70/96
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Record No. 1970 / 96

Tests of the V.L.F. Electromagnetic Method in the Comet and Sylvester Areas near Zeehan,

Tasmania 1970

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by

W.J. Langron and P.J. Gillespie

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ILLUSTRATIONS

SUMMARY

A v.l.f. electromagnetic test survey using Ronka EM16 equipment was made over an area near Zeehan, Tasmania.

The results are examined in terms of drilling information and other geophysical work. The effect of topography on the results is probably considerable but anomalies due to mineralization have steep gradients and can be readily distinguished.

The data for the Comet area have been filtered and contoured and the results agree closely with known geology and mineralization.

1. INTRODUCTION

The v.l.f. electromagnetic prospecting method offers several attractive features, chief of which are the portability of the equipment and the possibility of discriminating against conductive horizontal overburden.

However, in Australia the usefulness of the method is limited because of the generally unfavourable attitude of mineralized zones to the single transmitting station (NWC, North West Cape) which can be used for the work. This feature has been commented on by Haigh (1970a) for earlier work by the Bureau of Mineral Resources, Geology & Geophysics (BMR) in the Captains Flat area, New South Wales.

In further work in Tasmania, Haigh (1970b) included one traverse (22S) within the Comet area presently investigated by the writers. Along this traverse a promising but only partially defined 'cross-over' was obtained. Since Haigh's work, Geophoto Resources Consultants, the operators for the Permit holders Texins Development Pty Ltd, have carried out further geological mapping, and some self-potential (S-P) and induced polarization (IP) geophysical work; diamond drilling has revealed encouraging mineralization over a wide zone and at varying depths.

The strike of the conducting bodies is nearly ideal for the v.l.f. method and because of the amount of relevant information which the Company was prepared to make available, arrangements were made with the Company to carry out further tests with the v.l.f. method. This work included nine traverses in the Comet area (Plate 1) and three traverses at Sylvester (Plate 12).

The geophysical party consisted of the writers. The work was carried out between 11 and 17 March 1970.

The co-operation of Geophoto Resources Consultants, and in particular of the Company's resident geologist Mr. R.G. Paterson, is gratefully acknowledged.

2. GEOLOGY

The several accounts of the geology of Zeehan and surrounding area are summarizee by Blissett (1962). Of particular interest to the work at Dundas are reports by Elliston (1954) and Rattigan and Paterson (1969). No attempt will be made here to reproduce a full account of the geology of the areas surveyed; the notes which follow deal only with those matters pertinent to the present study.

Comet area

The surface geology and details of diamond-drill holes within the grid surveyed at Comet are shown in Plate 1. The geology of the Dundas district is complex and mapping is made difficult because of the thick rain forest cover.

The 'Comet Line' of mineralization, indicated by the occurrences of Gossan in Plate 1, is believed to be associated with a major fault or zone of faults trending north to northwest in Cambrian and Precambrian rocks and lying on the west flank of a major anticlinal feature. This feature is flanked, to the east, by the Oonah Quartzite and Slate, a Precambrian unit which contains some graphitic and pyritic slate, quartzite, and dolomite. Sheet-like basic intrusives (now evident as serpentinite, pyroxenite, etc.) of Cambrian age have invaded the older rocks but the wider bodies lie west of the area surveyed.

Rocks are all steeply dipping, folded, fractured, and severely dislocated by faulting. The 'Comet Line' appears to consist of a premineralization fracture zone in which a series of parallel faults has been mineralized.

In general terms, mineralization in the Comet-Maestries Section north of the area shown in Plate 1 consists of silver-rich lead ores; that in the Kosminsky Hill and Mine Section is a galena-sphalerite ore. The present survey related in the main to the Kosminsky Section.

Sylvester area

At Sylvester, silver-rich galena-siderite ore occurs in intensely faulted and shattered quartzites, slate, and dolomitic slates of the Oonah unit. There is little surface outcrop. One hole is presently being drilled to test an IP. anomaly on Traverse 00.

3. TECHNICAL ASPECTS

The primary aim of the survey was to test the v.l.f. method, particularly with regard to response from known mineralization, and to investigate its effective depth penetration. Thus the work at Comet was confined to the southernmost traverses where most of the Company drilling has been undertaken and where most is known about the geology.

It was hoped to survey some traverses under both wet and dry conditions but unfortunately most of the work was done in steady rain. It is doubtful, however, if the sub-soil within the rain forest area would ever dry out sufficiently to provide a suitable contrast in ground conditions. At Sylvester much of the work was done over marshy and water-logged ground.

The performance of the Ronka EM16 unit was excellent under these conditions of extreme dampness. The NWC signal (22.3 kH_3) was received clearly at all times.

Most traverses were read with the observer facing away from the transmitting station so as to get sufficient light on the inclinometer dial. The instrument was tested, satisfactorily, for symmetry and all results are presented in the conventional manner, i.e. observer facing the transmitting station. Readings were taken at intervals of 25 feet along all traverses.

At the commencement of the work, a field strength meter (built in the Bureau of Mineral Resources Laboratories) was read at regular intervals at a base station. It was thought that such readings might show up any diurnal variation in the resultant field. Some marked variation was, in fact, detected on the first day but the performance of the instrument was suspect and the readings cannot be considered to be significant. It was impracticable, under the conditions, to transport the field strength meter along the traverses.

4. DISCUSSION OF RESULTS

The theory and interpretation of the v.l.f. prospecting method have been discussed by Haigh (1970a). The results are displayed as profiles of vertical, in-phase component (inclinometer readings) and quadrature component (potentiometer readings) expressed in units of percent.

Results for the Comet area are shown in Plates 2 to 11, and for the Sylvester area in Plate 12. Drilling results and geophysical information are also included. In the Comet area, the drill sections have been projected onto the traverse section using the strike of the beds in the area.

Comet area

Anomalies occur on most traverses; those that most closely resemble theoretical type curves are at 13.0W on Traverse 22S (Plate 5), 4W on Traverse 26S (Plate 7), 14.5W on Traverse 18S (Plate 3) and 13.5W and 6.5W on Traverse 20S (Plate 4) - the location along the traverse corresponds to the point of inflexion on the in-phase profile. All of these anomalies appear in both in-phase and quadrature components although the curves are not symmetrical about the x-axis.

In other places there is an in-phase component anomaly whose shape approaches that of the type curve, but the quadrature component shows little variation (e.g. the anomaly at 14.0W on Traverse 32S, Plate 10). In all anomalies the quadrature component varies considerably less than the in-phase component.

There is little doubt that results are affected by topography, which can be responsible for very large (amplitude up to 70%) but extremely slowly varying curves. The anomalies due to mineralization are much steeper and of smaller amplitudes (up to 30%). Whittles (1969) has also discussed effects due to topography.

With regard to the effective depth penetration of the method it was noted that where a traverse crosses outcrop (i.e. gossan, usually with evidence of mineralization) the gradient of the anomaly (cross-over) is very steep, with an amplitude of almost 30%. Such a feature is that at 13.0W on Traverse 22S (Plate 5). Mineralization at depths of up to 100 feet (30 metres) produces pronounced, steep anomalies with amplitudes of 10-20% (Plates 3, 4, 6). Although these anomalies possibly arise from the upper portions of the lode, the gently sloping cross-over with amplitudes of 10% or less at about 10W on Traverse 28S (Plate 8) appears to be due to mineralization at a depth greater than 100 feet. The two intersections of mineralization beneath that anomaly appear to be resolved in the v.l.f. profile. A similar resolution of two intersections is apparent at 13W on Traverse 24S (Plate 6).

A gradual anomaly of about 10% is barely distinguishable from background (such as the effects of topography), and under the survey conditions at Comet it is considered that the maximum depth penetration of the method - i.e. the deepest body that will produce reliable anomalies - is about 100 feet (30 metres). We can compare this estimate with theoretical considerations of attenuation of the signal. The skin depth for a primary magnetic field of frequency 20 kHz in moderately conductive ground (resistivity 100 ohm-metres) is about 40 metres. Considering that the secondary field is further attenuated in its passage to the surface, 30 metres would seem to be a reasonable limit for reliable response in this environment.

The results were filtered and smoothed using a process described by Fraser (1969) and a computer programme, VLFILTER, listed in Appendix 1. Filtering gives a plot proportional to the first discrete derivative and thus the points of inflexion are indicated by maxima or minima. The filtered values were contoured at 10-unit intervals in the Comet-Kosminsky area (Traverses 14S - 32S) and the result is shown in Plate 11. The negative values were not contoured since they are due to the points of inflexion on the flanks of the cross-over.

The central positive closure in Plate 11 correlates very well with the results from drilling and with the outcrops of gossan. The anomaly at 18W on Traverse 14S suggests the possiblity of a cross-fault displacing the line of lode to the west, between Traverses 18S and 14S. There are two other zones of positive values. The one in the west of the contoured area bears a similar relation to mapped gossan (with mineralization) as does the central closure. There are several old workings here. Induced polarization (IP) work along Traverse 26S indicated an anomalous zone between 13.5W and 15.5W and a tightly closed self-potential (S-P) anomaly of -800 mV is located at 16 W on Traverse 24S. The positive values in the east of the area occur over graphitic and pyritic slates in a very steep portion of the area. S-P anomalies of -800 mV or less are located at 4W and 00 on Traverse 24S and a 2W on Traverse 22S. On Traverse 26S an IP anomalous zone between 2W and 4W indicates a good conductor, and a strong v.l.f. cross-over occurs at 3.75W. Other IP anomalous zones are located at 2E-4W and 5E-8E; only the latter indication shows some correlation with the v.l.f. results.

One encouraging feature of the equipment was that readings were found to be reproducible within the limits of instrument error. Repeat readings taken at the same stations a day or so later differed by less than one percent in-phase and quadrature. However, a comparison between Haigh's 1969 profile and the present profile for Traverse 22S indicates curves of virtually identical shape but with the present profile displaced about 10 percent below Haigh's.

Sylvester area

The area is generally flat and grass covered, and swampy in parts, with little outcrop.

On Traverse 00, an IP anomalous zone between about 7E and 9E was being drilled at the time of the v.l.f. work (the target zone being 300 feet (90 metres) below 7E). The drilling showed ten feet of disseminated and massive pyrite at the target zone and galena-sphalerite mineralization west of and deeper than the main IP target zone. A rather poor v.l.f. cross-over is located at 10E, i.e. to the east of the IP anomalous zone.

On Traverse 800N a very good cross-over is located at about 13.5E. This anomaly is in heavily grassed, swampy ground, the effect of which on v.l.f. results is not known clearly at this stage. The indication is near the Company's lease boundary and hence the full profile was not completed.

On Traverse 800S an indication similar to that on Traverse 00 was obtained. IP results were poor on this traverse.

The line of strike given by the above three anomalies seems to be compatible with present geological knowledge of the area. In addition the anomalies suggest a source somewhat deeper than the bodies responsible for the anomalies at Comet.

5. CONCLUSIONS

The results of the present work show that results of good quality can be obtained with the v.l.f. method where mineralization approaches near the surface and the conductors strike approximately in the direction of the transmitting station.

The study indicates that the depth penetration of the method is about 30 metres in the Zeehan area.

Though it was not the purpose of the survey to explore for new mineralization, it is nevertheless recommended that the Company examine more closely the positive zones of Plate 11 and especially about 14S/18W, 26S/4W, and 20S/6.5W where no surface geology or drilling information is available. The eastern portion of Traverse 800N at Sylvester should also be examined.

The writers also feel that model test studies are desirable; these could be carried out fairly easily and would aid considerably in the interpretation of v.l.f. work. They would be of particular help in such problems as the effect of topography with ground of varying conductivity, and the more theoretical aspects of interpretation involving the shift in the inflexion points as between the in-phase and quadrature components, the generally smaller amplitude of the quadrature component, and the significance, if any, of positively sloping steep gradients.

6. REFERENCES

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APPENDIX 1

PROGRAMME VLFILTER

```
      PROGRAM VLFILTER
C     C(I) IS CO-ORDINATE IN UNITS OF 100 FEET
C     D(I) IS FIELD READING OF DIP-ANGLE EXPRESSED IN PERCENT
C     ZL(K) IS FILTERED RESULT ASSOCIATED WITH CO-ORDINATE C(K)
C     TR IS TRAVERSE NAME
      DIMENSION C(100),D(100),ZL(100)
   14 READ(60,400)N $ IF(EOF,60)13,16
  400 FORMAT(I3)
   16 WRITE(61,500)N
  500 FORMAT(1X,2HN=I3)
      READ(60,600)TR
  600 FORMAT(A5)
      WRITE(61,700)TR
  700 FORMAT(5X,8HTRAVERSE,2X,A5)
      WRITE(61,300)
  300 FORMAT(1X,11HCO-ORDINATE,5X,9HDIP-ANGLE)
      READ(60,100)(C(I),D(I),I=1,N)
  100 FORMAT(13(F3.1,F3.0))
      M=N-3
      DO 1 K=1,M
      AB=D(K+2)+D(K+3)
      BA=D(K+1)+D(K)
      ZL(K)=AB-BA
      C(K)=(C(K+1)+C(K+2))/2
    1 WRITE(61,200)C(K),ZL(K)
  200 FORMAT(4X,F5.2,5X,F3.0)
      GO TO 14
   13 CONTINUE
      STOP
      END
```

To accompany Record No. 1970/96

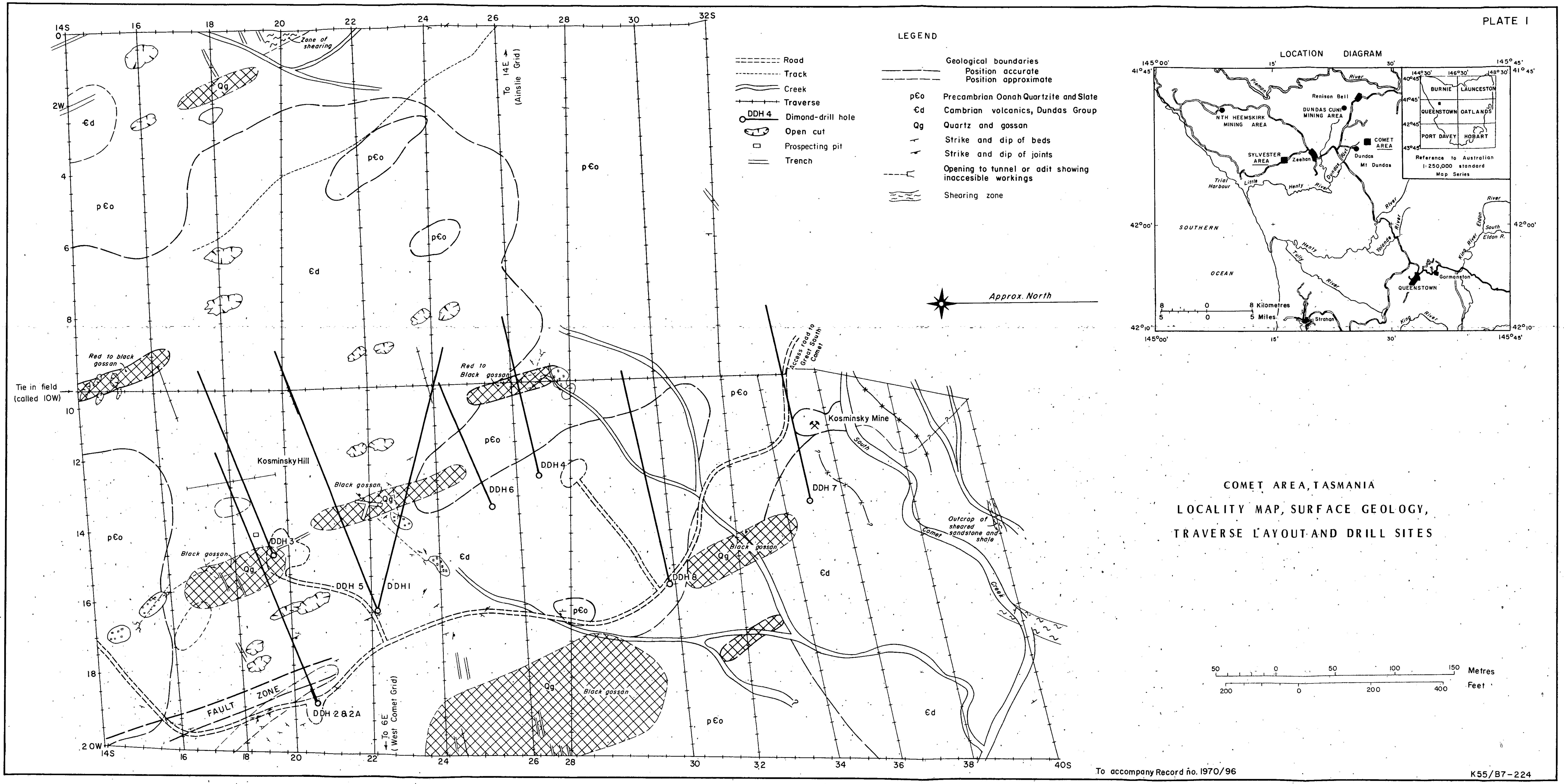
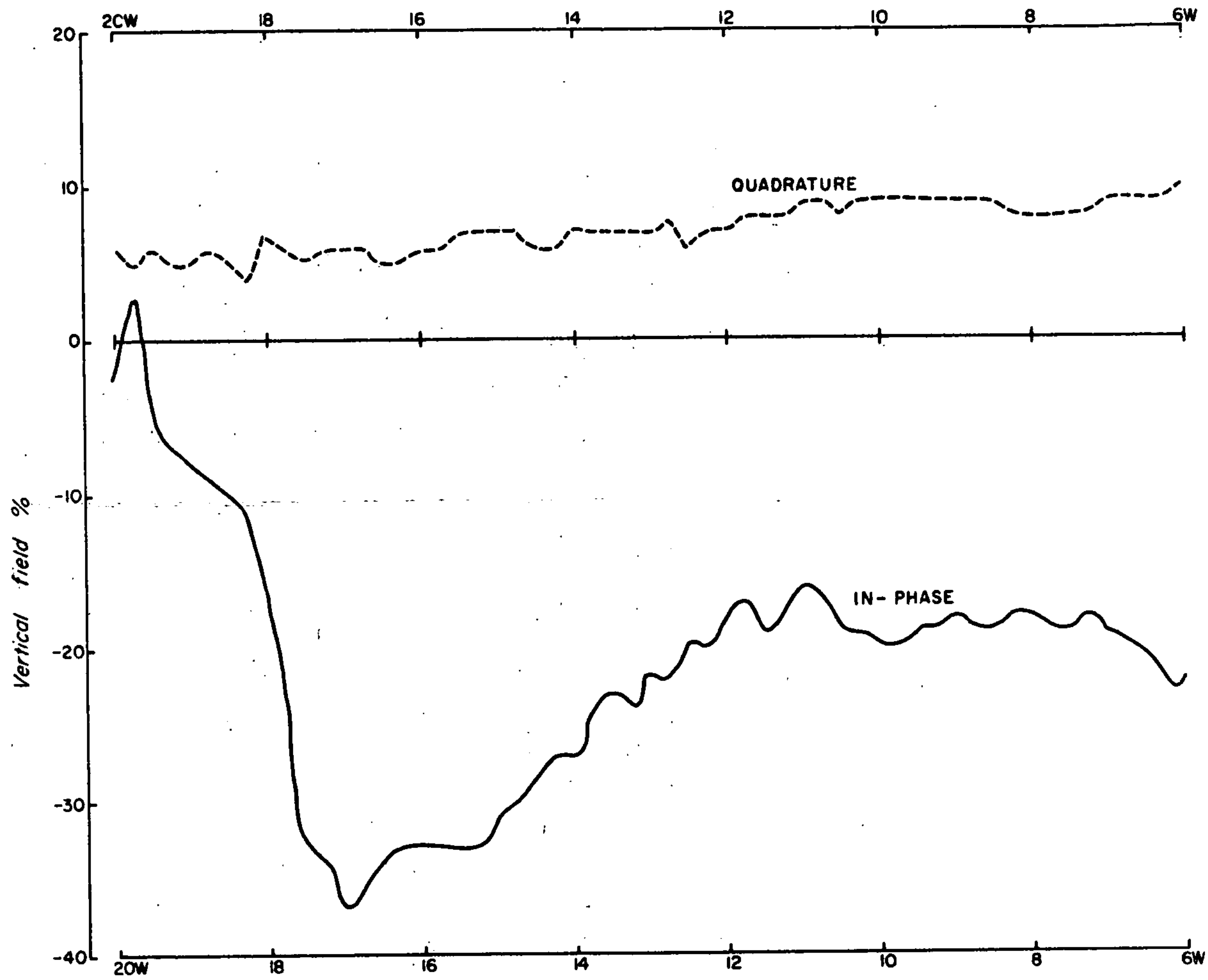


PLATE I
LEGEND
Road
Track
Creek
Traverse
DDH 4
Dimond-drill hole
Open cut
Prospecting pit
Trench
Geological boundaries
Position accurate
Position approximate
p€o Precambrian Oonah Quartzite and Slate
€d Cambrian volcanics, Dundas Group
Qg Quartz and gossan
Strike and dip of beds
Strike and dip of joints
Opening to tunnel or adit showing inaccessible workings
Shearing zone
Approx. North
LOCATION DIAGRAM
145°00'
15'
30'
145°45'
41°45'
42°00'
42°10'
Renison Bell
DUNDAS CUNI MINING AREA
NTH HEEMSKIRK MINING AREA
SYLVESTER AREA
Zeehan
COMET AREA
Dundas
Mt Dundas
Trial Harbour
Little
Henty River
SOUTHERN
OCEAN
QUEENSTOWN
Gormanston
Strahan
King River
Yolande River
Tully River
Eldon River
South Eldon R.
8 0 8 Kilometres
5 0 5 Miles
BURNIE
LAUNCESTON
QUEENSTOWN
OATLANDS
PORT DAVEY
HOBART
Reference to Australian 1:250,000 standard Map Series
Zone of shearing
To 14E (Ainslie Grid)
Red to black gossan
Tie in field (called 10W)
Red to Black gossan
Kosminsky Hill
Black gossan
Kosminsky Mine
Access road to Great South Comet
South Comet Creek
Outcrop of sheared sandstone and shale
FAULT ZONE
To 6E (West Comet Grid)
DDH 1
DDH 2 & 2A
DDH 3
DDH 4
DDH 5
DDH 6
DDH 7
DDH 8
COMET AREA, TASMANIA
LOCALITY MAP, SURFACE GEOLOGY,
TRAVERSE LAYOUT AND DRILL SITES
50 0 50 100 150 Metres
200 0 200 400 Feet
To accompany Record no. 1970/96
K55/B7-224

PLATE 2



COMET AREA, TASMANIA

TRAVERSE 14S

V.L.F. RESULTS

50 0 50 100 150 Metres

200 0 200 400 Feet

To accompany Record no. 1970/96

K55/B7-225

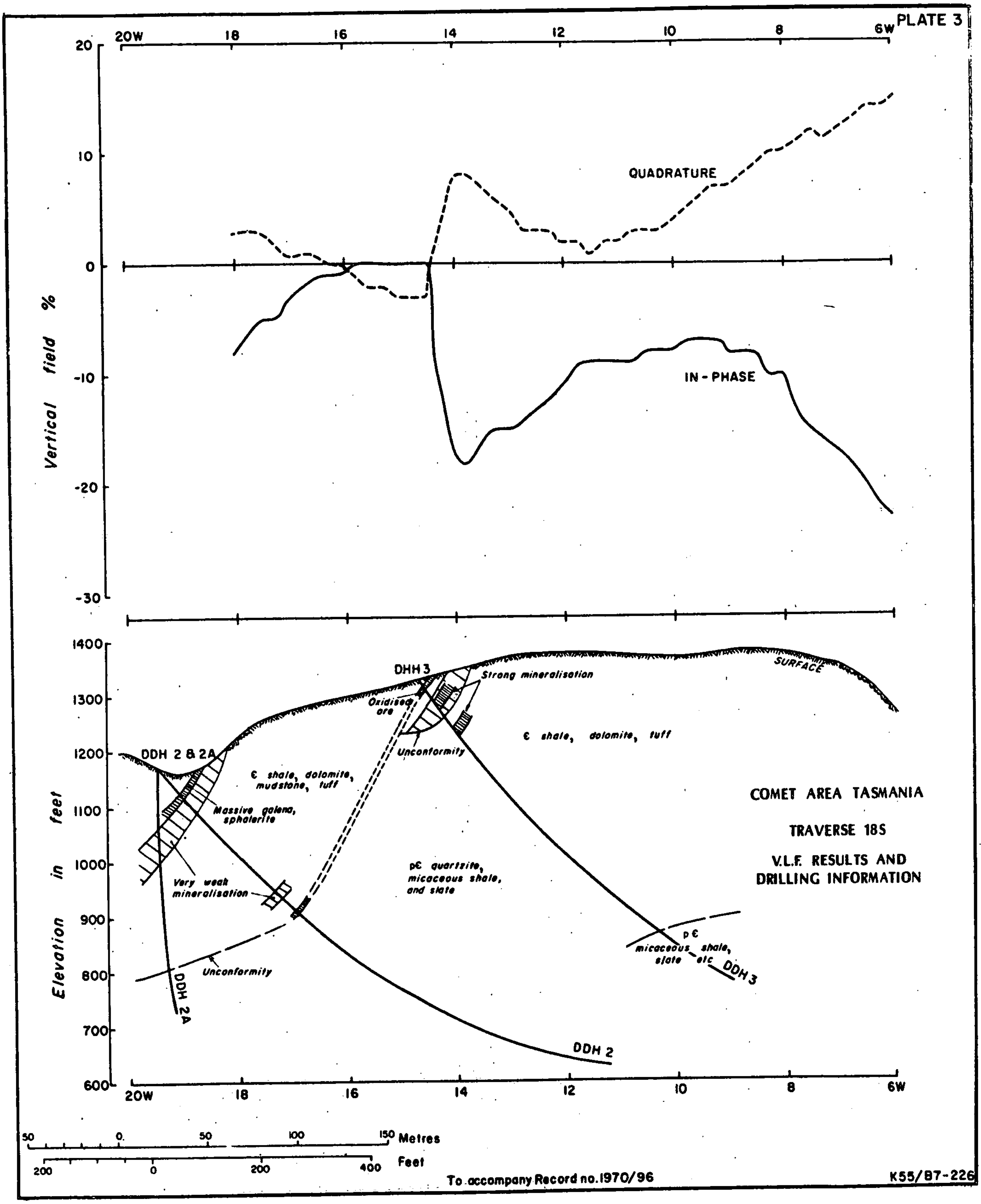
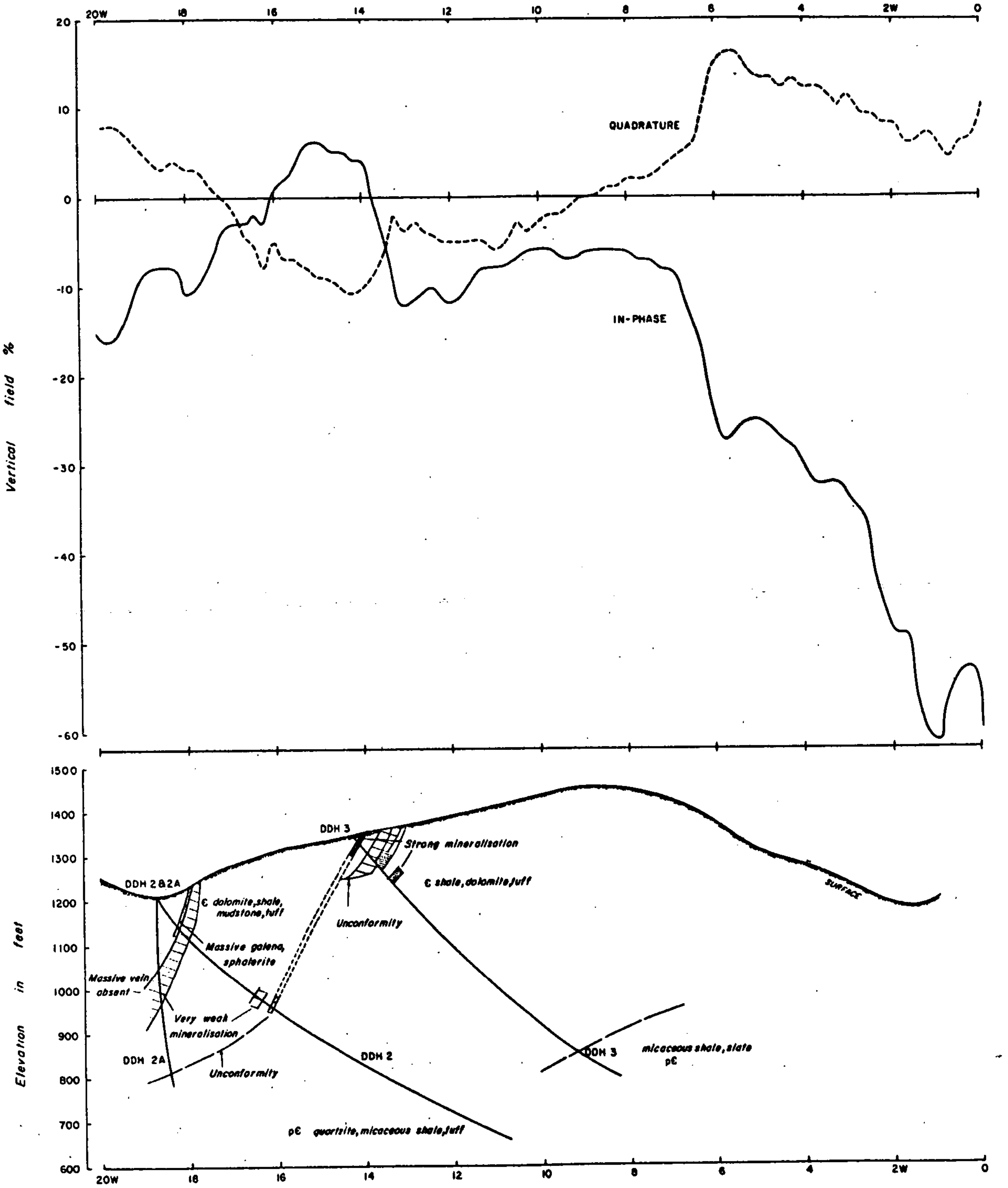


PLATE 3
20W
18
16
14
12
10
8
6W
20
10
0
-10
-20
-30
Vertical field %
QUADRATURE
IN - PHASE
1400
1300
1200
1100
1000
900
800
700
600
Elevation in feet
SURFACE
DHH 3
Strong mineralisation
Oxidised ore
Unconformity
€ shale, dolomite, tuff
DDH 2 & 2A
€ shale, dolomite, mudstone, tuff
Massive galena, sphalerite
pЄ quartzite, micaceous shale, and slate
Very weak mineralisation
Unconformity
DDH 2A
DDH 2
pЄ micaceous shale, slate etc
DDH 3
COMET AREA TASMANIA
TRAVERSE 18S
V.L.F. RESULTS AND DRILLING INFORMATION
50
0
50
100
150 Metres
200
0
200
400
Feet
To accompany Record no.1970/96
K55/B7-226

PLATE 4



COMET AREA, TASMANIA

TRAVERSE 20S

V.L.F. RESULTS AND DRILLING INFORMATION

To accompany Record no 1970/96

K55/B7-227

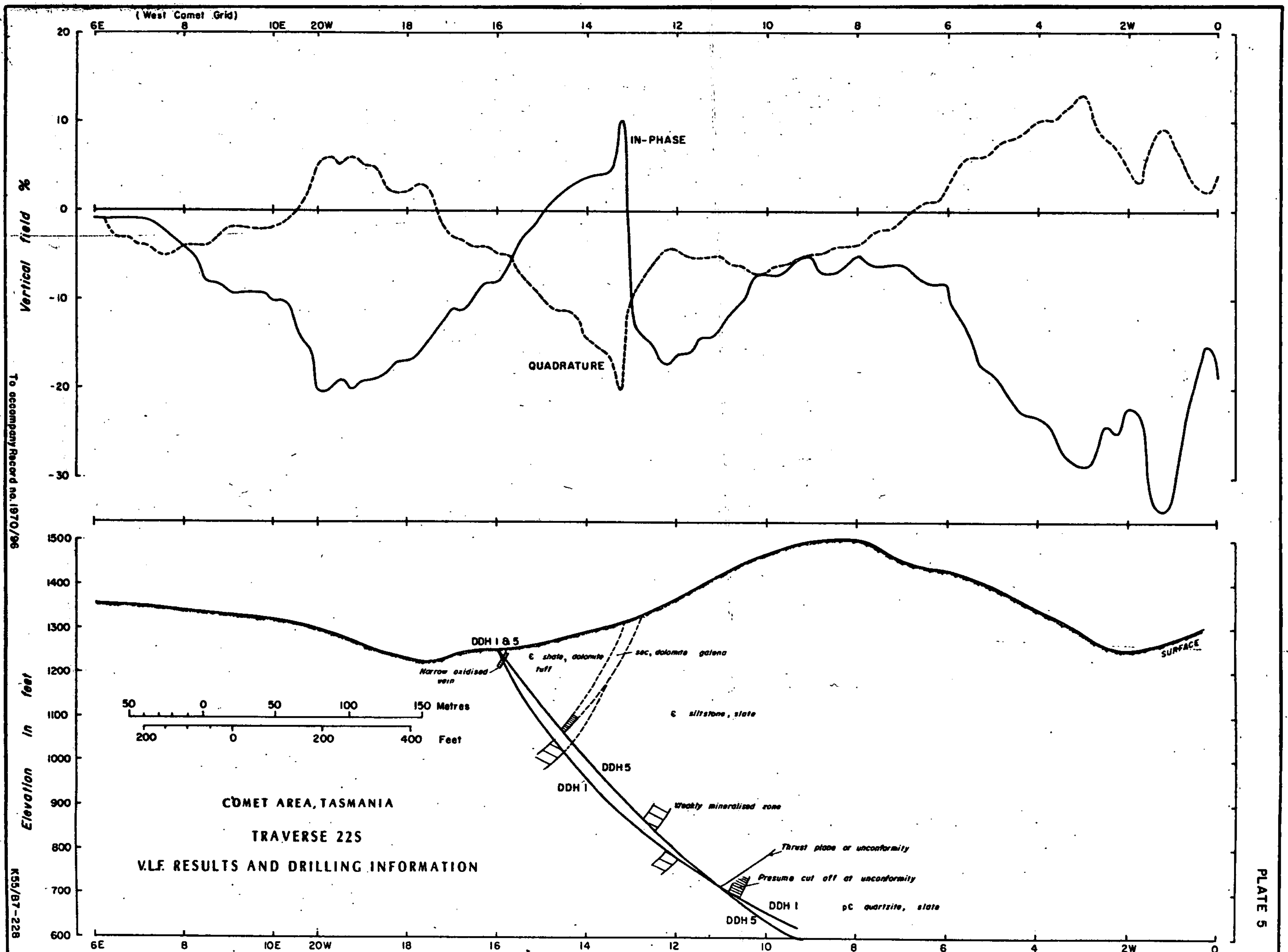
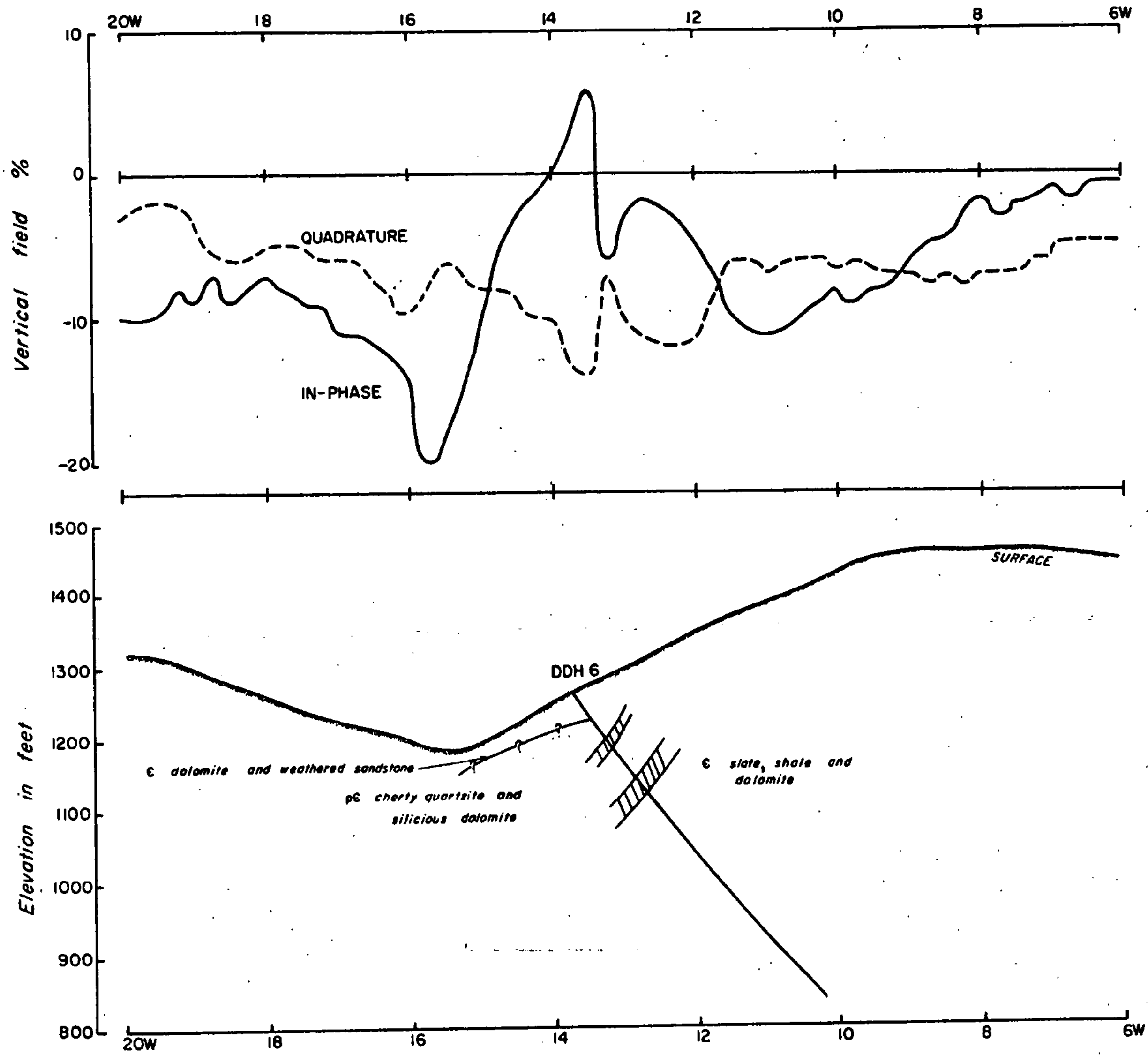

(West Comet Grid)
6E 8 10E 20W 18 16 14 12 10 8 6 4 2W 0
Vertical field %
20
10
0
-10
-20
-30
IN-PHASE
QUADRATURE
Elevation in feet
1500
1400
1300
1200
1100
1000
900
800
700
600
DDH 1 & 5
Narrow oxidised vein
€ shale, dolomite tuff
sec. dolomite galena
€ siltstone, slate
DDH 5
DDH 1
Weakly mineralised zone
Thrust plane or unconformity
Presume cut off at unconformity
pC quartzite, slate
SURFACE
50 0 50 100 150 Metres
200 0 200 400 Feet
COMET AREA, TASMANIA
TRAVERSE 22S
V.L.F. RESULTS AND DRILLING INFORMATION
To accompany Record no. 1970/96
K55/B7-228

PLATE 5

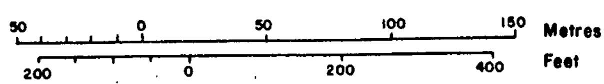
PLATE 6



COMET AREA, TASMANIA

TRAVERSE 24S

V.L.F. RESULTS AND DRILLING INFORMATION



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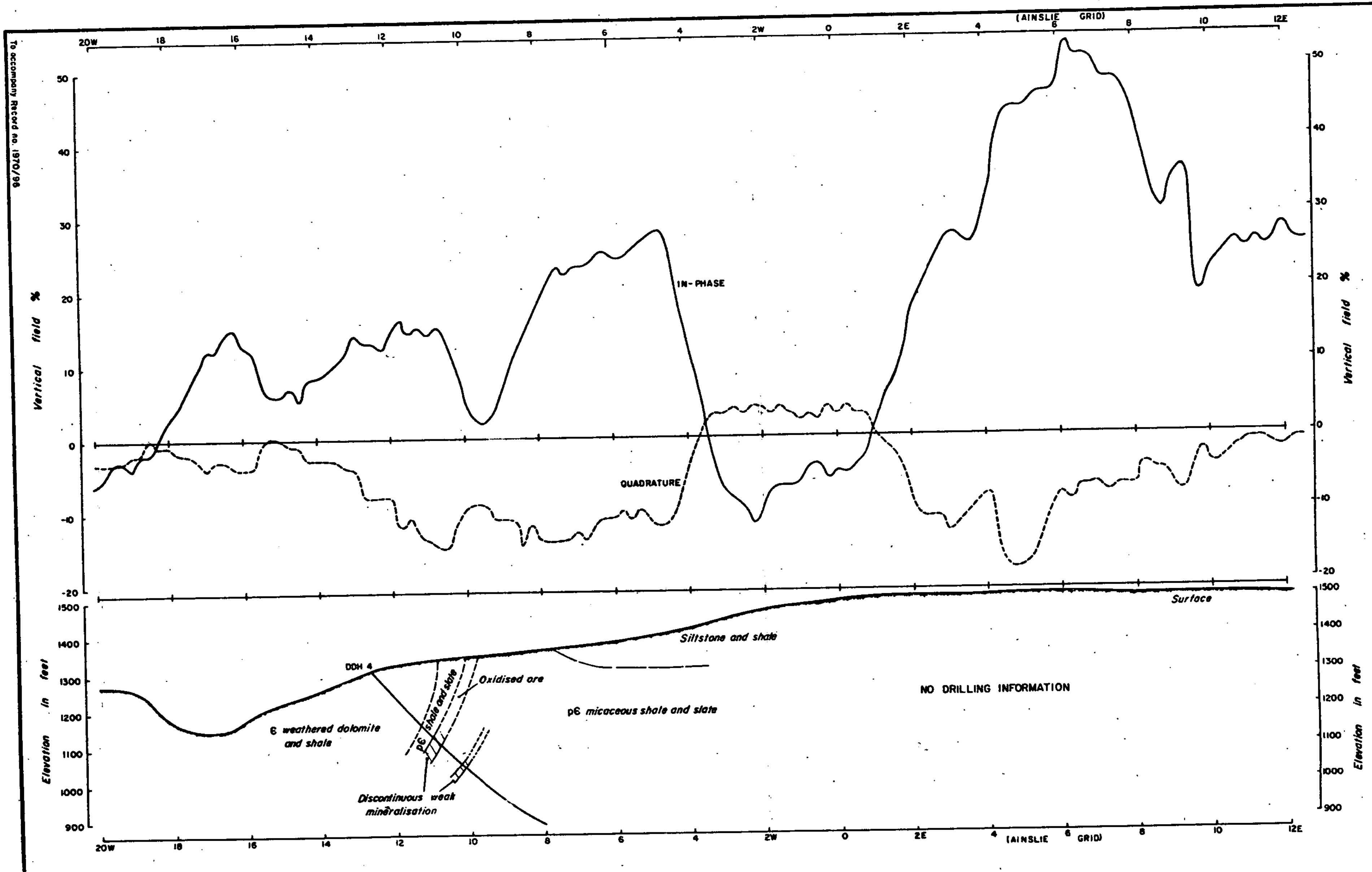
K55/B7-229



COMET AREA

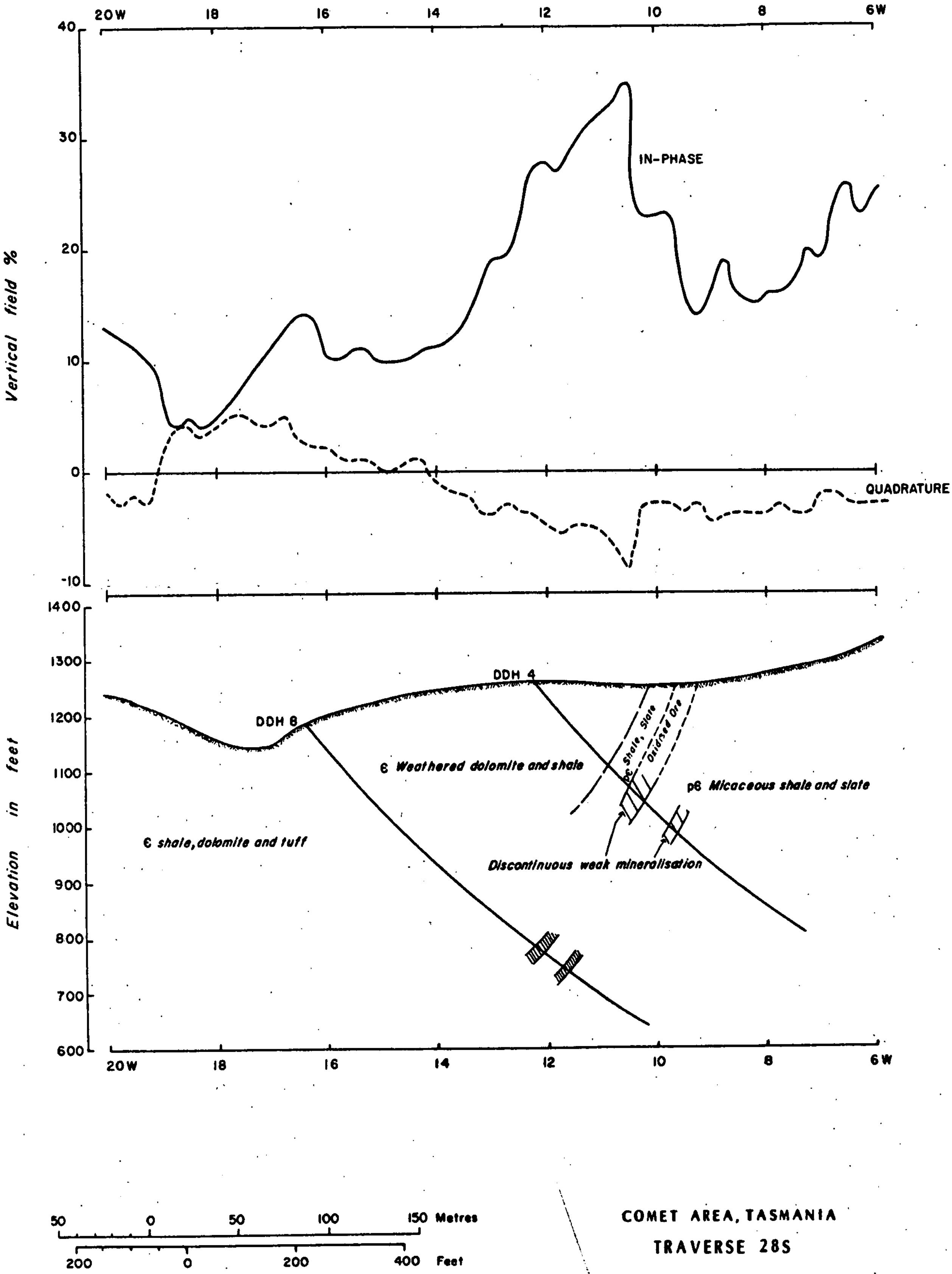
TRAVERSE 26S

V.L.F. RESULTS AND DRILLING INFORMATION

PLATE 7

K55/B7-230

PLATE 8



COMET AREA, TASMANIA

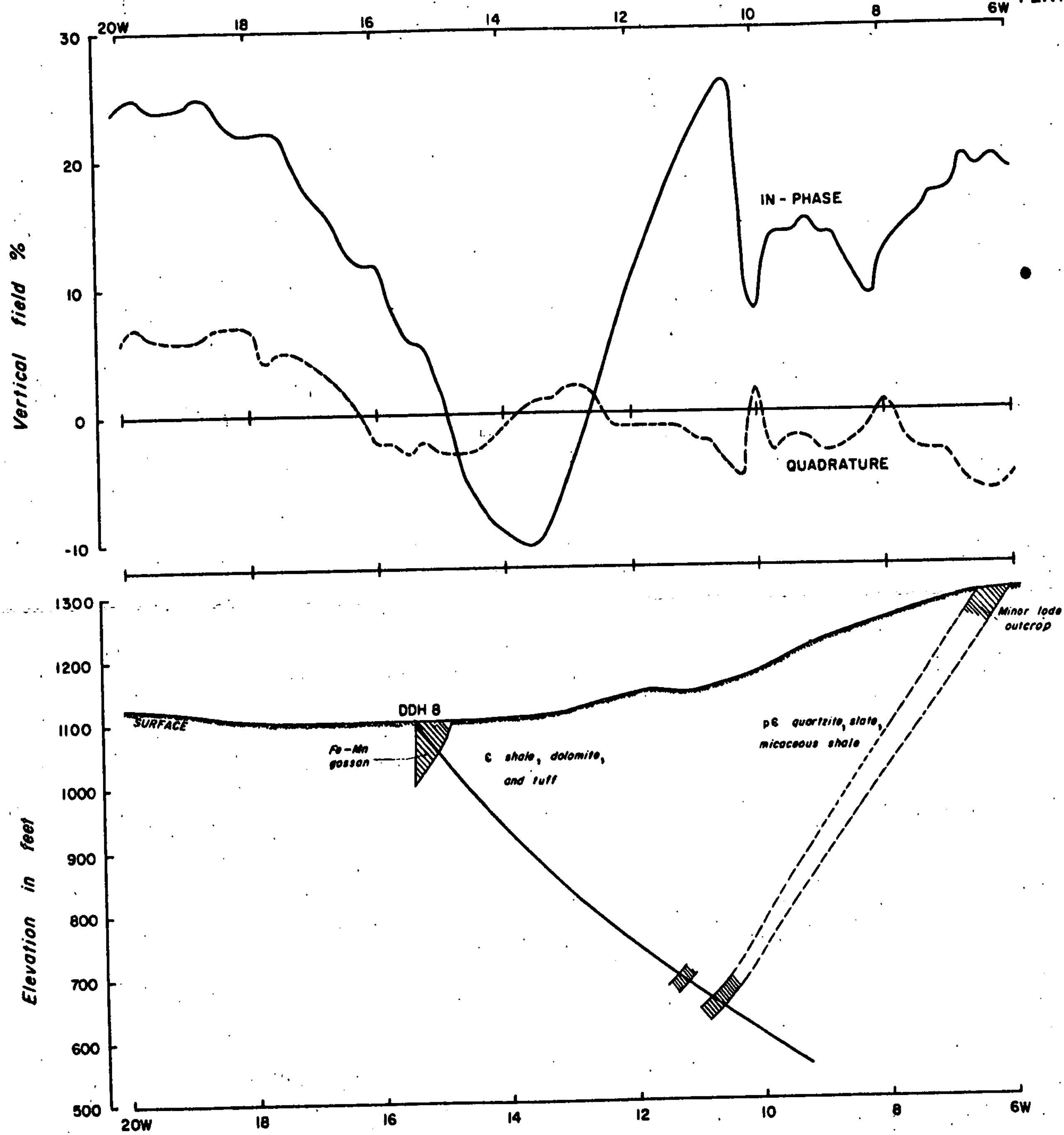
TRAVERSE 28S

V.L.F. RESULTS AND DRILLING INFORMATION

To accompany Record no. 1970/96

K55/B7-231

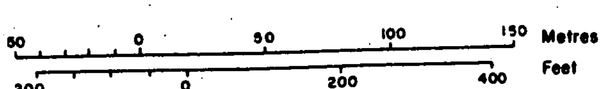
PLATE 9



COMET AREA, TASMANIA

TRAVERSE 30S

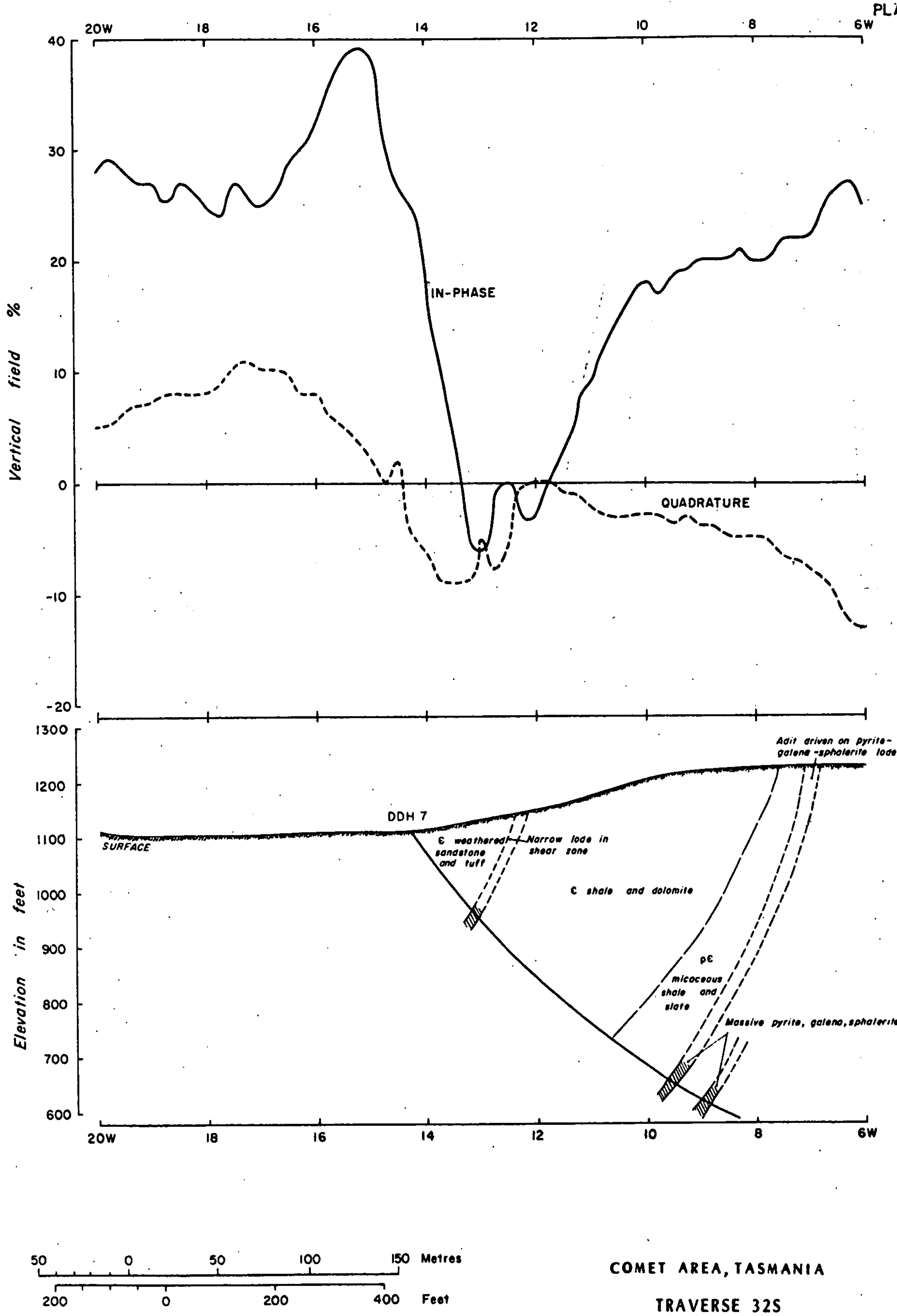
V.L.F. RESULTS AND DRILLING INFORMATION



To accompany Record no. 1970/96

K55/B7-232

PLATE 10



COMET AREA, TASMANIA

TRAVERSE 32S

V.L.F. RESULTS AND DRILLING INFORMATION

To accompany Record no. 1970/96

K55/B7-233

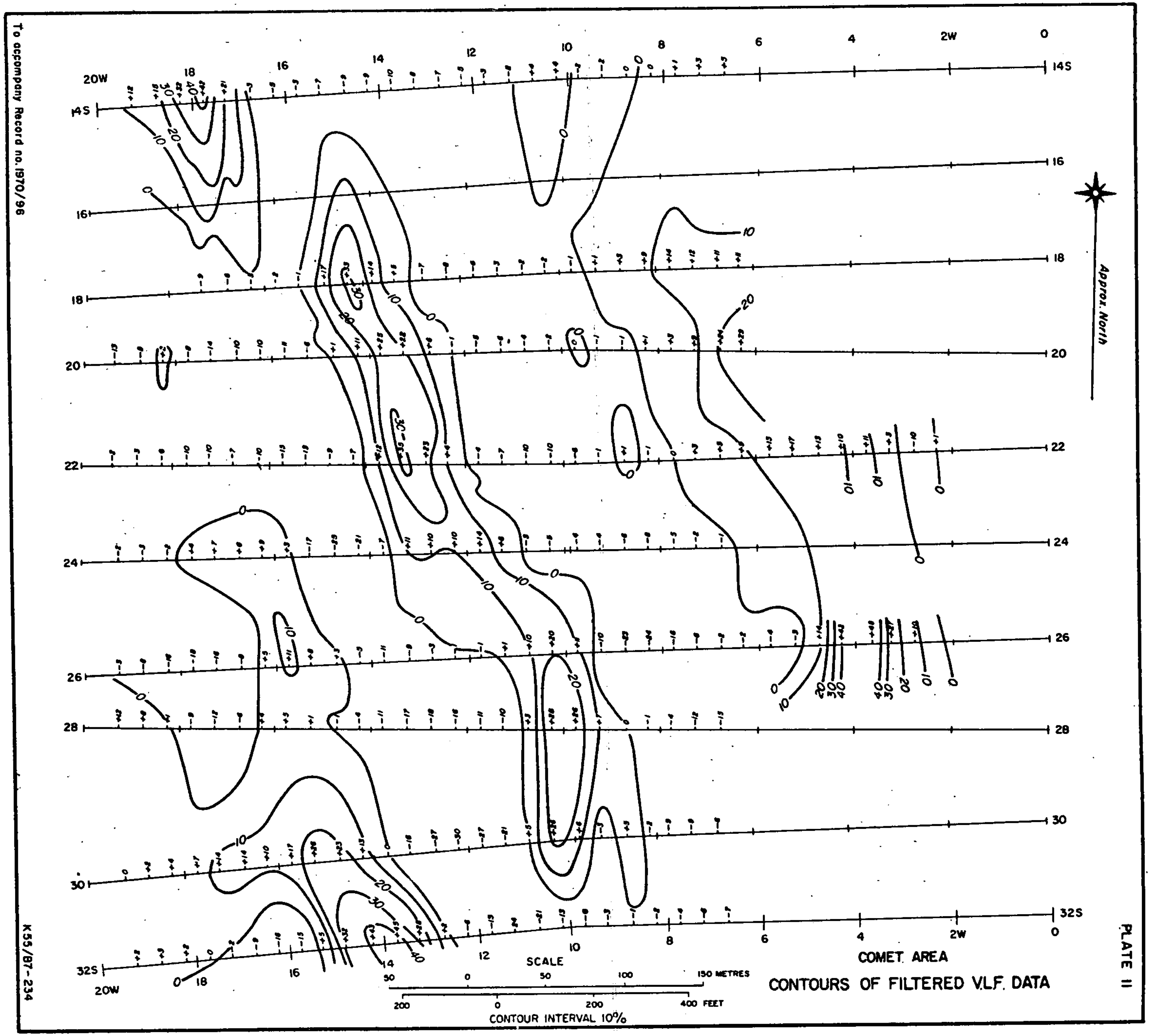
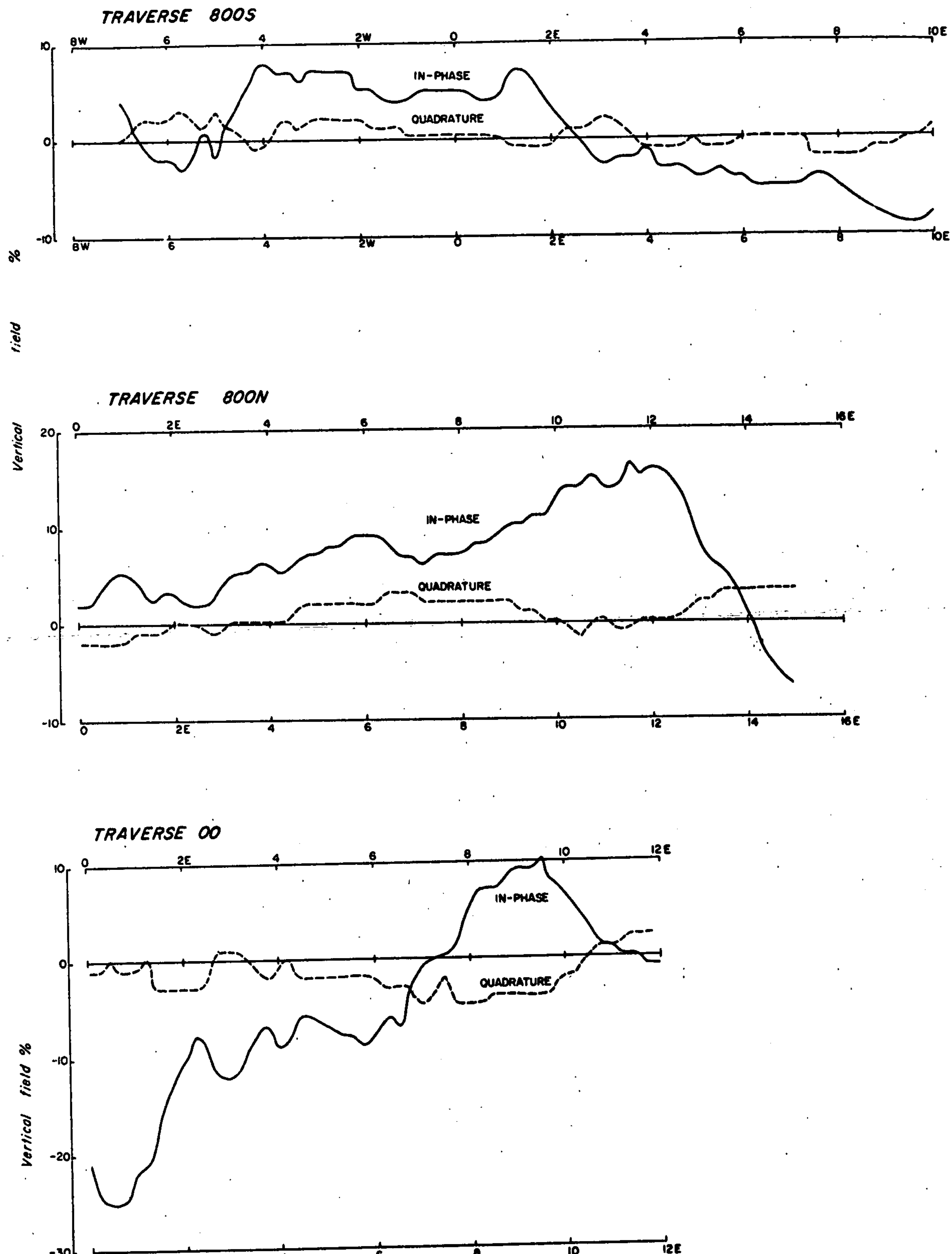


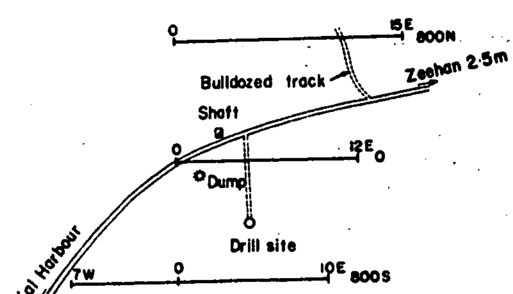
PLATE II

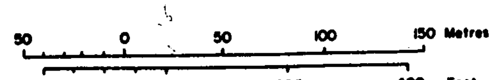
COMET AREA

CONTOURS OF FILTERED V.L.F. DATA

PLATE 12







SYLVESTER AREA

TRAVERSE LAYOUT AND V.L.F. RESULTS

To accompany Record no.1970/96

K55/B7-235