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RESULTS OF

A MAX-MIN (Horizontal Loop) EM SURVEY

over the

RIO TINTO 'EASTERN' ANOMALY,

EAST TYNDALL AREA

for

THE MT. LYELL MINING AND RAILWAY COMPANY LTD.

by

Dr. J.R. BISHOP

ML/MG81/05

March, 1981



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SUMMARY

A Horizontal Loop EM system (trade name Max-Min) was used to locate, and if possible, better define the Rio Tinto 'Eastern' anomaly. This anomaly resulted from a Turam survey of the area carried out by Rio Tinto in 1958. The Max-Min survey covered the eastern portions of the Mt. Lyell grid, lines 22N to 26N (incl.). A coil separation of 150m. was used with a station interval of 50ft. (15m.). The work was carried out by Geoterrex Pty. Ltd. on 30th and 31st January 1981.

The Turam anomaly was located (Figure 1), however the Max-Min anomalies were weak and poorly defined. Evaluation of the Turam results (Bishop 1981a) suggested that the faulted contact between the Owen Conglomerate and the Tyndall Group rocks to the west may have been the cause of the anomaly. However, the Max-Min results do not coincide with the interpreted position of the fault (Figure 2) and it is suggested that conductive ground conditions (moraine cover) caused the response. It is postulated that the strong Turam response was caused by using an earth return current (grounded loop) whereby the galvanic current (i.e. not an induced current) concentrated in the surface conductors and possibly the fault.

The Max-Min system appeared to be well suited to the environment of Mt. Lyell's exploration licences; previous EM (and IP) surveys have shown that the rocks are generally resistive and thus good hosts for EM targets. A more thorough examination of the Max-Min's performance and suitability is given by Bishop 1981b.

The discouraging results of the Max-Min survey and the lack of any other supporting evidence, geochemical or geological, lead to a recommendation that no further effort be made to explore the Rio Tinto 'Eastern' anomaly.

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AIMS AND METHOD

It was desired to both locate and test a Turam anomaly defined by Rio Tinto in 1958. The anomaly is referred to as the 'Eastern' anomaly and is located in the Howard area on the eastern edge of Mt. Lyell's East Tyndall grid. It was decided to use an EM survey since this would best locate the anomaly and it was also expected that a more detailed and extensive survey using modern equipment would permit a more meaningful interpretation than was possible with the Turam results.

It was decided to use a horizontal loop system operating under the trade name of Max-Min. The equipment was manufactured by Apex Ltd. (Canada) and was operated by Geoterrex Pty. Ltd. The name Max-Min refers to the possible coil configurations: maximum coupled (horizontal, co-planar), which is also called the Horizontal Loop configuration (or 'Slingram' after the original system using this method); alternatively the receiving coil can be held so that the transmitting and receiving coils are minimum coupled (not normally used). The system has five frequencies; 222, 444, 888, 1777 and 3555 Hz. The transmitting and receiving coils are connected by a reference cable and results are measured as in-phase and out-of-phase signals expressed as a per cent of the primary field.

Various coil spacings were tried (50m., 103 and 150m. - see Figure 4) and it was found that 150m. gave the most responsive results. This spacing was then used over all five lines. At least two frequencies were measured on each line, but on all lines the highest frequency (3555 Hz) was recorded since this gave the best response.

The horizontal loop system is very sensitive to the geometry of the two coils and in-the-field corrections are applied for slope variations. To reduce errors due to separation variations, the profiles should be surveyed into equal horizontal station intervals. If this is not done (as is the case for all of Mt. Lyell's grids), the in-phase response will change rapidly with only small changes of distance. (The out-of-phase response is not affected.) (Tests for change of response with variation in tilt and distance were made and these are reported in Bishop, 1981b in which the method's suitability for ground follow-up of Dighem anomalies is evaluated.) In this survey, the spacing between the coils was monitored



by the cable length joining the coils (the errors associated with this method are discussed in the Results). The transmitter was placed at the 100ft. spaced pegs and at 50 ft. intermediate stations (i.e. the survey used a 50 ft. (15m.) station interval). The results were plotted midway between the two coils.

RESULTS AND CONCLUSIONS

The Max-Min anomalies are very weak and poorly defined, particularly when compared with the strong Turam anomalies from the Rio Tinto survey. This difference is not considered to be due to any shortcomings in the Max-Min system but rather to the differences in the geometries of the two systems and in the way the EM fields are applied. This point is further discussed below.

The results of the survey are presented in profile form in Figures 5 to 9. The horizontal scale is 1:2000 and the in- and out-of-phase responses are plotted at 1cm. = 5%. The survey coverage is listed below:

- line 22N; 888 and 3555 Hz were recorded from 250E to 1700E.
- line 23N; 222, 888 and 3555 Hz were recorded from 250E to 1100E.
- line 24N; 444, 888, 1777 and 3555 Hz were recorded from 250E to 950E.
- line 25N; 888 and 3555 Hz were recorded from 250E to 1100E.
- line 26N; 888 and 3555 Hz were recorded from 250E to 900E.

On all lines, the amplitude of the signal increases with increasing frequency and the quadrature* channel is the most responsive. Such behaviour is consistent with the response to a conductive overburden. Despite the poor response, Figures 1 and 2 show that a definite anomalous zone has been found and that the Rio Tinto anomaly has been located.

Figure 1 gives the highest frequency (3555 Hz) quadrature results in contour form and this is compared with the 2⁰ phase contour of the Turam survey. It can be seen that the Max-Min results define a north-south

* In common use in the geophysical literature are the equivalent words out-of-phase, imaginary and quadrature; and in-phase and real.



striking anomaly which parallels and closely matches the Rio Tinto 'Eastern' anomaly (the most negative values should coincide with the Turam results). Part of the discrepancy in position may be due to inaccuracies in the plotted positions of the Rio Tinto and Mt. Lyell grids. It may also be due in part to the two systems responding to different parts of a conductor(s).

Figure 2 shows the same Max-Min results in profile form and these are compared with the interpreted position of the faulted contact between the Owen Conglomerate and the Tyndall Group rocks. The type response for a Max-Min type EM system traverse over a thin vertical sheet is shown in Figure 3. For a vertical body, the curves would be symmetric. The profiles in Figure 2 show that while some lines have been insufficiently sampled to show the 'shoulders' of the anomaly (either to the west because of power lines, or to the east because of uncut survey lines), a minimum is defined on each line. With the possible exception of line 22N, this does not coincide with the interpreted position of the fault (interpretation by P. Komysan, geologist responsible for this area) and it is suggested that the response is due, at least in part, to conductive layers within the moraine which overlies much of the survey area (see Bishop, 1981a).

The Turam anomaly is strong (maximum phase difference of 7° and ratio 1.5) and though poorly sampled (every 100 ft.), is sharply defined. The energising field for this survey used an earth return, i.e. a single wire was laid out with grounded electrodes at each end. It is postulated that the earth return current concentrated within the surface conductors and possibly the fault, giving rise to strong anomalies as the receiving coils traversed over the current concentration (the Turam system is capable of good depth penetration and is not very sensitive to topographic effects). A ground return current may be used to enhance anomalies due to poor conductors, however this example illustrates the pitfalls of such a practice.

The Max-Min response is largely out-of-phase which suggests a very poor conductor. The increase in amplitude with increase in separation (Figure 4) is consistent with a response from a surface conductor. Horizontal



loop methods are sensitive to changes in distance between the loops and since the connecting cable was used to control this separation, changes occurred at breaks in slope. These 'separation anomalies' may be seen as gradual increases in the in-phase response on the eastern side of the profiles. It is particularly evident on lines 23N and 24N on all frequencies. The out-of-phase response is not affected.

Like the Turam method, results from Horizontal Loop surveys may be quantitatively interpreted, however the anomalies from this survey are too poor to give any meaningful results. Further, in the absence of an interesting target, the work is not warranted.

RECOMMENDATIONS

The Max-Min system allows good progress through cleared lines in typical West Coast terrain. Whilst it is not yet clear that it is capable of responding to weak anomalies hitherto only detected by operationally more cumbersome systems such as SIROTEM, it is certainly an advance for frequency domain EM and appears well suited for use in Tasmania.

The Max-Min survey showed that there was no conductor at the foot of the Tyndall Range in the Howard area as was suggested by an earlier (1958) Turam survey. From the results of this survey, over rock types considered to be of low prospectiveness, and in conjunction with the lack of any geochemical anomalies, it is recommended that the Rio Tinto 'Eastern' Turam anomaly be no further explored.

J.R. Bishop
March, 1981

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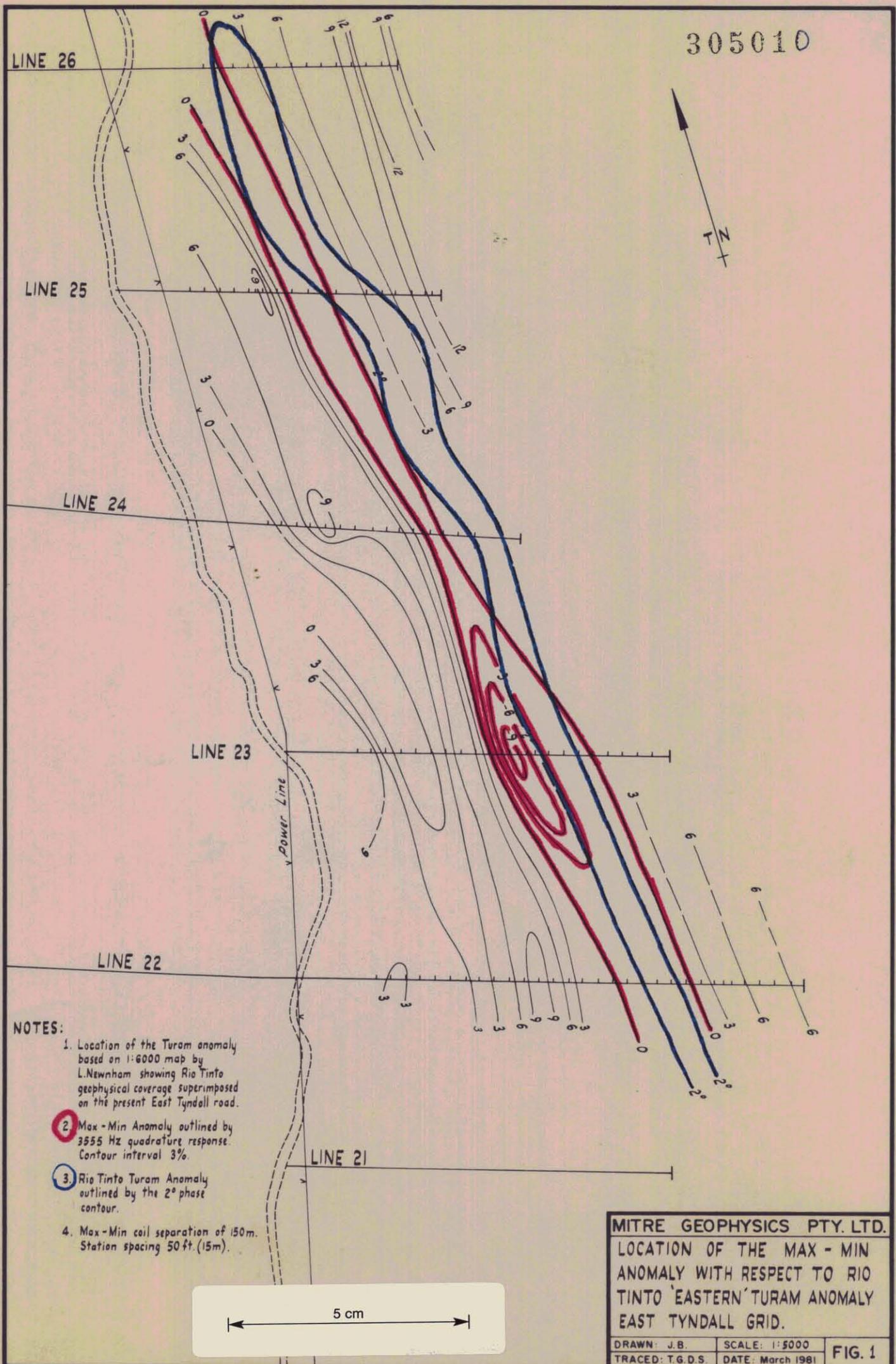
REFERENCES

BISHOP, J.R., 1981a. An evaluation of the Rio Tinto 'Eastern' Turam Anomaly, East Tyndall Area. Mitre Geophysics report for Mt. Lyell.

BISHOP, J.R., 1981b. EM methods for ground follow-up of Dighem anomalies. Mitre Geophysics report for EZ and Mt. Lyell.

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305010



NOTES:

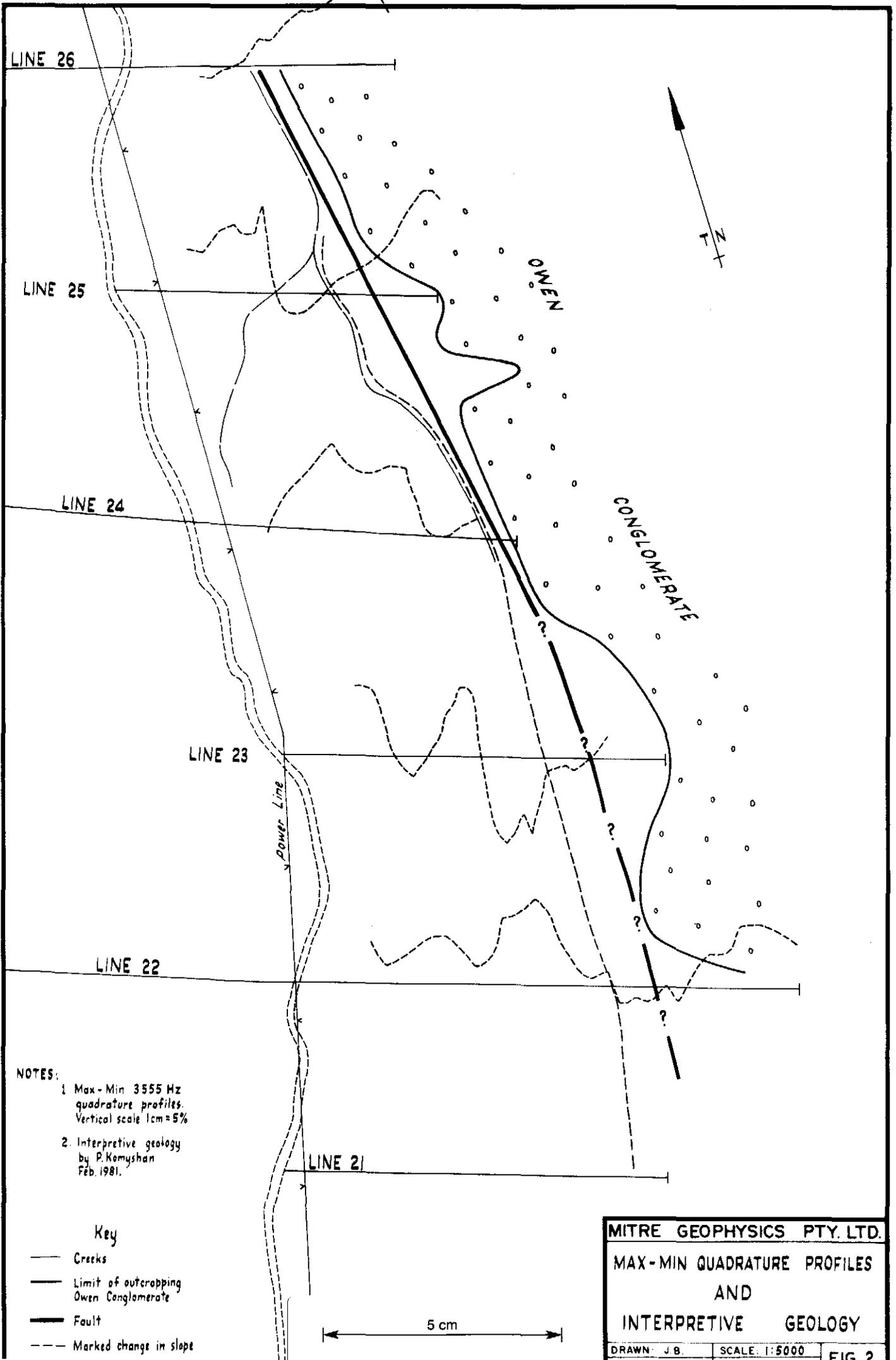
1. Location of the Turam anomaly based on 1:6000 map by L. Newnham showing Rio Tinto geophysical coverage superimposed on the present East Tyndall road.
2. Max - Min Anomaly outlined by 3555 Hz quadrature response. Contour interval 3%.
3. Rio Tinto Turam Anomaly outlined by the 2° phase contour.
4. Max - Min coil separation of 150m. Station spacing 50 ft. (15m).

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LOCATION OF THE MAX - MIN ANOMALY WITH RESPECT TO RIO TINTO 'EASTERN' TURAM ANOMALY EAST TYNDALL GRID.

DRAWN: J.B. SCALE: 1:5000
TRACED: T.G.D.S. DATE: March 1981

FIG. 1



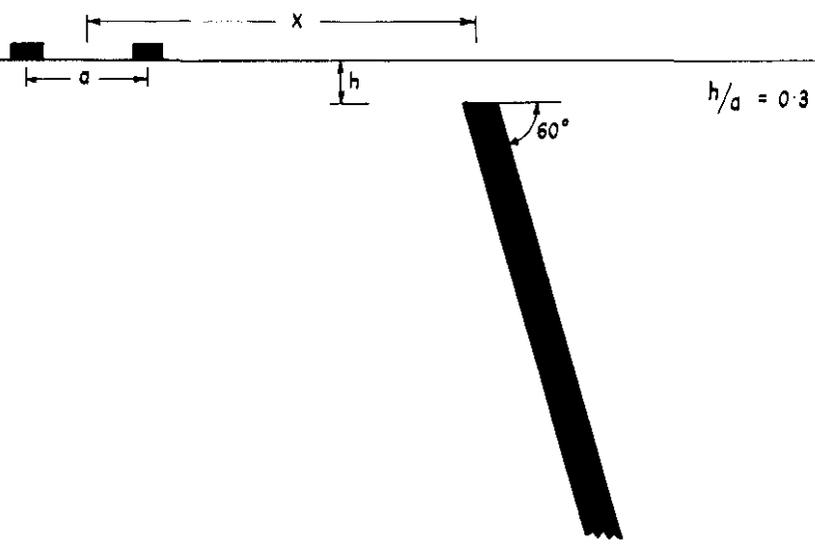
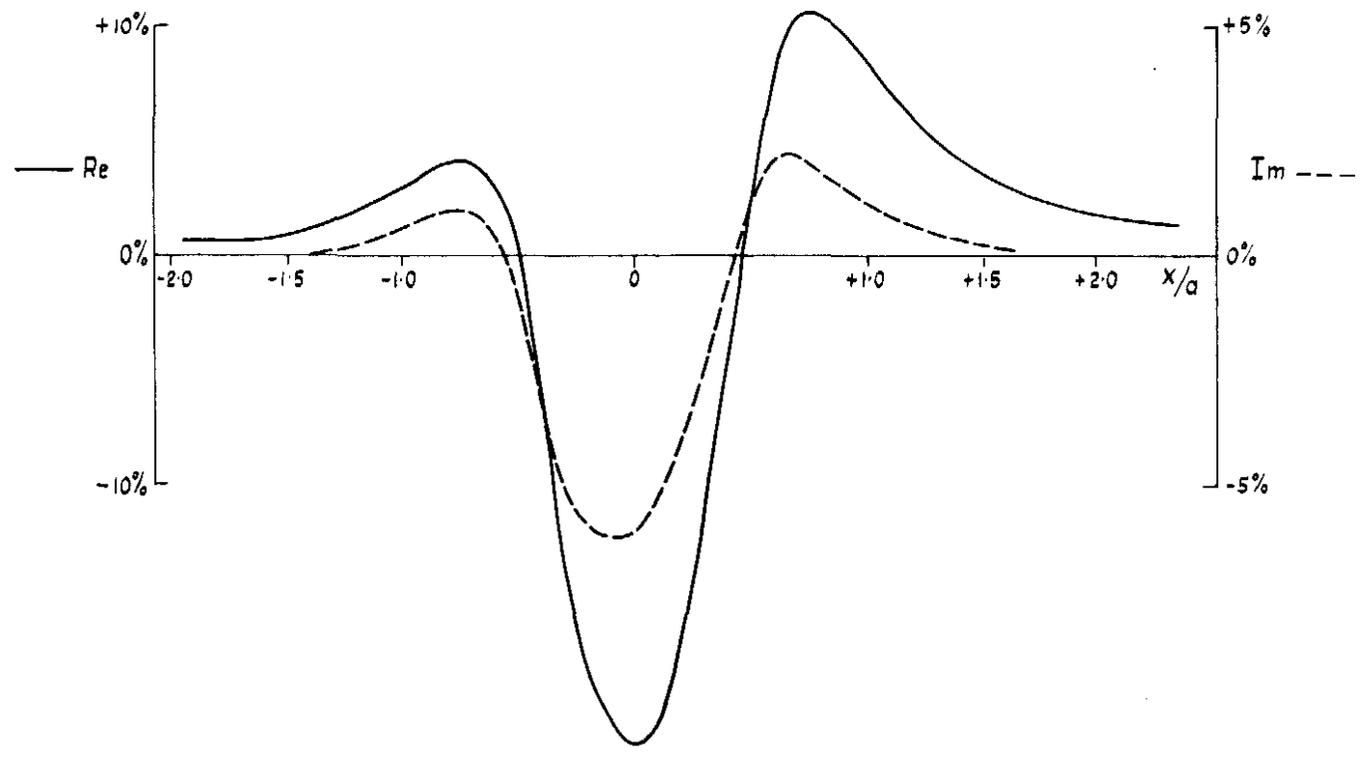
NOTES:
 1 Max-Min 3555 Hz quadrature profiles. Vertical scale 1cm=5%
 2. Interpretive geology by P. Komysan Feb. 1981.

- Key
- Creeks
 - Limit of outcropping Owen Conglomerate
 - Fault
 - - - Marked change in slope

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MAX-MIN QUADRATURE PROFILES AND INTERPRETIVE GEOLOGY	
DRAWN: J.B.	SCALE: 1:5000
TRACED: T.G.D.S.	DATE: March 1981

FIG. 2

011



NOTES: Results from a model experiment using a good conductor (zinc) in an insulating host (air).
 frequency = 3600 Hz.
 model parameters
 $\theta \mu \omega \alpha \delta = 29.7$
 $\alpha = 10 \text{ cm}$
 $\delta = 0.82 \text{ mm}$
 $\theta = 12.76 \times 10^6 \text{ mho/m}$

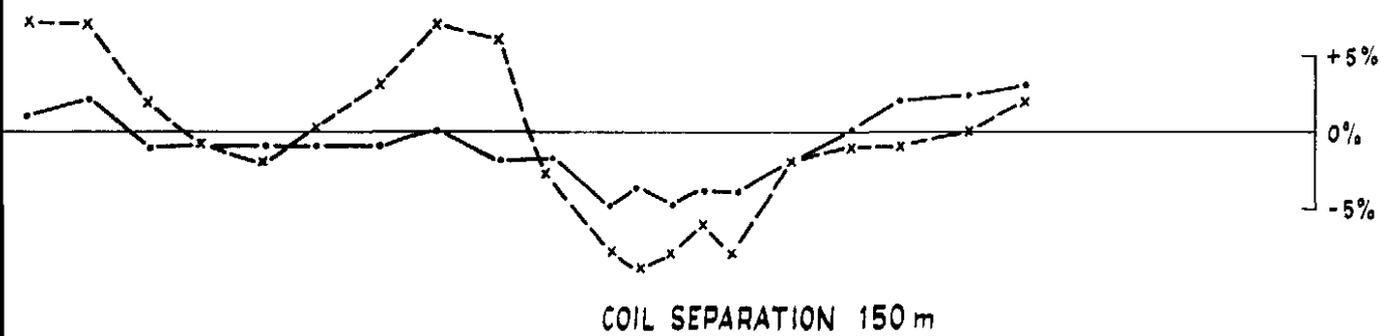
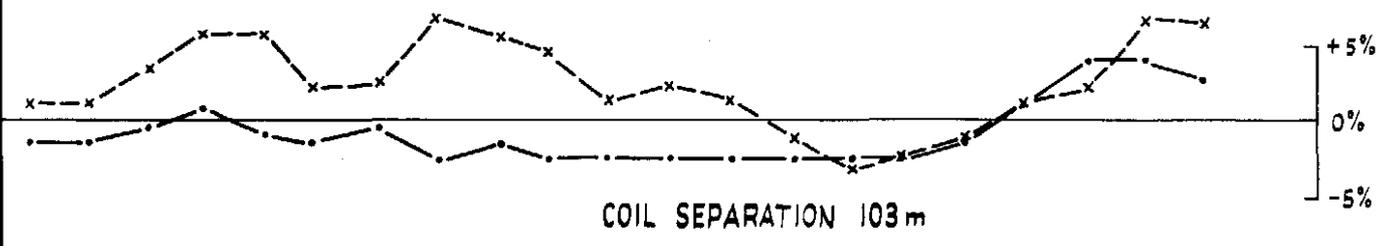
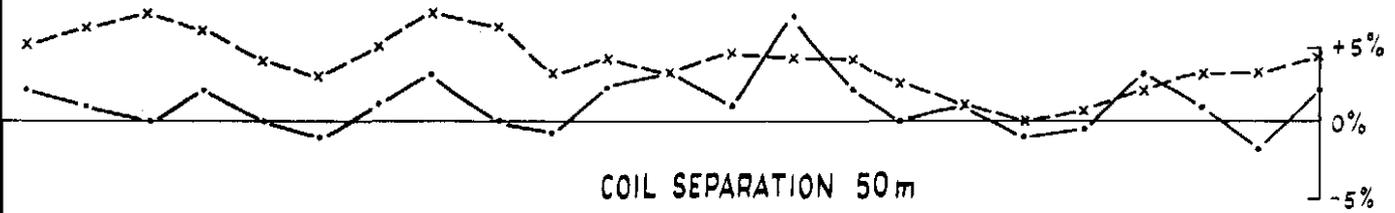
MITRE GEOPHYSICS PTY. LTD.

HORIZONTAL LOOP E.M. RESPONSE
 OVER A STEEPLY DIPPING CONDUCTOR

DRAWN: J.B. SCALE: TRACED: T.G.D.S. DATE: March 1981 FIG. 3

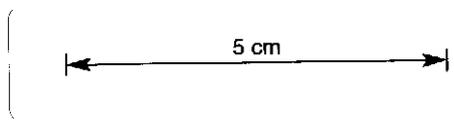
012

FREQUENCY 3555 Hz



300 E. 400 E. 500 E. 600 E. 700 E. 800 E. 900 E. 1000 E. 1100 E. 1200 E. 1300 E.

NOTE: Max-Min survey over Rio Tinto
 'Eastern' Turam anomaly,
 Howards area, East Tyndall.



MITRE GEOPHYSICS PTY. LTD.	
Horizontal loop E.M. Survey	
LINE 23 N.	
Coil spacings of 50m, 103m & 150m.	
DRAWN: J.B.	SCALE: 1:2000
TRACED T.G.D.S.	DATE March 1981

FIG. 4

013

FREQUENCY

+5%
0% 222 Hz
-5%

+5%
0% 444 Hz
-5%

+5%
0% 888 Hz
-5%

+5%
0% 1777 Hz
-5%

+5%
0% 3555 Hz
-5%

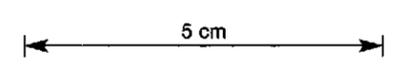
KEY

—•— In-phase

x—x Out-of-phase

NOTES:

- 1 Survey by Geoterrex Pty. Ltd 30-31 Jan. 1981.
- 2 Coil separation 150m.
- 3 Station spacing 50ft. (15m).



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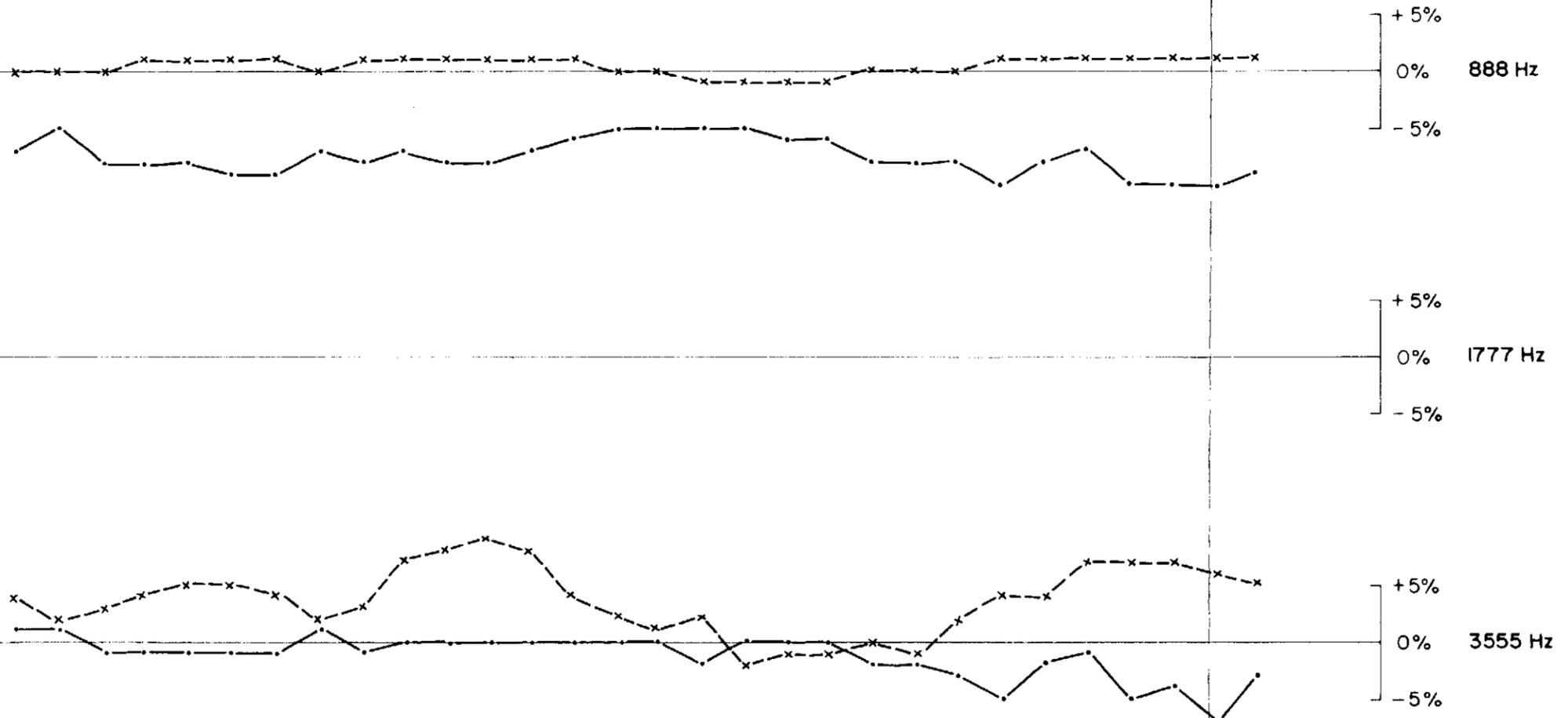
MITRE GEOPHYSICS PTY. LTD.

EAST TYNDALL GRID
Horizontal loop (Max.- Min.)
E.M. Survey
LINE 22 N.

DRAWN: J.B. SCALE: 1:2000
TRACED T.G.S. DATE: March 1981

FIG. 5

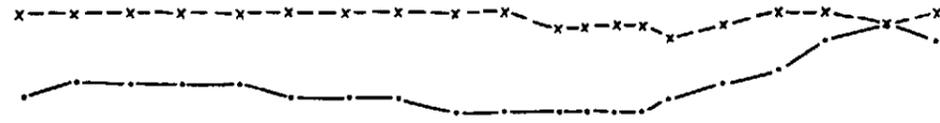
0 100E. 200E. 300E. 400E. 500E. 600E. 700E. 800E. 900E. 1000E. 1100E. 1200E. 1300E. 1400E. 1500E. 1600E. 1700E. feet



014

FREQUENCY

+5%
0% 222 Hz
-5%



+5%
0% 444 Hz
-5%



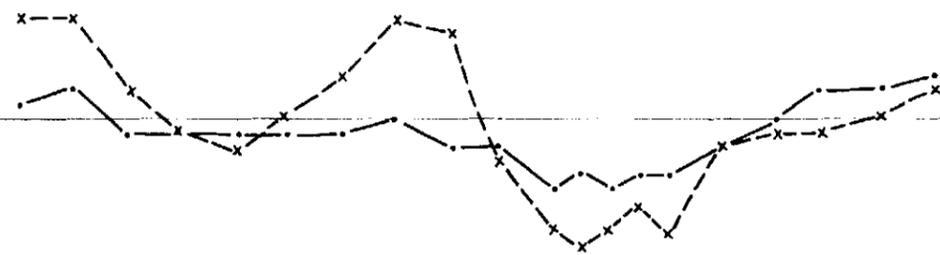
+5%
0% 888 Hz
-5%



+5%
0% 1777 Hz
-5%



+5%
0% 3555 Hz
-5%



KEY
 ····· In - phase
 x---x Out - of - phase

NOTES
 1 Survey by Geoterrex Pty Ltd
 30-31 Jan 1981.
 2 Coil separation 150m
 3 Station spacing 50ft (15m).

5 cm

0 100E 200E 300E 400E 500E 600E 700E 800E 900E 1000E 1100E feet

305015

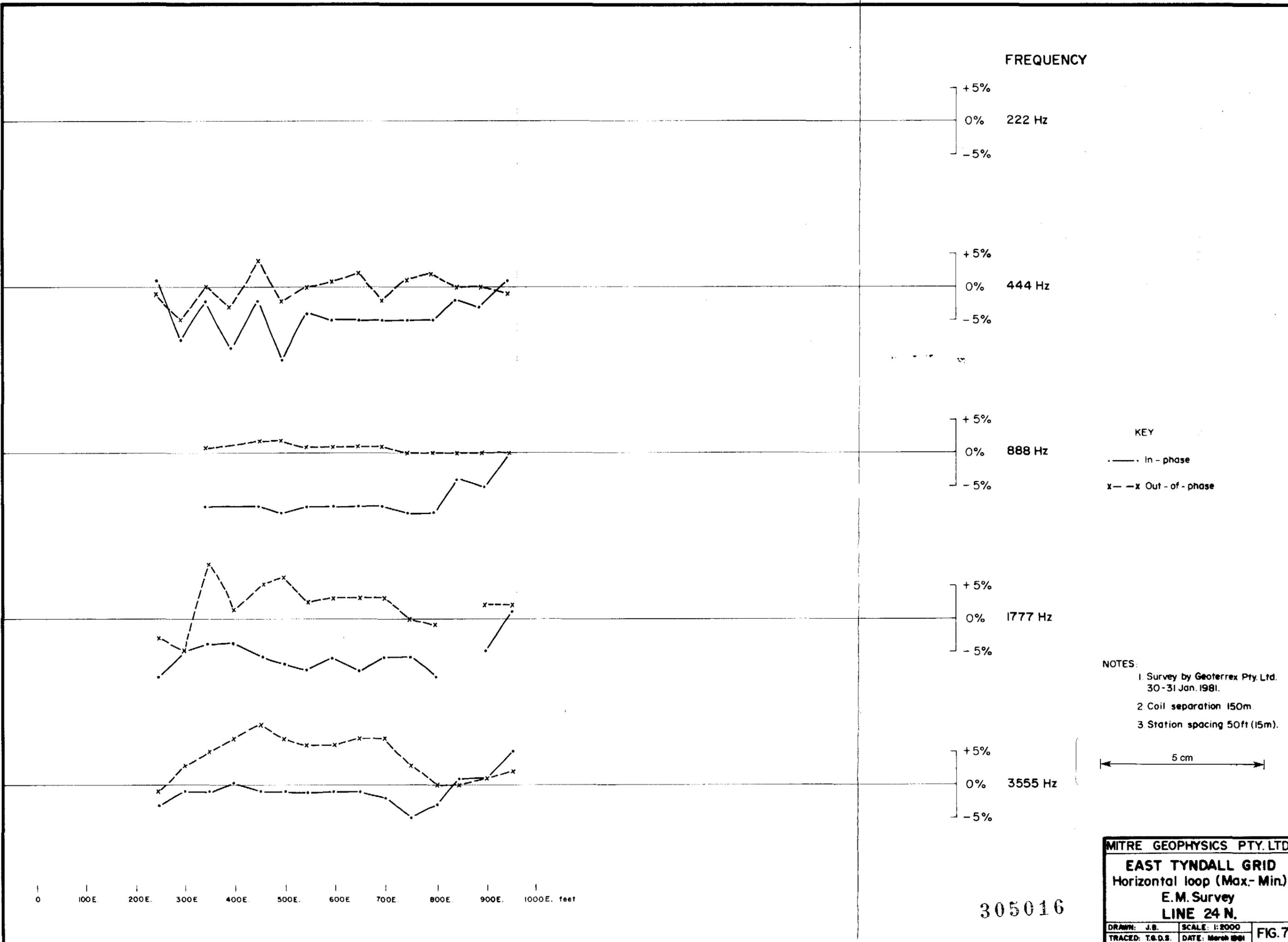
MITRE GEOPHYSICS PTY. LTD.

EAST TYNDALL GRID
 Horizontal loop (Max.- Min.)
 E.M. Survey
 LINE 23 N.

DRAWN: J.B. SCALE: 1:2000
 TRACED: T.G.D.S. DATE: March 1981

FIG. 6

015



FREQUENCY

+5%
0% 222 Hz
-5%

+5%
0% 444 Hz
-5%

+5%
0% 888 Hz
-5%

+5%
0% 1777 Hz
-5%

+5%
0% 3555 Hz
-5%

KEY
 . — . In - phase
 x - - x Out - of - phase

NOTES:
 1 Survey by Geotrex Pty. Ltd.
 30 - 31 Jan. 1981.
 2 Coil separation 150m.
 3 Station spacing 50ft (15m).

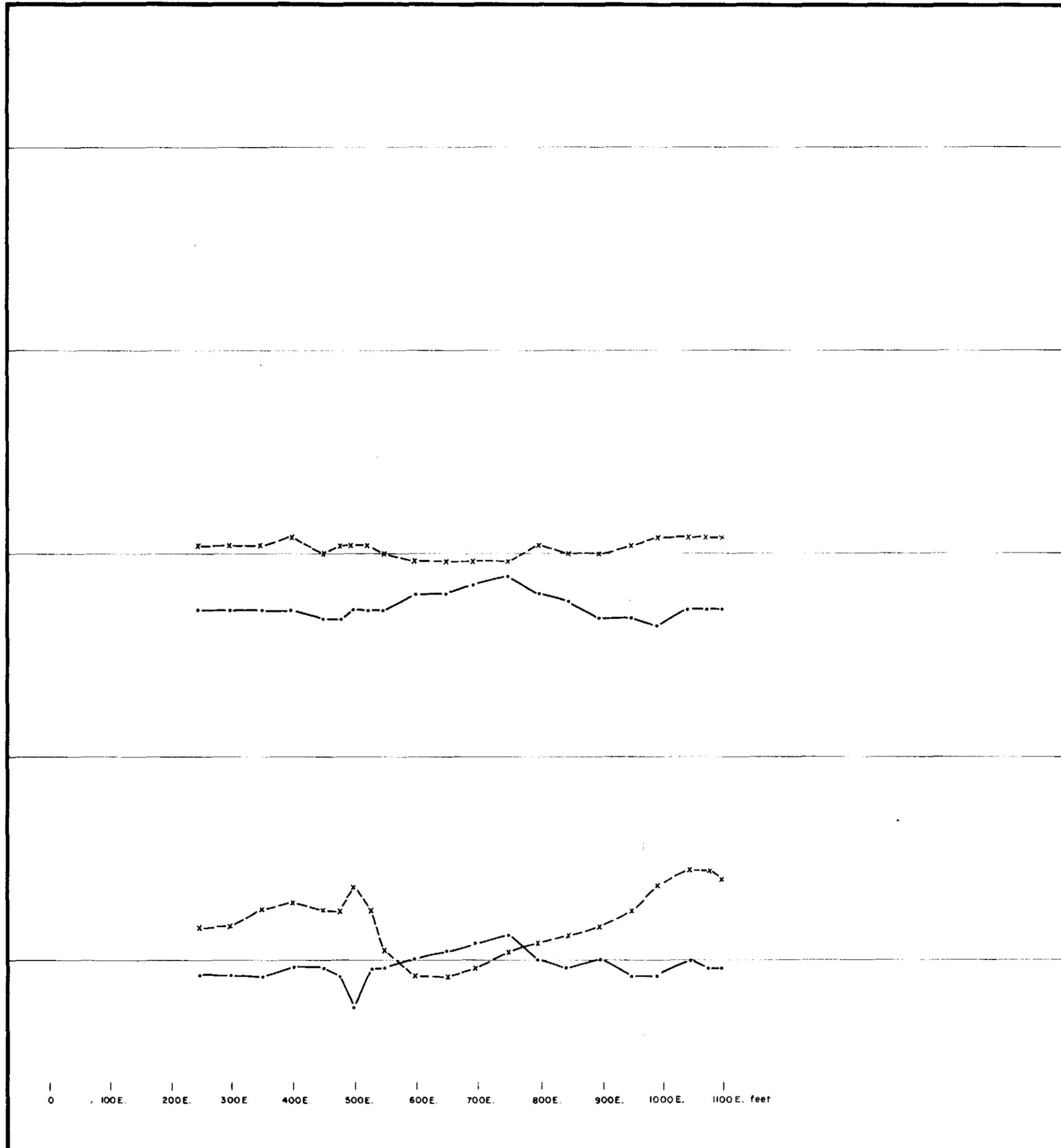
5 cm

0 100E 200E 300E 400E 500E 600E 700E 800E 900E 1000E. feet

305016

MITRE GEOPHYSICS PTY. LTD.		
EAST TYNDALL GRID		
Horizontal loop (Max.- Min.)		
E. M. Survey		
LINE 24 N.		
DRAWN: J.B.	SCALE: 1:2000	FIG. 7
TRACED: T.G.D.S.	DATE: March 1981	

016



FREQUENCY

+ 5%
 0% 222 Hz
 - 5%

+ 5%
 0% 444 Hz
 - 5%

+ 5%
 0% 888 Hz
 - 5%

+ 5%
 0% 1777 Hz
 - 5%

+ 5%
 0% 3555 Hz
 - 5%

KEY
 —•— In - phase
 x--x Out - of - phase

NOTES:
 1 Survey by Geotrex Pty Ltd
 30-31 Jan. 1981.
 2 Coil separation 150m.
 3 Station spacing 50ft (15m).

5 cm

0 100E. 200E. 300E. 400E. 500E. 600E. 700E. 800E. 900E. 1000E. 1100E. feet

305017

MITRE GEOPHYSICS PTY. LTD.
EAST TYNDALL GRID
 Horizontal loop (Max.- Min.)
 E.M. Survey
 LINE 25N.
 DRAWN: J.B. SCALE: 1:2000
 TRACED: T.G.S. DATE: March 1981 **FIG 8**

017

FREQUENCY

+5%
0% 222 Hz
-5%

+5%
0% 444 Hz
-5%

+5%
0% 888 Hz
-5%

+5%
0% 1777 Hz
-5%

+5%
0% 3555 Hz
-5%

KEY
—•— In - phase
x—x Out - of - phase

NOTES:
1 Survey by Geotrex Pty Ltd
30-31 Jan. 1981.
2 Coil separation 150m
3 Station spacing 50ft (15m).

5 cm

0 100E 200E 300E 400E 500E 600E 700E 800E 900E. feet

305018

MITRE GEOPHYSICS PTY. LTD.	
EAST TYNDALL GRID	
Horizontal loop (Max.- Min)	
E.M. Survey	
LINE 26 N.	
DRAWN: J.B.	SCALE 1:2000
TRACED: T&DS	DATE March 1981

FIG. 9