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DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

Record No. 1968 / 77

Chewton Geophysical Survey,

Victoria 1967

by

B.B. FARROW

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RESTRICTED

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ILLUSTRATIONS

Note. This Record supersedes Record No. 1967/88.

SUMMARY

A geophysical survey using magnetic, self-potential, Turam, and induced polarisation methods was made by the Bureau of Mineral Resources in the Chewton Goldfield, near Castlemaine, Victoria, in February and March 1967, to assess the applicability of these methods in the search for auriferous reefs.

A grid was laid out over old surface workings on the Mona reef, where an induced polarisation anomaly was recorded during a test survey in 1965. The present induced polarisation results indicate a zone of mineralisation at depth in the western limb of the Mona anticline with a possible associated auriferous quartz reef, apparently unrelated to the original Mona reef. Two drill holes are recommended to test the geophysical interpretation.

Three reconnaissance induced polarisation traverses were read outside the Mona area and numerous anomalies were observed, many of them over known gold-bearing reefs.

1. INTRODUCTION

During February and March 1967, a geophysical survey was conducted in the Chewton Goldfield, near Castlemaine, Victoria. During a previous test survey by the Bureau of Mineral Resources in 1965 (Williams, 1965), an induced polarisation anomaly had been detected close to the Mona workings. It was hoped that this anomaly was indicative of mineralisation in association with an auriferous quartz reef, and the present survey was designed to investigate the anomaly in more detail and to recommend drilling targets if encouraging results were obtained. Several reconnaissance induced polarisation traverses were also read outside the Mona area to test the response of other known reefs.

The survey area with the Mona grid and reconnaissance traverses is shown in Plate 1. The area, which lies within leases held by the Eureka Gold Mining Syndicate and Wattle Gully Gold Mines N.L., is south-west of Chewton township, three miles from Castlemaine and about 70 miles north-west of Melbourne. The Wattle Gully Gold Mine is the only mine in the area currently being worked. The survey was carried out with the co-operation of the Eureka Gold Mining Syndicate and Wattle Gully Gold Mines N.L. and the Victorian Mines Department.

The geophysical survey party comprised B.B. Farrow, party leader, and D.H. Quick (geophysicists), G.B. Blincoe (field assistant), and field hands supplied by the lease holders.

The surveying of traverses was done by A. Moore, surveyor with Wattle Gully Gold Mines N.L. and members of the Eureka Gold Mining Syndicate. The grid in the Mona area is based on the mine grid, which has its origin at the Wattle Gully main shaft, and grid north is 10°10' east of true north. Reconnaissance traverses B and C were surveyed in by chain and compass and subsequently located accurately with theodolite and tape, the zero peg on these traverses was located arbitrarily. Traverse A was also surveyed in with compass and chain but pegs were numbered according to the mine grid.

2. GEOLOGY

The general geology of the Chewton Goldfield has been described by Thomas (1940), Baragwanath (1903), and Thomas (1953).

The dominant lithology of the goldfield comprises Lower Ordovician slates and sandstones. Numerous graptolitic horizons occur which, when mapped, help to reveal the structure. The strata are tightly folded into asymmetric anticlines and synclines, with axes trending north-south, and with about 600 to 1000 ft between crests. The general geological structure is shown in Plate 1.

The anticlines generally have their eastern limbs vertical or slightly overturned, and their axes normally pitch to the north, but local reversals of pitch frequently occur, which can control reef formation. The folding forms part of the Chewton anticlinorium, which itself is a northern extension of the Blackwood-Trentham dome. The main axis lies about 2 miles east of the goldfield.

The stresses which caused the folding also produced extensive faulting. Strike faulting is the most common type and is often strong enough to cut across the axis of a fold, intersecting the bedding at a high angle to become bedded again in the next fold. Faults striking east-west or crosscourses were normally formed later than the quartz reefs; one, the Chewton crosscourse, occurs in the area of the survey.

Large quantitites of gold were originally won from alluvium in the area, but surface workings soon uncovered gold-bearing reefs and the emphasis changed to subsurface mining with shafts or tunnels. Although it is known to occur in the country rock, the gold is associated mainly with quartz reefs, which can exist in several forms.

Fissure reefs occur in well-marked fissures which do not conform in strike or dip with the enclosing strata.

Saddle reefs occur along the axial lines of anticlines and consist of masses of quartz that fill the otherwise open spaces created by the slipping of beds at the crests. Very often, saddle reefs occur where two strike faults of opposing dip intersect at a crest, the faults themselves possibly carrying fault reefs. Most of the mines in the Chewton Goldfield were worked on saddle reefs which often repeated at depth.

Fault reefs consist of masses of quartz associated with strike faults similar to the 'leather jacket' formations of the Ballarat Goldfield. The faults were named 'leather jackets' from the leathery nature of the comminuted material along the fault planes. The most favourable conditions for fault reef formation appear to be where strike faults cut the steeply dipping beds on the eastern flanks of anticlines, and gold concentration often occurs in association with a particular bed. A west-dipping fault reef is being worked at present in the Wattle Gully gold mine, and enrichment of the reef has been apparent where it cuts across the beds known as the Wattle Gully slates.

Spurry reefs in the form of irregular masses and veins of quartz deposited in the country rock are common in the goldfield and are often sufficiently numerous to form a stockwork which can be profitably worked for gold. Deadmans reef is a good example of this type of formation. Thomas (1953) states that probably one half of the gold obtained from quartz was won from stockworks of this nature.

Sphalerite, galena, and other sulphide mineralisation normally accompanies the quartz in reef formation, arsenopyrite and pyrite tending to occur in the wall rocks. The presence of galena and blende is regarded as indicating favourable conditions for gold occurrence.

The detailed geology of the Mona area is shown in Plate 2, where individual slate and sandstone beds are plotted as accurately as possible. The plate is based on a geological map prepared by C. Layden, geologist with Wattle Gully Gold Mines N.L., and shows the Mona anticline, which passes through the area in a direction a few degrees west of north, and the adjacent synclines about 400 ft to the east and west. The workings on the Mona reef are on the eastern limb of the anticline about 80 ft from the axis. The reef itself comprised a long wide outcrop of almost pure quartz; good yeilds of gold were obtained from below the surface but the yield from the reef as a whole was rather poor. The quartz was later mined as ballast for the railway; a few rich auriferous veins were revealed. The reef may have been part of the east leg of a saddle reef or the remains of a fault reef; evidence of faulting in the open cuts suggests the latter (K. Bowen, pers. comm).

The beds are disrupted at about 2500N by the Chewton cross-course, which displaces the anticlinal axis about 50 ft.

3. FIELDWORK

The methods tested in the Mona area were magnetic, self-potential electromagnetic (Turam), and induced polarisation; the induced polarisation method alone was used on the reconnaissance traverses.

Magnetic

Readings of the vertical component of the Earth's magnetic field were taken every 50 ft along all the traverses in the Mona area, using a Sharpe fluxgate magnetometer type MF-1. Except when close to buildings, fences, or rubbish dumps, only minor variations in the magnetic field were encountered (less than 50 gammas), which gave no information on geological structure or the location of mineralisation.

Self-potential

Measurements of self-potential were taken on two traverses over the Mona anticline using a BMR type RL807B S-P meter and non-polarising electrodes. The results proved to be unreliable because of bad ground contacts resulting from a prolonged drought in the area. Attempts to improve the contacts by liberal watering were unsuccessful and the method was finally abandoned. However, it is possible that the method may be useful with improved conditions.

Turam

The entire Mona grid was surveyed using ABEM Turam type 2S equipment with a coil separation of 100 ft. The alternating primary fields at frequencies of 220 and 660 c/s were generated from a horizontal loop 3600 ft long by 1800 ft wide. Readings were taken every 50 ft along traverses which were generally 200 ft apart. The location of the loop and traverses is shown in Plate 1.

Readings were difficult to take at the eastern ends of traverses where the primary field was weak and interference originated from buildings and power lines. Fences in the area do not appear to have had a detrimental effect on the Turam results generally.

Induced Polarisation (IP)

The IP work was done using Geoscience frequency domain equipment (transmitter type 5070, receiver type 5260). Measurements were made at frequencies of 10 and 0.3 c/s. The dipole-dipole configuration was used throughout with iron spikes as current electrodes. The reconnaissance traverses and all traverses in the Mona area except 700N and 800N were surveyed with a dipole length of 200 ft. Traverses 900N to 1500N in the Mona area were also surveyed with a dipole length of 100 ft.

Bad ground contacts frequently occurred, particularly on rocky sandstone outcrops, and a number of readings had to be repeated. Some interference was experienced from electrical systems when close to the Wattle Gully mine or houses, making it difficult to take readings in those areas, but reliable results could be obtained over the Mona anticline and on the reconnaissance traverses generally. The section of traverse A over the mine had to be surveyed when the mine was not working so that consistent results could be obtained. There are several grounded wire fences in the Mona area, but there is no definite evidence to suggest that they interferred with the IP measurements.

4. RESULTS AND INTERPRETATION

Mona area

Turam. The Turam results are characterised by numerous anomalies which lie along the strike; this is shown clearly in Plate 3, which shows contours of phase differences at 660 c/s. Phase difference anomalies are much larger than the corresponding ratio anomalies, indicating that their sources are weak conductors. The anomalies are probably caused by conducting shears, aligned roughly along the geological strike. Current concentrations are not deep, being probably within 100 ft of the surface. It is unlikely that the Turam anomalies indicate mineralisation directly.

Induced Polarisation. The anomaly associated with the Mona anticline outlined in the 1965 survey on traverse 700N (Williams, 1965) was relocated during the present survey on traverse A, which is the same traverse extended to the east and west. Using a 200-ft dipole length the anomalous zone was investigated to the north with traverses 200 ft apart and to the south with a traverse at 400N. Traverses could not be put in further south because of a tailings dump which was still in use.

The apparent resistivity pseudo-sections show the strong influence of near-surface effects. An important example of this occurs on most traverses, where all the apparent resistivities associated with a particular dipole are considerably lower than those on the rest of the traverse. Because of the geometry of plotting, this appears on the pseudo-section as narrow bands of low resistivity dipping at 45° east and west from the same point on the surface. The effect can be seen on traverses 900N and 1300N in Plate 5, and is caused by a zone of low resistivity which tends to shortcircuit a particular dipole. Resistivity patterns of this nature may have an undue influence on the metal factor and may detract from the value of the metal factor pseudo-sections for the purpose of the interpretation.

Frequency effect anomalies, however, are well-defined and the interpretation is largely based on them. The anomalous zone associated with the Mona anticline can be traced north from traverse 400N (Plate 4), and is strongest south of 1500N with frequency effect values up to 11½%. The anomalies decrease in strength towards the north, and are too weak to be recognised beyond 3100N.

The anomalies are most probably caused by pyrite mineralisation. By surveying traverses 900N to 1500N with a dipole length of 100 ft, more detailed anomalies were obtained over the mineralised zone. This allowed the position, in plan, of the top of the zone to be determined more accurately. By comparison with model tests (Hallof, 1967), the results indicate that the mineralisation does not reach the surface, and that the depth to the top of the zone is not more than 250 ft. The centres of the frequency effect anomalies with 200-ft dipole length are deeper and somewhat further east than those with a 100-ft dipole length on traverses 900N, 1300N, and 1500N, suggesting that the body causing the anomaly is tabular in shape and has an easterly dip. The mineralisation would thus occur in the western limb of the anticline and may be an aureole surrounding a strike fault which dips east at an angle which, by geological considerations, could be as low as 45°. The anomalies are generally very close to the Mona anticline axis and it is not unlikely that the fault carries a quartz reef which could develop into a saddle reef at depth.

It is impossible to determine from the geophysical results whether such a quartz reef would be auriferous, but the presence of pyrite, which is indicated here, is associated with gold occurrence elsewhere in the goldfield.

Although the geological structure is not clear, evidence from the geological map (Plate 2) and from the section published by Thomas (1953) suggests that the Wattle Gully slates may rise to within 200 ft of the surface in the Mona anticline. It is possible that the postulated fault cuts the slates at about that depth giving conditions for gold concentration similar to those in the Wattle Gully mine. However, it is suggested by K. Bowen (pers. comm.) that in fact the Wattle Gully slates are rather deeper, between 400 and 600 ft below the surface.

If a depth to the current concentration of 100 ft is assigned to the source of the Turam anomaly which lies at about 1400W between traverses 400N and 1700N, then the anomaly could be caused by the fault which was inferred from the IP results (Plate 5); the anomaly itself is not inconsistent with that due to a conductor dipping at 45° away from the transmitting loop.

A general pitch to the north may be assumed for the Mona anticline similar to that elsewhere in the goldfield. Because the Turam anomaly tends to approach the anticlinal axis in the north of the area, it can be inferred that the fault is there affecting beds higher in the sequence. If these beds are less favourable for the concentration of mineralisation then the diminution in the size of the mineralised zone and the consequently weaker IP anomaly are accounted for.

Reconnaissance traverses

The location of the reconnaissance traverses and associated anomalies is shown in Plate 1, and the IP pseudo-sections are shown in Plates 6, 7, and 8. Anomalies occur on all traverses and the results will be discussed separately for each axial line.

Eureka line. Traverse A crosses the anticline at about 3900W, 100 ft north of the Eureka and Vineyard shaft. A weak anomaly occurs over the axis with a depth to the source of about 200 ft. The reef itself is a saddle reef with a fissure reef developed above it, and is a northern continuation of the Eureka reef. Although this reef was worked for nearly three miles along its length, it was not worked below 200 ft in the Eureka and Vineyard mine. The IP results also show a very weak anomaly east of the axis, and mineralisation could continue to depth on that leg of the saddle.

Deadmans line. A definite anomaly to the east of the anticlinal axis occurs on traverse A at 2200W and on traverse 400N at 2100W. Both anomalies have frequency effects above 6%, and the anomaly on traverse A appears to have a deeper source consistent with an inferred northerly pitch. Deadmans reef was in the form of a stockwork and was mined by open cut. The source of the present anomaly is however between 200 and 300 ft deep in the eastern limb of the anticline, and may be a Wattle Gully type of formation. It is possible that the Wattle Gully slates occur at about the anomaly source, but geological considerations indicate that they may be considerably deeper.

The anticline dies out to the south and is replaced by another anticline east of the Irish line, which crosses traverse B at about 900W. A weak anomaly with a shallow source occurs west of the axis on this traverse but it is not considered to be related to the Deadmans anomalies.

Mona line. The anomalies close to the Mona reef were discussed in a previous section, but the anticline may continue south as far as traverse B, where the crest of an anticline is located at about 200E. A strong anomaly occurs to the west of this axis but is distorted by unreliable frequency effect readings. The top of the anomaly source is fairly shallow (less than 200 ft), but depth extent is difficult to determine. The source lies below the Bullock reef which was spurry at the surface, with large bodies of quartz occurring at depths of 100 ft or more. The reef, probably a fissure reef, dipped to the east, was rich in gold, and was associated with galena and pyrite mineralisation. Although a shaft was sunk to 300 ft, most of the gold was obtained between 80 and 140 ft.

The anticline is probably very small on traverse C, and the results show a broad shallow anomaly between it and the Daphne and West Wattle Gully line to the east.

Daphne and West Wattle Gully line. The eastern ends of the traverses in the Mona area show anomalous frequency effects, which may be caused by interference from houses and their electrical systems, but which are more probably caused by mineralisation. The anomalous region is crossed by traverse 2500N at about 600W where it is shallow and ill defined, and on traverse A at about 500W where its source appears to have considerable depth extent and may approach to within 200 ft of the surface. The source is in the western limb of the anticline and is interpreted as a mineralised strike fault similar to that suggested to account for the results in the Mona area. There appears to be no IP anomaly on traverse A that could be definitely attributed to the Wattle Gully reef, which occurs in the eastern limb of the anticline. The reef is considered to be too deep, the depth to the top being more than 500 ft. Any small effects caused by the reef would be masked by the adjacent strong anomalies.

No anomaly occurs on this anticline on traverse B, but a vague frequency effect indication occurs on traverse C at about 4500W; it is shallow and merges with that to the west. The Daphne mine was located on a small saddle reef close to the surface about 200 ft north of traverse C at this point, but does not appear to have been a major gold producer.

Blacksmith Gully, Specimen Hill and Chewton line. On traverse A a strong anomaly is located west of the axis at 500E with a depth to the source of about 250 ft, and is interpreted as another east-dipping mineralised shear, which intersects the Wattle Gully slates at a depth of about 300 ft. The Phillips reef, which was highly auriferous, outcrops at 300E, dips west to a depth of about 200 ft, and probably contributes in part to the anomaly.

A comparable anomaly occurs at 1300E in the eastern limb of the anticline, 500 ft from the axis, close to a small syncline. A mineralised fault or fissure reef is indicated.

The anticline contained several broad saddle reefs at different depths, such as the German reef at about 300 ft, and Priors reef at the surface. The latter was the remains of the west leg of a saddle reef and consisted of a fine ferruginous vein system in sandstone. The high frequency effects close to the axis are probably caused by mineralisation associated with these reefs.

On traverse C a weak anomaly at 3600W has a shallow source in the western limb of the anticline, but a deeper source gives rise to a separate anomaly east of the axis, with a zone of high frequency effects extending to the next anticline to the east. These anomalies occur about 1000 ft south of Specimen Hill where large quantitites of gold were mined from a great system of saddle reefs close to the surface.

New Era line. An anticline of low amplitude occurs on this line which dies out 1000 ft south of traverse C. On traverse C itself a minor anomaly arising from a deep source occurs at 2300W, east of the axis, but a source close to the surface about 400 ft to the west tends to distort it.

Traverse A shows anomalies arising from close to the surface between 1500E and 2000E, but their relation to the anticline is not clear.

White Horse line. Traverse A crosses the White Horse reef at about 2400E and shows an anomaly at the axis of the anticline caused by a deep source, with an anomaly rising from a shallower source to the west extending to the New Era line. The White Horse reef itself consisted of large, flat-lying bodies of quartz which presumably represented the west leg of a saddle reef, and was worked to a depth of about 200 ft. The IP results suggest a second major mineralised saddle at a depth of about 400 ft.

Traverse C crosses the line at 1500W and shows an anomaly with a deep source close to the anticlinal axis, but with high frequency effects arising from sources near the surface to the east and west. The anomaly suggests the presence of saddle or fissure reefs at a depth of about 300 ft.

Burns Hill and Nimrod line. Traverse A crosses this line at about 3800E and shows an ill-defined zone of anomalous frequency effects which appear to arise from a source at depth to the east of the axis and a source closer to the surface west of the axis.

5. CONCLUSIONS AND RECOMMENDATIONS

Mona area

The induced polarisation results indicate the presence of an anomalous zone west of and parallel to the Mona anticline. This is interpreted as being caused by a mineralised aureole surrounding a strike fault which dips to the east. The conditions are considered favourable to the formation of a quartz reef which could be auriferous. Two drill holes are recommended to test the geophysical indications and are set out below

Hole	Collar	Inclination	Direction	Target Position	Target Depth	Length
DDH1	1300N/ 1040W	60°	Grid W	1300N/ 1250W	350ft	550ft
DDH2	900N/ 1060W	60°	Grid W	900W/ 1220W	350ft	550ft

The location of the drill holes is shown in plan in Plate 4 and in section with the relevant geophysical results in Plate 5.

Reconnaissance traverses

The IP results on the reconnaissance traverses show many anomalies throughout the goldfield, several of which may be attributed to mineralised strike faults.

The anomalies on traverse A between Deadmans reef and the New Era line are of particular interest, because they are all well-defined and they all possibly occur in close association with the Wattle Gully slates. The area between the Blacksmith Gully, Specimen Hill, and Chewton line and the Daphne and West Wattle Gully line has been heavily mined for reef gold in the past on both saddle reefs and fault reefs. If the IP results have been interpreted correctly, further gold bearing reefs are indicated immediately to the east and west, particularly under the Mona and Deadmans reefs, neither of which has been explored at depth.

IP anomalies of varying strength occur over all known auriferous reefs. If encouraging results are obtained from drilling the anomaly in the Mona anticline, then the IP method could be used to delineate equally promising drilling targets elsewhere in the goldfield.

6. REFERENCES

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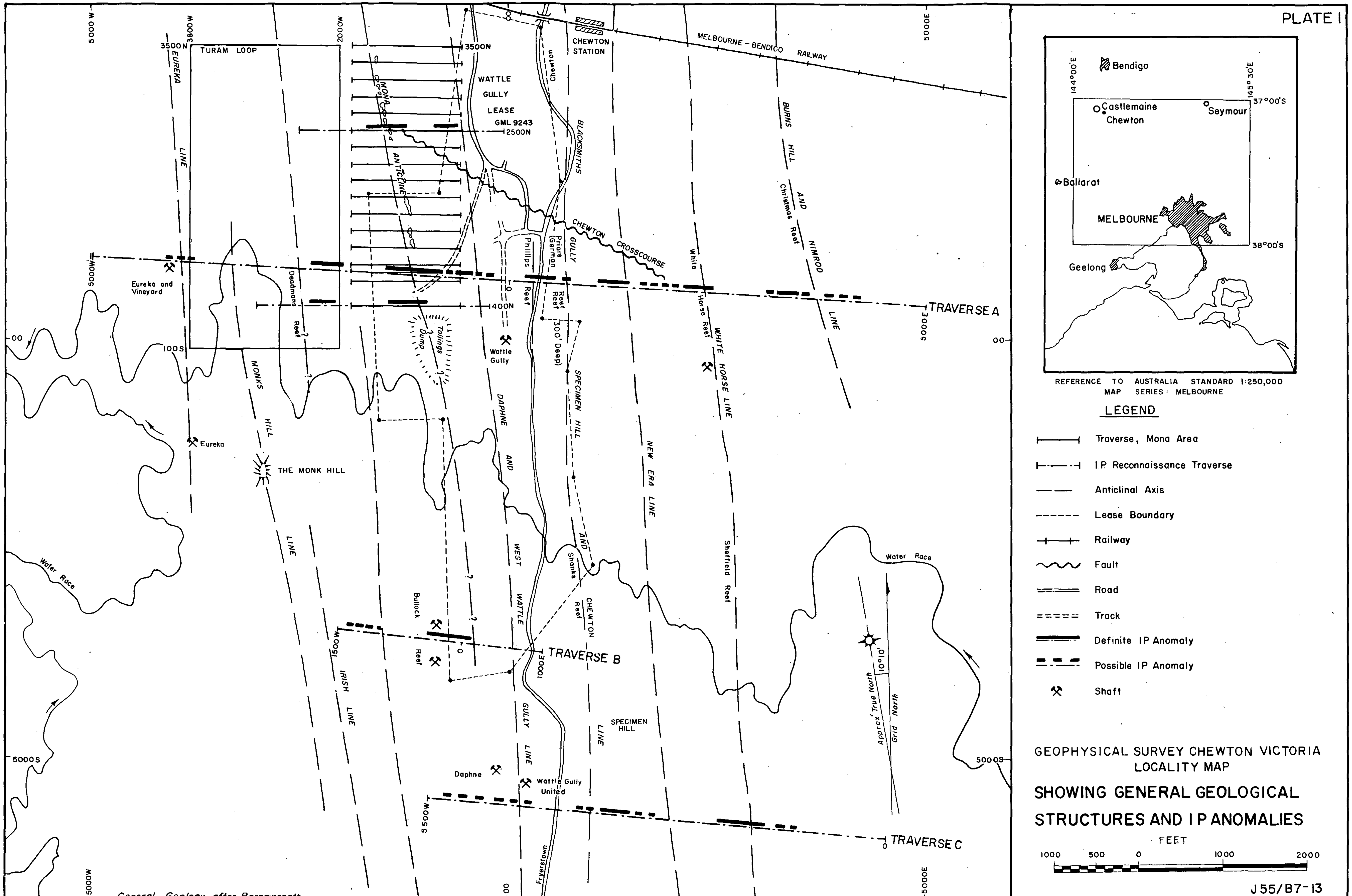


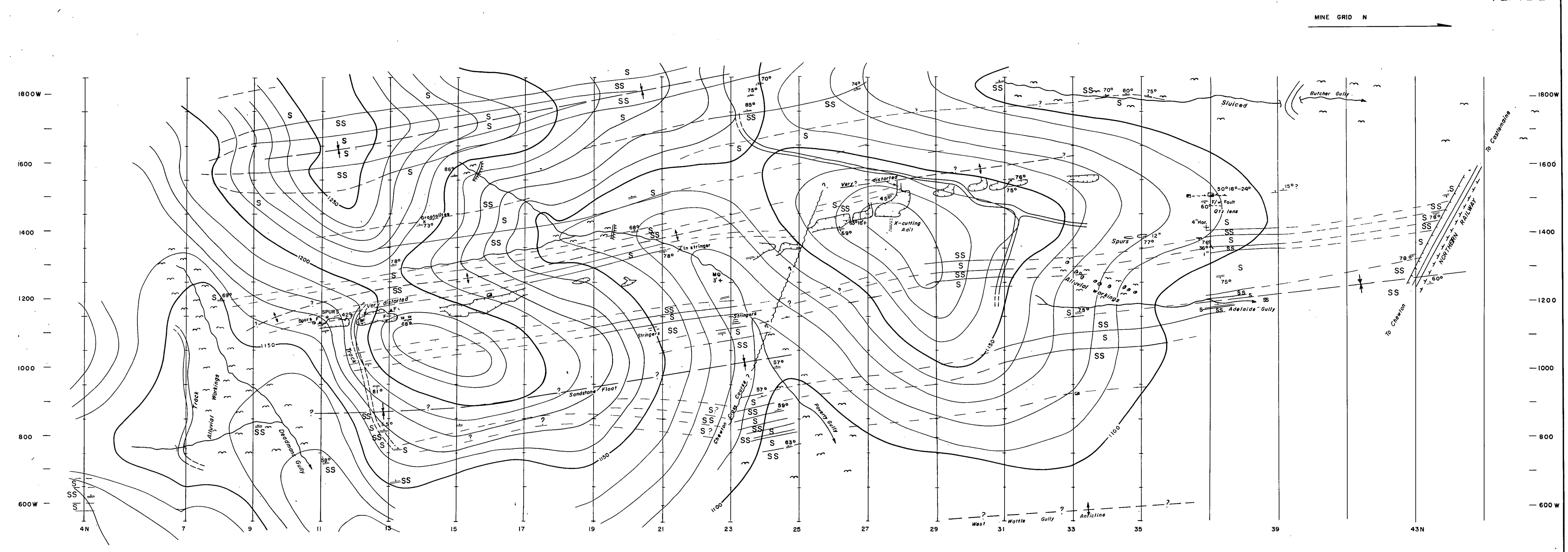
GEOPHYSICAL SURVEY CHEWTON VICTORIA
LOCALITY MAP

SHOWING GENERAL GEOLOGICAL STRUCTURES AND I P ANOMALIES

J55/B7-13

TO ACCOMPANY RECORD No 1968/77

PLATE 2



LEGEND

- 1150 — Topographic Contours
- — Alluvium
- S — Slates & Shales
- SS — Sandstone
- — Surface Workings
- — Shaft

FEET

200 100 0 200 400 600

MONA GRID

SURFACE GEOLOGY

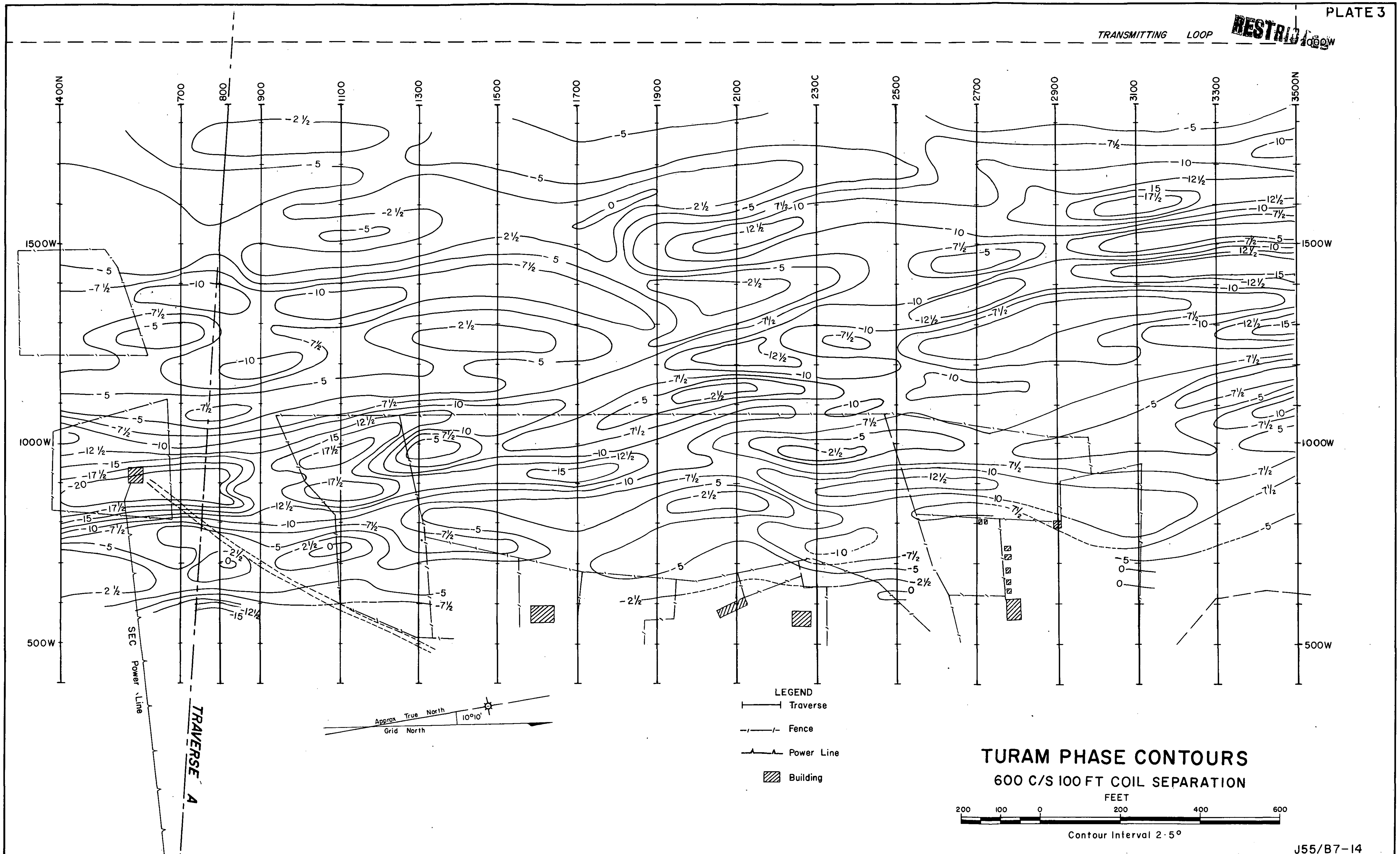
GEOLOGY AFTER C LAYDEN

(SUPPLIED BY WATTLE GULLY GOLD MINES N L)

J55/B7-9

TO ACCOMPANY RECORD No 1968/77

CHEWTON VICTORIA. 1967

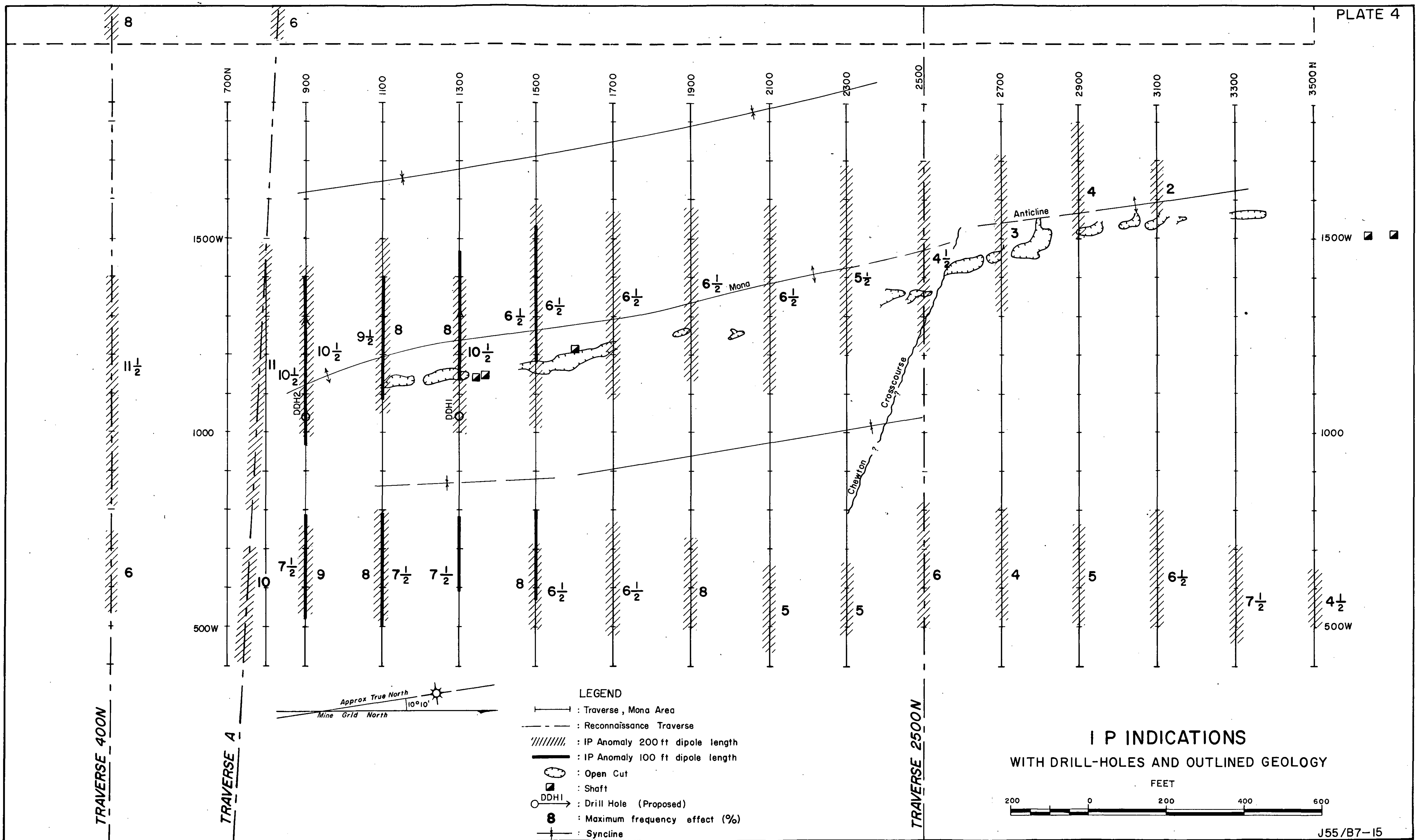


TURAM PHASE CONTOURS

600 C/S 100 FT COIL SEPARATION

J55/B7-14

TO ACCOMPANY RECORD No 1968/77



I P INDICATIONS

WITH DRILL-HOLES AND OUTLINED GEOLOGY

J55/B7-15

TO ACCOMPANY RECORD No 1968/77

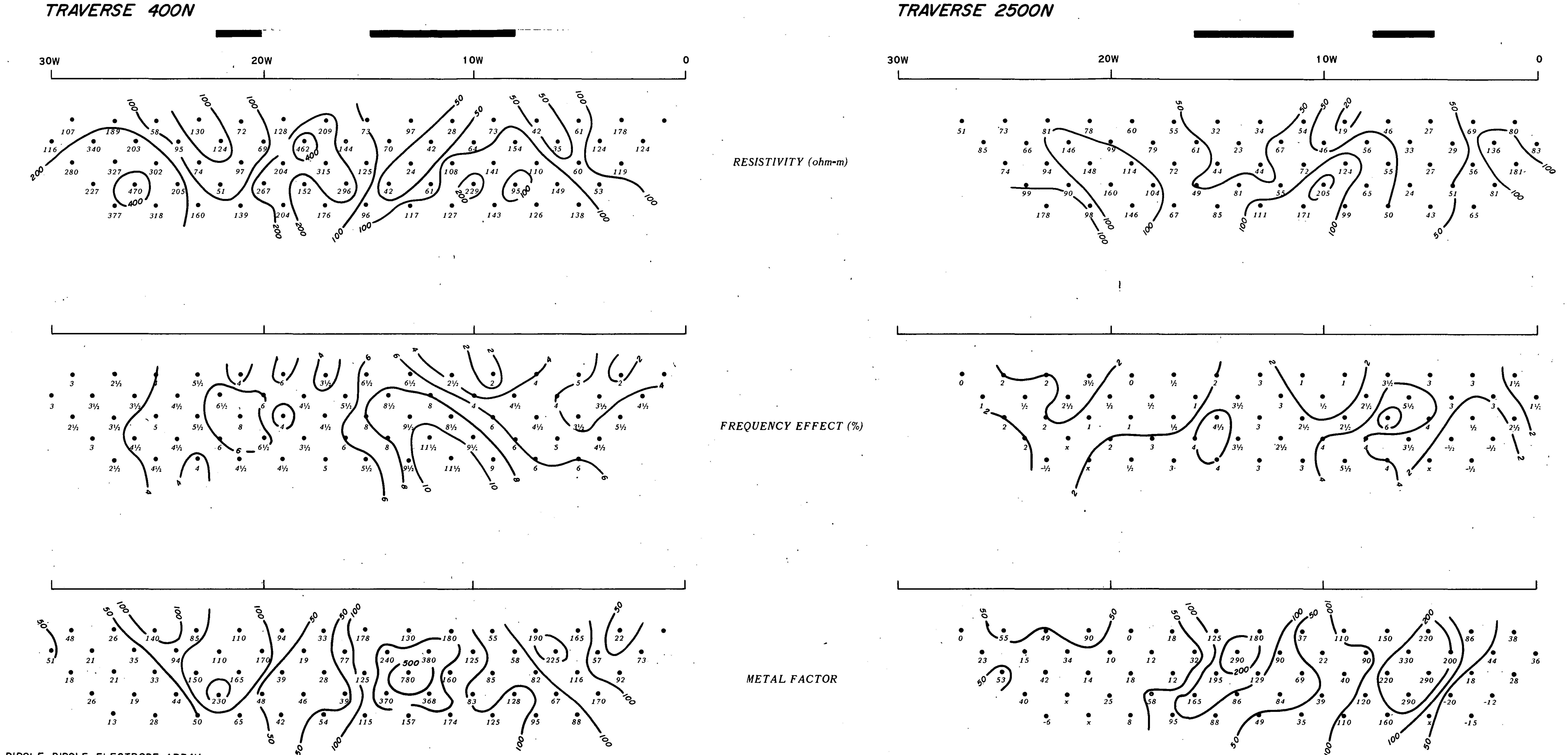
RESTRICTED

DRILLING RECOMMENDATIONS
WITH GEOPHYSICAL PROFILES

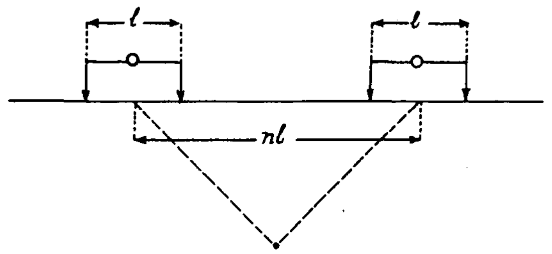
J55/B7-16

TO ACCOMPANY RECORD No 1968/77

PLATE 6



DIPOLE-DIPOLE ELECTRODE ARRAY



ℓ Dipole length; ℓ = 200ft
o IP transmitter or receiver
⊥ Electrode
· Plotted position of reading; n = 2,3,4.....

▬ Definite IP Anomaly

IP RESULTS
RECONNAISSANCE TRAVERSES 400N AND 2500N

FEET
400 200 0 400 800 1200 1600

J55/B7-12

TO ACCOMPANY RECORD No 1968/77

TO ACCOMPANY RECORD No 1968/77

CHEWTON VIC. 1967