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AFMAG Test Survey, Rum Jungle,

Northern Territory 1968

by

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SUMMARY

The AFMAG method of electromagnetic prospecting was tested in the Rum Jungle area, Northern Territory, during October 1968. Anomalies were obtained in several places, but for some of the time, readings were unreliable owing to local thunderstorms and low field strengths. It is considered that the method is not a precise prospecting tool, but it may have applications in certain geological problems.

1. INTRODUCTION

A test survey using the AFMAG method was conducted in the Rum Jungle area Northern Territory (Plate 1) during October 1968, as part of a BMR programme to test the capabilities of the method. The area was chosen because of its remoteness from powerlines and because there were several survey grids with good geological control which had been surveyed previously with other geophysical methods.

2. METHOD

The AFMAG method is described by Ward (1967); it is an inductive electromagnetic method in which the source is a natural audio frequency magnetic field arising from atmospheric discharges, predominantly lightning discharges in thunderstorms. The field consists of a near-vertical electrical field and a horizontal magnetic field. Although the magnetic component has an essentially random azimuth, it generally exhibits a preferred direction when observed over a period of time. In the vicinity of conductive inhomogeneities in the earth the magnetic component departs from the horizontal, and it is the azimuth of the field and its dip which the instrument is designed to measure.

Marked changes in the field strength are caused by variations in the height and condition of the ionosphere and by the variation of the number and location of thunderstorms. The field is generally strongest during the night and in summer, but large unpredictable changes in field strength can occur from day to day and hour to hour. Consequently, quite a large proportion of working time can be lost because of low field strengths. Reading is difficult when thunderstorms are located close to the area of survey as strong electromagnetic pulses cause wild excursions of the meter needle. A second and more serious difficulty is caused by electricity supply lines, which act as strong electromagnetic sources in all frequencies owing to switching transients, as well as the normal 50-Hz frequency and its harmonics. These power-line fields are vertical and when combined with the variable horizontal AFMAG fields of about the same amplitude cause large irregular dip readings. Ideally, power lines should be at least two miles from the survey area. A similar effect is caused by telephone lines, but to a lesser extent.

The instrument used was a McPhar ground AFMAG unit, type A652. This apparatus comprises two orthogonal coils (a signal coil and a reference coil) which can rotate about an axis perpendicular to the axes of both coils. The reference coil detects random signals both in phase and out of phase with those in the signal coil. These in-phase and out-of-phase signals are displayed on a meter as positive and negative fluctuations respectively. When the axis of the signal coil is aligned in the direction of maximum field the meter needle spends as much time on one side of the null position as on the other. If the signal coil is displaced from this direction the meter will show predominantly positive or negative fluctuations. The field procedure is to rotate the two coils in the horizontal plane until the axis of the signal coil is along the field azimuth, and then to rotate the coils in the vertical plane in this azimuth until the axis of the signal coil lies along the direction of maximum field, when the dip angle may be read from a clinometer attached to the coil assembly.

The azimuth is determined using a magnetic compass. The accuracy with which the signal coil is aligned with the field, even with strong fields, depends to a large extent on the skill and patience of the operator, since it needs several minutes of observation to take a proper sample of field variations.

Readings are taken at two frequencies, 140 and 470 Hz, chosen by the makers to give minimum response to power-line field harmonics and, according to the instrument handbook, to give good response to massive sulphide orebodies.

During the test survey the AFMAG field was stronger at the lower frequency, and it was found convenient to determine the azimuth at this frequency initially and use the same azimuth for dip recordings at both frequencies. It was also found that large excursions of the meter needle were given undue emphasis because of the needle's inertia; consequently the gain control on the instrument console was turned down to the lowest level consistent with readability.

Battery checks can be made by means of the function switch on the console, but this should be done only after about two hours of continuous reading since battery voltage recovers temporarily when the instrument is turned off. Battery changes were necessary at intervals of about a fortnight.

Certain conventions have to be adopted when booking and plotting results so that ambiguity is avoided. In the present work the dip is recorded as positive when the axis of the signal coil points down in the direction of the azimuth, and negative otherwise. Plotting by the vector method (Hallof & Sutherland, 1962) is straightforward; an arrow is drawn on a plan with its base at the station and in the direction of the dip of the field, i.e. the direction of dip of the signal coil, with the length of the arrow proportional to the dip angle. Ambiguity arises when plotting dip angles on a profile since there can be no distinction between positive and negative dips when the azimuth information is missing. The convention adopted is such that the dip angles when read from left to right on the profile change from positive to negative over the source of the anomaly.

3. RESULTS

Several traverses were run over known and suspected faults and known lithological conductors. Slingram results were available on most of the traverses; these allowed a comparison to be made of the two methods.

Mount Minza area

Traverses were read over the conducting black shale in the Mount Minza area between 193S and 237S. The results are shown as a vector plot superimposed on the Slingram real-component contour map (Farrow, 1967) in Plate 2 and as dip-angle profiles in Plate 3.

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From the vector plots it can be seen that the azimuth of the AFMAG field was generally southerly when undisturbed, and turned almost east or west over the conducting region, which strikes north. The anomalies on most traverses are well-defined; dip angles increase towards the conductor, change sign above it, and decrease again on the other side. Traverse 217S does not show this very well since the dip values are rather small; the reason for this is not known. Because the traverses were read over a period of nearly three weeks it is to be expected that variations in the response of the conductor should occur, with the AFMAG fields varying from day to day. However, traverse 205S was read on two separate occasions ten days apart and the two profiles were very similar (see Plate 3). It should be noted that traverses 217S and 225S are over a multiple conductor, as can be seen from the Slingram results. Traverse 193S is across the double conductor which the AFMAG failed to resolve, whereas traverses 229S and 237S do each show some effect from separate sources. Traverse 237S is also interesting in that it crosses the same conductor twice, and the AFMAG anomaly is similar to that over a model having the same geometry as the conductor, as published by Ward et al (1966).

The anomalies at the two frequencies were of approximately the same amplitude, which indicates that the tops of the conductors are close to the surface.

Traverse 205S was extended westward to cross a fault located at about 428E but only a small, poorly defined dip angle anomaly was observed over the fault.

Gould area

Two traverses were read over anomaly zone "A", where the Slingram anomalies were attributed to conducting shales (Farrow, 1967). Definite AFMAG anomalies were observed (Plate 2); that on traverse 181S did not clearly resolve the two conductors indicated in the Slingram results whereas that on 173S indicated one conductor only. Possibly the second conductor on the latter traverse was too small to give any response. As in the Mount Minza area, depth of burial is small and both frequencies give a response of about the same magnitude.

Mount Fitch area

Traverse 120S of the Rum Jungle East grid had been previously extended across the Rum Jungle Complex, and sections of it in the Mount Fitch area (from 520W to 562W and from 564W to 594W) were surveyed with AFMAG during two non-consecutive days. The results are shown in Plate 4. It can be seen that the general azimuth was very different on the two days. Several conductors are indicated but their type is not known.

Triangle area

One traverse, 110N, was read over the supposed Mount Fitch Fault. Two small anomalies occur (Plate 4) but there is no anomaly of the magnitude to be expected from a fault zone of the size proposed. The easternmost anomaly corresponds to a definite Slingram anomaly and could be caused by a lithological conductor.

Traverse 154N was read across the Giants Reef Fault and gave a strong anomaly centred at 185E (Plate 4). The azimuth of the field rotated to a direction perpendicular to the strike of the fault and an extensive dip angle anomaly was observed.

A less pronounced dip angle anomaly occurs at about 171E. Slingram anomalies occur at both these locations, and although the Giants Reef Fault is a multiple shear, it is not certain that it is the cause of the AFMAG anomalies, since lithological conductors are abundant in the area. However, the size and extent of the main anomaly suggest that its source is an extensive body.

Traverses were also read in the Rum Jungle East area but the results were poor, showing irregular dip angles, probably owing to local thunderstorms which were prevalent at the time of reading. Lack of time prevented repeat readings on these traverses and the results are not presented in this report.

4. CONCLUSIONS

The results show that, in good conditions, the AFMAG method can delineate subsurface conductors, but not accurately. The variability of the results due to the vagaries of the fields appears to be a serious drawback and loss of reading time due to low field strengths and local disturbance can be considerable. Available Slingram results demonstrated that this method located the conductors more readily, more quickly, with more precision, and with better resolution than the AFMAG method. However, the AFMAG method may prove superior for locating weak, but extensive conductors, such as fault and shear zones, or conductors buried at depth.

5. REFERENCES

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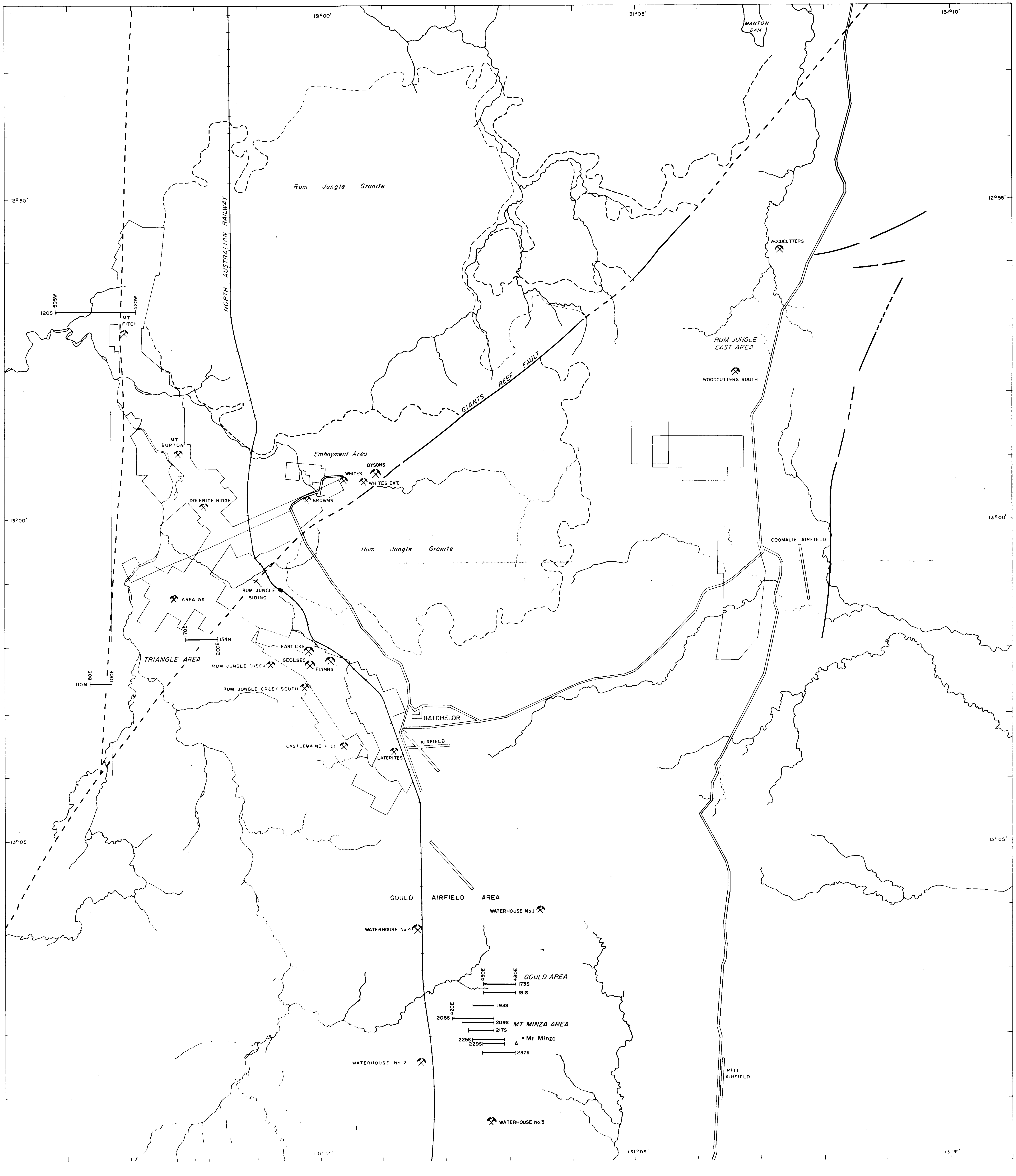
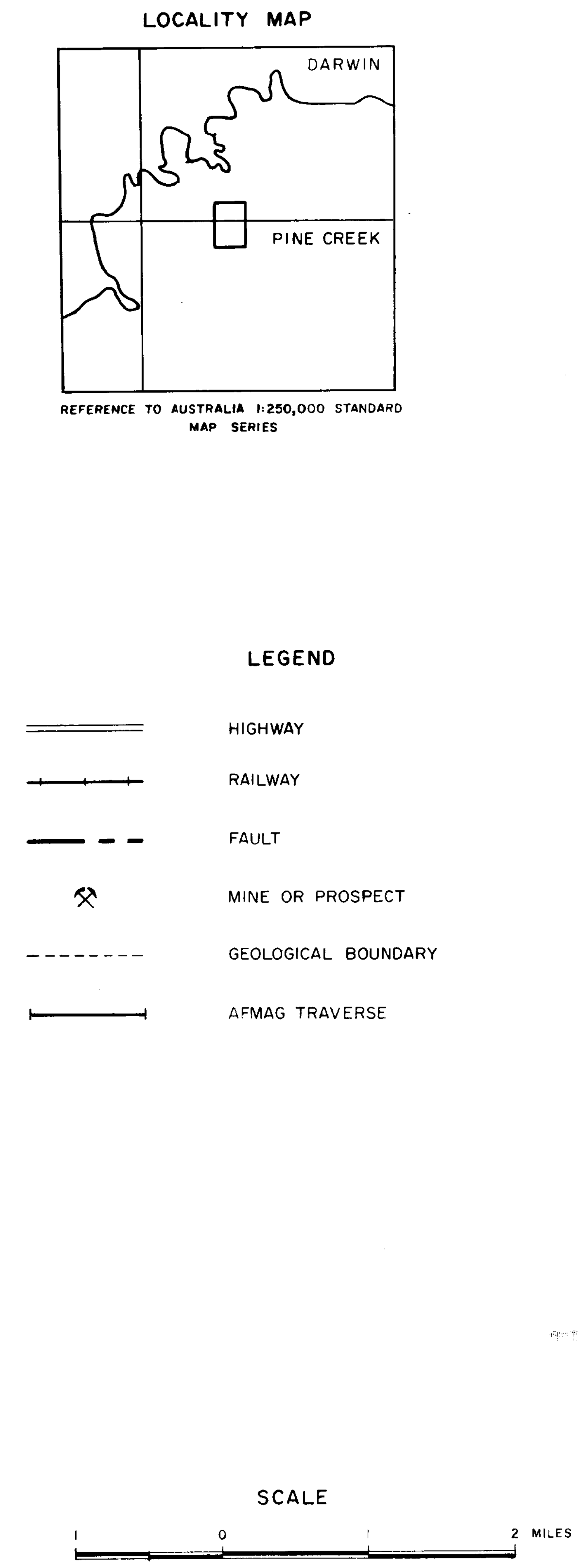


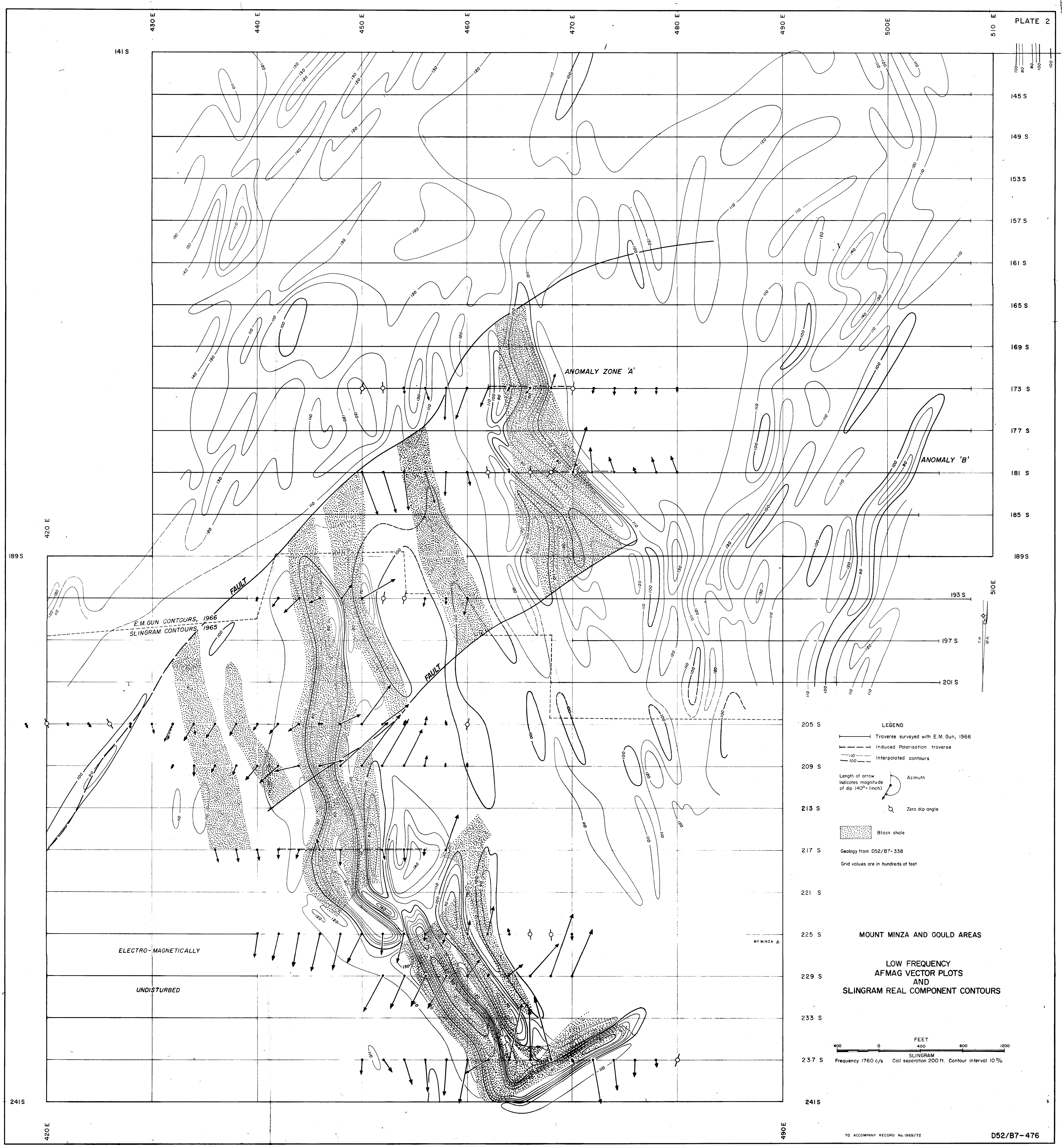


RUM JUNGLE NT, 1968

AFMAG TEST SURVEY

LOCALITY MAP

PLATE 2



MOUNT MINZA AND GOULD AREAS

LOW FREQUENCY AFMAG VECTOR PLOTS AND SLINGRAM REAL COMPONENT CONTOURS

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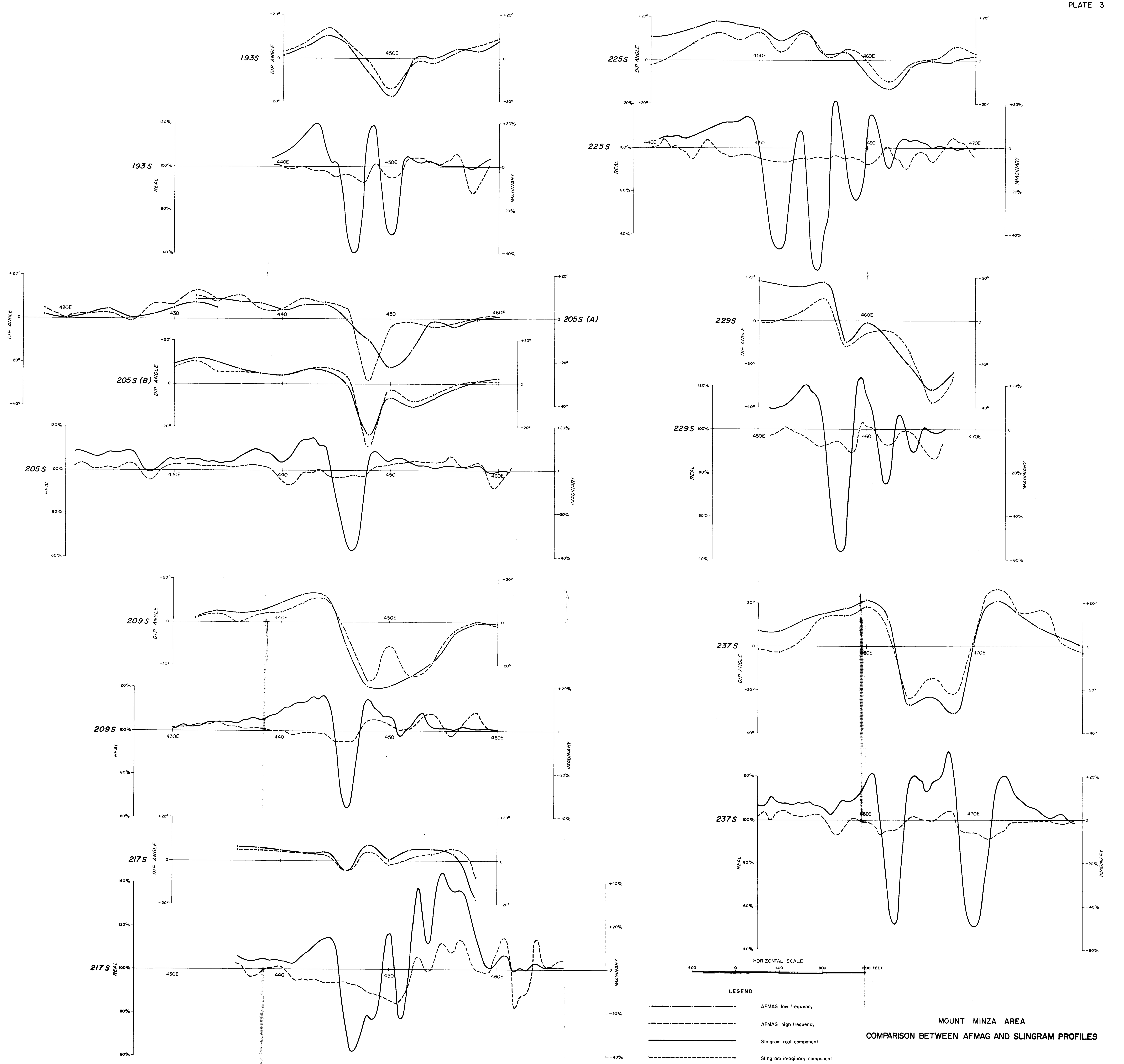

MOUNT MINZA AREA

COMPARISON BETWEEN AFMAG AND SLINGRAM PROFILES

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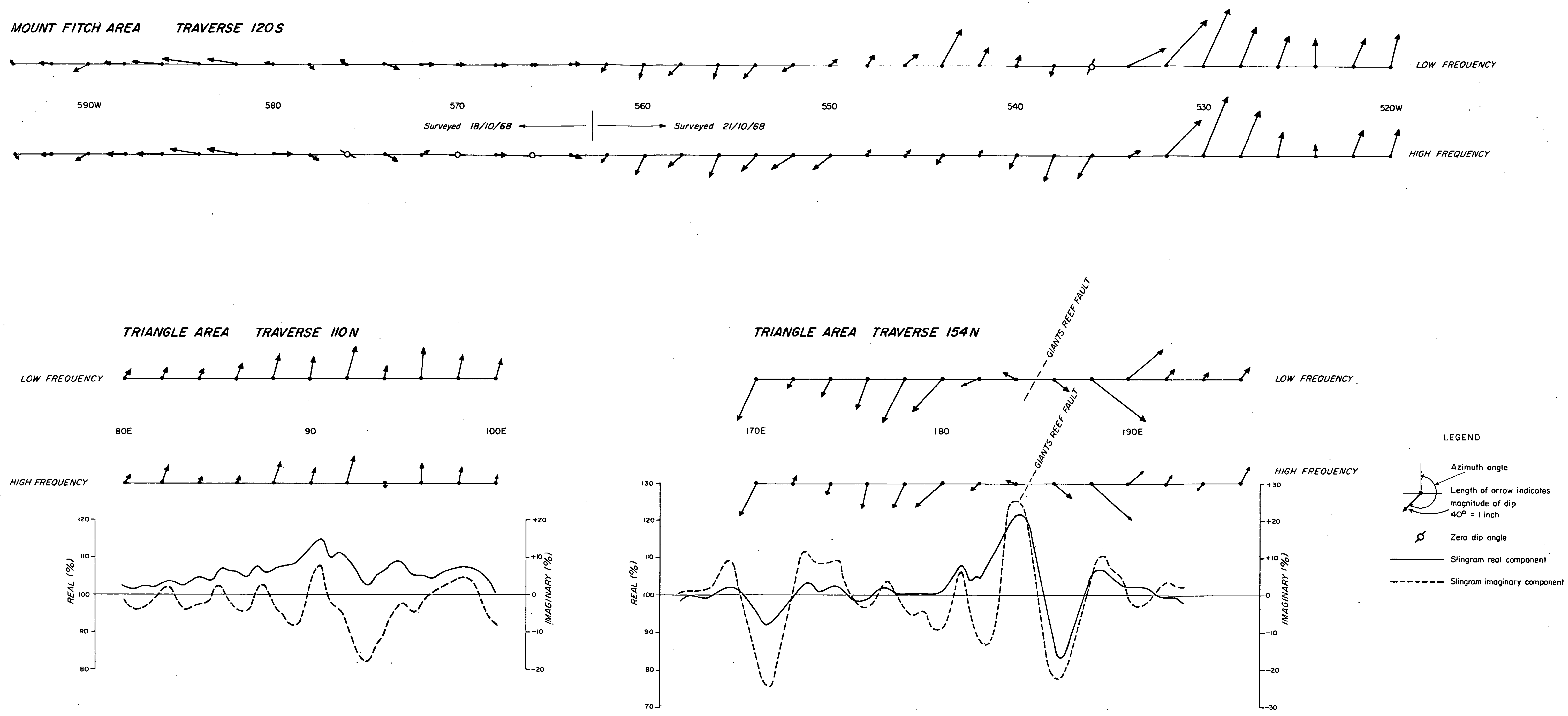
D52/B7-474



HORIZONTAL SCALE

400 0 400 800 1200 FEET

AFMAG Vector scale 40° = 1 inch

AFMAG VECTOR PLOTS AND SLINGRAM PROFILES

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