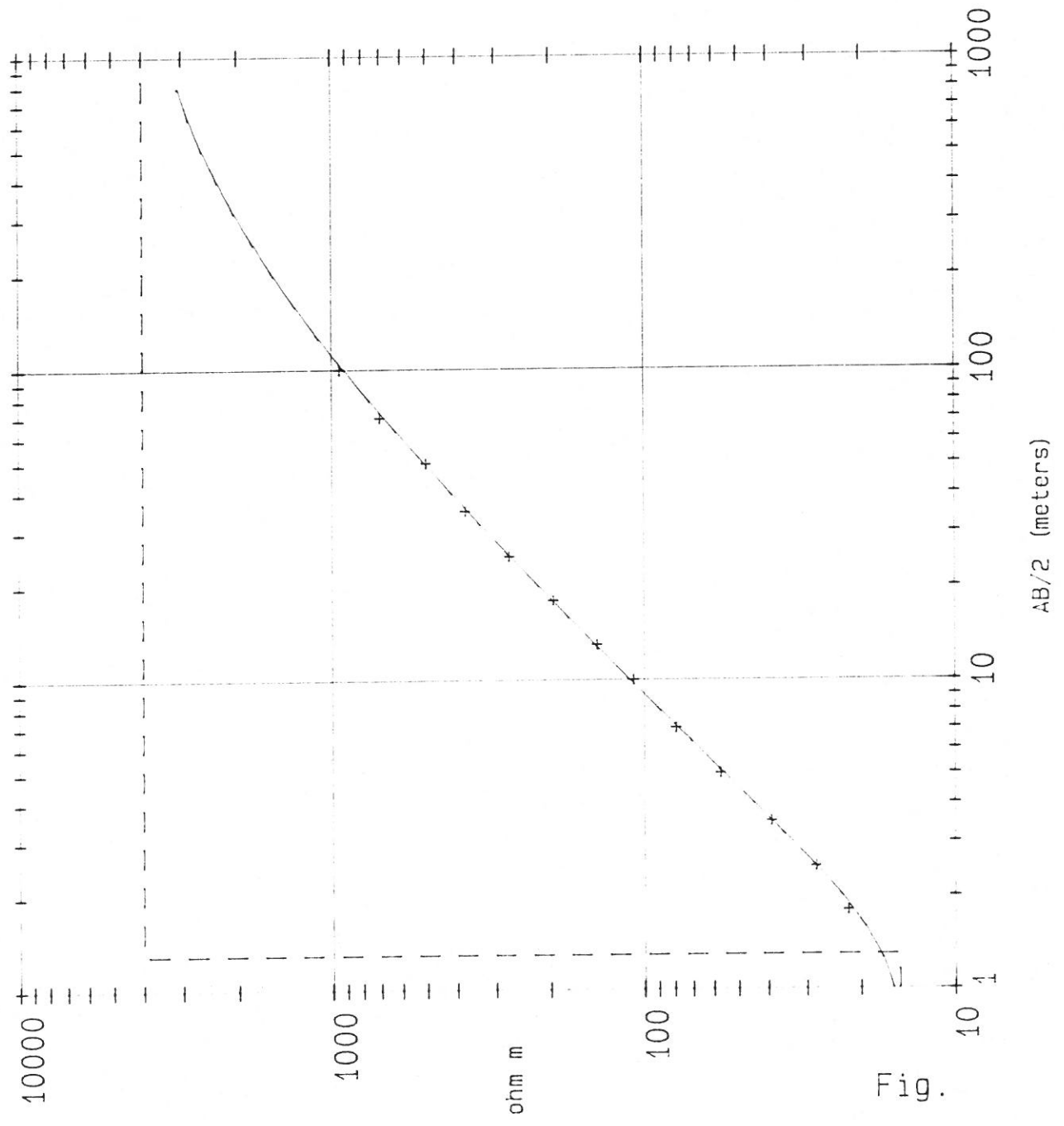


Fig.



+ Field data
 — Computer model
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BODIBE
 V.E.S 02

GEOLOGY
 DOLOMITE

Fig.

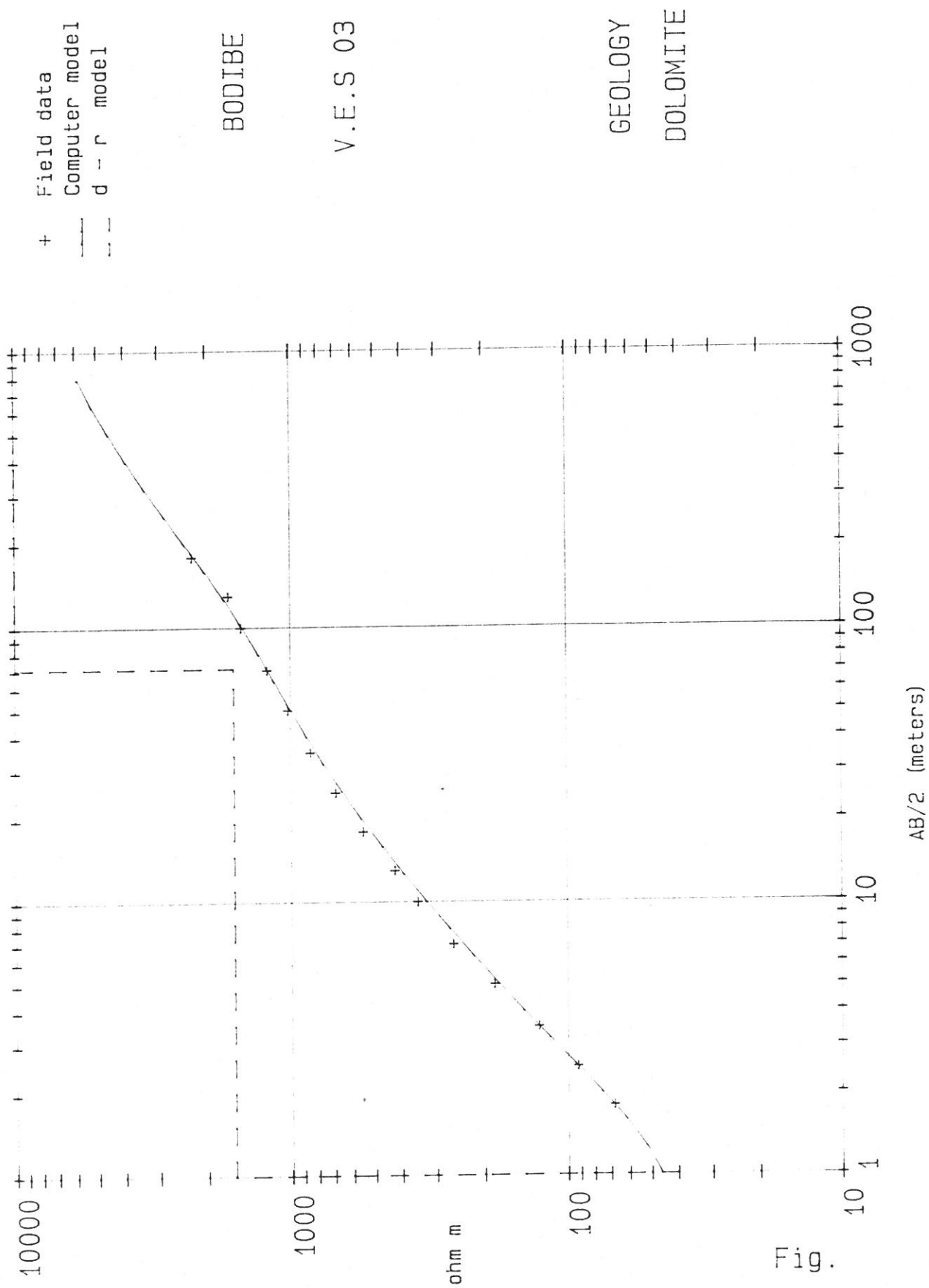


Fig.

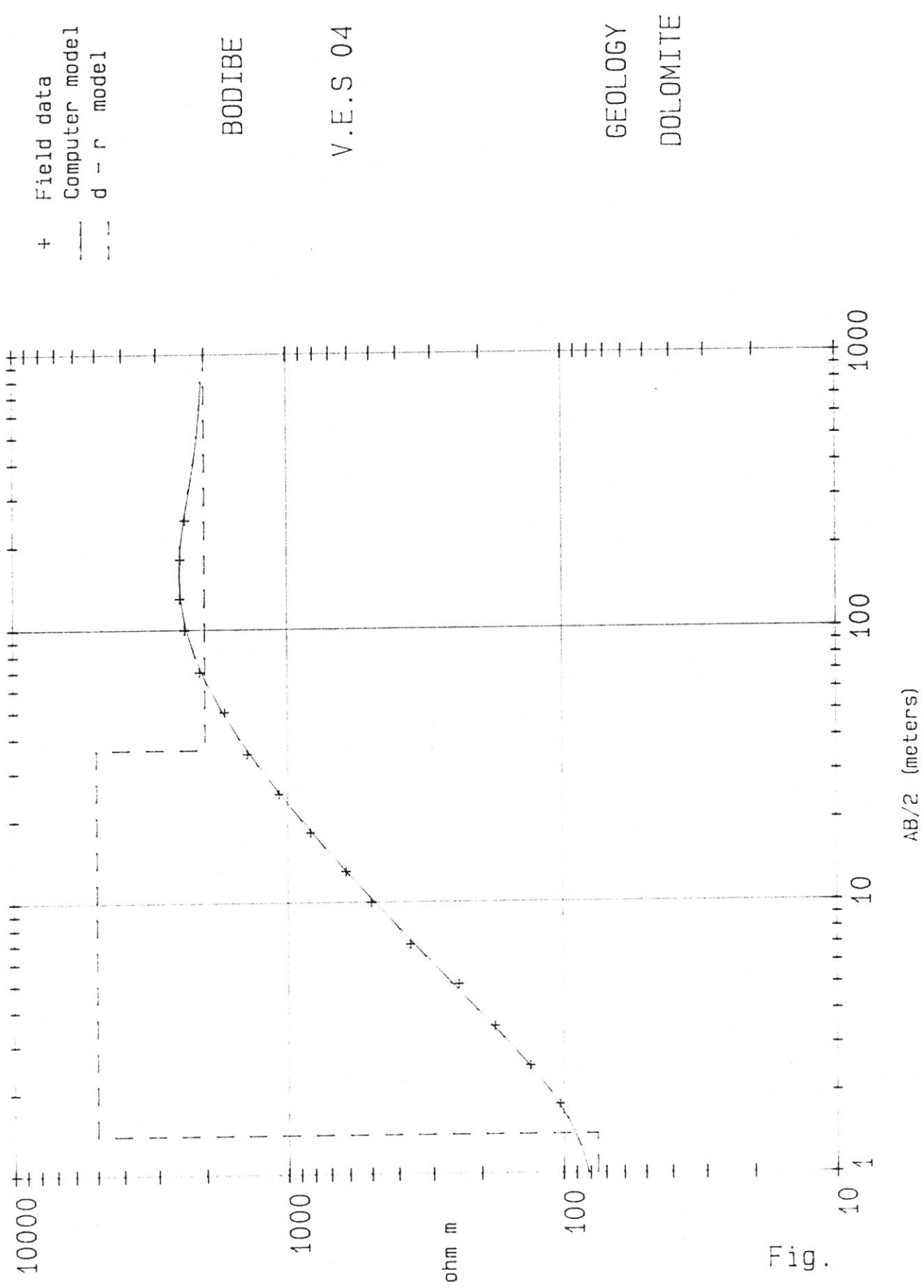


Fig.

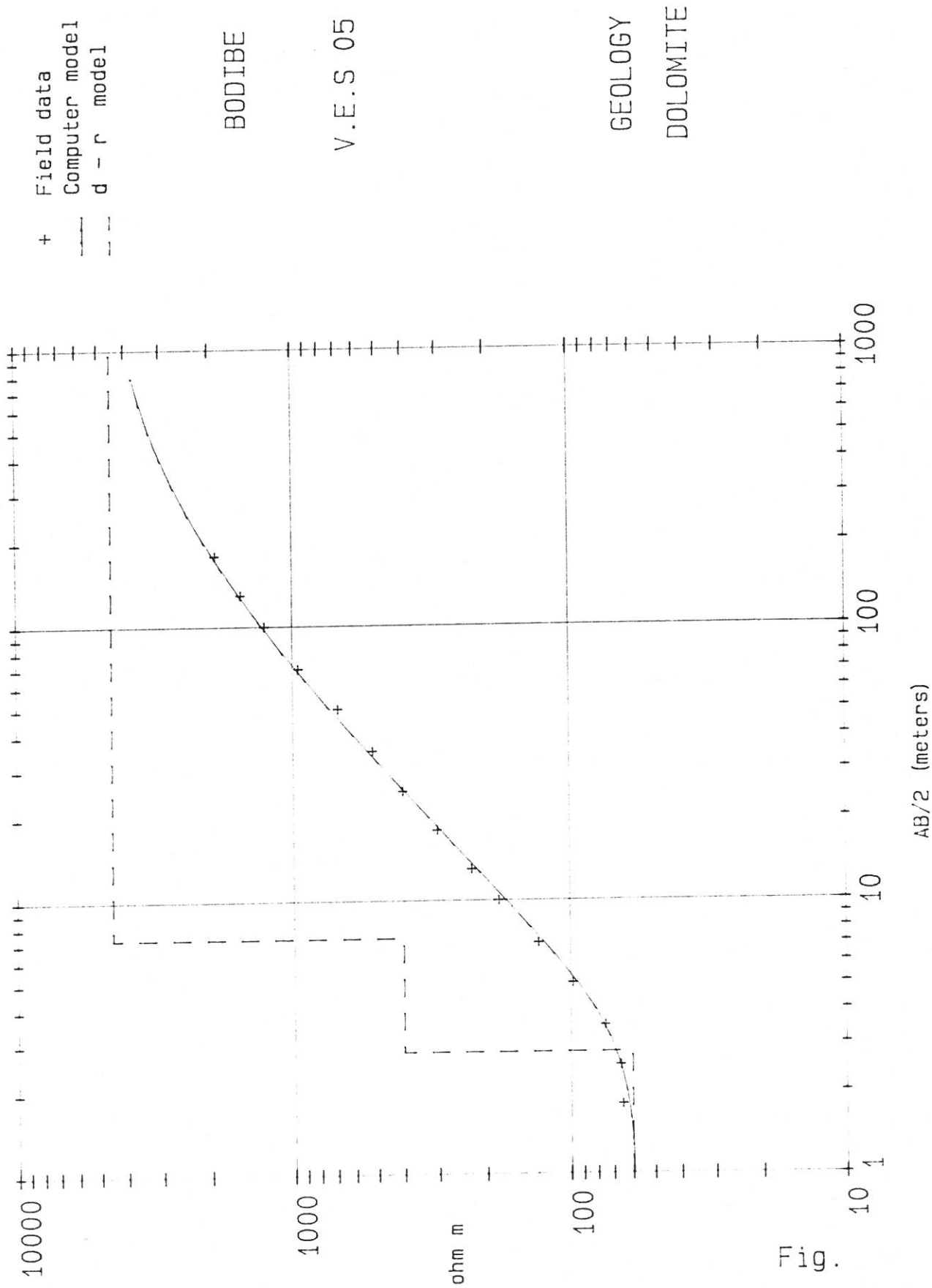


Fig.

+ Field data
 --- Computer model
 - - - d - r model

BODIBE

V.E.S 06

GEOLOGY

DOLOMITE

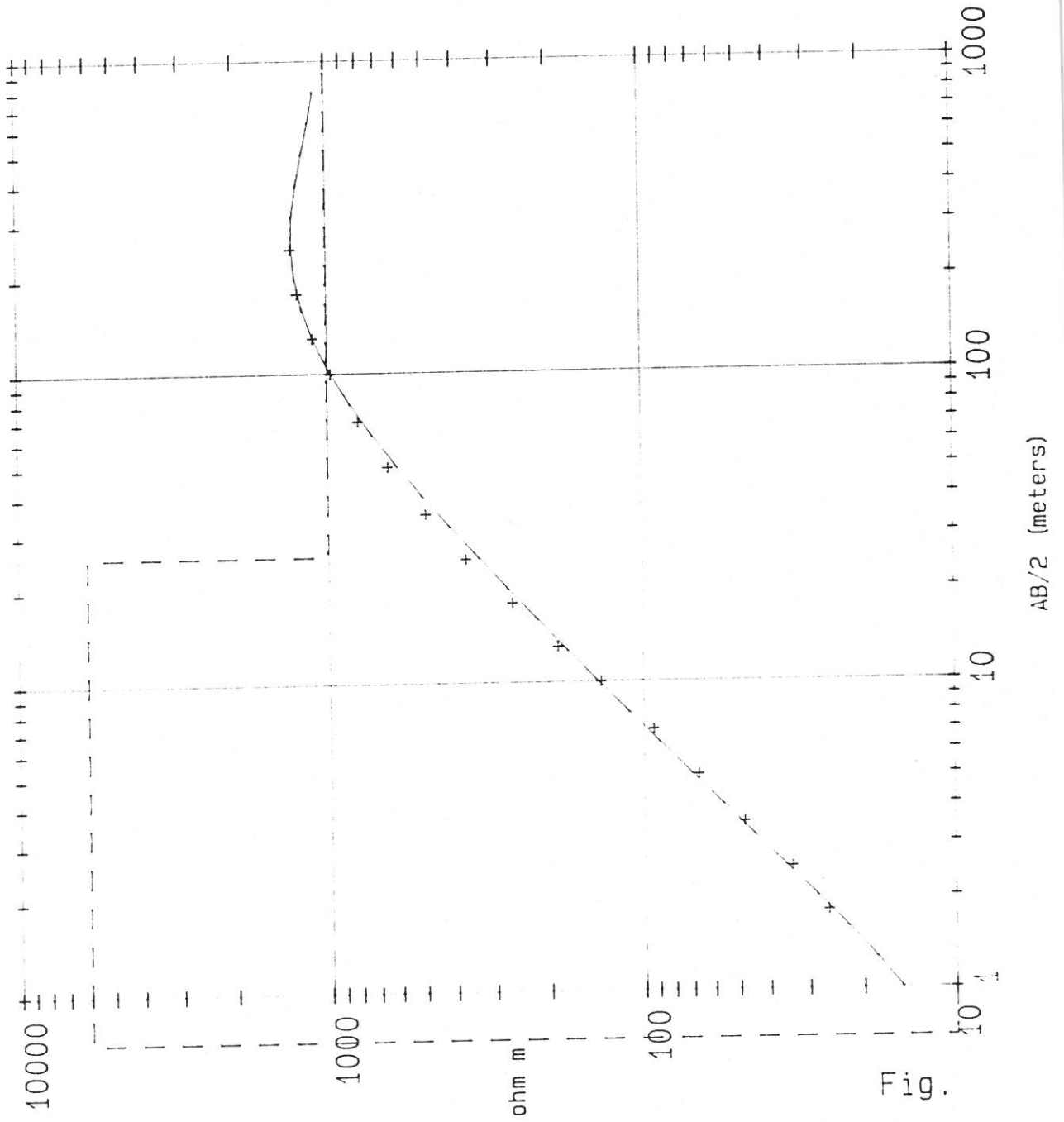


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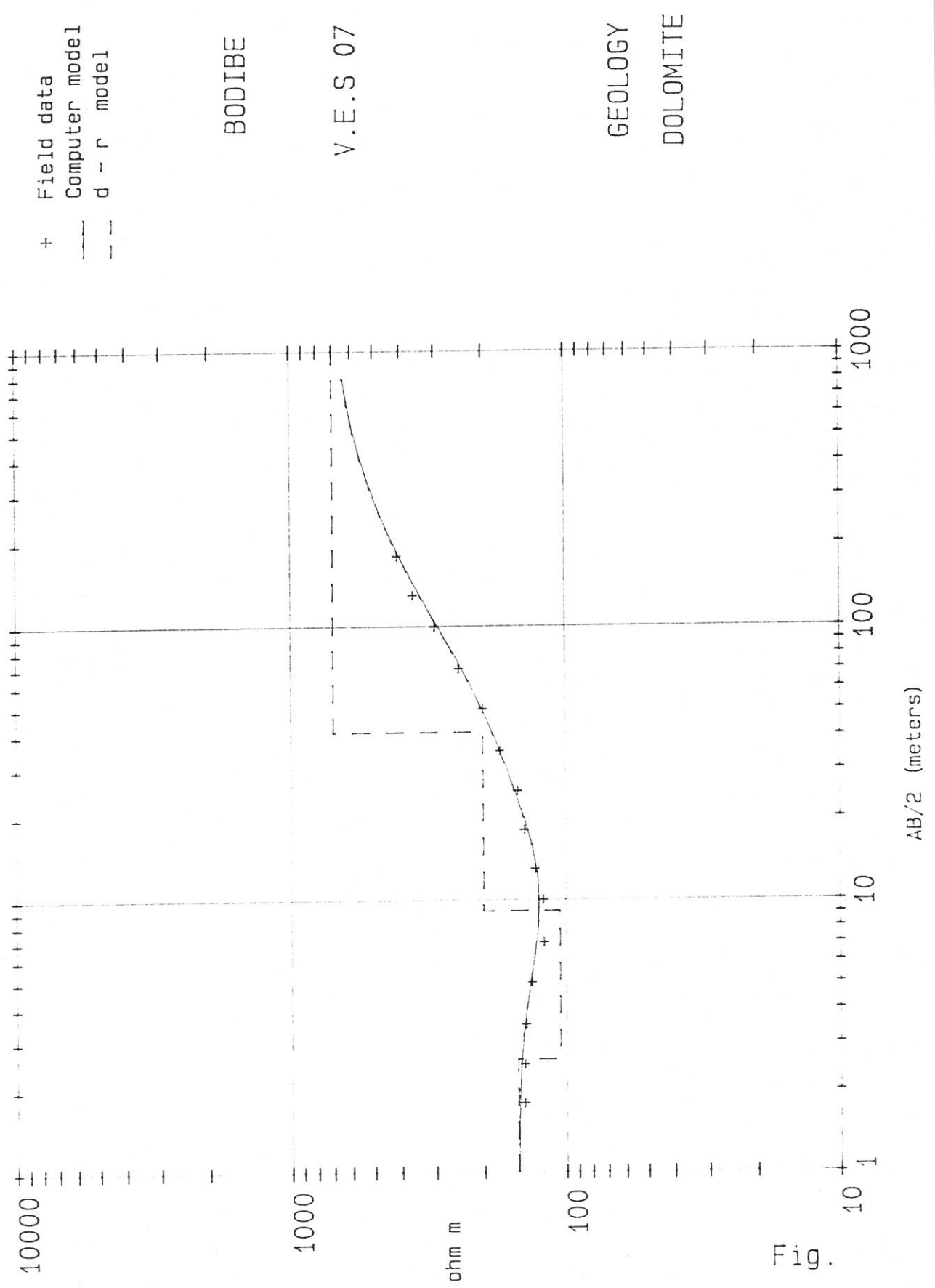


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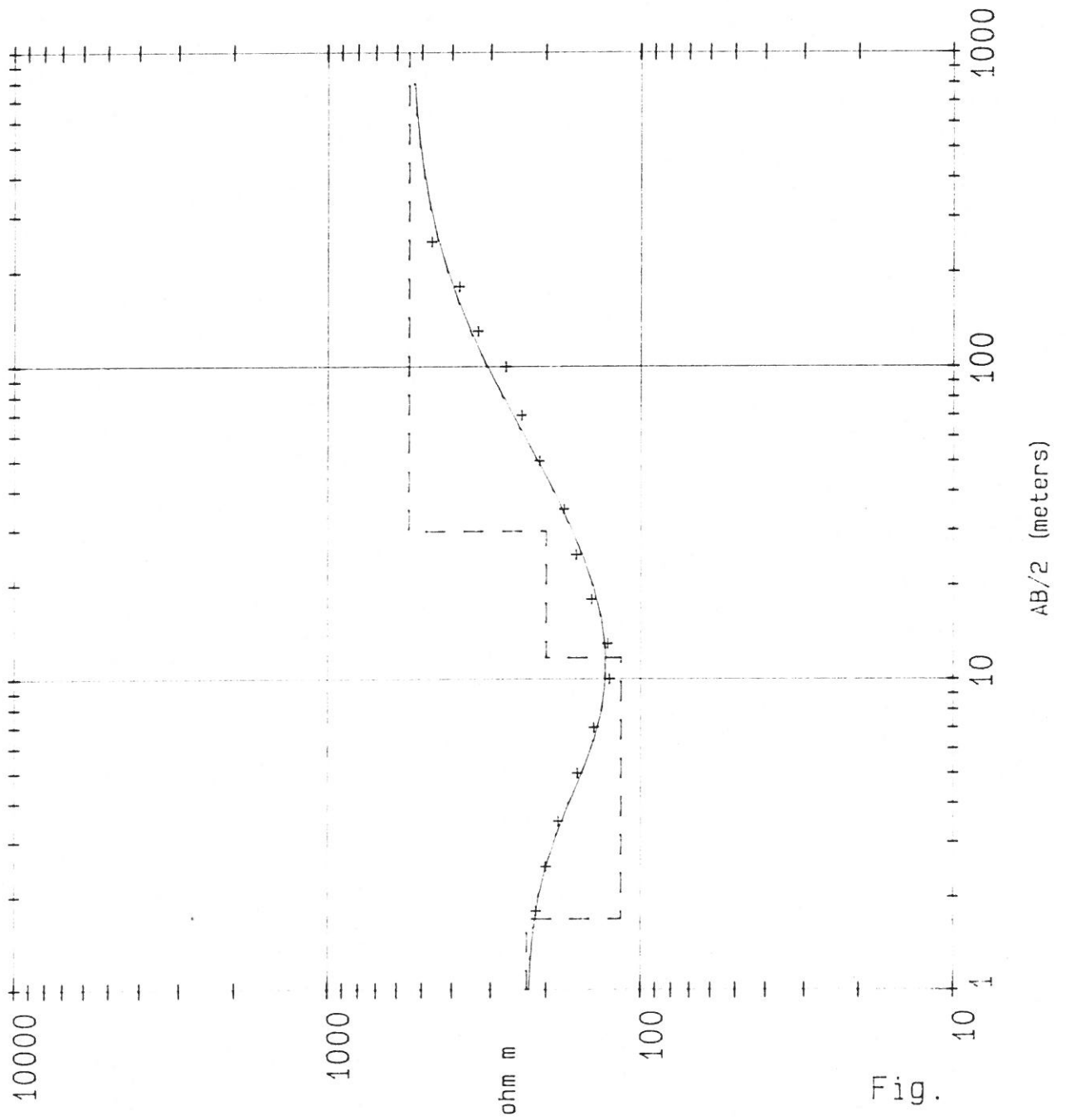
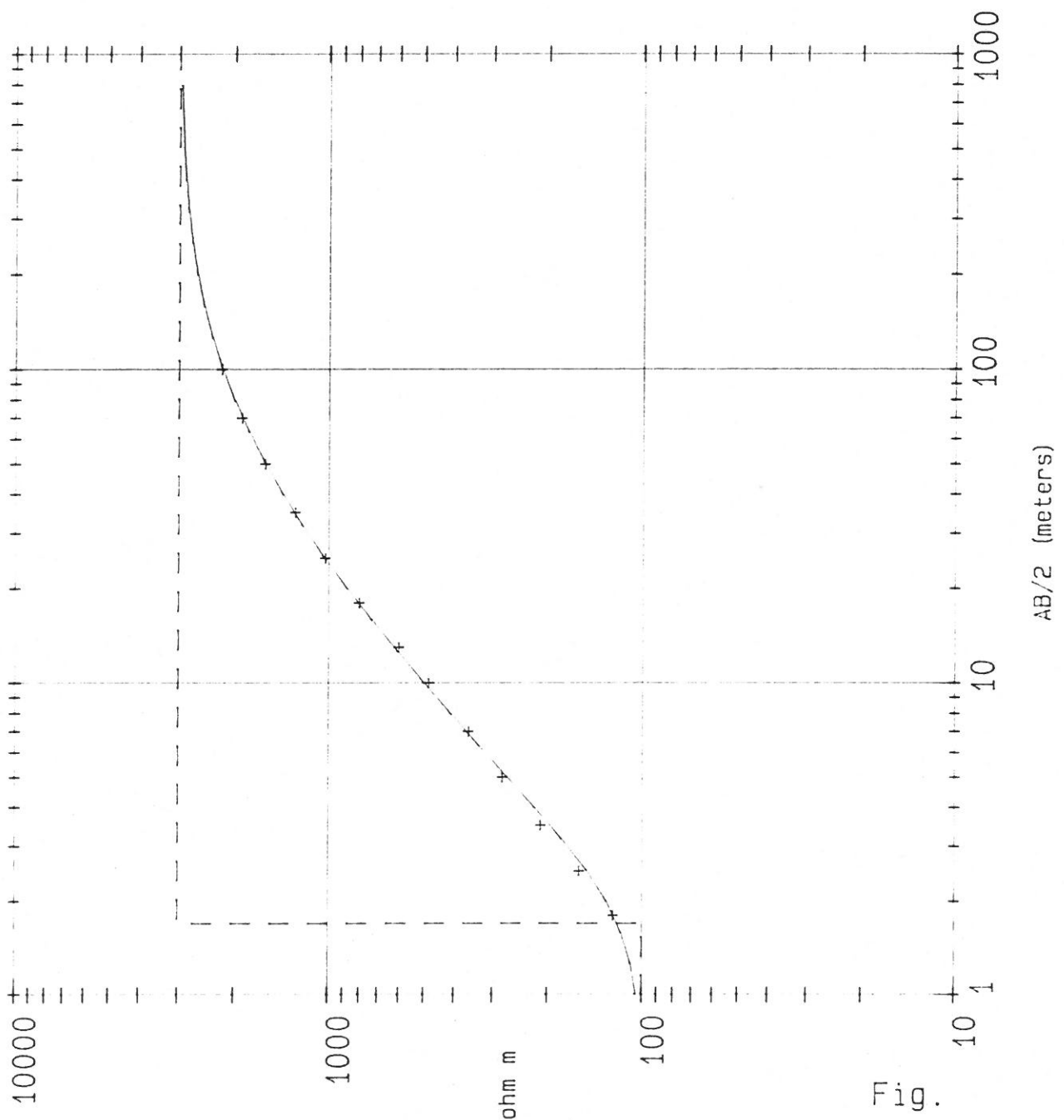


Fig.



BODIBE

V.E.S 09

GEOLOGY

DOLOMITE

Fig.

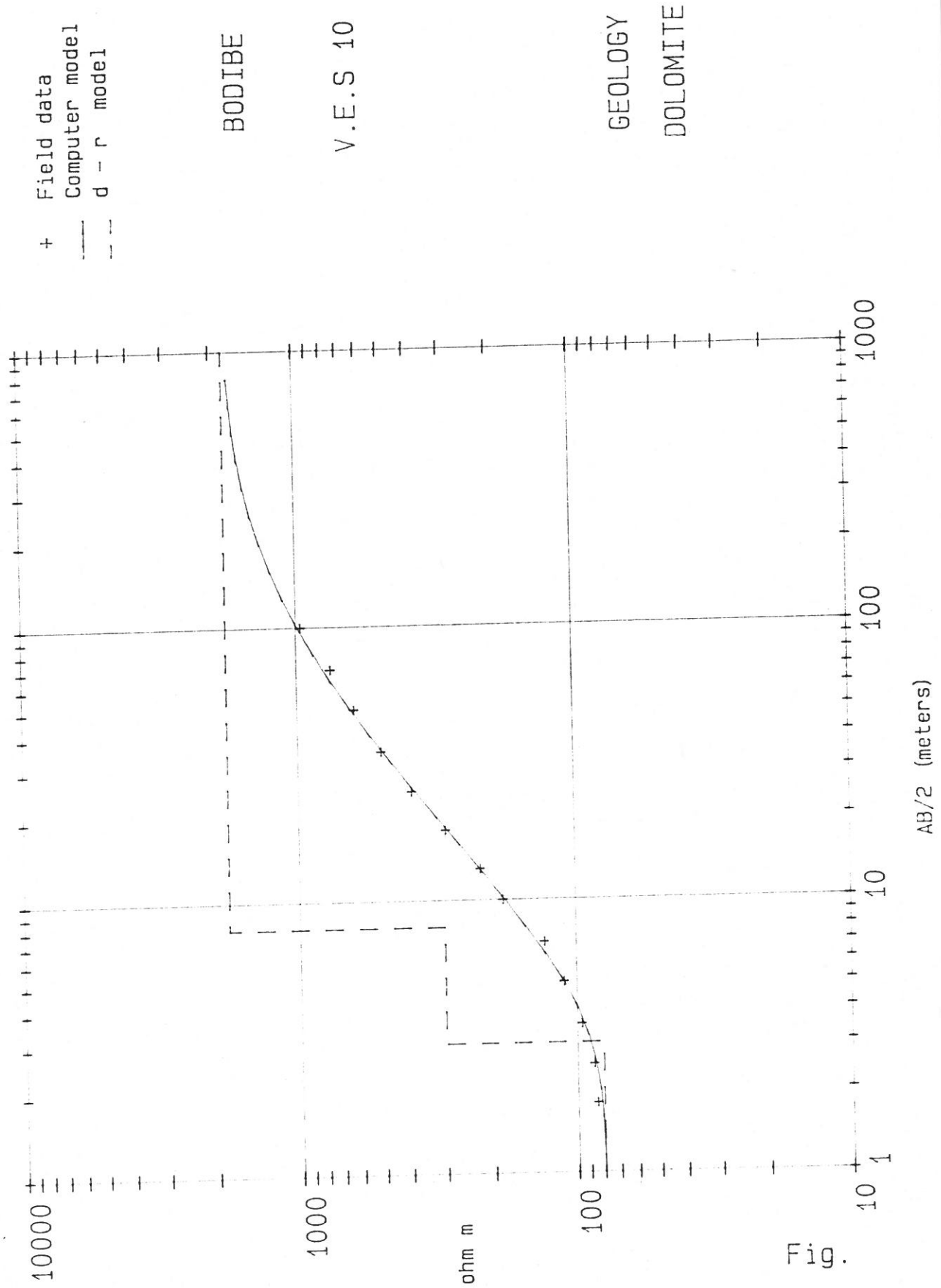


Fig.

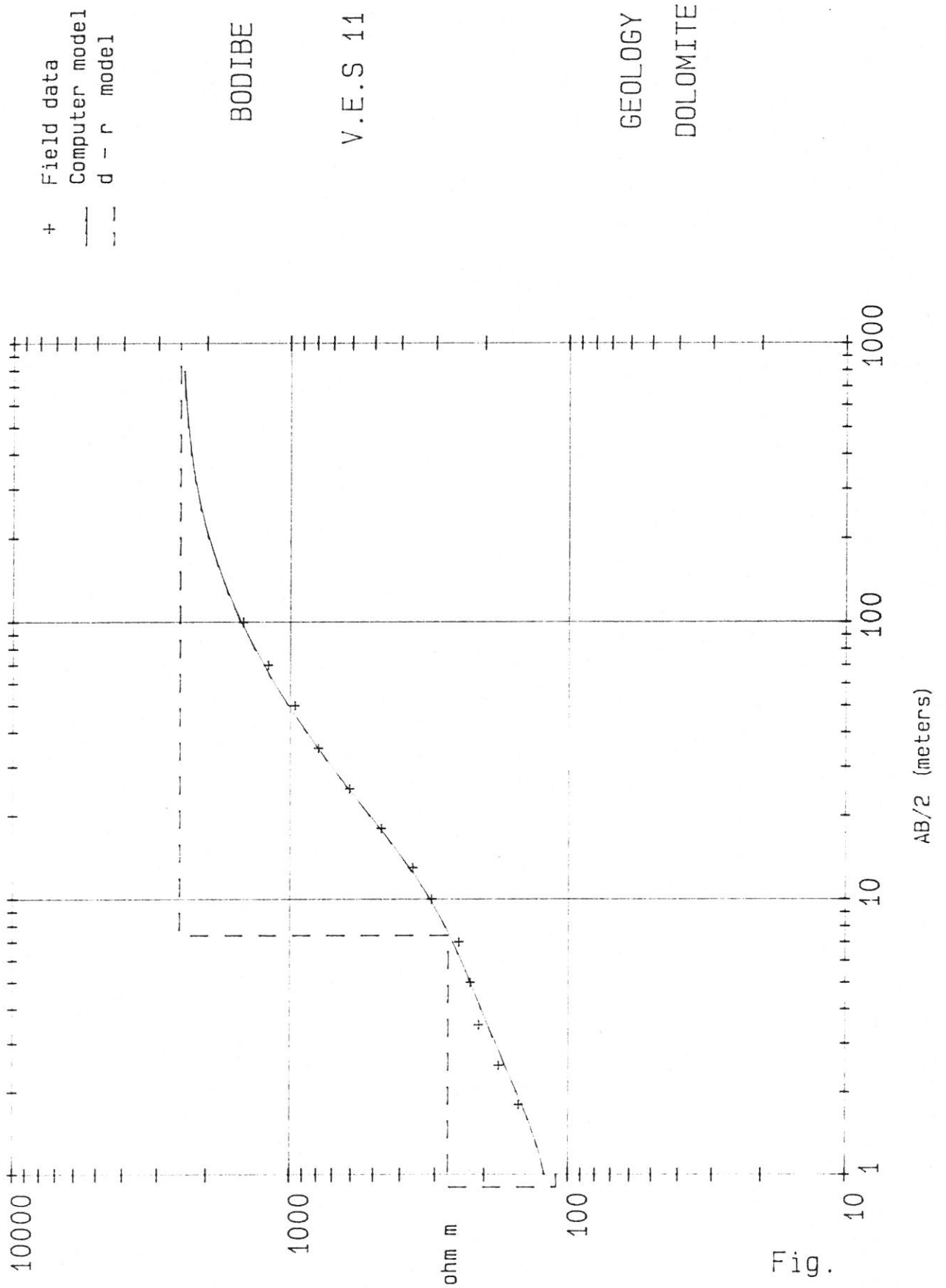
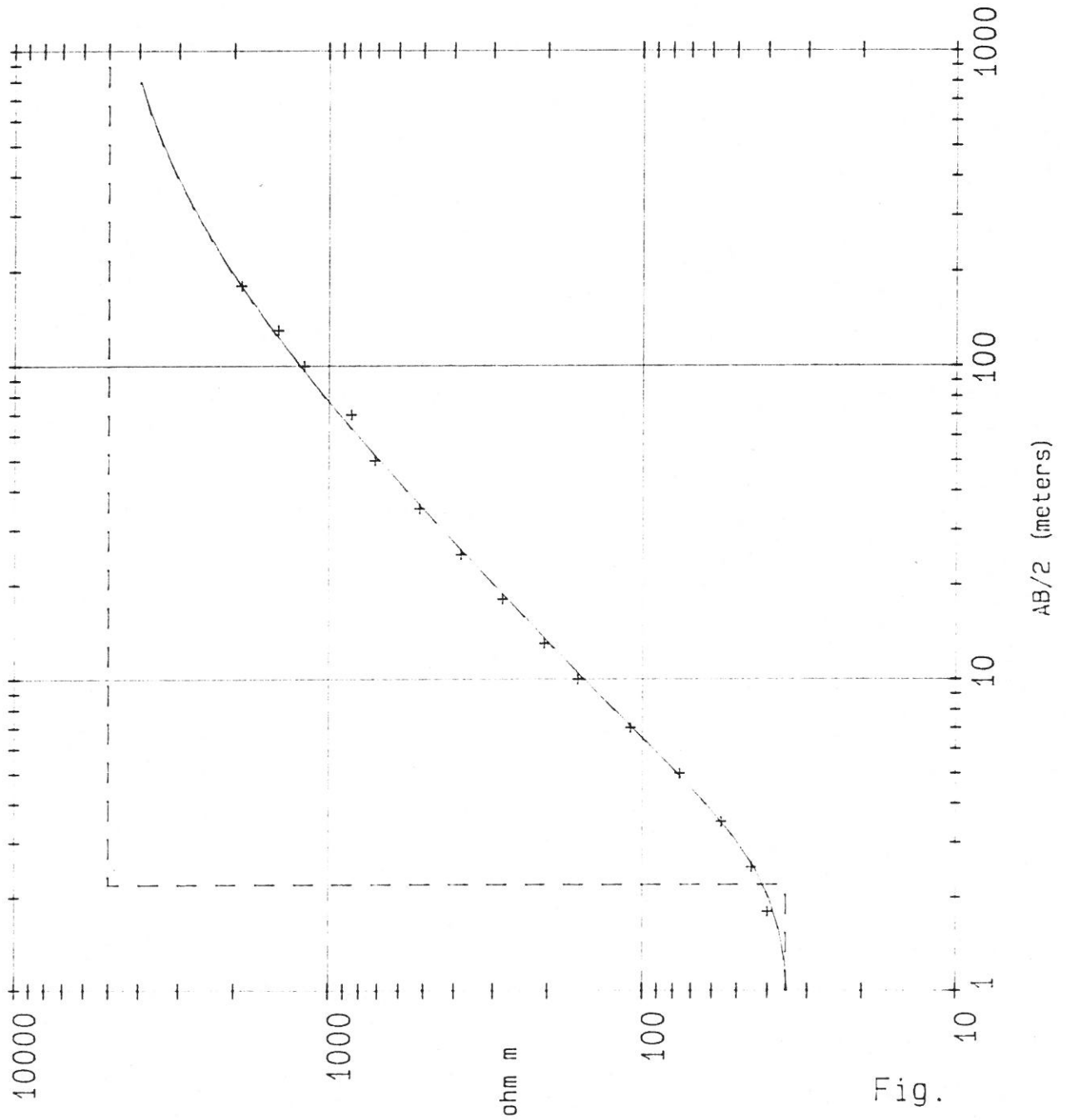


Fig.



+ Field data
 --- Computer model
 - - - d - r model

BODIBE

V.E.S 12

GEOLOGY
 DOLOMITE

Fig.

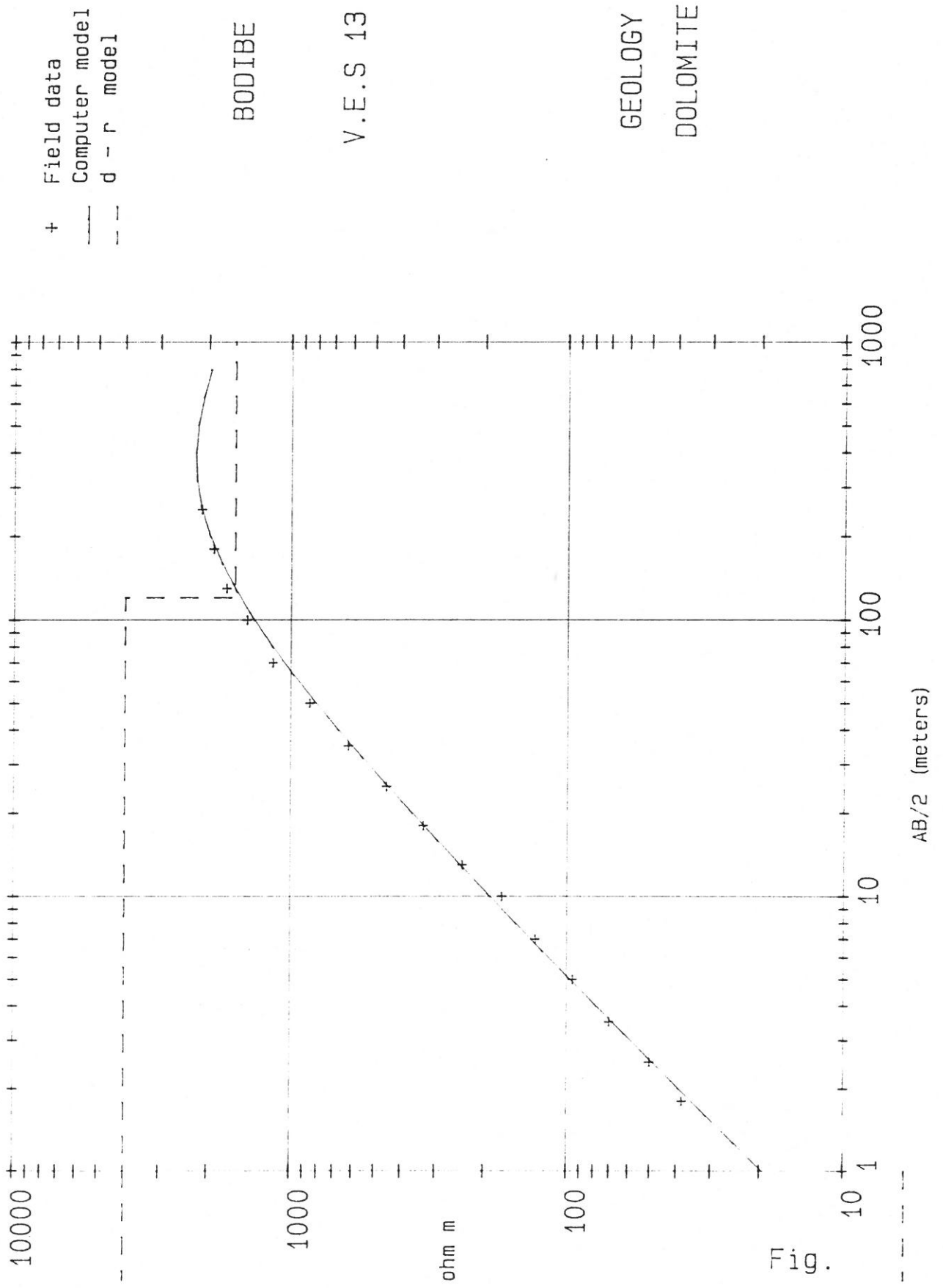


Fig.

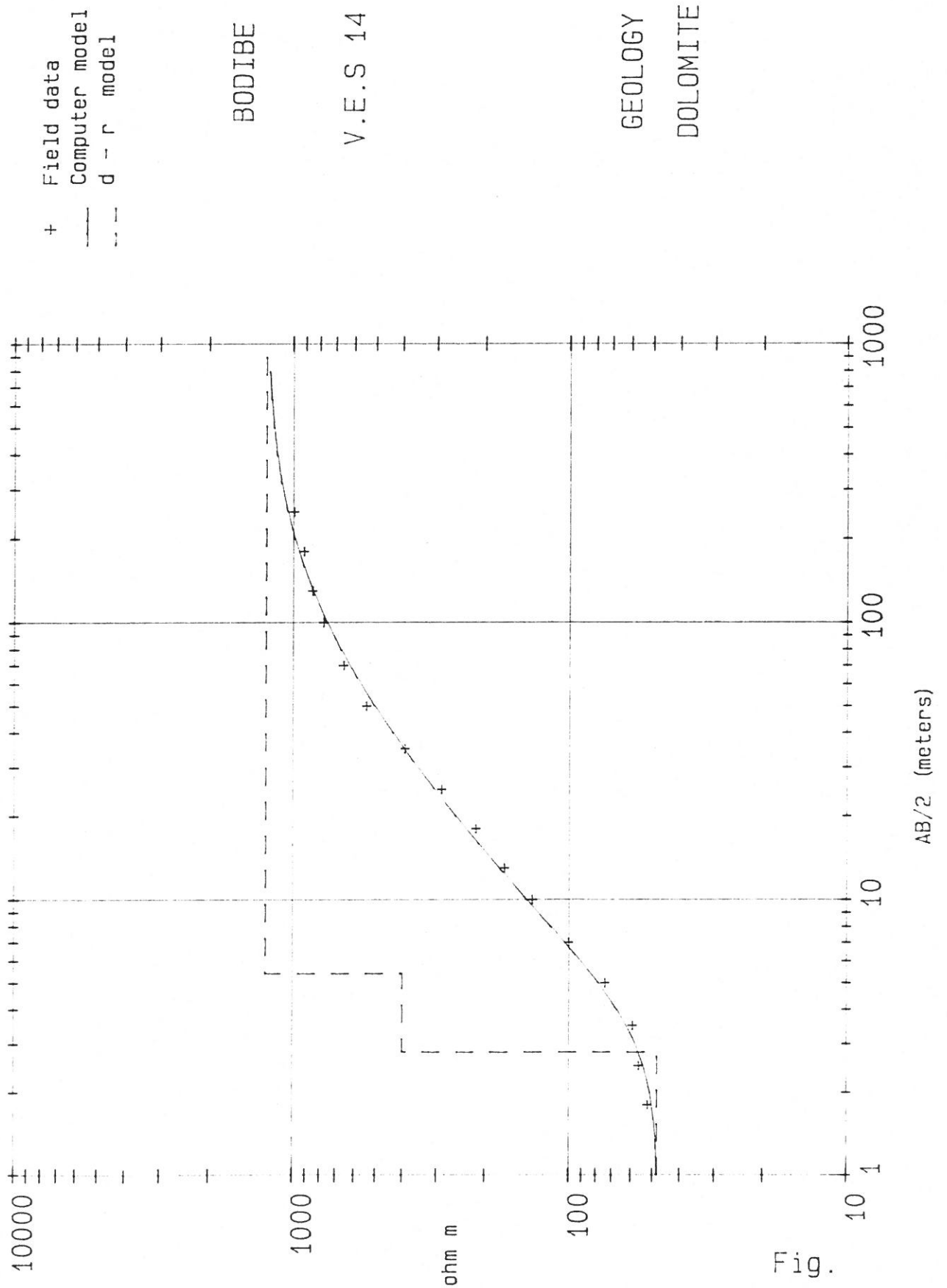


Fig.

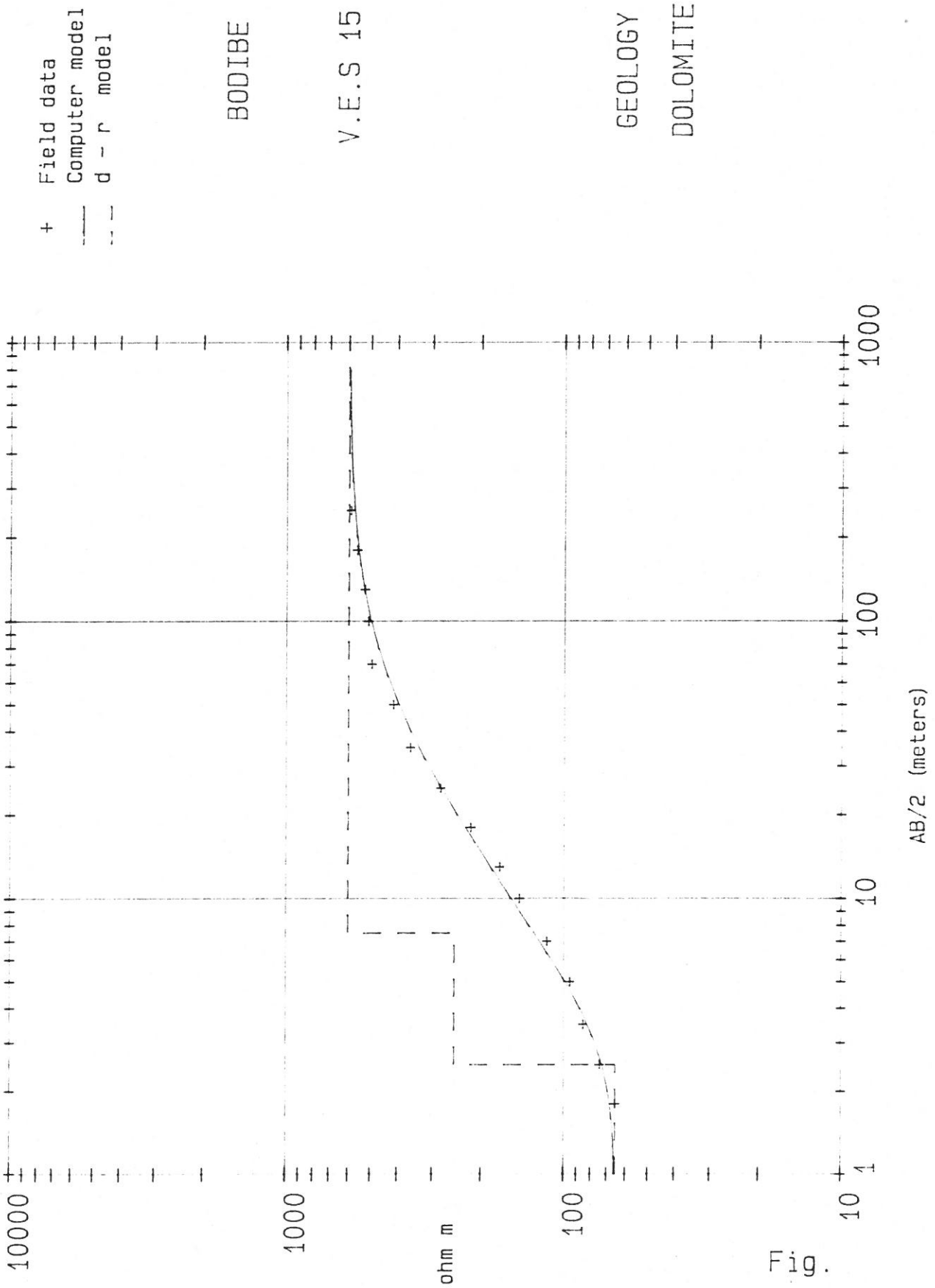


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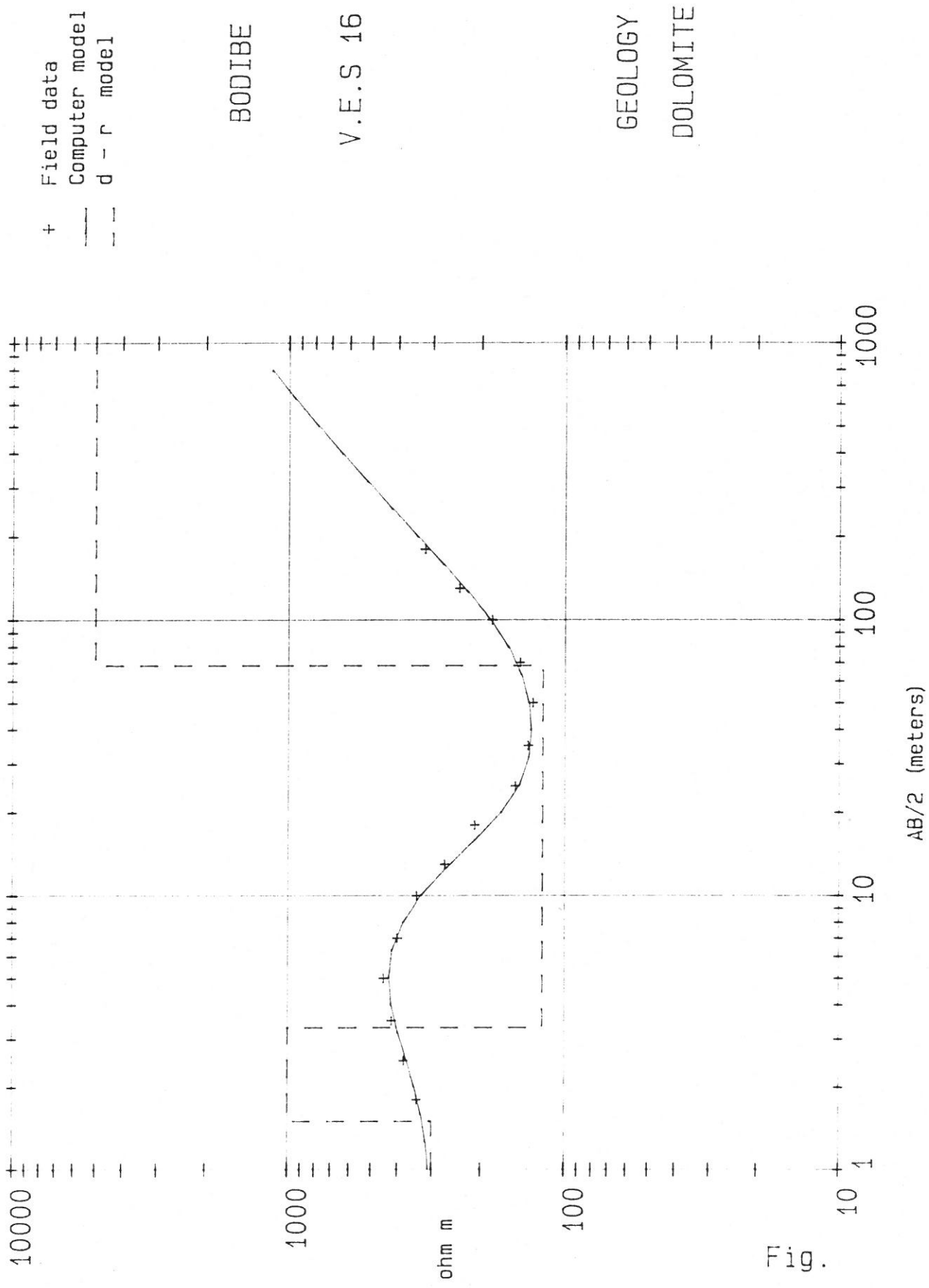


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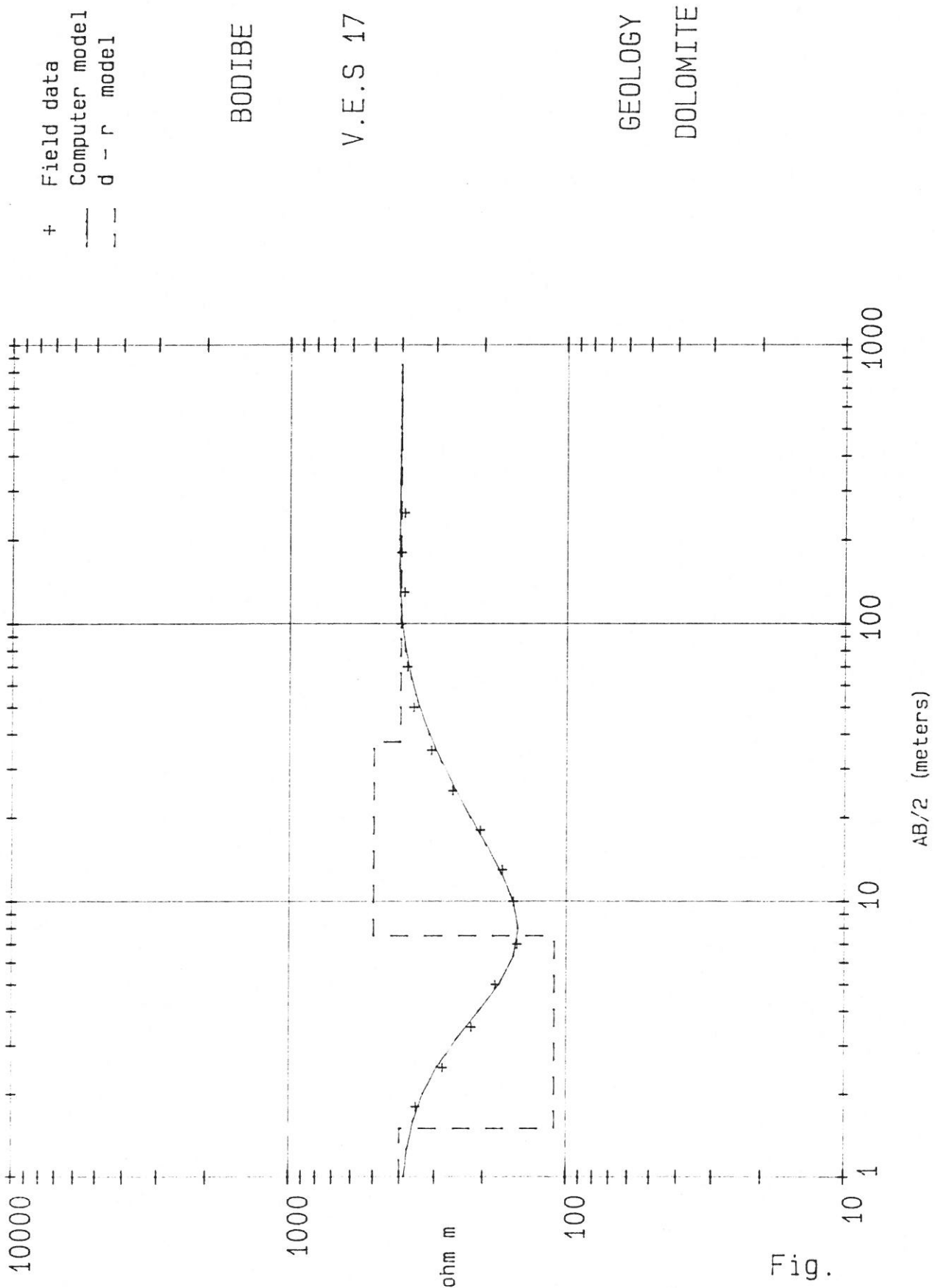
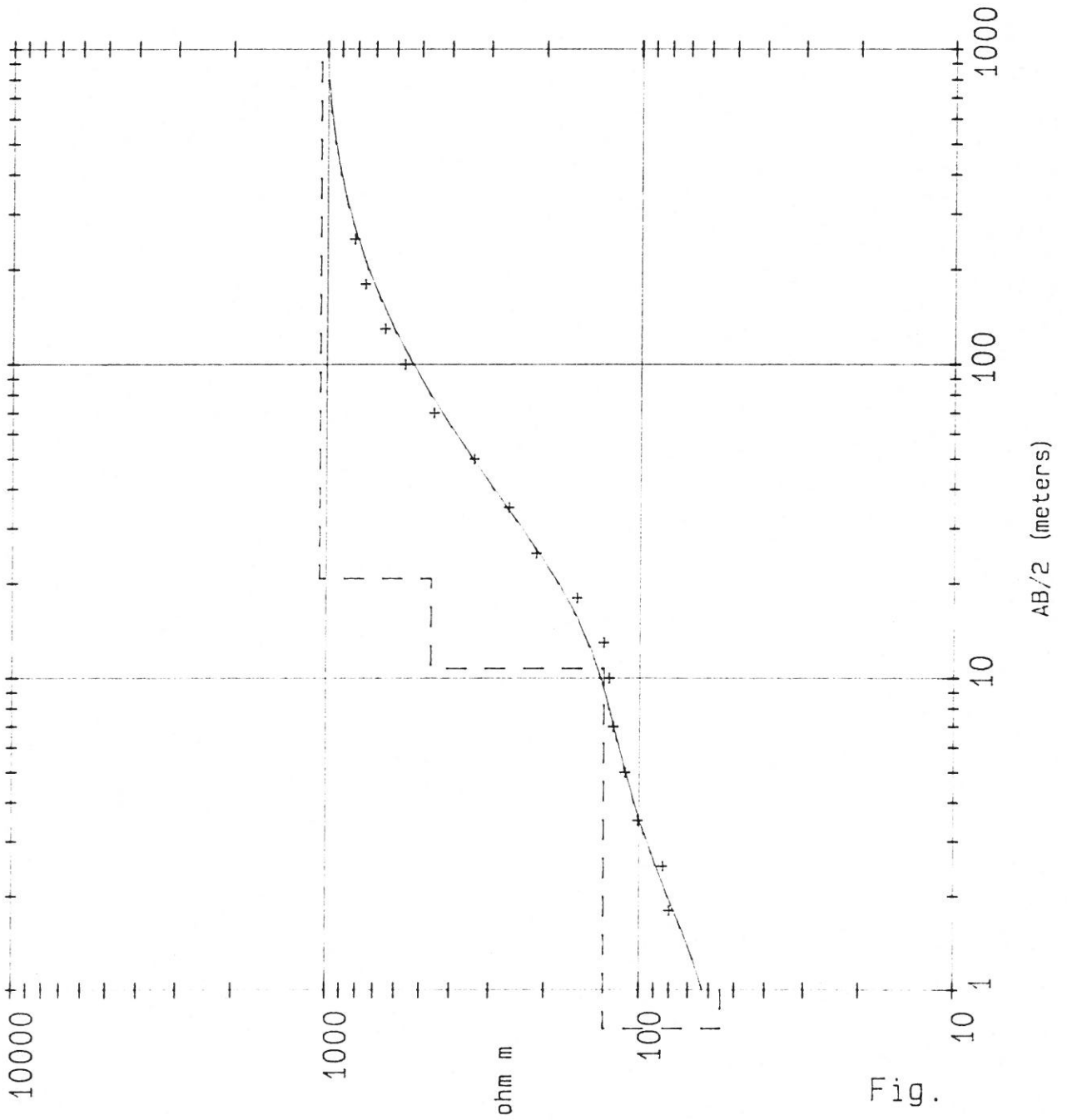


Fig.



+ Field data
 — Computer model
 - - - d - r model

BODIBE

V.E.S 18

GEOLOGY
 DOLOMITE

Fig.

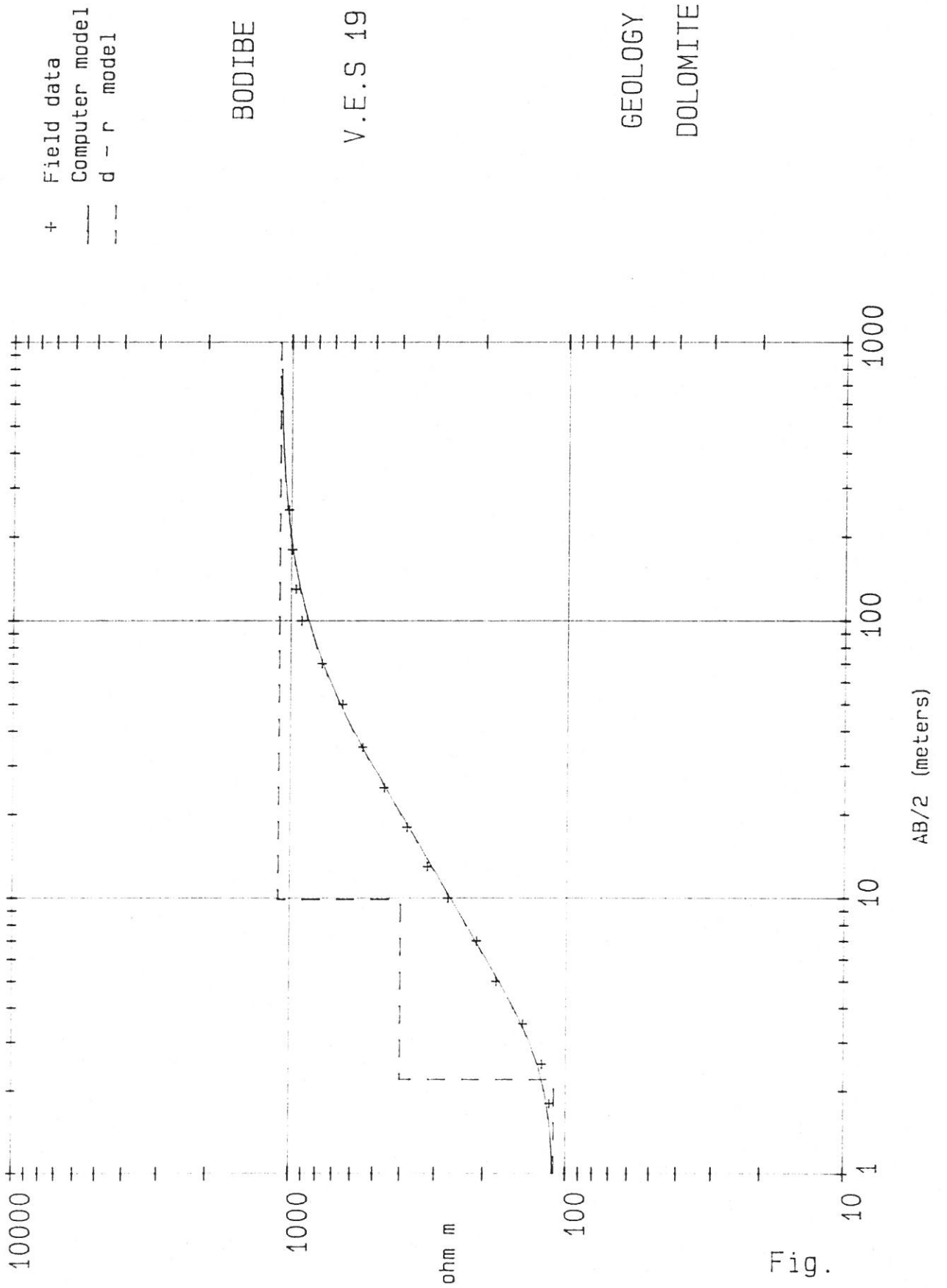


Fig.

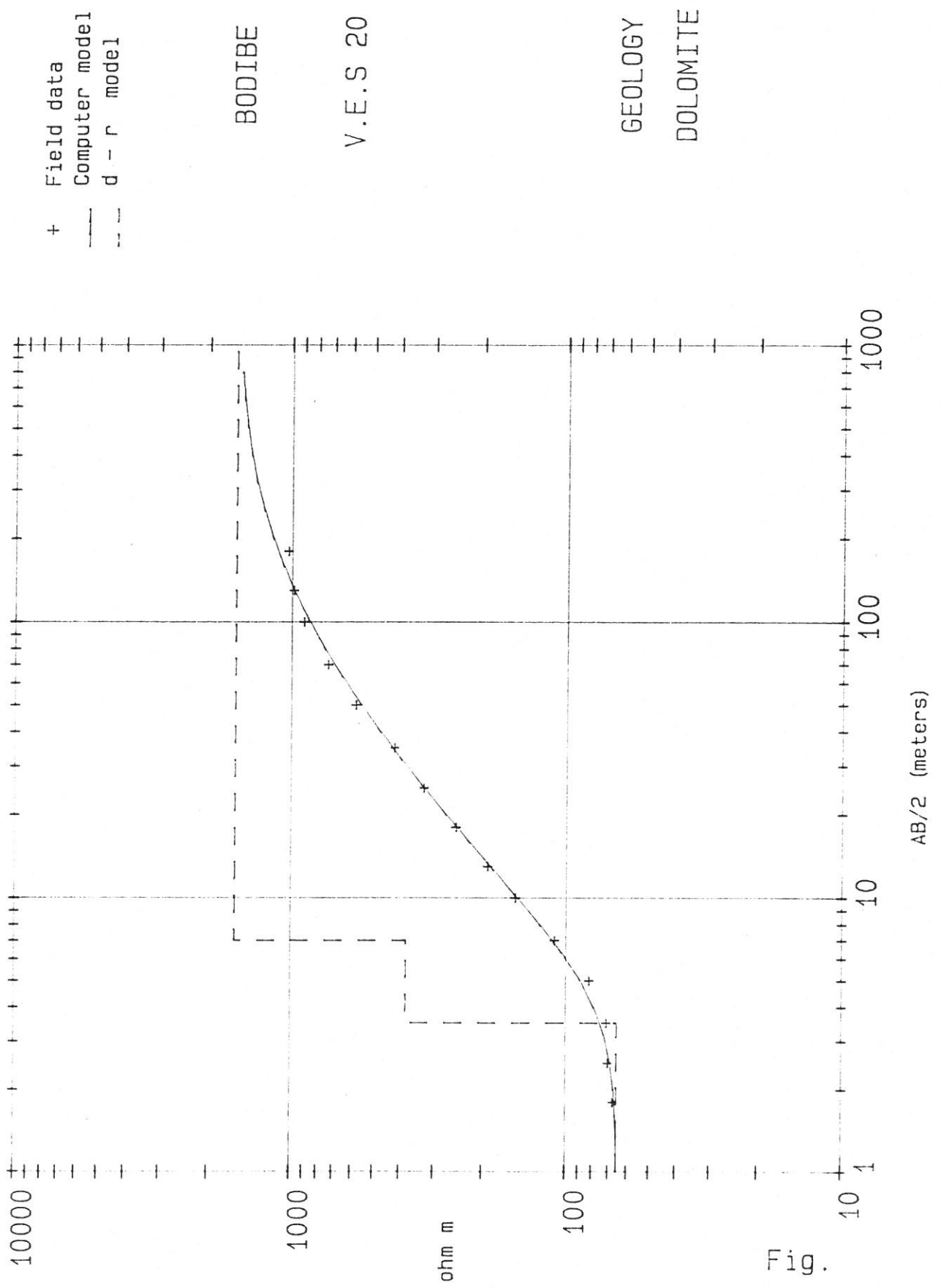
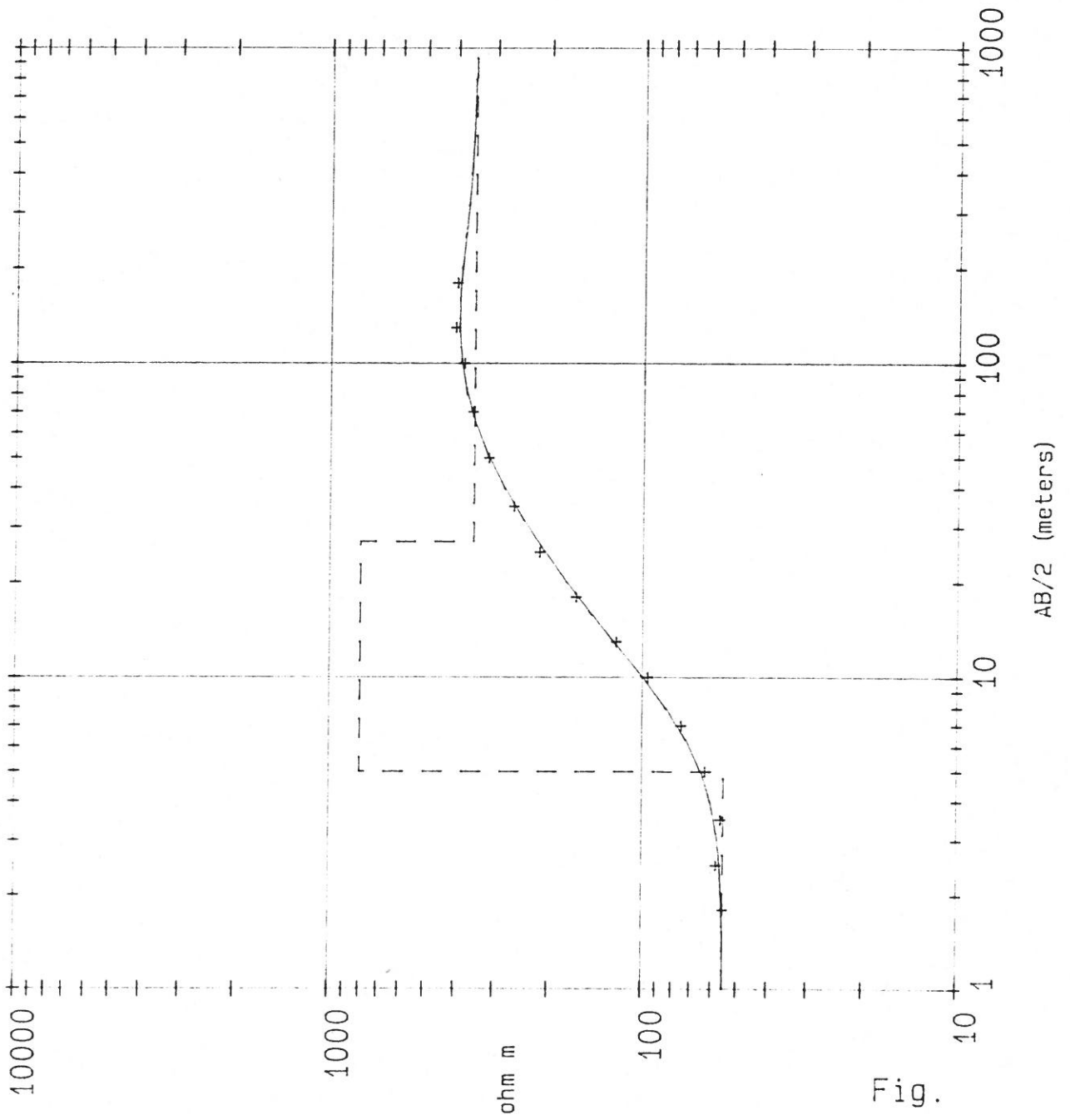


Fig.



+ Field data
 — Computer model
 - - - d - r model

BODIBE

V.E.S 21

GEOLOGY
 DOLOMITE

Fig.

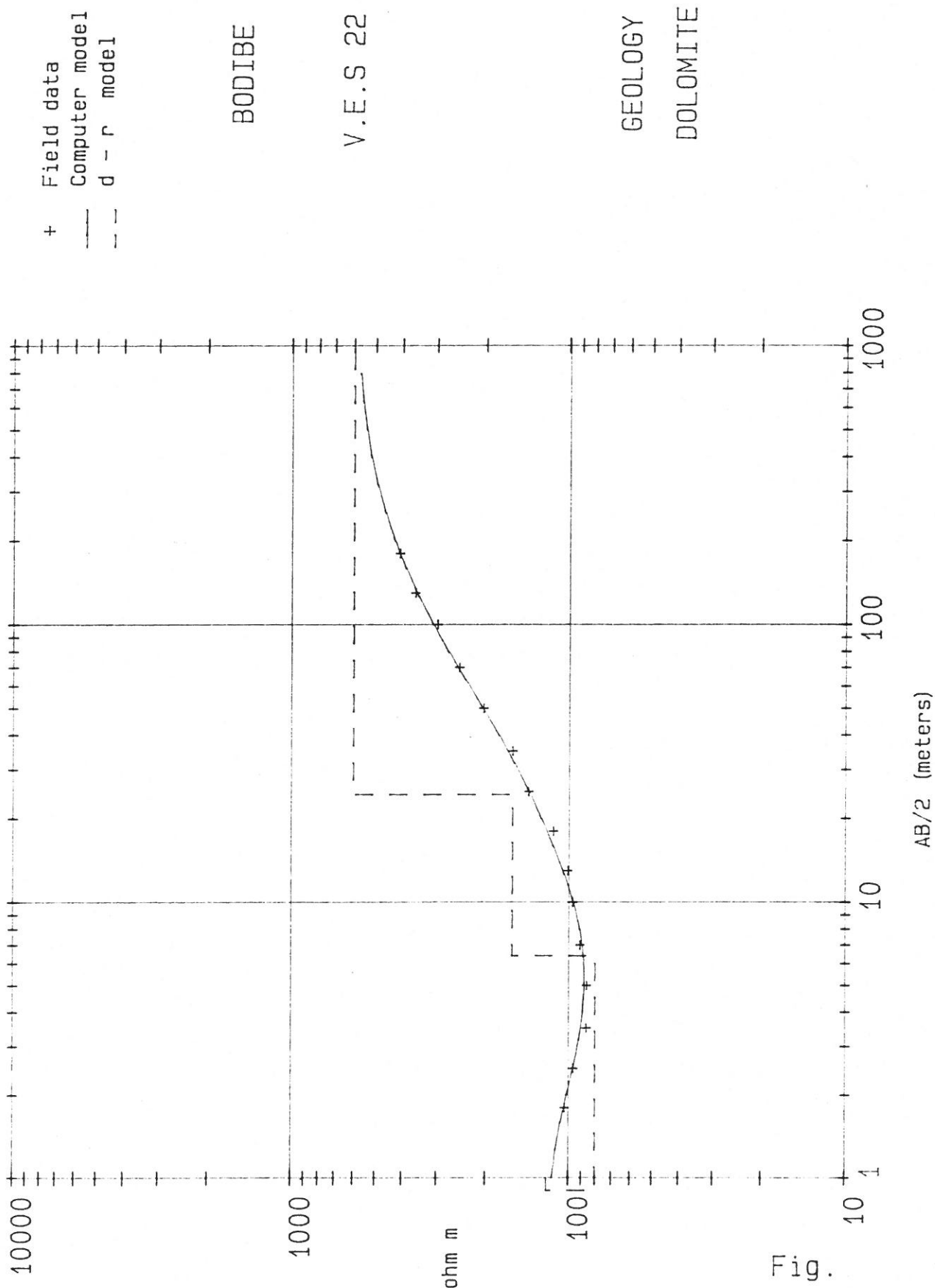


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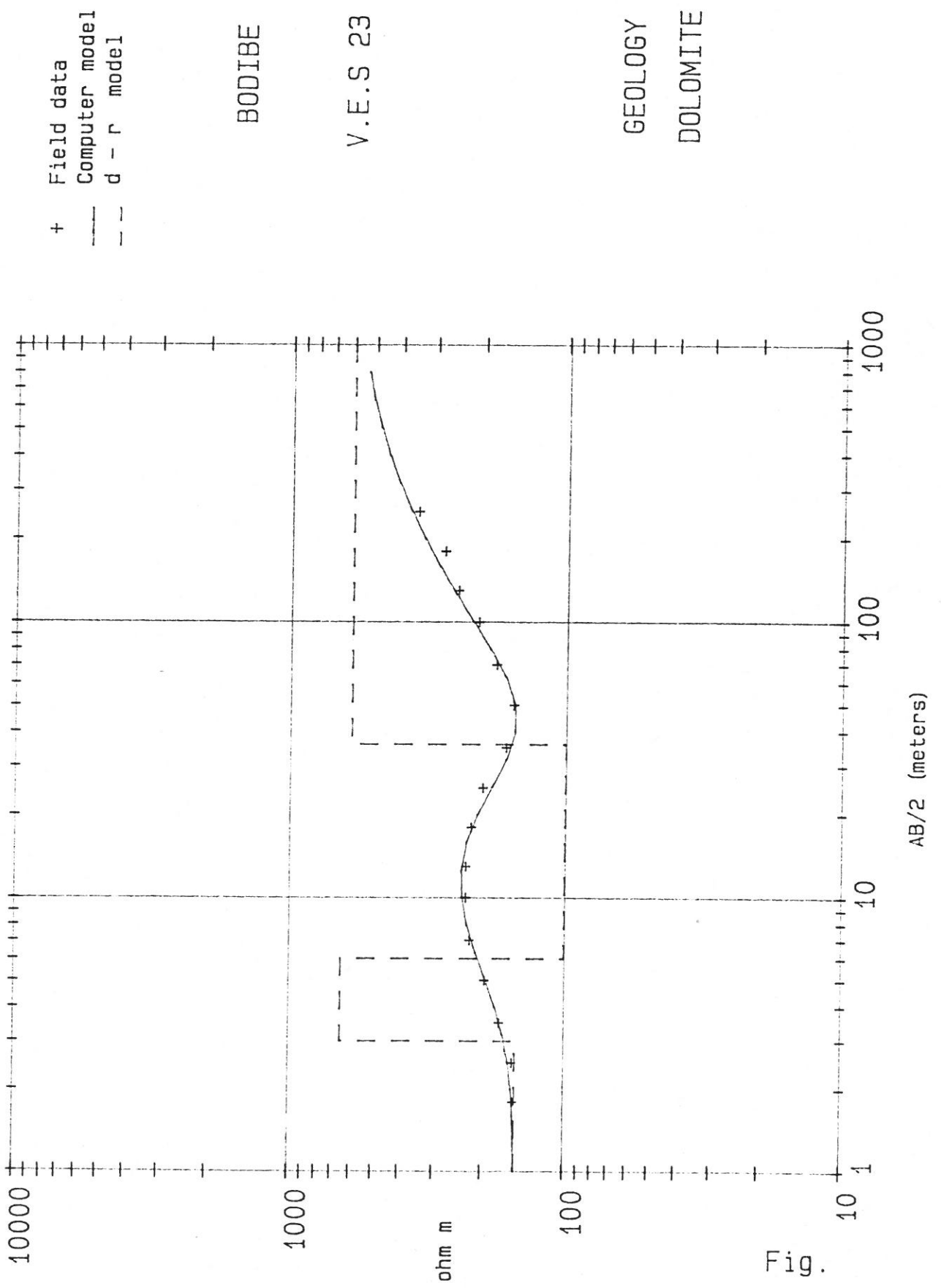


Fig.

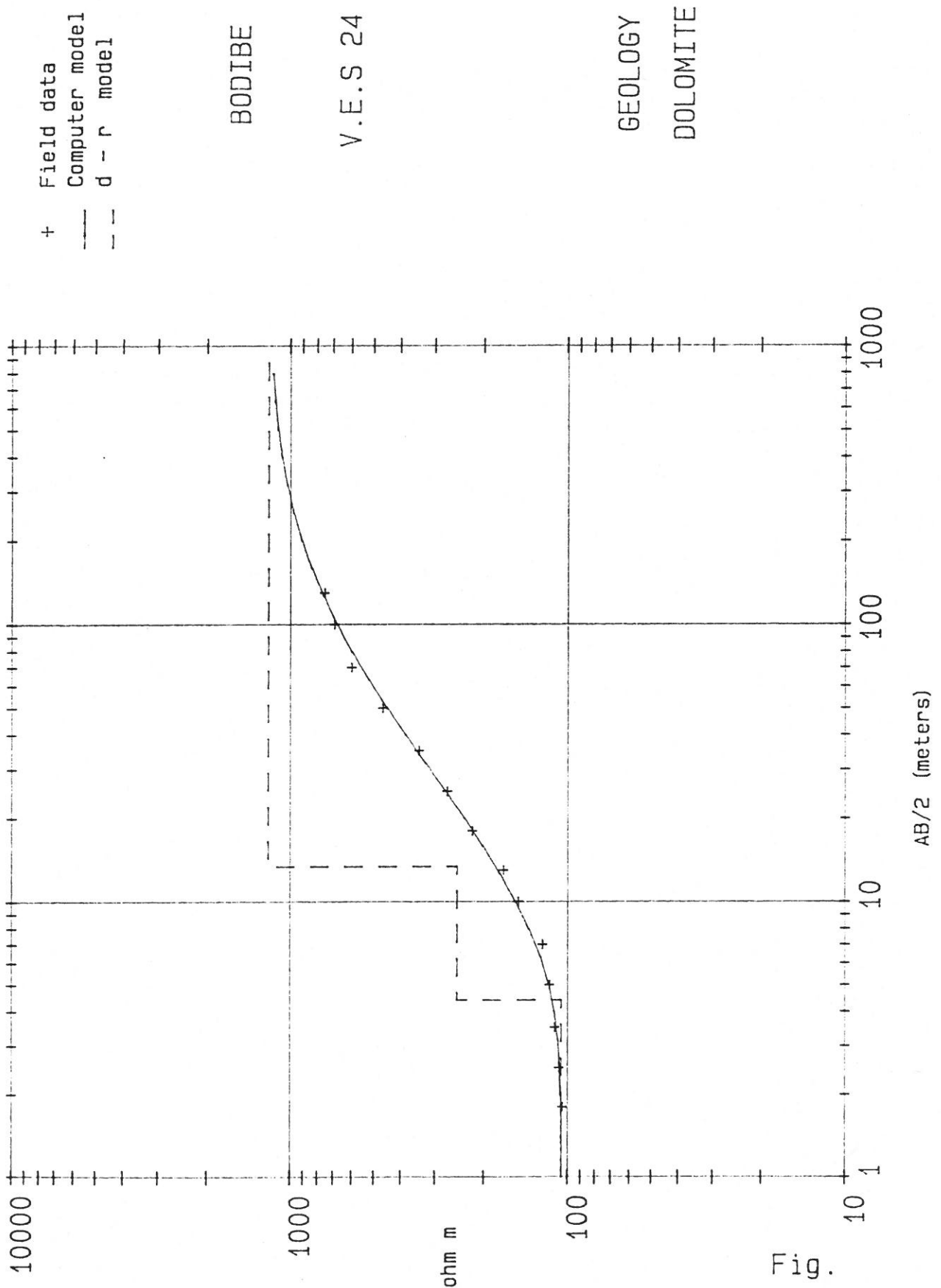


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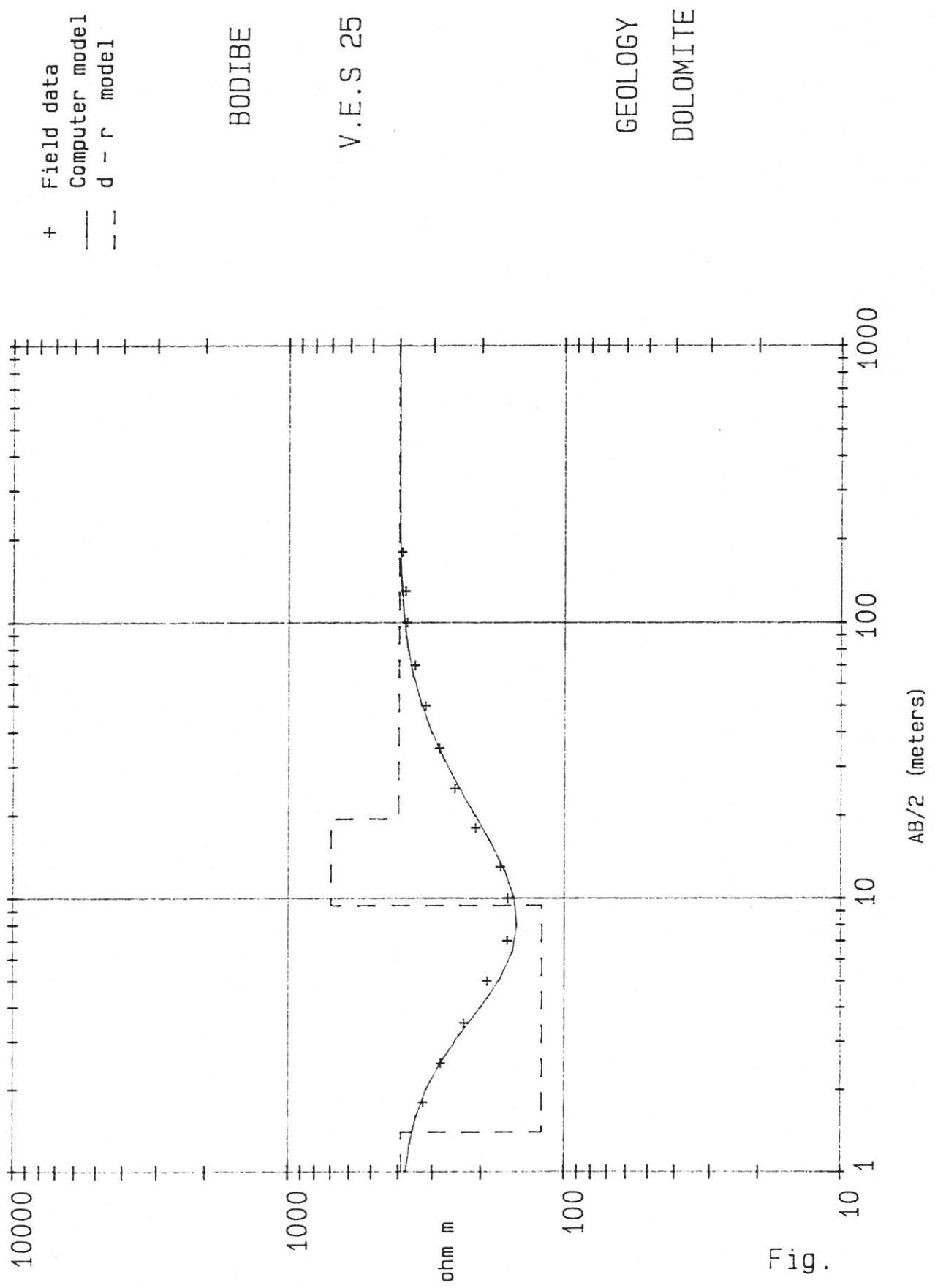


Fig.

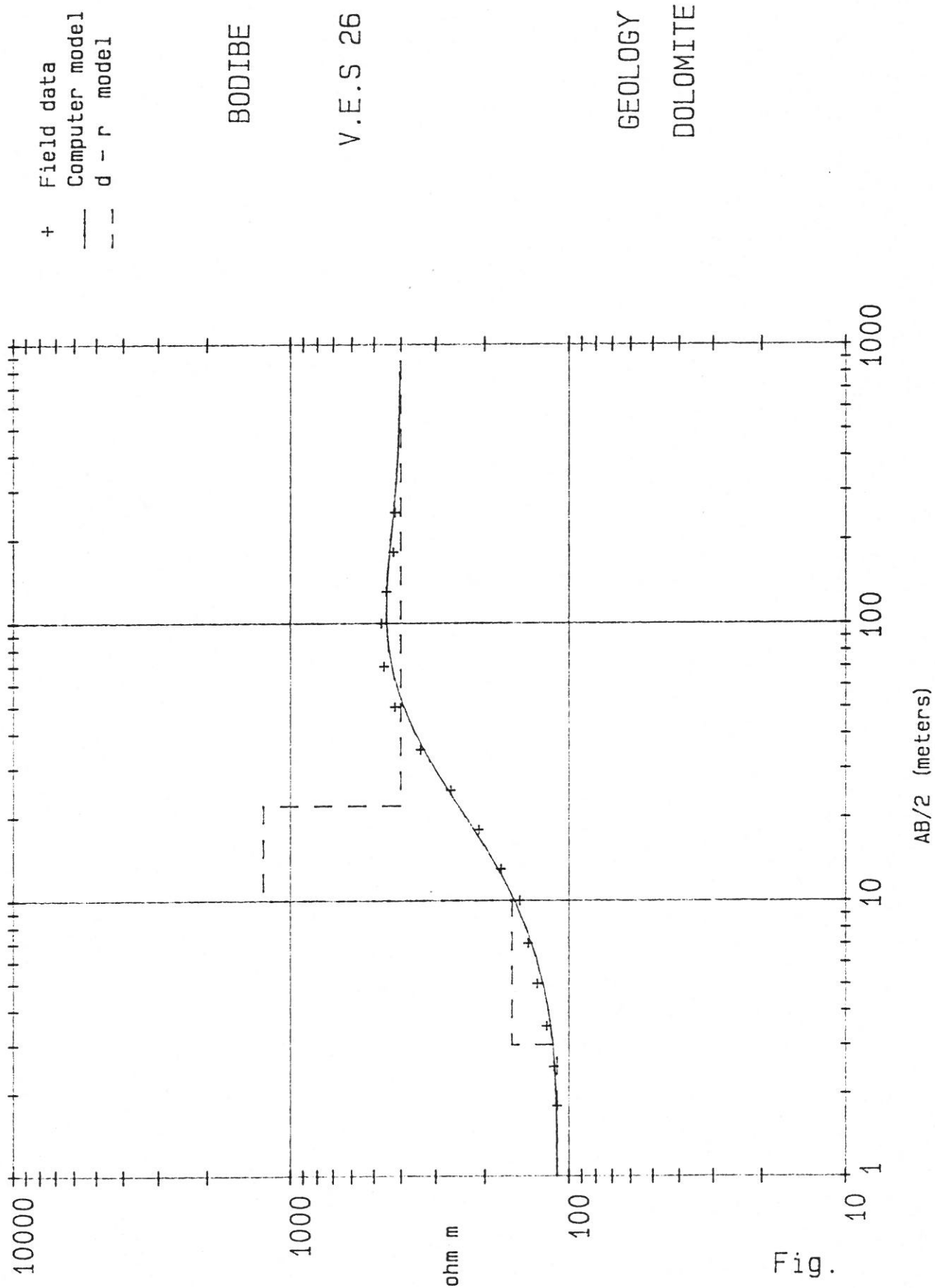


Fig.