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Record No. 1968 / 107

Mount Minza Area Experimental Geophysical Surveys, Northern Territory 1966 and 1967

by

K. Duckworth

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ILLUSTRATIONS

SUMMARY

Turam, self-potential, and induced polarisation surveys were made in the Mount Minza area of the Northern Territory to investigate further a zone of high conductivity that was discovered in 1965 during a survey made with Slingram, Turam, and radiometric methods. The Turam results had shown some unusual features and a more detailed survey was done to examine the efficacy of the Turam method; some limitations of the method were revealed. The S-P survey revealed two excellent anomalies associated with a shale conductor, and the IP survey produced unusual results which will require more investigation.

1. INTRODUCTION

The work described in this Record was done to investigate further a zone of exceptional conductivity that was discovered in 1965 during a survey made with Slingram. Turam, and radiometric methods in the Mount Minza area of the Northern Territory (Shatwell and Duckworth, 1966). The Turam results showed some unusual features and it was decided to examine them by a more detailed Turam survey.

Also, as the area bears a strong resemblance to El Sherana West, where the self-potential (S-P) method was responsible for the discovery of a uranium orebody, it was felt that the S-P method might give useful results at Mount Minza.

The conductor involved is known to be a graphitic black shale and it was expected that this would cause strong frequency effects in an induced polarisation (IP) survey. Two IP traverses have been read, one in 1966 by Farrow (1967) and a second in 1967 by Gardener. The first traverse did not reveal the expected frequency effect anomalies, whereas that done by Gardener and described in this Record did. This discrepancy is surprising but has a counterpart in the S-P results.

2. FIELD WORK

The Turam work was done in July and September 1966 by a party consisting of K. Duckworth (geophysicist), C.J. Braybrook and N. Ashmore (geophysical assistants), and W. Fraser and J. Blincoe (field assistants).

The S-P work was done in August 1967 by J.P. Williams (geophysicist), W. Fraser (geophysical assistant), and P. Maylor (field assistant). The instrument was a converted Cambridge pH meter and readings were taken every 50 feet along lines 400 feet apart. Two or three readings were taken at each station to ensure elimination of errors due to bad electrode contacts.

The second IP traverse was surveyed in December 1967 by J.E. Gardener (geophysicist), W. Fraser (geophysical assistant), and P. Maylor (field assistant) using McPhar frequency domain equipment.

Detailed descriptions of the area have been given by Farrow (1967).

3. DISCUSSION OF RESULTS

The influence of geometry on Turam results

Previous geophysical surveys in the Rum Jungle area located several zones of unusually high conductivity. While investigating these zones with the Turam apparatus it became apparent that Turam anomalies are greatly dependent upon the geometry of the induction system. To investigate this dependence systematically a survey was carried out in July 1966 over a conductor discovered in 1965 in the Mount Minza area. This area was selected for the investigation because of the simple structures involved and the high conductivities present. The location of the area and principal geophysical results are shown in Plate 1.

The conductor is a steeply-dipping tabular body formed by a bed of graphitic black shale. The body is about 100 feet thick, strikes north-south, dips to the west, is about 6000 feet long in the north-south direction, and exhibits exceptionally high conductivity. The top of the body probably coincides with the intersection of the shale bed with the base of the weathered zone. In this area weathering does not appear to be deep and the top of the conducting body may well lie within 50 feet of the surface at some points. An inferred geological section, together with geophysical profiles, along traverse 201S is shown in Plate 2.

East-west traverses were surveyed across the conductor at intervals of 400 feet with stations pegged every 50 feet along the traverses.

The Turam 2S equipment was used operating on 220 and 660 c/s with a coil separation normally set at 50 feet. The induction system was a rectangular loop with a short side length of 1800 feet laid with its long axis parallel to the conductor, the whole loop being always to the west of the conductor.

The initial investigation showed that of lines 193S to 223S, lines 209S, 205S, and 197S were most suitable for studying the effects of geometry on Turam results. This suitability, especially on line 209S lay in the relatively moderate values of the anomalies and the lack of extraneous disturbance. Lines 205S and 213S were later investigated.

A series of three primary loops was laid to investigate the effect on the anomalies of increasing D, the distance from the nearest long side of the loop along a traverse to the position of projected outcrop of the conductor. The conductor was at about 446E and the nearest side of the primary loop was situated at 442E, 438E, and 434E in succession.

The results obtained are illustrated in Plates 3 to 7 and the conclusions drawn from them are summarised below.

1. The magnitude of the Turam ratio anomaly generally increases as D increases.

2. This effect is more pronounced the higher the inducing signal frequency.

3. For low frequency, the size of the ratio anomaly may be almost independent of D (i.e., if the size of the anomaly is taken as the ordinate distance between the top of the ratio peak and the bottom of the associated trough).

4. As D increases, the ratio peak is diminished while the associated trough is enhanced in proportion. This effect may be so pronounced at large values of D as to completely suppress the peak and leave only the trough.

5. The size of the ratio anomaly appears in general to be greater the higher the signal frequency.

6. The 660 c/s ratio anomaly appears in general to be displaced to the up-dip side of the 220 c/s anomaly.

7. As the value of D increases, the ratio anomaly moves to follow the loop.

8. Conclusion 2 is strongly dependent upon the type of conductor involved.

9. The magnitude of the Turam phase anomaly increases in general as the value of D increases.

10. This effect is more pronounced the higher the inducing signal frequency.

11. The size of the phase anomaly appears in general to be greater the higher the signal frequency.

12. The 660 c/s phase anomaly appears in general to be displaced to the up-dip side of the 220 c/s anomaly.

13. As the value of D increases the phase anomaly does not move to follow the loop.

14. Conclusion 10 is strongly dependent upon the type of conductor involved.

15. In general for this conductor the phase anomaly is displaced to the up-dip side of the corresponding ratio anomaly.

Some tests were made to determine the best way to treat data obtained when the coil spacing had to be halved or quartered when reading over very strong anomalies. The tests consisted of traversing particular lines first at 50-ft coil spacing, then at 25-ft spacings. This was done on lines 209S and 213S.

There were three possible ways of treating such data:

(a) The method recommended by ABEM is that the ratio reading should first be multiplied by the appropriate reduction factor then squared if the spacing is half normal, raised to the power 4 if the spacing is a quarter normal and so on. These may then be plotted.

(b) The ratio readings can each be multiplied by the appropriate reduction factor and then multiplied together in groups to give the ratio for the normal spacing, i.e. if the spacing was half normal multiply pairs; if a quarter multiply in groups of four. These may then be plotted.

(c) The ratio readings may be multiplied together in pairs, groups of four etc, to give the ratios for the normal spacing, then reduced using the factors for the normal spacings.

These three methods were used on data from lines 209S and 213S and the results are illustrated in Plate 8. It can be seen that method (a) produced curves which exhibit many minor extraneous effects and that where a strong anomaly is concerned these extraneous effects become exaggerated. Methods (b) and (c) produce curves which are virtually identical and only curves from method (c) are shown in Plate 8. As line 209S shows, curves from method (c) correspond well to the anomaly derived with the normal spacing (see Plate 3). There is some increase in the anomaly size as shown by lines 213S and 209S with the cable at 434E.

Of methods (b) and (c), method (c) is to be preferred, firstly because it requires less computation, and secondly it facilitates field procedure in that any spacing less then normal can be used, even an irregular one. In fact the Turam search coils can follow any path available between two pegs if the following coil is always situated exactly where the lead coil was on the previous reading. Thus no accurate surveying of intermediate pegs is required, whereas methods (a) and (b) do require this.

It is evident that there is a very complex relation between Turam anomalies and the whole environment of a survey. Variables which appear to operate on the magnitude and shape of a Turam anomaly are D, conductor geometry, orientation, and conductivity; coil separation and signal frequency are instrumental influences. This is probably not a complete list. In addition it is probable that these are not independent variables and that in fact the size of an anomaly depends to a large extent upon the mutual effects of selections of these variables.

Even if these considerations of anomaly dependence on D and coil separation are largely peculiar to this survey, there is a strong probability that they may apply to other surveys and, in fact, conclusions 1 and 9 have been observed to do so. Thus as the magnitude of a Turam anomaly is not purely a function of the characteristics of the conductor being investigated the contouring of such results can have little physical significance.

There is a natural tendency to assume that the regions of largest magnitude on a contour map are those of most physical significance (i.e., the bigger the anomaly, the better the conductor and the more likely is it to be due to mineralisation). It would only be fortuitous if this were the case with a Turam contour map. It is preferable that results be presented in profile and each profile treated for its individual peculiarities. Therefore the contouring of Turam results is an encouragement to the making of dangerous assumptions.

Self-potential

These results are presented in contour form in Plate 10. Profiles along lines 210S, 235S, and 237S are shown in Plate 9. As can be seen, two zones of strong negative potential were found in this area.

The anomaly centred on line 235S at 474E is exceptionally strong being approximately 800 millivolts from peak to trough.

Both zones of low potential correspond well to the outcrop of a graphitic black shale which is knwon to be the cause of some very strong electromagnetic effects (Farrow, 1967; Shatwell and Duckworth, 1966). A characteristic of the electromagnetic Slingram anomalies is that they are very persistent throughout the area and their magnitude is fairly constant. Thus it seems that the graphitic shale is also persistent, yet the S-P effects, as can be seen, are confined to only certain parts of it. A cause for this localisation is difficult to find. Fluctuations of the water table level have been used as an explanation of similar effects in other areas but this seems inappropriate here for the anomaly to the north is on a hillside, whereas the one to the south is in a valley. It seems possible then that the S-P results reflect some change of composition in the shale bed. This change would not have any relation to conductivity, for in the southern anomaly the strongest S-P effects do not occur with the strongest Slingram effects. A hard laterite layer covers a large part of the centre of the area and it might mask some of the effect on lines 221S to 229S but not on lines 213S and 217S, both of which are crossed by strong Slingram effects but little or no S-P effect.

Induced polarisation

The results of an IP traverse on line 235S are shown in Plate 11. The IP work did not follow 235S exactly but followed a black soil flat close to the traverse in order to be able to get good electrode contacts.

As can be seen, a fairly strong resistivity and frequency effect anomaly occurs at about 458E to 463E. This corresponds well to a strong Slingram anomaly, the centre of which is at 463E. A second weaker Slingram anomaly is centred at 465E and this corresponds to a small resistivity anomaly at the same place.

The IP effect is much broader than the Slingram anomaly and this may be a reflection of the dip of the shale bed, which is known to be the source of the Slingram effects. This shale bed is about 100 feet thick, strikes almost due north, and dips steeply to the west. The shale is highly graphitic and was expected to cause strong frequency effects, as it does at this site. However, on line 217S the same shale bed was crossed by an IP traverse and gave little frequency effect but a strong resistivity anomaly. It can be seen from Plate 10 that no significant S-P anomaly was found on line 217S. Thus it may be that there is some correlation between S-P and frequency effect anomalies and more IP work would be useful to test this.

Traverse 235S, if extended to the east, would cross the 800-millivolt S-P anomaly, but outcrops of hematitic quartz breccia make this very difficult.

Useful follow-up work with IP would be:

(a) A traverse on 201S from 438E to 458E. This would cross a strong S-P anomaly and a good Slingram anomaly. Electrode contacts could be hard to make owing to outcrops of the hematitic quartz breccia. A strong frequency effect might be expected here from the same shale bed encountered on 217S and 235S. The shape of the shale bed and its dimensions are particularly well known on this line as a result of Slingram probing.

(b) A traverse on 213S from 438E to 458E. This line across a small black soil flat should offer good electrode contacts. As this line lies just north of 217S, a good resistivity anomaly may be expected, but frequency effects may be small particularly as there is very little S-P effect, as on 217S.

(c) An extension of line 235S to 482E is possible. A small valley with a black soil bottom runs slightly north of east and approximately in the position of line 235S extended. A strong frequency effect, as well as a strong resistivity effect, is to be expected.

4. CONCLUSIONS

The Turam survey was purely an experiment concerned with the method. It demonstrated that little value can be put on the magnitude of Turam anomalies either absolutely or relatively. Consequently Turam results can not be contoured.

The self-potential distribution is possibly a reflection of differentiation of the constituents of the shale bed and this should be investigated by pattern rotary drilling of the top of the bed down to a depth of not more than 200 feet.

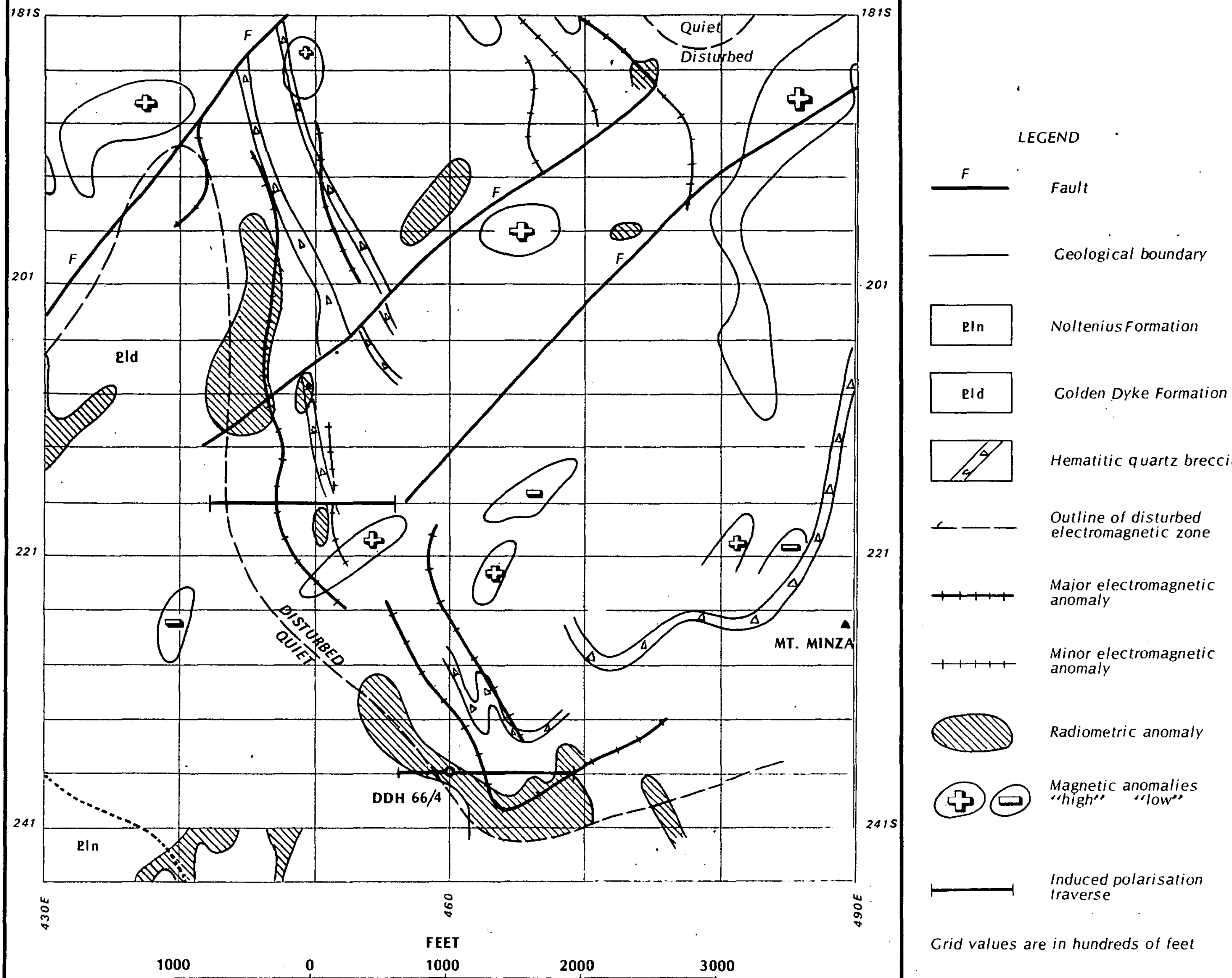
The induced polarisation effects are unexpected and further work is desirable.

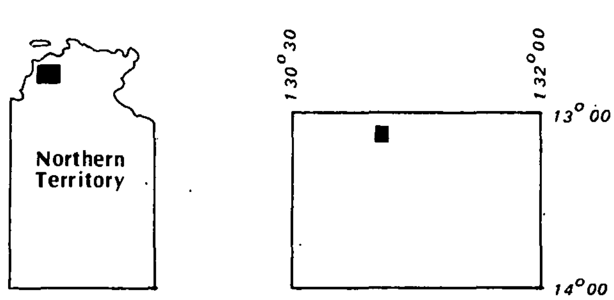
5. REFERENCES

FARROW, B.B. 1967 Gould Area (Mount Minza and Waterhouse No. 2, Geophysical Survey, Northern Territory, 1966. Bur.Min.Resour.Aust. Rec. 1967/97.

SHATWELL, D.O. and DUCKWORTH, K. 1966 Gould Area Geochemical and Geophysical Surveys, Rum Jungle Area, Northern Territory, 1965. Ibid 1966/154.

PLATE 1





REFERENCE TO AUSTRALIA 1:250,000 STANDARD MAP SERIES. PINE CREEK

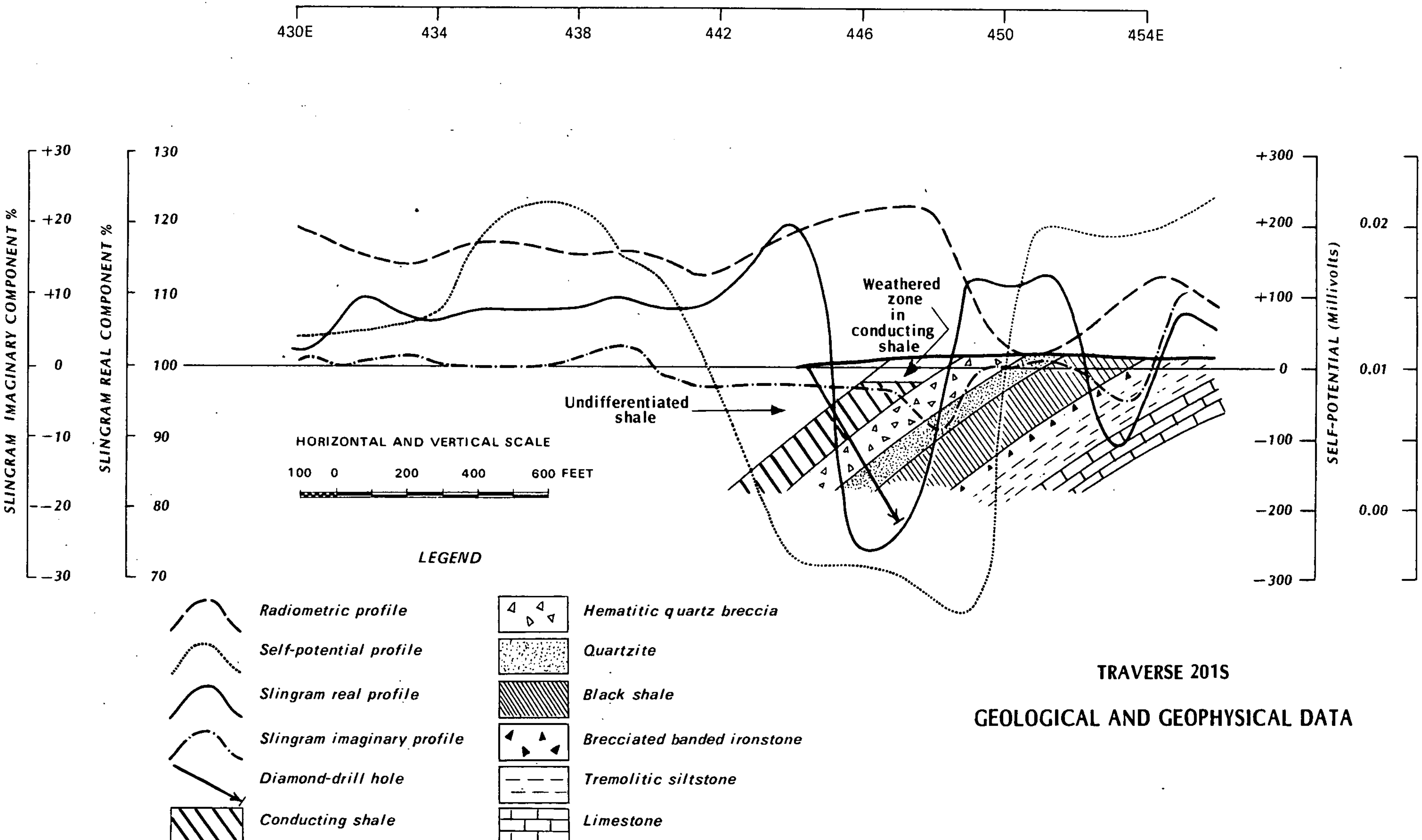
MOUNT MINZA AREA, NT

LOCALITY MAP AND SUMMARY OF GEOPHYSICAL INDICATIONS

(BASED ON D52/B7—223—1)

To accompany Record No. 1968/107

D52/B7— 382



TRAVERSE 201S

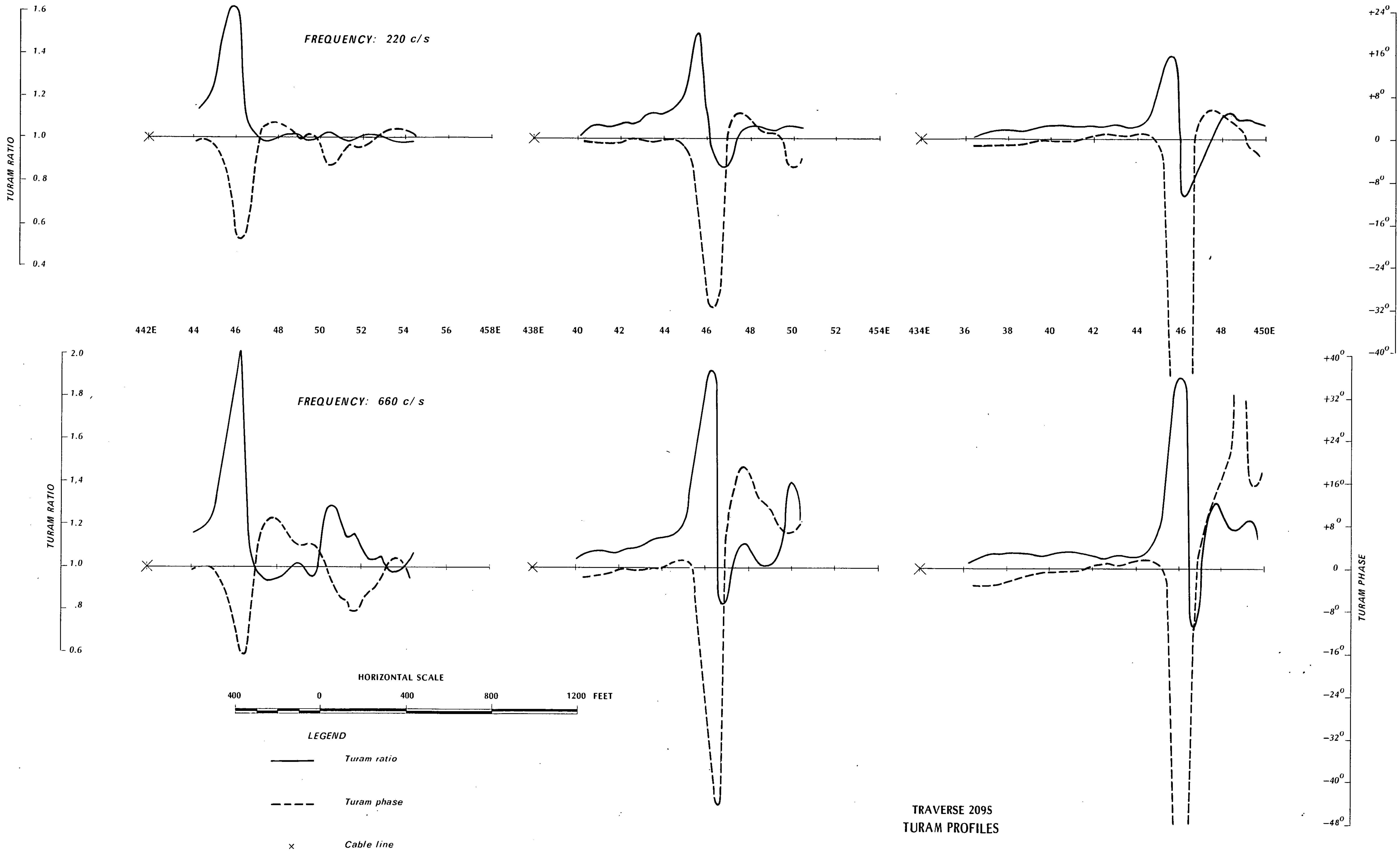
GEOLOGICAL AND GEOPHYSICAL DATA

PLATE 2

To accompany Record No.1968/107

D52/B7–380

(BASED ON D52/B7–354)



TRAVERSE 209S
TURAM PROFILES

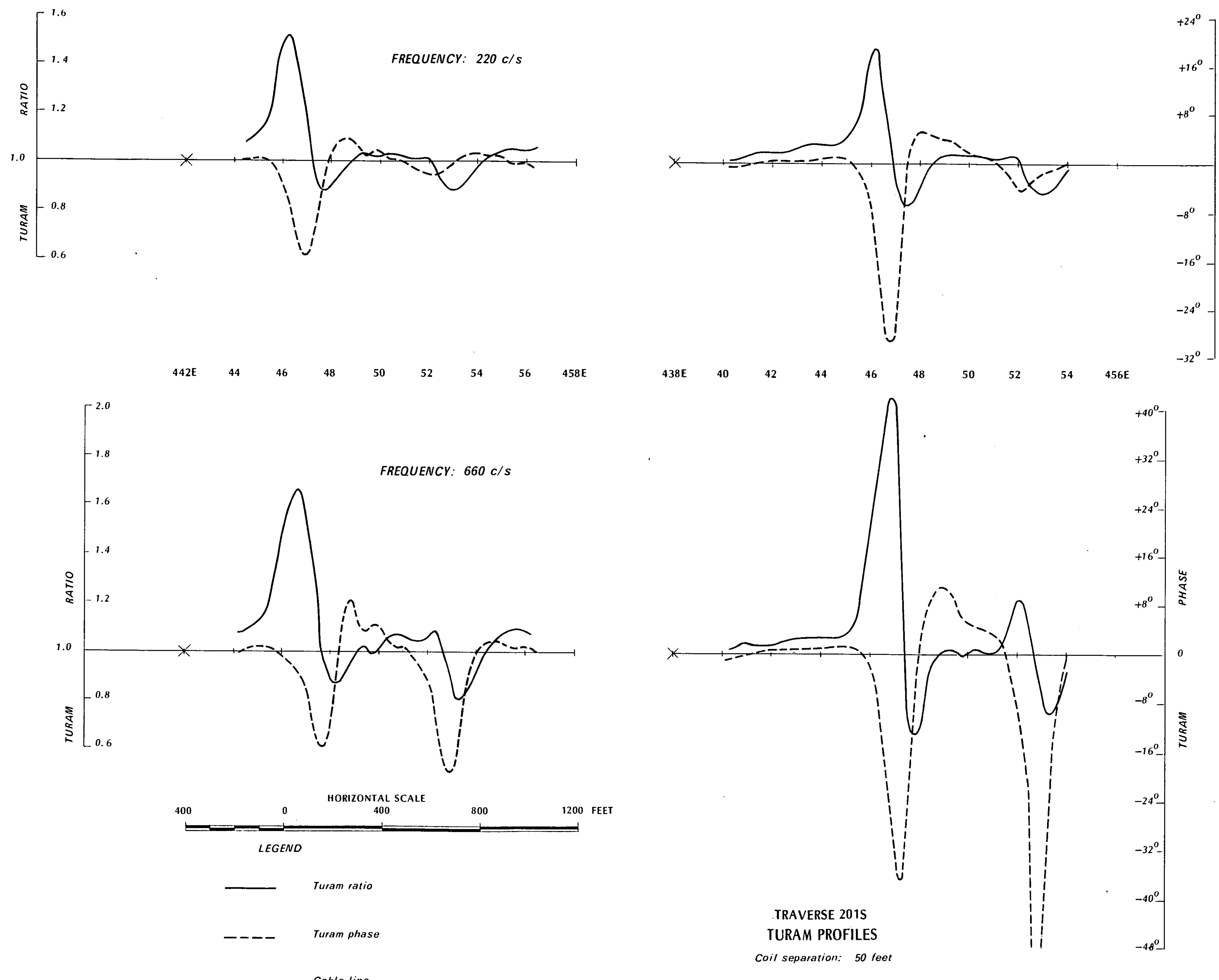
Coil separation: 50 feet

MOUNT MINZA NT

To accompany Record No. 1968/107

D52/B7-414

PLATE 4



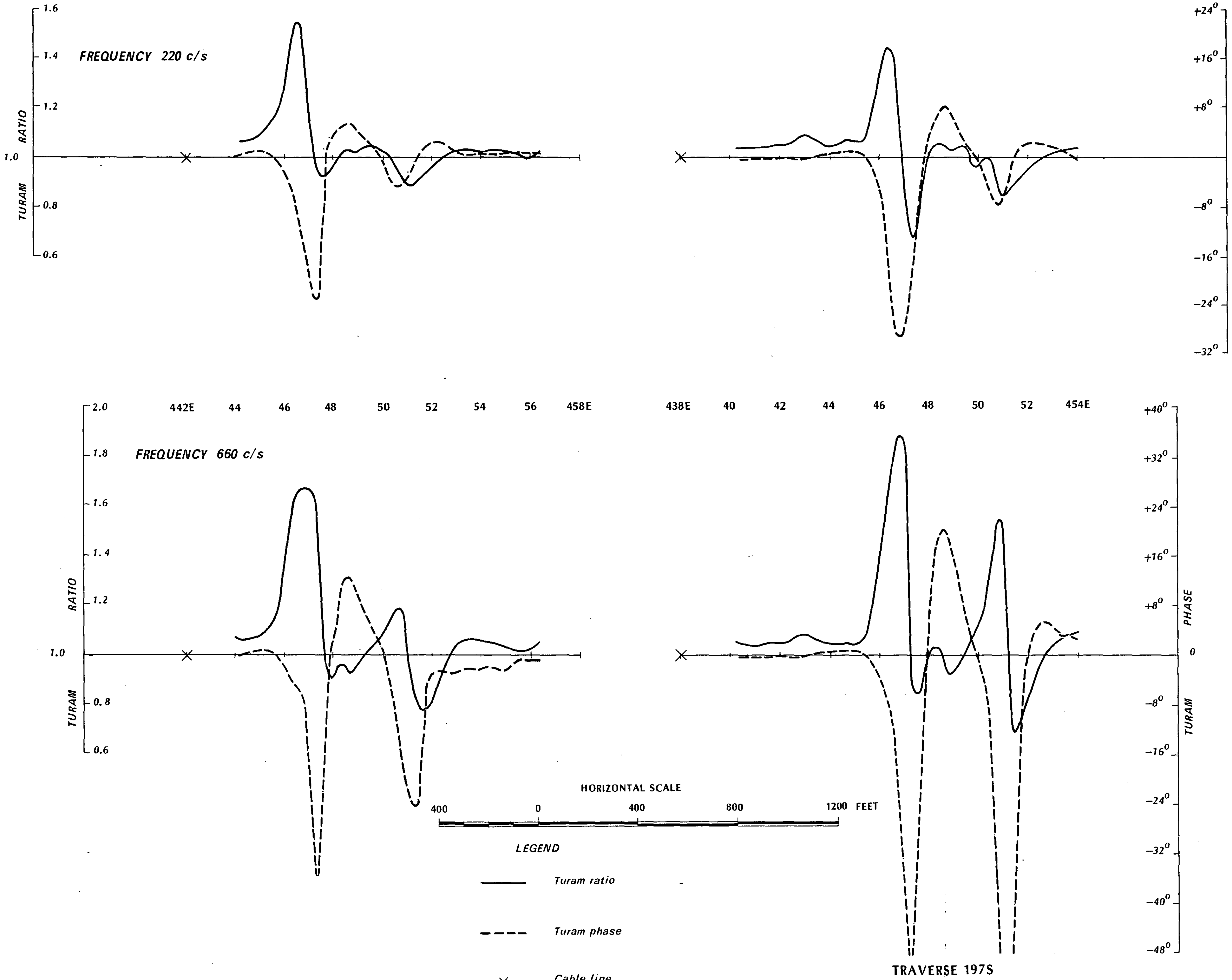
TRAVERSE 201S
TURAM PROFILES
Coil separation: 50 feet

To accompany Record No. 1968/107

D52/B7-417

MOUNT MINZA NT

PLATE 5



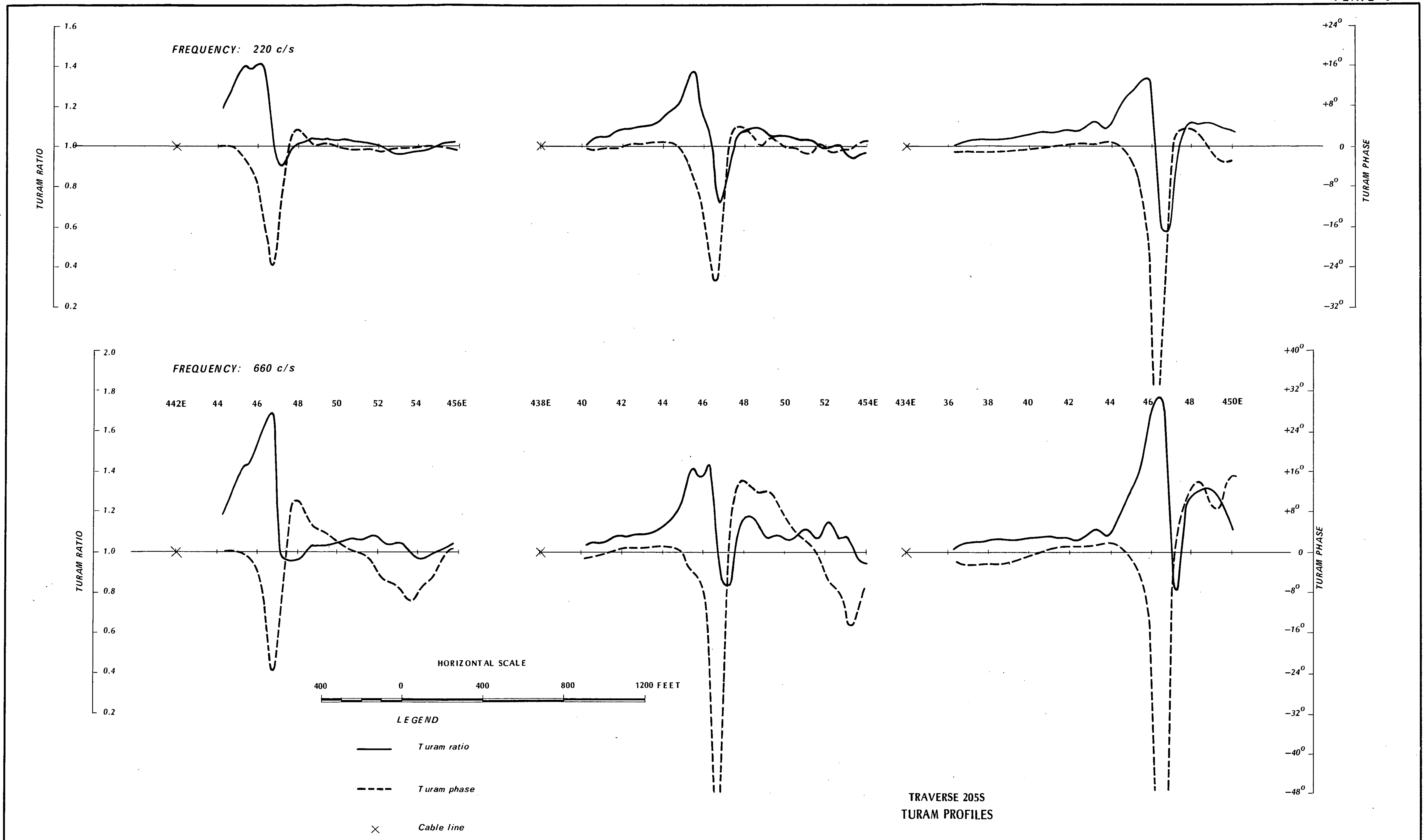
TRAVERSE 197S
TURAM PROFILES

Coil separation : 50 feet

D52/B7-415

To accompany Record No. 1968/107

MOUNT MINZA NT



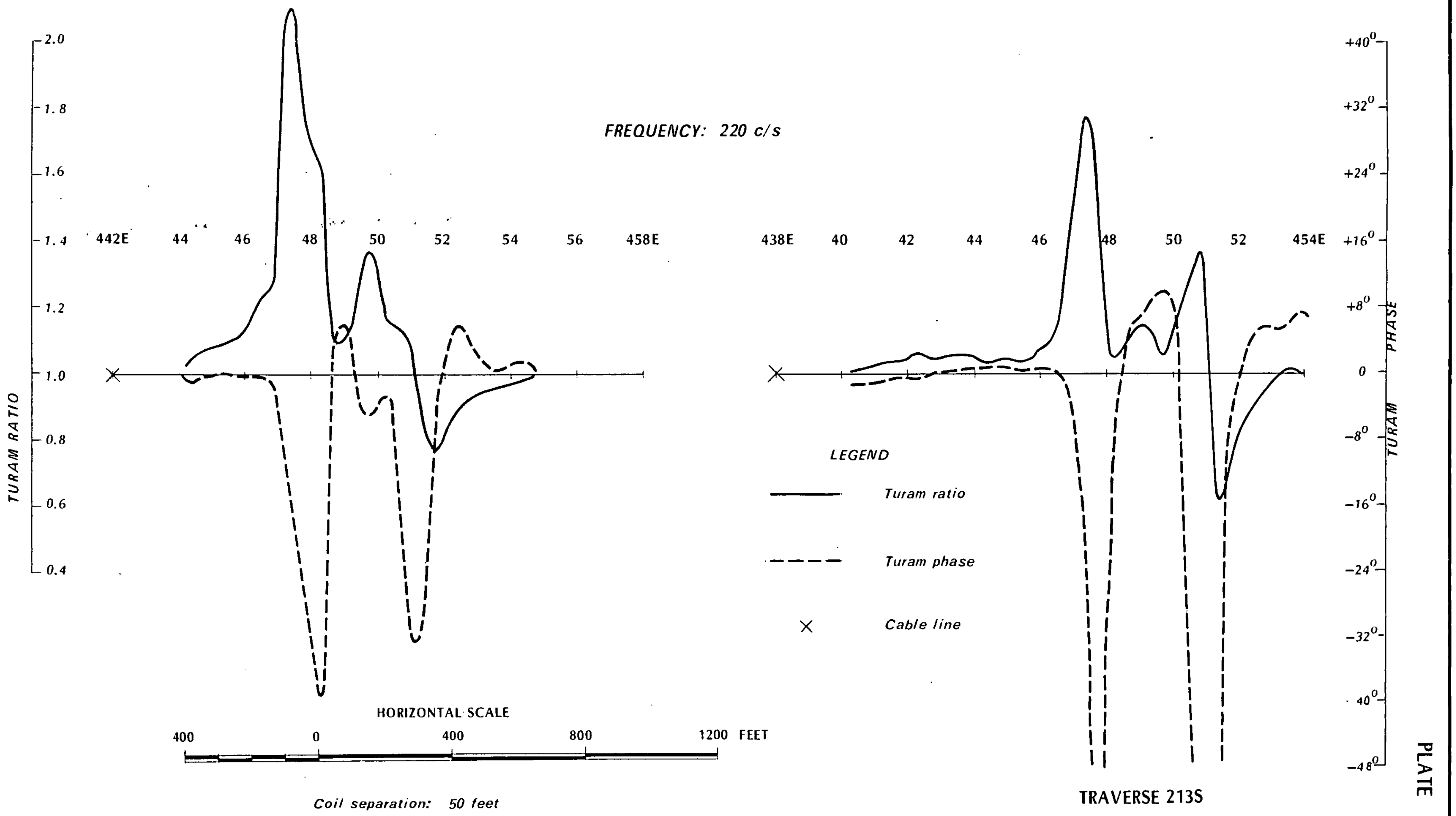
TRAVERSE 205S
TURAM PROFILES

Coil separation: 50ft

To accompany Record No. 1968/107

D52/B7-413

MOUNT MINZA NT



TRAVERSE 213S

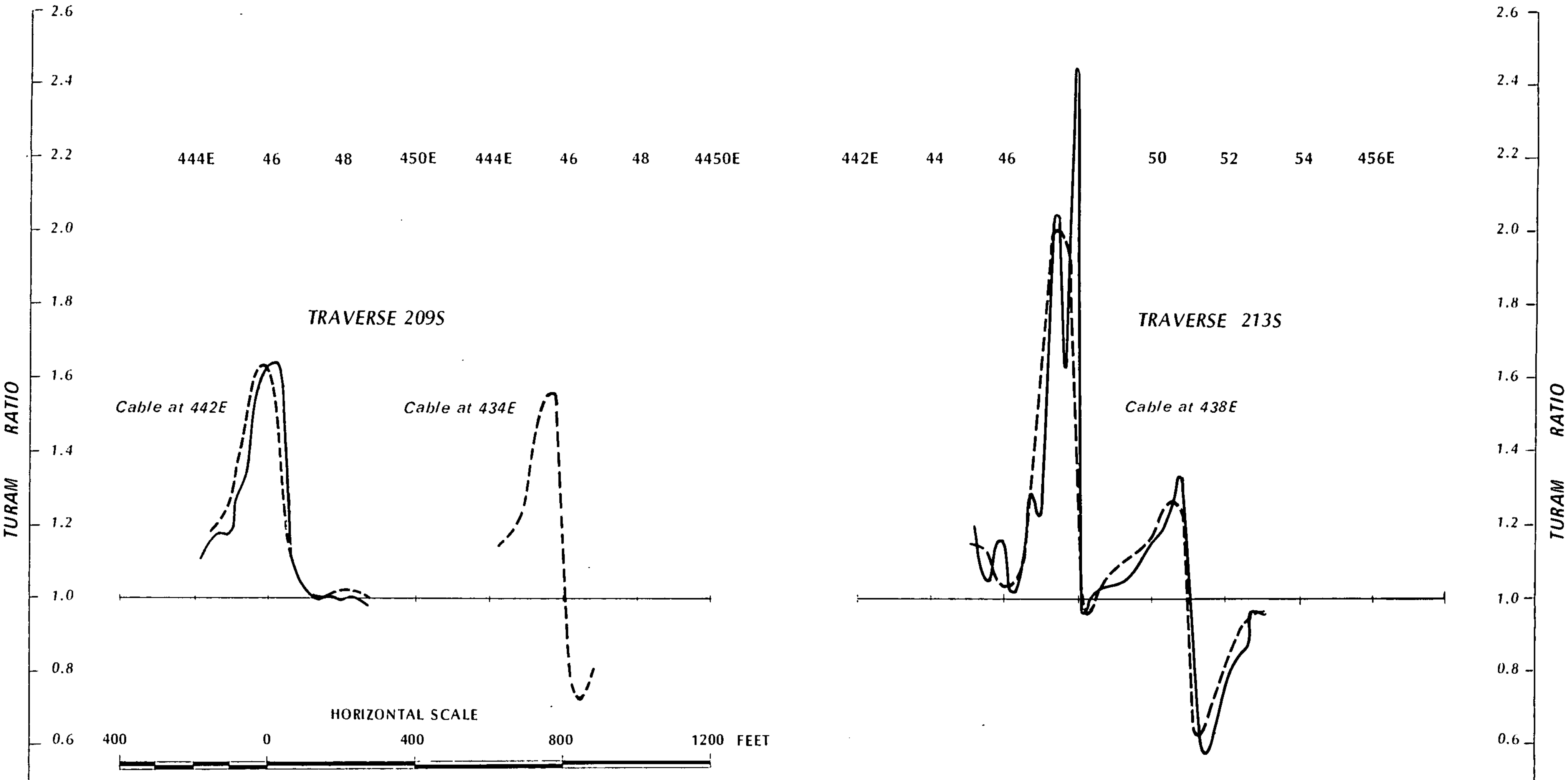
TURAM PROFILES

PLATE 7

D52/B7–416

To accompany Record No. 1968/107

To accompany Record No. 1968/107



Method (a) — Curve derived by reducing each 25ft value squaring and plotting

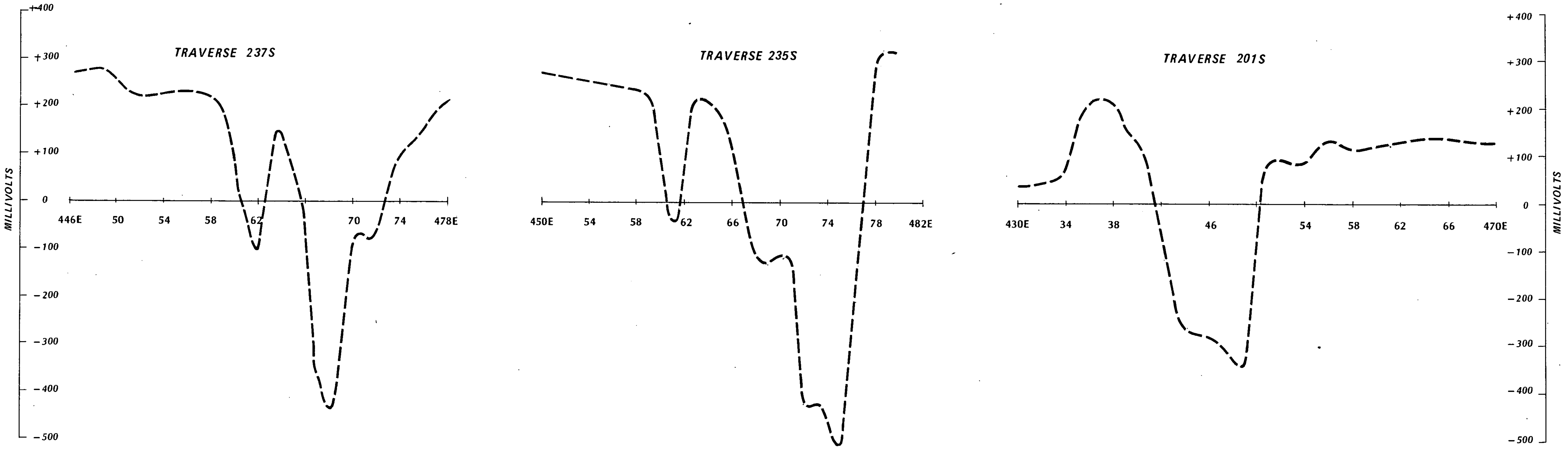
Method (b) & (c) — Curve derived by reducing each 25ft value multiplying into 50ft pairs and plotting. If 25ft values are multiplied together before reduction it gives almost exactly the same curve

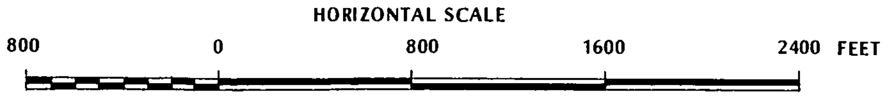
Frequency: 220 c's

COMPARISON OF METHODS FOR REDUCING TURAM DATA FOR DIFFERENT COIL SPACINGS

PLATE 8

D52/B7 – 418





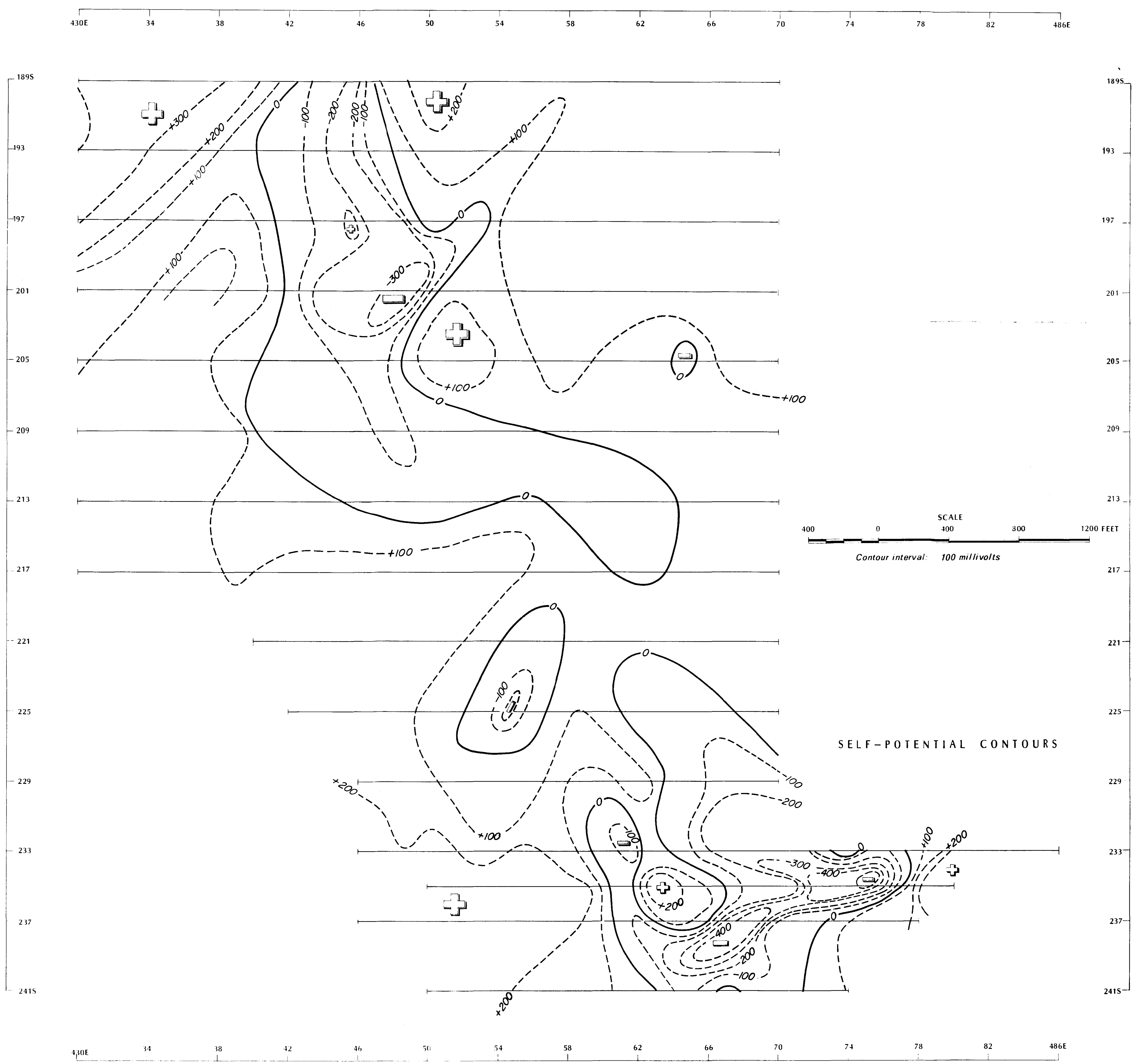
SELF-POTENTIAL PROFILES

To accompany Record No. 1968/107

D52/B7-421

MOUNT MINZA NT 1967

PLATE 10

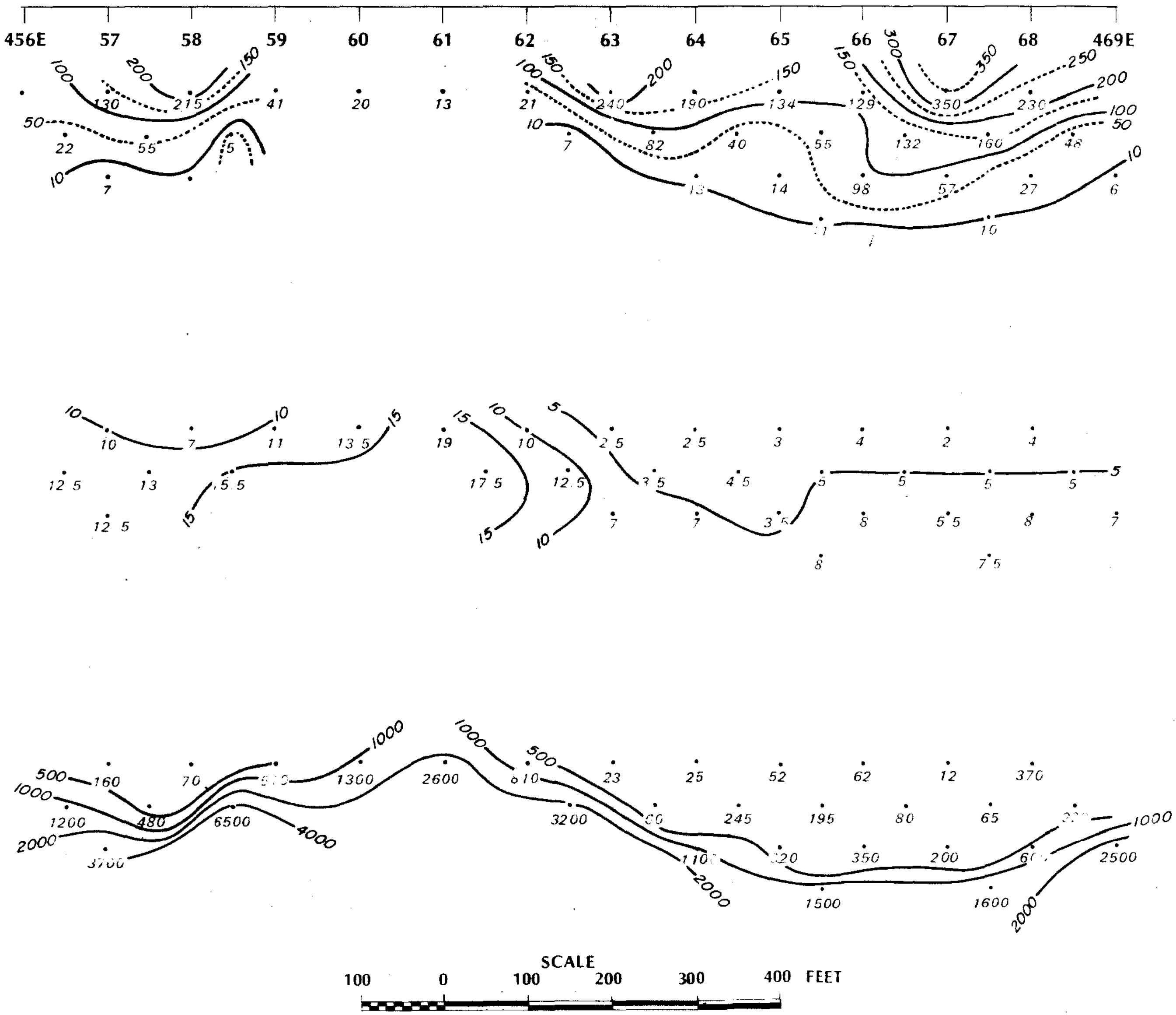


MT MINZA NT 1967

To accompany Record No. 1968 107

D52/B7-420

To accompany Record No. 1968/107



RESISTIVITY (ohm-metres)

FREQUENCY EFFECT (%)

METAL FACTOR

TRAVERSE 235S

INDUCED POLARISATION RESULTS

PLATE 11

D52/B7–419