

AERIAL, GEOLOGICAL AND
GEOPHYSICAL SURVEY
OF
NORTHERN AUSTRALIA.

REPORT
WESTERN AUSTRALIA, No. 64.

**GEOPHYSICAL REPORT ON THE WILUNA AREA,
WILUNA**

(PART 2, MAGNETIC SURVEYS)

BY

L. A. RICHARDSON, J. M. RAYNER, B.Sc., AND P. B. NYE, M.Sc., B.M.E.



By Authority :
L. F. JOHNSTON, Commonwealth Government Printer, Canberra.
(Printed in Australia.)

LIST OF PUBLICATIONS.

PERIODICAL REPORTS.

- Report for Period Ended 30th June, 1935
 Report for Period Ended 31st December, 1935 } In one publication.
 Report for Period Ended 30th June, 1936.
 Report for Period Ended 31st December, 1936.
 Report for Period Ended 30th June, 1937.
 Report for Period Ended 31st December, 1937.
 Report for Period Ended 30th June, 1938.
 Report for Period Ended 31st December, 1938.
 Report for Period Ended 30th June, 1939.
 Report for Period Ended 31st December, 1939.
 Report for Period Ended 30th June, 1940.
 Report for Period Ended 31st December, 1940.

GENERAL REPORTS.

- No. 1, Geophysical Practice of the Aerial, Geological and Geophysical Survey of Northern Australia, by J. M. Rayner, B.Sc., F.Inst.P., R. F. Thyer, B.Sc., A.Inst.P., and L. A. Richardson, A.Inst.P.

INDIVIDUAL REPORTS.

WESTERN AUSTRALIA.

- No. 1, McPhee's Patch Area, Pilbara Gold-field, by K. J. Finucane, M.Sc.
 No. 2, The North Pole Mining Centre, Pilbara Gold-field, by K. J. Finucane, M.Sc.
 No. 3, Lalla Rookh Mining Centre, Pilbara Gold-field, by K. J. Finucane, M.Sc. (See also W.A. No. 11.)
 No. 4, The Nullagine Conglomerates, Pilbara Gold-field, by K. J. Finucane, M.Sc.
 No. 5, The Nullagine River Concessions, No. 695H, Pilbara Gold-field, by K. J. Finucane, M.Sc.
 No. 6, Talga Talga, Pilbara Gold-field, by M. O'Halloran, B.Sc.
 No. 7, The Blue Spec Gold-Antimony Quartz Veins, Middle Creek-Nullagine District, Pilbara Gold-field, by K. J. Finucane, M.Sc.
 No. 8, Marble Bar Mining Centre, Pilbara Gold-field, by K. J. Finucane, M.Sc.
 No. 9, Bamboo Creek Mining Centre, Pilbara Gold-field, by K. J. Finucane, M.Sc.
 No. 10, Halley's Comet Centre, Pilbara Gold-field, by K. J. Finucane, M.Sc. (See also W.A. No. 28.)
 No. 11, Lalla Rookh Gold Mine, Pilbara Gold-field, by K. J. Finucane, M.Sc. (Supplementary to W.A. No. 3.)
 No. 12, Station Peak Mining Centre, Pilbara Gold-field, by K. J. Finucane, M.Sc.
 No. 13, The Just-in-Time Conglomerates, Pilbara Gold-field, by K. J. Finucane, M.Sc.
 No. 14, The North Shaw Mining Centre, Pilbara Gold-field, by K. J. Finucane, M.Sc.
 No. 15, McLeod's Find, Dalton Mining Centre, Pilbara Gold-field, by K. J. Finucane, M.Sc.
 No. 16, The Tambourah and Western Shaw Mining Centres, Pilbara Gold-field, by K. J. Finucane, M.Sc.
 No. 17, The Sharks Well Mining Centre, Pilbara Gold-field, by K. J. Finucane, M.Sc. (In same publication as W.A. No. 26.)
 No. 18, The Twenty Ounce Mining Centre, Pilbara Gold-field, by K. J. Finucane, M.Sc., and C. J. Sullivan, B.Sc.
 No. 19, Mining Centres East of Nullagine, Pilbara Gold-field, by K. J. Finucane, M.Sc.
 No. 20, The Warrawoona Area, Pilbara Gold-field, by F. H. Jones.
 No. 21, The Salgash-Apex Area, Pilbara Gold-field, by K. J. Finucane, M.Sc.
 No. 22, The Boodalyerrie Mining Centre, Pilbara Gold-field, by K. J. Finucane, M.Sc.
 No. 23, The Yandicoogina Mining Centre, Pilbara Gold-field, by K. J. Finucane, M.Sc.
 No. 24, The Braeside Lead Field, Pilbara District, by K. J. Finucane, M.Sc.
 No. 25, Recent Gold Discoveries near Wyman's Well, Pilbara Gold-field, by K. J. Finucane, M.Sc.
 No. 26, The Country between Sharks and North Shaw, Pilbara Gold-field, by F. H. Jones. (In same publication as W.A. No. 17.)
 No. 27, The Hall's Creek-Ruby Creek Area, East Kimberley District, by K. J. Finucane, M.Sc. (In same publication as W.A. Nos. 41 and 42.)
 No. 28, Halley's Comet and Adjacent Mines, Pilbara Gold-field, by K. J. Finucane, M.Sc. (Supplementary to W.A. No. 10.)
 No. 29, The Mount Dockerell Gold Mining Centre, East Kimberley District, by K. J. Finucane, M.Sc. (with Appendix on the Christmas Creek Area, by C. J. Sullivan, B.Sc.)
 No. 30, Tin-Columbite Deposits South-East of Mount Dockerell, East Kimberley District, by K. J. Finucane, M.Sc.
 No. 31, The Mount Amherst Gold and Silver-Lead Deposits, East Kimberley District, by F. H. Jones.
 No. 32, The King Sound Tin-Wolfram Deposit, West Kimberley District, by K. J. Finucane, M.Sc.
 No. 33, The Mount Broome Area, West Kimberley District, by K. J. Finucane, M.Sc.
 No. 34, The Chromite Deposits of Coobina, Peak Hill Gold-field, by K. J. Finucane, M.Sc.
 No. 35, Geophysical Report on the Kookynie Area, North Coolgardie Gold-field, by E. L. Blazey, M.E.E., J. M. Rayner, B.Sc., and P. B. Nye, M.Sc., B.M.E.
 No. 36, Geophysical Report on the Wiluna Area, Wiluna. (Part 1, Electro-magnetic Surveys), by E. L. Blazey, M.E.E., J. M. Rayner, B.Sc., and P. B. Nye, M.Sc., B.M.E.
 No. 37, (a) Notes on the Geology of the Big Bell Area, by K. J. Finucane, M.Sc.
 (b) Geophysical Report on the Big Bell Area, by E. L. Blazey, M.E.E., J. M. Rayner, B.Sc., and P. B. Nye, M.Sc., B.M.E. } One publication.
 No. 38, Geophysical Report on the Norseman Area, Norseman, by E. L. Blazey, M.E.E., J. M. Rayner, B.Sc., and P. B. Nye, M.Sc., B.M.E.
 No. 39, Geophysical Report on the Bamboo Creek Area, Pilbara Gold-field, by E. L. Blazey, M.E.E., J. M. Rayner, B.Sc., and P. B. Nye, M.Sc., B.M.E.
 No. 40, The Grant's Creek Gold Mining Centre (Panton River), East Kimberley District, by K. J. Finucane, M.Sc.
 No. 41, The Mary River Gold Mining Centre, East Kimberley District, by K. J. Finucane, M.Sc., and C. J. Sullivan, B.Sc. } In same publication as W.A. No. 27.
 No. 42, The Twelve-mile Alluvial Workings and Elvire River Dredging Reserves (893H and 948H) Hall's Creek, East Kimberley District, by K. J. Finucane, M.Sc.
 No. 43, The Barker River Area, West Kimberley District, by K. J. Finucane, M.Sc., and F. H. Jones } In one publication.
 No. 44, The Granite Range Area, West Kimberley District, by K. J. Finucane, M.Sc.
 No. 45, The Jimblebar Gold Mining Centre, Peak Hill Gold-field, by K. J. Finucane, M.Sc.
 No. 46, The Tantalite Deposits of the Pilbara Gold-field, by K. J. Finucane, M.Sc., and R. J. Telford.
 No. 47, The Antimony Deposits of the Pilbara Gold-field, by K. J. Finucane, M.Sc., and R. J. Telford } In one publication.
 No. 48, The Mullina and Peewah Mining Centres, Pilbara Gold-field, by R. J. Telford.
 No. 49, The Blue Asbestos Deposits of the Hamersley Ranges, Western Australia, by K. J. Finucane, M.Sc.
 No. 50, The Iron Deposits of Yampi Sound, Western Australia, by K. J. Finucane, M.Sc.
 No. 51, The Weeriana, Nicol Bay and Glenroebourne Mining Centres, Pilbara Gold-field, by K. J. Finucane, M.Sc., F. H. Jones and R. J. Telford.
 No. 52, The Hong Kong, Pilbara and Egina Mining Centres, Pilbara Gold-field, by C. J. Sullivan, B.Sc.
 No. 53, The Toweranna Mining Centre, Pilbara Gold-field, by R. J. Telford.
 No. 54, The Chrysotile Deposits of the Pilbara and Ashburton Gold-fields, by K. J. Finucane, M.Sc., C. J. Sullivan, B.Sc., and R. J. Telford.
 The Well and Mons Cupri Copper Mines, Pilbara Gold-field, by K. J. Finucane, M.Sc., and C. J. Sullivan, B.Sc.

AERIAL, GEOLOGICAL AND GEOPHYSICAL SURVEY OF NORTHERN AUSTRALIA.

GEOPHYSICAL REPORT ON THE WILUNA AREA, WILUNA (PART 2, MAGNETIC SURVEYS).

WESTERN AUSTRALIA REPORT No. 64.

TABLE OF CONTENTS.

	PAGE.
I. INTRODUCTION	3
II. GEOLOGY	3
III. NATURE OF THE PROBLEM	4
IV. METHOD USED	4
V. ANALYSIS OF OPERATIONS	4
VI. TESTS UNDER KNOWN CONDITIONS	5
VII. RESULTS—	
(a) General.. .. .	5
(b) Between 0 and 4000S	6
(c) Lake Fault (Indication A)	6
(d) Between Lake Fault and 5400S	6
(e) South-east of 5400S	6
(i) An anomalous area centred at 6000S/100E	6
(ii) Bending of the main magnetic markers	6
(iii) Strongly disturbed area	7
(iv) Termination of the magnetic markers	7
VIII. RECOMMENDATIONS FOR TESTING—	
(a) Indication B	8
(b) Indication C	8
(c) The strongly disturbed area	8
IX. TESTING	8
X. SUMMARY AND CONCLUSIONS	8
APPENDIX	11

SUPPLEMENTARY REPORT.

I. INTRODUCTION	15
II. INTERPRETATION ASPECTS	15
III. ANALYSIS OF MAGNETIC ANOMALIES	16
(1) Well-defined magnetic " highs " presumably due to magnetite segregations	16
(2) Irregularly disturbed anomalies	17
IV. INTERPRETATION OF SURVEY RESULTS	18
V. REVIEW OF ELECTRO-MAGNETIC INDICATIONS.. .. .	20
VI. CONCLUSIONS	20

PLATES.

1. Plans of layout showing geology, isoanomaly lines, magnetic markers and indications, and suggested drilling sites.
 2. Profiles of the vertical component of the magnetic field, traverses 00 to 7000S (Magnetic Survey co-ordinates).
 3. Profiles of the vertical component of the magnetic field, traverses 7200S to 11200S (Magnetic Survey co-ordinates) and 3600S, 3900S and 4500S (Wiluna Gold Mines co-ordinates). Tests for magnetic effects of cores from surface drill holes.
 4. Plan of layout showing suggested geological structure based on interpretation of magnetic results.
- 2548/41.

AERIAL, GEOLOGICAL AND GEOPHYSICAL SURVEY OF NORTHERN AUSTRALIA.

GEOPHYSICAL REPORT ON THE WILUNA AREA, WILUNA (PART 2, MAGNETIC SURVEYS).

I. INTRODUCTION.

The mining centre of Wiluna is situated in the central portion of Western Australia and is 460 miles by air line north-east of Perth.

During the 1937 field season, an extensive electro-magnetic survey was made by the North Australia Survey in the vicinity of the Wiluna gold mine, and the results are described in a previous report⁽¹⁾.

During 1938 it was decided to conduct a magnetic survey over portions of the Wiluna field. For reasons to be discussed in section III.⁽²⁾, it was considered that such survey would not only check the results of the electro-magnetic survey but in addition would yield information in areas which, for technical reasons, did not fall within the scope of the electro-magnetic survey. Further it was anticipated that it would be possible to trace certain magnetic horizons in the volcanic series of rocks.

This extension of the geophysical surveys at Wiluna was approved by Mr. F. G. Forman, Government Geologist of Western Australia.

The survey was commenced half a mile south-east of the Wiluna gold mine and extended a further 2 miles to the south-east.

The co-operation and assistance of the staff of the Wiluna Gold Mines Ltd. is gratefully acknowledged.

II. GEOLOGY. (see Plate 1.)

A report made by H. J. C. Conolly to Wiluna Gold Mines Ltd. on Ore Prospects describes the geology of the Wiluna area, and the following description is based on that report.

The Wiluna-Moonlight area shows a succession of Pre-Cambrian lavas with Flow III. at the bottom and Flow I. at the top of the volcanic pile. In this series between Flow II. and Flow III. there are also bands of quartz dolerite, hornblende and actinolite rocks. The flows are invaded by several other intrusives, the most important of which is the porphyrite underlying the western margin of the area mapped. The bands of dolerite and the lava flows strike north-west, dip steeply and form part of the south-western limb of an anticline pitching north-west.

The lava flows have been described as under:—

Flow I.—Spherulitic lava, pillow and greenstone types.

Flow II.—Porcelanic lava, pillow and greenstone types.

Flow III.—Actinolite and hornblende rocks (this group contains several beds of slate and some spherulitic lava).

There has been profound dislocation of the rock assembly by faults, along north and north-east lines of faulting, the blocks on the western sides of the faults having northerly displacements. The vertical component of the displacements appears to be much smaller than the horizontal and, on the whole, the blocks on the western sides are probably on the downthrow sides. The faults dip to the east in the greater part of the area and to the west in the Moonlight portion. The ore deposits are found along these faults.

The most important break is marked by the straight Graphite shear (or No. 2 West Lode fault) near the eastern margin of the porphyrite dyke. It should be noted that no gold has been found on the Graphite shear away from intersections of tributary fractures. Another fault or shear—the Lake fault—was detected as a result of diamond drilling operations about 1 mile south-east of the Wiluna main shaft.

The faults tend to stretch the beds along the faults. This tendency is particularly evident on the Wiluna 1400-ft. level where the continuity of Flow II. has not been completely broken by the East Lode fault. This character of the dislocation is again shown by the very unusual changes in attitude of important fault lines, the highly variable displacements on successive mine levels and the apparent rapid dying out of the structures.

⁽¹⁾ Blazey, E. L., Rayner, J. M. and Nye, P. B. Geophysical Survey of the Wiluna Area, Wiluna (Part 1, Electro-magnetic Surveys), Aer. Geol. Geoph. Sur. N. Aust. Rept. No. 36, 1940.

⁽²⁾ See p. 4.

The Wiluna faults are not simple planes and the beds are not uniform in thickness, and the complicated structures thereby developed provided the loci for the deposition of ore. The rock contacts show rolls of rude cylindrical and conical shapes, and very irregular drag folds. In addition, the beds thicken and thin with impressive twists and changes of strike as the mine workings reach greater depths.

The members of the volcanic pile have exhibited different response to the stresses causing the faulting. The heterogeneous environment of the Flow I.—Flow II. contact has shattered freely and has been, and will probably remain, the most important ore producer of the field. The ore occurs in Flow II. or Flow I. or both rocks, the contact at the Wiluna and Moonlight mines being generally included within the deposits. *There is not much doubt that the contact of Flow I. and Flow II. lava is the most favorable rock environment for the occurrence of ore on the field.*

This Flow I.—Flow II. contact passes under cover south-east of the mine, and the Wiluna company conducted exploration by diamond drilling in the search for faults intersecting this favorable environment. Twenty-two holes have been drilled. One fault, named the Lake fault, was discovered and lode material (not payable) was found. In other parts of the field, the results suggested the presence of faulting but the information obtained was too indefinite to indicate the structural details and to be of much use.

The geological information available at the beginning of the survey is shown on plate 1, the interpretation of the drilling results being made by the staff of the Wiluna Gold Mines Ltd.

III. NATURE OF THE PROBLEM.

The electro-magnetic method was used in the 1937 survey in an attempt to trace any faults and shears, as such features are one of the main controls in the localization of the ore-bodies on the Wiluna field. This method, while successful in locating shears in areas adjoining the mines and north of Lake Violet, could not be effectively used on the southern side of the lake and along its northern margin owing to the high electrical conductivity of the surface layers (soil, alluvium, &c.) containing saline waters.

Another important geological feature controlling the localization of the ore-bodies is the contact between two of the lava flows (Flow I. and Flow II. greenstones) in the volcanic series. The ore-bodies occur either in Flow I. or Flow II. or in both rocks at their contact where intersected by shears. In view of the fact that rocks similar in type to the Flow I. and Flow II. greenstones have intense magnetic properties, it was decided to make a magnetic survey of the area south-east of the Wiluna mine in order to trace the favorable horizon. It was anticipated that, in the course of this survey, dislocations of the magnetic horizon would reveal any faults or shears. In this way the magnetic survey would give information concerning the faults and shears in areas not falling within the scope of survey by the electro-magnetic method.

IV. METHOD USED.

The method used was the magnetic one, and the vertical component of the earth's magnetic field was measured.

Two magnetometers (Watts Vertical Force Variometers Nos. 15,887 and 16,128) were used, the scale values being 31.1 and 34.3 gammas respectively. Most of the observations were made with Variometer No. 15,887. The repetition of readings and the temperature compensation of these instruments were satisfactory. These instruments measure variations in the vertical component of the earth's magnetic field (Z).

The intensity of the earth's magnetic field is modified locally owing to the effect of the magnetic properties of rocks present. The magnetic properties depend primarily on their content of magnetic iron oxides (magnetite, &c.). In general, the effect of a rock rich in magnetite is to increase the value of the intensity in the vicinity of such rock. The intensity is usually uniformly high immediately above such a rock in which the magnetite distribution is uniform. In rocks in which the magnetite distribution is not uniform, rapidly alternating high and low intensities will be found. Frequently, erratic polarization of small portions within a rock is found, and will produce a very irregular field. Such an irregular field is observed at the surface when the polarized portions are at no great depth.

V. ANALYSIS OF OPERATIONS.

The survey was commenced about half a mile south-east of the Wiluna gold mine and extended a further 2 miles to the south-east and covered an area of approximately 850 acres. Of this area, there are exposures of bedrock on only 40 acres. Lake Violet, with salt water up to 4 feet in depth at the time of the survey, embraces about 250 acres, a thin sheet of mill residues covers about 80 acres; and sand hills and clay pans occur on the remainder.

Field work was commenced on 12th July and concluded on 24th September, thus occupying 10 weeks. Two technical officers, L. A. Richardson and C. H. Zelman and two field assistants were employed as required, the party being in charge of Mr. L. A. Richardson.

Readings were taken at 25 feet intervals along traverses which were generally spaced 200 feet apart, and which had a bearing of $45^{\circ} 30'$. The meridian adopted was that of the Wiluna Gold Mines and is approximately magnetic north and south. A number of traverses crossed the waters of Lake Violet but it was found that the speed of the work was not greatly reduced under such conditions.

The co-ordinates used were based upon a base-line bearing $135^{\circ} 30'$, but the system (Magnetic Survey) differs from that used by the Wiluna Gold Mines and those of the 1937 electromagnetic surveys. Three traverses across the southern extension of the Wiluna faults were, however, surveyed on the Wiluna Gold Mine co-ordinate system.

VI. TESTS UNDER KNOWN CONDITIONS.

The survey was commenced with three test traverses (0, 200S and 400S) near the mine where the geological structure was known from surface mapping, and extended to the south-east where previous drilling had yielded a certain amount of information. Thus there were excellent opportunities for obtaining correlations from known geological sections and the magnetic results obtained along such sections.

The profiles along the test traverses are shown on plate 2. It was found that the magnetic intensity was practically uniform above Flow III., the quartz dolerite and Flow II. On Flow I. the intensity was found to be high and somewhat irregular. The work was continued to the south-east with traverses at 200 feet intervals. The traverses were extended in length to embrace more of Flow I. and it was found that the magnetic field above this flow could be divided into three zones parallel to each other and trending along the strike of the flow. Zone A corresponds to that portion of the flow adjacent to Flow II., is about 450 feet wide and shows an anomaly up to 300 gammas relative to the regional value of the intensity. Zone B adjoins Zone A on the south-west, and is about 600 feet wide and shows an anomaly up to 600 gammas. Zone C adjoins Zone B on the south-west, appears to be about 1,050 feet in width and shows no anomaly. The south-western boundary of the latter zone was not well-defined.

At the conclusion of the field work, field tests were made on diamond drill cores to determine the relative magnetic properties of the various rocks. Cores from eleven surface and ten underground holes were examined and the results of the former are shown on plate 3. Low and fairly uniform values of the magnetic properties were indicated for Flow III., the quartz dolerite, Flow II. and Zone C of Flow I. Higher values of the magnetic properties were indicated for Zone A of Flow I. and still higher values for Zone B of Flow I.

Drill core specimens representative of the various flows and the quartz dolerite were submitted to Dr. F. L. Stillwell, Mineragraphist, Council for Scientific and Industrial Research. Dr. Stillwell's Report^(*) is included as an Appendix to this report. It disclosed that specimens from Zone A of Flow I. contain numerous minute particles of hematite and magnetite, and that specimens of Zone B of Flow I. show an abundance of fine microlites and skeletal crystals of magnetite.

Thus, both field tests and petrological determinations explain why Zones A and B of Flow I. give rise to anomalies in the earth's magnetic field.

Zone B served as a reliable marker indicating the position and the strike of Flow I., and the interpretation of the results has been based chiefly on this marker. Less pronounced features in the results appear to denote other markers (contacts of rocks). These results provide a means of determining the geological structure of the area in some detail.

The naming of the rock types as adopted by Wiluna Gold Mines Ltd. seems in particular cases to be somewhat at variance with the results of Dr. Stillwell's examination. For the purpose of this report it appears advisable to accept the classification of Wiluna Gold Mines Ltd. because the geological mapping is based upon such classification and because the results of the Survey will be of primary interest to the company.

VII. RESULTS.

(a) *General*.—The field observations were reduced and plotted as profiles (see plates 2 and 3), showing the variation in the vertical intensity from station to station. The centre of Zone B anomaly and the junction of Zones B and C of Flow I. provide markers conforming in strike to the flows. The principal structural interpretation has been based on these markers and they are shown on plate 1. The centre of Zone B anomaly is referred to as the main magnetic marker. In addition to these markers other magnetic features in the profiles provide minor markers which also have a bearing on the geological structure.

(*) Stillwell, F. L. Drill cores from Wiluna, Mineragraphic Investigations of the Council for Scientific and Industrial Research. Rept. No. 148, 1939.

The position of a rock boundary inferred from the magnetic survey, may not agree accurately with the position of the contact at the surface. Where weathering, causing oxidation of the magnetite, is deep, the dip of the rocks would displace the magnetic anomaly in the direction of dip and away from the contact at the surface.

After smoothing the profiles of minor anomalies of shallow-seated origin, plans showing lines of equal anomaly in vertical intensity (magnetic isoanomaly lines) were prepared and are shown on the upper portion of plate 1. Plates 2 and 3 show all magnetic profiles and the manner of smoothing.

(b) *Between 0 and 4000S.*—The Zone B–Zone C marker maintains a course parallel to the Flow I.–Flow II. contact throughout the region where those rocks could be geologically mapped. This agreement suggests that the marker indicates a boundary between separate rock types within Flow I. or alternatively between portions of Flow I. with notably different magnetite segregations. The Wiluna Gold Mines geological staff regard Flow I. as a series of flows. The magnetic zones may therefore represent separate flows with differing magnetic characteristics.

There is slight buckling in the main marker and in the marker corresponding to the Flow I.–Flow II. contact, near traverses 1800S and 2400S. The presence of minor faulting in this vicinity had previously been suspected by geologists of Wiluna Gold Mines Ltd. The markers continue undisturbed to the south-east until the Lake fault is reached.

(c) *Lake Fault (Indication A).*—In this vicinity the magnetic marker horizons are displaced to the south on the plan along a line which shows excellent agreement with the position of the Lake fault as determined geologically. As the geological determination was based upon evidence from drill holes only, the position and strike as determined magnetically may be the more accurate ones. The location of this fault demonstrated in a most striking manner the applicability of the method to this type of problem.

The line of displacement is shown on plate 1 as indication A. The indication is clearly shown by the Flow I. markers but to the north of these markers other features in the profiles suggest that the fault plane bends at about 3800S/0 and passes by drill hole No. 514. This north-eastern continuation, however, is at variance with the geological interpretation of the drill hole results.

(d) *Between Lake Fault and 5400S.*—South-east from the Lake fault, the profiles show the typical characteristics up to traverse 5400S.

(e) *South-east of 5400S.*—South-east of 5400S lies the area where diamond drilling has indicated complexity in geological structure and has not elucidated same. The magnetic results also indicate changed conditions in this portion of the field and the principal features of the results are as follows:—

(i) *An Anomalous Area Centred at 6000S/100E.*—Between traverses 5400S and 6400S, a well-defined anomaly (increased intensity) appears. The anomaly covers a lens-shaped area, its axis being parallel to the base-line and situated at about 100E.

On its western side, the margin of the anomaly agrees with the narrow band of Flow II. found in drill holes Nos. 630 and 636. Four drill holes had been bored and the cores were examined for magnetic properties. It was found that the average susceptibility was high and comparable with that of Zone B of Flow I. The rock has generally been referred to as quartz dolerite. Its magnetic properties, however, distinguish it from the normal quartz dolerite of other parts of the area surveyed, and Dr. Stillwell's report states that it "differs considerably in appearance from the normal quartz dolerite. The most striking difference is the abundance of fairly coarse crystals of magnetite throughout the rock." The Wiluna Gold Mines geological staff consider that field work has not yet given any reason for assuming this body to be a separate sill from the main quartz dolerite greenstone.

(ii) *Bending of the Main Magnetic Marker.*—The marker indicating the junction between Zones B and C of Flow I. was traced beyond the Lake fault and up to traverse 6000S without any bends. Between traverses 6000S and 8000S, the profile characteristics of the zones of Flow I. are less distinct and interpretation is difficult. However, the main marker remains fairly well-defined and has at least two bends. These bends are generally similar to that at indication A and, therefore, are considered to indicate faulting and/or folding of the rocks. It seems that the faulting and/or folding would affect the Flow I.–Flow II. contact and possibly produce zones favorable for ore deposition.

Beyond traverse 6600S, the magnetic features on the profiles are confused and, although the main marker can be reliably traced, interpretation to give the structure beyond that traverse is not possible. It seems, however, that there is irregularity in strike and in thickness of the various flows. Drill hole No. 621 (7000S/400W) was vertical, 197 feet deep and the unweathered zone was not reached. The bore log shows undeterminable rock to 118 feet and Flow II. from 118

to 197 feet. Near the drill hole there is 200 gammas relative anomaly, whereas Flow II., where known elsewhere, shows no more than 50 gammas. It is therefore suggested that the classification should be Zone A of Flow I. Four specimens were supplied to Dr. Stillwell for examination which was inconclusive due to the weathered nature of the rock. Dr. Stillwell reports⁽⁴⁾—" . . . they are suggestive of highly altered forms of a fine-grained greenstone".

To mark the axis of the faulting and/or folding in the flows, indications B and C are shown on plate 1. Indication B passes drill hole No. 623. The log of this bore reveals unusual conditions in that fine yellow quartz sand occurs to a depth of 130 feet. The lower part of this hole, which is 213 feet deep, shows quartz dolerite. Similar sand deposits occur in two other drill holes. No. 507, which is close to the Lake fault, revealed alluvial sand to a depth of 165 feet. No. 500, 460 feet north-west of No. 507, encountered well-rounded to sub-angular sand to a depth of 140 feet.

(iii) *Strongly Disturbed Area*.—The main magnetic marker can be traced to traverse 8000S. An abrupt change then occurs, the profiles showing strong and irregular disturbances over an area as marked on plate 1. It has a general trend in an east-west direction. As far as traced it has a length of 5,000 feet and a width ranging from 400 to 1,200 feet. The edges were well-defined along the western part which terminates at a point near 5100S/2200W. The eastern part, which falls within Lake Violet, is not so well-defined.

A smaller area with similar features is present on traverses 6400S to 7800S near, and to the south of, the base line.

On the large area, anomalies up to 6,000 gammas were measured and extreme fluctuations occur, e.g. a change of 5,000 gammas between stations 25 feet apart. An analysis of the results is difficult on account of the irregularities. The anomalies appear to indicate a very shallow-seated origin such as magnetic over-burden. Cases occur, however, notably on traverse 8000S, where an anomaly centred at 1500W is of a type usually attributable to a deeper-seated source. Moreover, the area of anomalies crosses lakes, salt pans and sand hills, without showing any alteration in the above characteristics.

To seek information concerning the origin of the anomalies, pits and boreholes were sunk to shallow depths to test the superficial layers. The greatest depth reached was 12 feet. Sand and clay were revealed but no strongly magnetic material. These tests were inconclusive since it was not practicable, with the means at the party's disposal, to penetrate the overburden as far as would have been desirable.

If these anomalies do not arise from magnetic material in the overburden, they must arise from an irregular distribution of magnetic material in the bedrock at shallow depths. As a result of discussions with Mr. H. A. Ellis, Acting Government Geologist for Western Australia, it appears possible that the formation responsible is a jaspilite.

In later correspondence Mr. Ellis supplied the following information:—

I had a quick look at Mr. Richardson's plans during the short interval he was in Perth, and, as a consequence of what he told me, I concluded that there was every possibility that the major anomaly of his plan was caused by the occurrence of a hidden band of what we call "jaspilite" in this State.

This jaspilite is similar to the banded ironstone formation, banded quartz-hematite schist, &c., of American and Indian Pre-Cambrian geology, and consists of a rock composed of interbanded layers respectively rich in silica (quartz or chalcedony) and iron oxides (magnetite, hematite and limonite).

Various amounts of ferruginous amphiboles are sometimes present and the Western Australian jaspilites are frequently contorted and brecciated.

They occur in the Greenstone Series of the Pre-Cambrian rocks right throughout Western Australia, and I know they occur as outcrops near Wiluna.

These jaspilites are associated with the lava flows and are, of course, of sedimentary origin. Most of our mines are situated in close proximity to jaspilite and they form a conspicuous feature of most of our gold-bearing areas.

They are of lenticular nature and frequently reveal evidence of intense folding.

Mr. Ellis strongly recommended testing to determine the nature of the material responsible for the anomalies and stressed the importance of prospecting the zone for gold if jaspilite is found.

(iv) *Termination of the Magnetic Markers*.—The magnetic markers were traced satisfactorily to the vicinity of traverse 8600S. The intensity of the anomaly associated with Flow I. gradually diminished from the Lake fault to traverse 8600S. In the area south-east from 8600S, the intensely magnetically disturbed area described in (c) above, the magnetic markers could not be recognized. Further traverses were made to the south-east of the disturbed area, but there was no indication of the characteristic magnetic markers on the profiles. The explanation of the above may lie in the fact that the magnetic content of Flow I. gradually becomes less to the south-east and consequently the associated magnetic anomalies decrease in intensity until they become unrecognizable. It is equally likely that the geological structure is different either due to wedging out of the lava flows or to the presence of rocks not present in the north-western portion of the layout.

(4) Stillwell, F. L. *op. cit.*

VIII. RECOMMENDATIONS FOR TESTING.

(a) *Indication B.*—Two sites on this indication are considered to warrant testing by diamond drilling. The No. 1 site has been selected to intersect the apparent line of faulting and/or folding in the vicinity where the Flow I.—Flow II. contact is considered to exist. The No. 2 site has been selected to explore the faulting and/or folding east of the magnetic quartz dolerite and near the small zone showing strongly disturbed magnetic conditions. Particulars of these drill sites are—

No. 1.—At 7590S/4770E (W.G.M. co-ordinates). Inclined hole, bearing 282° , depression 60° . Suggested depth 425 feet, or at 7520S/4430E (W.G.M. co-ordinates). Inclined hole, bearing 102° , depression 45° .

No. 2.—At 6980S/4610E (W.G.M. co-ordinates). Inclined hole, bearing 102° , depression 45° . Suggested depth 425 feet.

(b) *Indication C.*—The final selection of a site for the testing of indication C would best be left until the results of drilling on indication B become available. However, a preliminary selection has been made to intersect the apparent line of faulting and/or folding in the vicinity where the Flow I.—Flow II. contact is considered to exist. Particulars for this site (No. 3) are—

No. 3.—At 8200S/4800E (W.G.M. co-ordinates). Inclined hole bearing 102° , depression 45° . Suggested depth 425 feet.

(c) *The Strongly Disturbed Area.*—The testing of the strongly disturbed area to determine the nature of the material responsible could be done at any convenient position on the elongated part of this area between traverses 5400S and 8600S.

In the first instance, it would be advisable to conduct such testing by shaft sinking. If the cause of the anomalies is not found within the overburden at a shallow depth, then some testing by diamond drilling would be desirable. For the latter contingency two drill sites have been selected. They are based upon the assumption that the anomalies arise from jaspilite or other magnetic material in the bedrock. In addition site No. 4 has been selected so that an inclined drill hole would test the boundary between the strongly disturbed area and the adjoining formation (assumed to be Flow I.). Particulars of this site (No. 4) are—

No. 4.—At 9530S/4870E (W.G.M. co-ordinates). Inclined hole bearing 18° , depression 45° . Suggested depth 425 feet.

Site No. 5 has been selected for testing the disturbed zone where a strong dyke-like anomaly was obtained, centred at about 8000S/1500W (Magnetic Survey co-ordinates).

No. 5.—At 9560S/4500E (W.G.M. co-ordinates). Inclined hole bearing 30° , depression 45° . To shallow depth.

IX. TESTING.

The shallow testing conducted during the progress of the survey, to throw some light on the origin of the large magnetically disturbed area at the south-eastern extremity of the area surveyed, has already been described. It extended only to shallow depths and was inconclusive.

The results of the survey and the recommended sites for testing have been given to the Wiluna Gold Mines Ltd. No particulars of any drilling conducted by the company have so far been made available to the Survey.

X. SUMMARY AND CONCLUSIONS.

A magnetic survey was made of the area to the south-east of the Wiluna gold mine in order to supplement and extend the information gained from the electro-magnetic survey made in 1937. This area is one in which the surface is occupied by salt-water lakes, sandhills, alluvial and detrital deposits, &c. The magnetic method of prospecting was able to yield information concerning the nature and structure of the underlying rocks, which information could not be gained by geological or other geophysical means.

It was found possible to trace for considerable distances magnetic marker beds corresponding to certain horizons in the series of lava flows. In this way, mapping of the contact of the Flow I. and Flow II. greenstones could be achieved—this contact had been shown as a result of the geological surveys of Wiluna Gold Mines Ltd. to be one of the favorable features localizing the gold deposits at Wiluna.

In addition to tracing the beds, the magnetic survey showed where breaks or bends of the magnetic markers occurred and these have been interpreted as faulting and/or folding in the greenstone flows. It is the intersection of faults with the favorable Flow I.—Flow II. contact that gives the environment for the localization of the gold deposits.

At the Lake fault, previously known from drilling results, the magnetic marker beds were found to be considerably displaced along a line which agreed with the Lake fault in position and trend. This successful detection of the Lake fault demonstrated in a very satisfactory manner the usefulness of the magnetic method for the conducting of structural studies involving the Pre-Cambrian basic volcanic rocks.

The magnetic pattern obtained at the Lake fault was repeated to a certain extent at places farther to the south-east and consequently it was considered that further faulting and/or folding of the greenstone flows occurred at such places. Sites for testing by diamond drilling were selected along these faults or folds where they are considered to intersect the Flow I.—Flow II. contact. After following the magnetic marker horizons to the south-east for approximately 9,000 feet they terminated. The termination is considered to be due either to the decrease in the magnetic content of the flows or else to the existence of an entirely different geological structure beyond this place. To the south-east of the termination, a large and elongated zone of intense and irregular magnetic anomalies was found. The origin of these anomalies is not known. They may arise from magnetic material in the overburden or possibly from a rock type such as jaspilite in the bedrock. It is considered advisable that a small amount of testing should be conducted to determine the material responsible for the anomalies. If jaspilite is found to be present, further testing would be justified.

(Sgd.) L. A. RICHARDSON,
Applied Geophysicist.

(Sgd.) J. M. RAYNER,
Consultant Geophysicist.

(Sgd.) P. B. NYE,
Executive Officer.

Sydney, 21st April, 1939.

APPENDIX.

MINERAGRAPHIC INVESTIGATIONS OF THE COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH.

Report No. 148.

University of Melbourne,
17th March, 1939.

DRILL CORES FROM WILUNA.

A number of drill cores have been submitted for examination by the Aerial, Geological and Geophysical Survey of Northern Australia, in connexion with the Magnetic Survey carried out immediately south-east of the Wiluna Mine. The specimens, marked according to the number of the drill hole and the depth in feet, were listed by the Survey as follows:—

<i>Flow I.</i> —Magnetic Zone "A"—					
630/340', 636/470'	..	..	..	..	Surface hole.
Magnetic Zone "B"—					
643/230', 643/670'	..	..	..	..	Surface hole.
Magnetic Zone "C"—					
663/400', 663/600'	..	..	..	..	Surface hole.
<i>Flow II.</i> —621/133', 621/150', 621/170', 621/190'					
630/320'	..	..	..	..	Surface hole.
692/400'	..	..	..	..	2,000' level hole.
<i>Flow III.</i> —622/620', 622/940'					
Quartz dolerite, normal.—622/360', 622/440'	..	..	..	..	1,200' level hole.
Quartz dolerite, magnetic.—636/305', 636/340'	..	..	..	..	Surface hole.

Flow I.—Magnetic Zone "A".

630/340' is a pale coloured rock except where it is streaked with segregations of chlorite. The original phenocrysts are wholly converted into chlorite and calcite, and the groundmass is somewhat indefinite from alteration, but suggestive of the actinolite base of 663/400'. Dust-like particles of iron-ore are disseminated through the rock, and in places are rather densely aggregated. They are probably magnetite.

636/470' is an altered basic rock in which the pyroxene, occurring originally both as phenocrysts and in the groundmass, is completely altered to chlorite. Felspar laths are distinguishable in the groundmass, which is largely altered to a cloudy mass of secondary products which include chlorite and other micaceous matter, calcite, a little epidote and sphene. Some of the calcite from this alteration has segregated into veinlets together with a little quartz and iron oxide. Particles of leucocene are scattered through the rock, and there are fairly numerous minute particles of hematite and magnetite, as well as a few scattered particles of chalcopryrite and pyrite. The rock is finer grained than a normal quartz-dolerite, and, except in the segregation veins, there is no conspicuous quartz.

Magnetic Zone "B".

643/230' is essentially an aggregate of long, acicular crystals of actinolite which are sometimes altered to chlorite or calcite and quartz. The needles occur in somewhat divergent groups and a few contain traces of the pyroxene from which they have been derived. Throughout the rock there are numerous fine microlites and skeletal crystals of magnetite, as well as finely granular particles of sphene. The felspar is mostly segregated in a vein which also contains calcite, quartz, chlorite, and a little pyrite. The rock is clearly related to the type from 3400S/1250E, described in Report No. 134.

643/670' is similar to the preceding in the abundance and distribution of skeletal crystals of magnetite. Otherwise the rock does not represent the same advanced state of metamorphism, and a considerable amount of the original pyroxene is preserved. The prisms of pyroxene are shorter and stouter than those in the specimen from 3400S/1250E. Some are partly replaced by actinolite and partly by chlorite at the core of the crystals. The interstitial areas between the pyroxene and amphibole crystals are occupied by a little felspar and a brownish material, which, when it can be resolved, appears to be a fine mass of actinolite fibres and chlorite.

Magnetic Zone "C".

663/600' contains chlorite pseudomorphs after pyroxene, which generally contain a few small particles of magnetite. In addition there are altered needles of presumably actinolite, set in a mass of brownish, compact aggregates of fibrous amphibole, occasionally crossed by segregation veinlets of calcite and epidote. There are occasional minute particles of chalcopryrite. The rock seems clearly related to specimen 2200S/780E, described in Report No. 134, and situated in a mapped area, the Magnetic Zone "A" of Flow I.

663/400' is a completely altered rock consisting of calcite, chlorite, and quartz in which clots and strings of dark chlorite are visible in the hand specimen.

Flow II.

621/133', 621/150', 621/170', 621/190' all consist of extremely uniform clay, and reveal no structure or recognizable mineral. They are suggestive of highly altered forms of a fine-grained greenstone.

630/320' is an altered basic lava which is similar to 636/470' in grain size and in the presence of chloritic pseudomorphs after phenocrysts of pyroxene. The felspathic groundmass is also similar but differs in the presence of small scattered areas of quartz, sometimes with rods of apatite. Sporadic ilmenite has been completely altered to leucocene. The rock is a fine-grained phase of a quartz-dolerite-greenstone.

692/400' is a less altered and coarser grained type than 630/320', and should be grouped with the normal quartz dolerite. Much of the pyroxene is unaltered, though some of it is altered to an unusual, hard, yellowish-green product with moderate refractive index and moderate polarization colours. Under high power, it is partly composed of small stellate aggregates which are probably fibrous amphibole (nephrite?). The felspar is moderately fresh, and occurs as long laths comparable in size with the pyroxene. It is similar to typical quartz dolerite in the presence of scattered quartz and patches of leucocene. Narrow veins of calcite traverse the section, and considerable areas of chlorite are present, as well as a little epidote.

APPENDIX—continued.

Flow III.

622/620' is a rock containing unusually elongated prisms of pyroxene, some of which have their central portions replaced by chlorite. They appear under crossed nicols as hollow, skeletal crystals. These prisms are set in a dense, compact groundmass containing some chlorite, a good deal of finely fibrous amphibole with probably a little zoisite and calcite. The rock is practically free from iron ore.

622/940' is a quartz dolerite, and differs from the preceding specimen in that the pyroxenes assume their normal crystalline form, and appear in more or less broad and short prisms. For the most part, they are relatively unaltered, but there is sometimes a slight marginal alteration to fibrous amphibole and chlorite. Traces only are observed of the peculiar nephritic (?) alteration of the pyroxene in 692/400'. Much of the felspathic groundmass in which the pyroxenes are set is altered, and there are occasional small clear areas of quartz, sometimes with included rods of apatite. A considerable amount of epidote and chlorite has developed, but much of the felspar has passed into a dense, cloudy mass. Occasional sphene and coarse patches of leucoxene are scattered through the rock.

Normal Quartz Dolerite.

622/360' is a rock consisting essentially of pyroxene, felspar with some quartz, and leucoxene. The felspar shows considerable alteration, though extinction angles of 15–20° can be measured, and indicate an acid andesine. Chlorite, epidote, and zoisite occur among the alteration products of felspar. Large plates of chlorite are also present. Quartz forms small, ragged areas, and is sometimes intergrown with felspar. There is also a trace of green hornblende.

622/440' is a much more felspathic type than the preceding. No pyroxene is present, but areas of chlorite among the interlocking crystals of felspar may have been derived from pyroxene. Felspar, which is andesine, occurs in stumpy prisms associated with irregular shaped quartz grains of equal dimensions, often containing rods of apatite. The felspar is partially altered to calcite and sericite, while calcite occurs as occasional large crystals. Leucoxene, derived from ilmenite, occurs as numerous scattered grains.

It is to be noted that the specimens from drill hole No. 622 indicate normal quartz dolerite at 360', a felspathic phase of quartz dolerite at 440', a pyroxenic phase at 940'. The specimens at 620' and 940' have been attributed in the field to Flow III. but the possibility should be recognized that the felspathic and pyroxenic phases have arisen from differentiation within the quartz dolerite.

Magnetic Quartz Dolerite.

636/305' and 636/340' are essentially similar, and differ considerably in appearance from the normal quartz dolerite. The most striking difference is the abundance of fairly coarse crystals of magnetite throughout the rock. The magnetite is disclosed in a polished section to be modified by segregation veinlets of limonite. Felspar and pyroxene are the dominant minerals, the quartz occurring in minor amount in small grains. The pyroxene has a brownish tinge, and shows a little alteration to chlorite. It occurs as long prisms, and also in radiating "graphic" intergrowths with felspar. The felspar is an andesine, and for the most part occurs in stumpy prisms comparable in size to the pyroxene. A smaller generation of felspar laths occurs in the interstitial groundmass and in segregations where the small felspars are set in a chloritic and actinolitic groundmass. In 636/340' the felspar is lightly sericitized.

(Sgd.) FRANK L. STILLWELL.

SUPPLEMENT TO REPORT WESTERN AUSTRALIA No. 64.

WILUNA MAGNETIC SURVEY.

BY

L. A. RICHARDSON, J. M. RAYNER, B.Sc., AND
P. B. NYE, M.Sc., B.M.E.

AERIAL, GEOLOGICAL AND GEOPHYSICAL SURVEY OF NORTHERN AUSTRALIA.

WILUNA MAGNETIC SURVEY.

SUPPLEMENT TO REPORT WESTERN AUSTRALIA No. 64.

I. INTRODUCTION.

The main object of the magnetic survey of the south-eastern portion of the Wiluna area was to trace certain magnetic marker horizons in the rock series, and by this means to locate any faulting or bending of the beds, particularly near the Flow I-Flow II. contact, which was regarded by the Wiluna Company as a favorable environment for auriferous lodes. The results obtained have already been described in an annual report⁽¹⁾, and in the report to which this one is supplementary.

The main report was written during the 1938-39 interfield season. In that report the main magnetic marker, viz., the centre of Zone B of Flow I., was used to determine faulting or bending.

Further consideration was given to the magnetic results during 1941 and the present supplementary report was written.

The purpose of this report is to describe other features present in the profiles, and to give a more detailed interpretation based on all recognizable magnetic markers. The magnetic results obtained over the area between the Wiluna mine and the Lake fault provide markers which can be correlated with the known geology over that area. The interpretation of the magnetic results in the area south-east from the Lake fault is made on the basis of this correlation, the drill core determinations of rocks by Wiluna Gold Mines being largely disregarded. The reasons for this step are fully explained later.

The magnetic markers are shown on the profiles on plates 2 and 3, and the interpretation of the magnetic results is shown on plate 4.

II. INTERPRETATION ASPECTS.

A correlation of magnetic effects with known geological features shows the following characteristics for the various rocks:—

Flow I.—In the vicinity of the mine, Flow I. is assumed by Wiluna Gold Mines to extend from the underlying Flow II. to the fault or shear known as the Graphite shear. No attempt was made to divide this rock into separate flows, although the possibility of their existence was recognized. In the main report Flow I. has been divided into three magnetic Zones—A, B and C. Zones A and B show strong anomaly, while Zone C is practically free from anomaly. Field tests on drill cores representing these zones (taken from surface and underground drill holes) point to relative magnetic properties in accordance with the above.

The magnetic results suggest that Zones A and B represent one flow containing magnetite segregations, probably in the form of lenses, the principal segregation forming what has been referred to as Zone B, which gives the most pronounced anomaly. So far as magnetite content is concerned, Zone C is quite different from Zones A and B, and the junction between Zones B and C is sharp and well-defined. Zone C is, therefore, regarded as a second flow separate from Zones A and B.

On traverses 3900S and 4500S (W.G.M. co-ordinates) the profiles show a sudden change at 330W and 175E respectively, from the typically smooth profile due to Zone C to an irregularly disturbed profile due to a formation with appreciable magnetite content, and this formation will be referred to as Zone D.

Porphyrite.—Traverses 3900S and 4500S (W.G.M. co-ordinates) extend westwards across the Graphite shear from Zone D of Flow I. to the porphyrite. There is no marked change at the position of the Graphite shear, and on the basis of the results on these two traverses only, the contact between Zone D of Flow I. and the porphyrite cannot be fixed by magnetic methods. However, should the porphyrite be found adjacent to certain other rocks, e.g., Zone C of Flow I., the contact would probably be easily detected by magnetic survey.

⁽¹⁾ Report for period ended 31st December, 1938. Aer. Geol. Geoph. Surv. N. Aust.

Flow II.—The rock produces no magnetic anomaly, and profiles crossing this flow are very little disturbed. Field tests on drill cores produced no deflections, indicating relatively low magnetite content of the rock.

Flow III.—On test traverse A (zero) small disturbances are found on an otherwise anomaly-free profile. Tests of drill cores show no magnetic effects, indicating relatively low magnetite content.

Quartz dolerite.—On test traverse A (zero) the profile is disturbed irregularly to a minor extent where it crosses the quartz dolerite. On traverse 3000S, strong shallow-seated disturbances occur between 1800E and 2000E, where presumably quartz dolerite is present. However, the log of drill hole No. 500, which is nearby, shows sand to a depth of 140 feet, and it is, therefore, unlikely that the disturbances are produced by the quartz dolerite. On traverse 3900S, quartz dolerite is presumably present between about 900E and 1270E (*vide* drilling results), and the profile is little disturbed over this part. Profiles across the quartz dolerite are thus inconsistent. It is possible that magnetic material in the overburden is responsible for the small irregularities that are found in some places. Tests on drill core pieces show no magnetic effects.

It is evident from the foregoing characteristics of the various rocks that the magnetite segregations which occur within Flow I. are the most outstanding magnetic formations. They appear to have the strike of the flow, to be in the form of lenses, and to serve as reliable markers.

The anomaly produced by these lenses is pronounced on a number of the profiles. On traverses 0 to 3000S the profiles show strong and erratic anomalies of shallow-seated origin, superimposed on the broad magnetic "high" produced by the magnetite segregations as a whole. Most of these irregular anomalies occur where there is little or no cover and where the surface is strewn with small boulders of Flow I. Magnetic field tests and mineralogical tests show that some of these boulders are rich in magnetite, and the field tests show that they are polarized. The magnetite content of drill cores down to a depth of 50 feet or more seems to be generally low relative to the content at a greater depth. This is apparently due to normal oxidation processes. The magnetite-rich material probably includes the boulders referred to above and a thin superficial layer of rock in which there has been a concentration of magnetite. This feature has been noted in surveys over certain ironstone deposits at Tennant Creek.

The lenses would thus comprise from surface downwards:—

- (i) Thin mantle of superficial material rich in magnetite and with erratic arrangement of magnetic poles. (The magnetite-rich boulders would be derived from this mantle.)
- (ii) Oxidized zone of thickness 50 feet or more, where apparently the magnetite content is low, and the material, consequently, contributes little to the main anomaly.
- (iii) The remainder which is mainly responsible for the magnetic "high". As these segregations seem to be lens-shaped, their depth would probably be variable.

The effect of the first of these can be eliminated from the profiles by smoothing, the resulting smoothed profiles representing the anomaly due to the other two. In some cases the smoothing necessary is very severe.

Irregular disturbances are found in abundance on profiles in other parts of the area. They are particularly noticeable over the area of irregular anomaly shown in plates 1 and 4. These results are described in the main report where it is stated that the magnetic material responsible is not likely to be near-surface overburden.

III. ANALYSIS OF MAGNETIC ANOMALIES.

(1) *Well-defined magnetic "highs" presumably due to magnetite segregations.* The more or less regular form of the smoothed profile over Zones A and B of Flow I. represents an anomaly suitable for mathematical analysis within certain limits.

Of primary consideration is the nature of the magnetization responsible for the anomaly. The tests of drill core specimens from Zone B of Flow I. (diamond drill hole No. 643) show that on the average the intensity of permanent magnetization is approximately seven times the intensity of magnetization induced by the earth's field. The information on this subject is far from complete. For instance, the original attitude of all the drill core pieces was not known and the direction of this permanent magnetization has not been even approximately determined.

For cases where the anomaly arises from induction in the earth's field methods of calculation are available to cover a wide variety of conditions, and these methods have been described by numerous authors. Amongst others, Gulattee⁽²⁾ gives the following method for calculating the vertical component anomaly (ΔZ) due to a vertical dyke, the formula being derived from potential

(²) Gulattee, B. L. Magnetic Anomalies. Survey of India. Professional Paper No. 29, 1938.

theory using Poisson's Law and Green's Theorem. The lower end of the dyke is assumed to be at infinite depth, and the dyke is assumed to extend to infinity in the direction of strike both sides of the traverse which crosses the dyke at right angles.

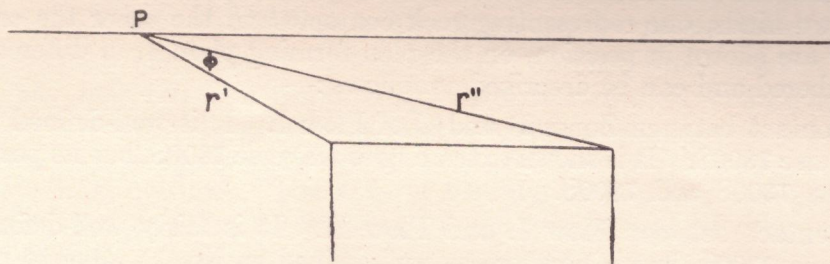


DIAGRAM 1

Referring to Diagram 1,

$$\Delta Z \text{ at } P = 2 k Z (\Phi) + 2 k H \log_e \frac{r'}{r''} \cos \beta \dots \dots \dots (1)$$

where k = susceptibility of the dyke material in c.g.s. units.

Z and H = vertical and horizontal components respectively of the earth's magnetic field, in gauss.

β = magnetic azimuth of the traverse in degrees.

Φ being expressed in radians.

Assuming the magnetite segregations Zones A and B of Flow I. to be vertically dipping dykes, calculations in accordance with the above fail to produce a satisfactory profile to fit the measured one. Presumably this is largely due to the fact that permanent magnetism is not being considered. It appears from the form of the anomaly that the magnetization responsible is more or less vertical. It is therefore necessary to introduce the effect of relatively strong permanent magnetization in a vertical direction.

Equation (1) then becomes:—

$$\Delta Z = 2 (k Z + I) (\Phi) + 2 k H \log_e \frac{r'}{r''} \cos \beta \dots \dots \dots (2)$$

where I = intensity of permanent magnetization in c.g.s. units.

(Diagram 2 occupies a full page and is to be inserted as near here as possible.)

Diagram 2 shows a profile calculated on the above basis to fit the measured profile on traverse 5600S (after smoothing) between 900W and 600E. This was obtained by calculating separate profiles for Zones A and B and compounding them. The dimensions and magnetic properties of the bodies used in the calculations are shown on the diagram. The assumed value for Z , H and β are 0.47, 0.28 (in gauss) and 45 degrees respectively.

The above treatment is regarded as a very approximate analysis of the magnetic anomaly. As is frequently the case when strong permanent magnetism is present, little else can be attempted. The work is intended to indicate the type of bodies apparently responsible for the magnetic "highs". The susceptibility figures deduced from the above treatment are lower than the value usually ascribed to basic volcanic rocks. However, for the purpose of this analysis it is considered that they are acceptable, and there seems to be little justification for further analyses by assuming other figures for depth to top of bodies, proportion of intensity of permanent to induced magnetization and direction of permanent magnetization.

Generally speaking this type of analysis can be applied to other similar magnetic "highs" appearing on the profiles.

(2) *Irregularly Disturbed Anomalies.*—Profile 5600S shown in diagram 2 exhibits, in addition to the magnetic "high" anomalies attributed to magnetite segregations, typical anomalies due to shallow-seated formations exhibiting strong permanent magnetism with erratic pole arrangement. The boundaries of the formations responsible for this type of anomaly are usually well-defined.

Between 1960W and 2350W, profile 5600S shows the results over part of the larger area of irregular anomaly shown on plates 1 and 4. Magnetic overburden frequently shows this type of anomaly, but as explained in the main report, the opinion is held that such overburden is probably not responsible in this case, but the presence of jaspilite, rich in magnetite, is suspected. If such is the case then the probable depth to the material responsible for this anomaly would be equal to the depth of overburden, which probably varies considerably. It is known that this depth exceeds 12 feet at 8000S/1450W, where a test hole was put down to that depth and revealed sand and clay only. On diagram 2 is shown the boundaries (marker No. 6) of this formation, and a distribution of random poles illustrating the erratic pole arrangement.

IV. INTERPRETATION OF SURVEY RESULTS.

On the basis of the method of analysis described in the previous section of this report, the position of magnetic markers has been placed on the profiles (plates 2 and 3). These markers are of two kinds, one representing rock contacts and the other the centre of magnetic "highs". They are shown in position, on the plan forming plate 4, in different symbols. The markers are numbered and can be described as follows:—

No. 1.—Contact between Zones B and C of Flow I. It is well-defined between traverse A (zero) and traverse 7300S. It is shown extending to traverse 7800S, but its position is somewhat uncertain between 7300S and 7800S.

No. 2.—Contact between Flow I. and Flow II. It is fairly well-defined from traverse A (zero) to traverse 3300S, but is nowhere as well-defined as No. 1. Due to poor definition its position is likely to be as much as 100 feet in error. South-east from traverse 3300S this marker is very doubtful in many places.

No. 3.—Western boundary of Zone C of Flow I., as shown by a change from smooth to disturbed conditions on profiles 3900S and 4500S (W.G.M. co-ordinates).

No. 4.—Western edge of an irregularly disturbed area. It is usually sharply defined. On traverse 3900S this marker occurs at 1270E where diamond drilling defines the contact between quartz dolerite and Flow III. It is considered possible, therefore, that the disturbed conditions may be due to erratic magnetite segregations within Flow III., and the interpretation on the plan is shown accordingly. Another possibility is that the disturbed conditions are due to a magnetic overburden which may or may not be closely associated with Flow III.

No. 5.—The eastern boundary of the irregularly disturbed area described under No. 4.

No. 6.—Boundary of the extensive area of irregular anomaly described in the main report and shown on plates 1 and 4. It is thought to be probably due to jaspilite.

No. 7.—Boundary of a smaller area showing similar characteristics to that outlined by No. 6 marker.

No. 8.—Centre of Zone B anomaly. It is very pronounced between traverse A (zero) and traverse 7200S. Beyond 7200S the anomaly either bends to the south and terminates on traverse 8400S (as shown on plate 4) or it continues in the position of marker No. 13.

No. 9.—Centre of a minor magnetite segregation occurring in Zone A of Flow I.

No. 10.—Centre of a minor magnetite segregation occurring in Zone A of Flow I. near to its contact with Flow II.

No. 11.—Centre of a minor magnetite segregation occurring in Zone A or B of Flow I. south-west of the Lake fault.

No. 12.—Centre of a magnetic "high" due to what has been referred to in the main report as magnetic quartz dolerite. Wiluna Gold Mines drill core determinations refer to this rock as quartz dolerite. Tests of drill cores and mineralogical determinations indicate the presence of much magnetite. For the purpose of this interpretation of results, this rock is regarded as another magnetite segregation within Zone A of Flow I. and corresponding generally in position to No. 10 farther to the north-west.

No. 13.—Centre of a minor magnetic "high" which may be the continuation of No. 8 or be due to another minor magnetite segregation within Flow I.

No. 14.—Centre of a small magnetic "high" apparently due to a minor magnetite segregation.

It should be noted that the geophysical interpretation conflicts with Wiluna Gold Mines geology in respect of the classification of drill cores from drill holes 621, 628, 630, 635 and 636. The core from drill hole 621 is regarded as Flow II. by Wiluna Gold Mines whereas geophysical results suggest that it is Flow I. The material in drill holes 628, 630, 635 and 636 determined by Wiluna Gold Mines to be quartz dolerite, is regarded on the geophysical evidence to be a magnetite segregation within Zone A of Flow I.

Dr. Stillwell's report ⁽³⁾ seems to suggest that a revision of the rock classification by the Wiluna Gold Mines might be necessary. In particular, so far as the above-mentioned drill holes are concerned, the following points are stressed:—

(i) Core from 305 to 340 feet in drill hole No. 636, described by Wiluna Gold Mines as quartz dolerite greenstone, is stated by Dr. Stillwell to "differ considerably in appearance from the normal quartz dolerite."

(ii) Core from 133, 150, 170 and 190 feet in drill hole 621 is stated by Dr. Stillwell to be "suggestive of highly altered forms of a fine grained greenstone", thus it may not necessarily be Flow II.

- (iii) Dr. Stillwell used the term "normal quartz dolerite" freely and refers to felspathic and pyroxenic phases which may have arisen from differentiation within the quartz dolerite. Thus it seems that some of the rocks described by the Wiluna Gold Mines as lava flows may be quartz dolerite and vice versa.

Attention is drawn to the logs of drill holes 500, 507 and 623 where alluvial sand was found to depths of 140, 165 and 180 feet respectively. The influence of underlying rocks in the adjacent magnetic profiles would be greatly reduced where so much cover is present.

Plate 4 shows the complete geophysical interpretation of the magnetic results with boundaries of certain beds outlined. The axes of bending or faulting, assumed to be present where displacement of the markers is indicated by the geophysical results, are shown in the form of indication lines.

The indication lines are described separately as follows :—

Indication A.—This is fixed by slight bending in markers 1, 8 and 2. There has probably been little displacement of the beds concerned.

Indication B.—This is due to the Lake fault. This fault was discovered by drilling and has been intersected at depth in five inclined drill holes. These drill holes fix the position of the fault over a distance of 1,200 feet. The geophysical results give its position over an additional length of 1,200 feet to the south.

The indication line represents the position of the fault plane at the top of the bedrock underneath the overburden. The position of the fault plane at depth, as revealed in the drill holes, is to the east of the indication line. This reveals that the fault plane is dipping to the east as do the other faults near the mine. Calculations show that the amount of dip is about 70 degrees.

Indication C.—This indication is not well-defined. It is based on the displacement of marker 4 between traverses 3700S and 3900S. This marker may, however, be due to superficial magnetic material and, therefore, of no use in determining underground structure. In drill hole 587 there is some evidence of shearing at 590–605 feet which may be due to a fault giving rise to this indication. This would mean that such a fault would have an almost vertical dip. Apparently no evidence of this postulated fault was found in drill hole 602.

Indication D.—The northern part of this indication is based on the behaviour of markers 4 and 5. As explained in the preceding paragraph, marker 4 may be of no use in determining structure and the same applies to marker 5.

In the vicinity of markers 2 and 12, this indication is defined fairly well by the bends in those markers.

The southern part of this indication is uncertain. It is shown joining with indication F near traverse 6600S, because marker 8 does not exhibit any suitable bending elsewhere which can be confidently related to the bending of markers 2 and 12. The slight bending in marker 8 between traverses 5600S and 6000S, and in marker 1 between 5800S and 6200S, is considered to be too indefinite to connect with the bending concerned in markers 2 and 12.

Of interest in connexion with structure in this part of the area is the sudden change in the behaviour of the 300 gamma magnetic contour line (*vide* plate 1) between traverses 5800S and 6000S. The form of the magnetic profiles across Zone B of Flow I. in these parts is not as simple as it is on the mine side of the Lake fault. It is possible that the lens giving rise to marker 11 has continued on from traverse 5100S to traverse 5800S, together with the marker 8 lens, in such a position that the effect of each lens cannot be separately recognized in the profiles. Marker 8 lens may have ended near traverse 5800S while faulting has brought marker 11 lens into the position of marker 8, shown on traverse 6000S and the succeeding traverses to the south-east. If such is the case the faulting referred to would be suitably placed to be related to the bending of markers 2 and 12 between traverses 5400S and 5600S, and to the bend in marker 1 between traverses 6200S and 6600S.

It will be seen that indication D is best defined in the region of markers 2 and 12, which is near to the favorable environment (Flow I.—Flow II. contact).

Indication E.—This indication, like the northern part of indication D, is based on markers 4 and 5 and consequently is very doubtful.

Indication F.—This indication passes through well-defined bends in markers 1 and 8 and a bend in marker 2, but the latter must be regarded as doubtful because the typical characteristics of Flow I. and Flow II. are not very pronounced on the magnetic profiles south-west of traverse 6200S.

Indication G.—This indication passes through bends in markers 1 and 8. It cannot be continued to the Flow I.—Flow II. contact because marker 2 cannot be traced beyond traverse 7200S.

V. REVIEW OF ELECTRO-MAGNETIC INDICATIONS.⁽⁴⁾

The electro-magnetic indications, marked by indication pegs I. to VIII., were regarded as being due to an extension of the Lake fault, and the indication was referred to as the Lake fault indication. The magnetic survey failed to trace the northern extension of the Lake fault beyond the Flow I.—Flow II. contact. However, the shear intersected at depth by drill hole 602 is considered by Wiluna Gold Mines to be the Lake fault. Continued northerly from the position so fixed, the Lake fault would pass to the west of the electro-magnetic indication, and possibly outside the area of the electrical survey. As shown on the magnetic survey plan, however, there is evidence from the magnetic survey to suggest the presence of a branch fault (indication C) passing by drill hole 514 and then trending in the direction of the electro-magnetic indication. The plan also shows another possible fault (indication D) trending towards the electro-magnetic indication.

The electrical indication marked by pegs IX., X. and XI., and referred to as the New fault indication, is a long way from the area of the magnetic survey. However, its extension southward would pass near to the area of complex bending as indicated by the magnetic survey results in the vicinity of traverse 7200S.

The electrical indication marked by indication pegs XV., XVI. and XVII. were considered to be due to shearing. Between traverses 4500S and 4800S (W.G.M. co-ordinates) this indication agrees closely with the western boundary of the magnetic Zone C of Flow I.

VI. CONCLUSIONS.

The detailed geophysical interpretation outlined in this report and shown on plate 4, agrees very closely with the known geology from traverse zero up to, and just beyond, the Lake fault.

There is a strong suggestion that Flow I. comprises three separate flows in the area adjacent to the mine. The most westerly of these separate flows, Zone D, may be represented by material shown as "Flow II. type (?)" on the Wiluna Gold Mines geological plans near traverses 3900S and 4500S (W.G.M. co-ordinates). The boundaries of the various components of Flow I. are outlined in some detail.

South-east from the Lake fault, an interpretation of the structure has been made which, more or less, disregards the rock determinations made by Wiluna Gold Mines for drill holes 621, 628, 630, 635 and 636. The "favorable environment" (Flow I.—Flow II. contact) is not clearly defined in the magnetic results south-eastwards from traverse 5100S. Its position beyond this traverse can be fixed only by inference in relation to the assumed position of Flow I. boundary.

The areas of irregular anomaly, and the parts of the area where interpretations are not given, show magnetic characteristics foreign to the area of known geology. The strong magnetic disturbances in the larger area of irregular anomaly are believed to be due to a shallow-seated and strongly magnetic formation with erratic pole arrangement. This formation has apparently not been affected by the bending or faulting exhibited by marker No. 1 between traverse 6200S and 8000S. It is, in fact, not conformable in strike to this marker. This suggests that the material responsible is either intrusive and of post-faulting age or a sub-surface deposit of the nature of a magnetic layer or laterite underlying the overburden of sand, &c. Laterite is frequently rich in magnetite, gives results of the kind obtained here, and is a feature on many of the gold-field areas. As already indicated, another possibility is that the material is jaspilite.

The assumed axes of bending or faulting as deduced from the behaviour of the magnetic markers, are shown on plate 4 in the form of indication lines. In the case of the Lake fault, the position of the fault axes as determined by the magnetic survey, is almost identical with the position as determined by drilling. Other axes of bending or faulting cannot be fixed with equal precision and the positions shown should be regarded as approximate, especially where bending is slight.

The presence of shearing cannot be determined directly by magnetic methods of survey. It can only be stated that, where the magnetic survey indicates the presence of bending or faulting, shearing and/or fracturing may be found.

The detailed geophysical interpretation described in this report is more complete than the preliminary interpretation made early in 1939. A comparison of the results obtained from the two interpretations shows that the position of indication C on plate 1 is about 200 feet south-east of the position of the corresponding indication G on plate 4. While the position occupied by indication G is favoured as marking the axes of bending in this vicinity, the matter is much in doubt due to poor definition of the markers concerned. The position of indication B on plate 1 is about 80 feet south east of that of the corresponding indication F on plate 4. The position of indication F is favoured in preference to that of indication B, but in this case the difference is not great.

⁽⁴⁾ Blazey, E. L., Rayner, J. M., and Nye, P. B. Geophysical Report on the Wiluna Area, Wiluna (Part 1, Electro-magnetic Surveys). Aer. Geol. Geoph. Surv. N. Aust. Rept., W. Aust. No. 36, 1938.

The supposition that the "magnetic quartz dolerite" is part of Flow I. has an important bearing on the structure of the area. If the supposition is found to be correct, it is recommended that indications D and F be tested by drilling where they cross marker 2 which represents the Flow I.—Flow II. contact.

As a result of the further analysis described in this report, it is considered that any testing of indications by drilling at the suggested drill sites given in the main report, should be postponed until the identity of the "magnetic quartz dolerite", and the magnetic material in the "area of irregular anomaly" has been established. For the former, further petrological examinations of specimens of drill cores would be required, and for the latter, shallow drilling would be satisfactory. When this information is available, it is considered that the subject of interpretation of the geophysical results should be reviewed. Drill sites for testing the indications should then be selected in collaboration with a geologist who is conversant with the Wiluna geological structures and ore occurrences, and who has local knowledge of the terrain concerned.

(Sgd.) L. A. RICHARDSON,
Applied Geophysicist.

(Sgd.) J. M. RAYNER,
Consultant Geophysicist.

(Sgd.) P. B. NYE,
Executive Officer.

Sydney, January, 1942.

LIST OF PUBLICATIONS—continued

WESTERN AUSTRALIA—continued

- No. 56, The Ellarine Hills and Andover Iron Deposits, Pilbara Gold-field, by K. J. Finucane, M.Sc., and R. J. Telford.
 No. 57, The Moolyella and Cooglegong Tin-fields, Pilbara Gold-field, by C. J. Sullivan, B.Sc.
 No. 58, Prospecting of the Coongan-Bamboo Creek Schist Area, Pilbara Gold-field, by F. H. Jones.
 No. 59, The Lalla Rookh-North Shaw Area, Pilbara Gold-field, by C. J. Sullivan, B.Sc.
 No. 60, The Black Hills Area, Ashburton Gold-field, by K. J. Finucane, M.Sc.
 No. 61, The Dead Finish, Mount Mortimer, Top Camp and Soldier's Secret Mining Centres, Ashburton Gold-field, by F. H. Jones and R. J. Telford. *In one publication.*
 No. 62, The Lead and Copper Deposits at Uaroo, Weston's and Hancock's, Ashburton Gold-field, by K. J. Finucane, M.Sc., and C. J. Sullivan, B.Sc. *In one publication.*
 No. 63, The Red Hill and Yarraloola Copper Fields, Ashburton District, by F. H. Jones.
 No. 64, Geophysical Report on the Wiluna Area, Wiluna (Part 2, Magnetic Surveys), by L. A. Richardson, J. M. Rayner, B.Sc., and P. B. Nye, M.Sc., B.M.E.

NORTHERN TERRITORY.

- No. 1, The Pine Creek Gold-field, by P. S. Hossfeld, M.Sc.
 No. 2, The Union Reefs Gold-field, by P. S. Hossfeld, M.Sc.
 No. 3, The Golden Dyke Mine and Adjacent Areas, by P. S. Hossfeld, M.Sc.
 No. 4, Report on Magnetic Prospecting at Tennant Creek, by J. M. Rayner, B.Sc., and P. B. Nye, M.Sc., B.M.E. (see also Nos. 23, 41 and 57).
 No. 5, The Mount Todd Auriferous Area, Pine Creek District, by V. M. Cottle (see also No. 31).
 No. 6, Geophysical Report on the Mount Todd Auriferous Area, Pine Creek District, by J. M. Rayner, B.Sc., and P. B. Nye, M.Sc., B.M.E.
 No. 7, Geophysical Report on the Fountain Head Area, Pine Creek District, by J. M. Rayner, B.Sc., and P. B. Nye, M.Sc., B.M.E. *In one publication.*
 No. 8, Geological Report on the Fountain Head Area, Pine Creek District, by V. M. Cottle *In one publication.*
 No. 9, Geophysical Report on the Yam Creek Area, Pine Creek District, by J. M. Rayner, B.Sc., and P. B. Nye, M.Sc., B.M.E. *In one publication.*
 No. 10, Geological Report on the Yam Creek Area, Pine Creek District, by V. M. Cottle. *In one publication.*
 No. 11, Geophysical Report on the Woolwonga Area, Pine Creek District, by J. M. Rayner, B.Sc., and P. B. Nye, M.Sc., B.M.E. *In one publication.*
 No. 12, Geological Report on the Woolwonga Area, Pine Creek District, by A. H. Voisey, M.Sc. *In one publication.*
 No. 13, Geophysical Report on the Iron Blow Area, Pine Creek District, by J. M. Rayner, B.Sc., and P. B. Nye, M.Sc., B.M.E. *In one publication.*
 No. 14, Geological Report on the Iron Blow Area, Pine Creek District, by P. S. Hossfeld, M.Sc. *In one publication.*
 No. 15, (a) Geophysical Test Surveys on the Britannia, Zapopan and Mount Wells Areas, Pine Creek District, by J. M. Rayner, B.Sc., and P. B. Nye, M.Sc., B.M.E. *One publication.*
 (b) Geological Notes on the Britannia and Zapopan Areas, Pine Creek District, by V. M. Cottle.
 No. 16, Geophysical Report on the Hercules Gold Mine, Pine Creek District, by J. M. Rayner, B.Sc., and P. B. Nye, M.Sc., B.M.E. (see also No. 47).
 No. 17, The Fletcher's Gully Area, Daly River District, by P. S. Hossfeld, M.Sc.
 No. 18, The Tin Deposits of the Buldiva-Collia Area, Daly River District, by P. S. Hossfeld, M.Sc.
 No. 19, The Daly River Copper and Silver-Lead Area, Daly River District, by P. S. Hossfeld, M.Sc. (see also No. 32).
 No. 20, The Eastern Portion of the Arltunga Area, Eastern MacDonnell Ranges District, by P. S. Hossfeld, M.Sc.
 No. 21, Quartz Body at Simpson's Gap, Alice Springs, by P. S. Hossfeld, M.Sc.
 No. 22, The Ciccone Mine, Winnecke Area, Eastern MacDonnell Ranges District, by P. S. Hossfeld, M.Sc. (In same publication as N.T. Nos. 39 and 40).
 No. 23, Second Report on Magnetic Prospecting at Tennant Creek (1936), by L. A. Richardson, J. M. Rayner, B.Sc., and P. B. Nye, M.Sc., B.M.E. (Supplementary to N.T. No. 4) (see also Nos. 41 and 57).
 No. 24, Geological Report on the Southern Extension of the Pine Creek Gold-field, Pine Creek District, by P. S. Hossfeld, M.Sc. *In one publication.*
 No. 25, Geophysical Report on the Southern Extension of the Pine Creek Gold-field, Pine Creek District, by J. M. Rayner, B.Sc., and P. B. Nye, M.Sc., B.M.E. *In one publication.*
 No. 26, The Evelyn Silver-Lead Mine, Pine Creek District:
 (a) Geological Report by P. S. Hossfeld, M.Sc.
 (b) Geophysical Report by J. M. Rayner, B.Sc., and P. B. Nye, M.Sc., B.M.E.
 No. 27, The Maude Creek Mining Centre, Pine Creek District, by V. M. Cottle.
 No. 28, The White Range Gold-field, Eastern MacDonnell Ranges District, by P. S. Hossfeld, M.Sc.
 No. 29, The Home of Bullion Mine, Central Australia, by P. S. Hossfeld, M.Sc.
 No. 30, Preliminary Report on The Granites Gold-field, Central Australia, by P. S. Hossfeld, M.Sc. (see also N.T. Nos. 43 and 48).
 No. 31, Second Report on the Mount Todd Auriferous Area, Pine Creek District, by P. S. Hossfeld, M.Sc., and P. B. Nye, M.Sc., B.M.E. (Supplementary to N.T. No. 5).
 No. 32, The Wallaby Silver-Lead Lode, Daly River District, by P. S. Hossfeld, M.Sc. (Supplementary to N.T. No. 19).
 No. 33, The Wolfram Hill-Hidden Valley Area, Pine Creek District, by A. W. Kleeman, M.Sc.
 No. 34, Geophysical Report on the Wolfram Hill Area, Pine Creek District, by R. F. Thyer, B.Sc., J. M. Rayner, B.Sc., and P. B. Nye, M.Sc., B.M.E. *In one publication.*
 No. 35, The Maranboy Tin-field, Pine Creek District, by T. V. Lewis, B.C.E. *In one publication.*
 No. 36, Geophysical Report on the Maranboy Tin-field, Pine Creek District, by R. F. Thyer, B.Sc., J. M. Rayner, B.Sc., and P. B. Nye, M.Sc., B.M.E. *In one publication.*
 No. 37, The Horseshoe Creek Tin-field, Pine Creek District, by A. W. Kleeman, M.Sc.
 No. 38, The Driffield Area, Pine Creek District, by P. S. Hossfeld, M.Sc.
 No. 39, The Glankroil Mine, Winnecke Gold-field, Eastern MacDonnell Ranges District, by P. S. Hossfeld, M.Sc. *In same publication as N.T. No. 22.*
 No. 40, The Winnecke Gold-field, Eastern MacDonnell Ranges District, by P. S. Hossfeld, M.Sc.
 No. 41, Third Report on Magnetic Prospecting at Tennant Creek (1937), by L. A. Richardson and J. M. Rayner, B.Sc. (see also N.T. Nos. 4, 23 and 57).
 No. 42, Geophysical Report on the Henbury Meteorite Craters, Central Australia, by J. M. Rayner, B.Sc.
 No. 43, The Gold Deposits of The Granites-Tanami District, Central Australia, by P. S. Hossfeld, M.Sc. (to which N.T. No. 30 was preliminary) (see also N.T. No. 48).
 No. 44, The Mineral Deposits of the Yerralba Area, near Katherine, by P. S. Hossfeld, M.Sc.
 No. 45, The Brock's Creek Area (including the Howley Gold Deposits), Pine Creek District, by P. S. Hossfeld, M.Sc.
 No. 46, The McKinley Gold Mine, Pine Creek District, by P. S. Hossfeld, M.Sc.
 No. 47, The Hercules Gold Mine, Pine Creek District, by C. J. Sullivan, B.Sc. (see also N.T. No. 16).
 No. 48, Geophysical Report on the Granites Gold-field, Central Australia, by R. F. Thyer, B.Sc., J. M. Rayner, B.Sc., and P. B. Nye, M.Sc., B.M.E. (see also N.T. Nos. 30 and 43).
 No. 49, Limestone Deposits near Alice Springs, Central Australia, by P. S. Hossfeld, M.Sc.
 No. 50, The Redbank (or Wollogorang) Copper Field, Northern Territory, by H. I. Jensen, D.Sc.
 No. 51, Geophysical Report on the Redbank (or Wollogorang) Copper Field, by R. F. Thyer, B.Sc., and J. M. Rayner, B.Sc.
 No. 52, The Wauchope Creek Wolfram Field, Central Australia, by P. S. Hossfeld, M.Sc.
 No. 53, The Hatches Creek Wolfram Field, Central Australia, by P. S. Hossfeld, M.Sc.
 No. 54, The Mount Doreen Wolfram Field, Central Australia, by P. S. Hossfeld, M.Sc.
 No. 55, The Mount Hardy Copper Field, Central Australia, by S. N. Kirk, B.Sc.
 No. 56.
 No. 57, Fourth and Final Report on Magnetic Prospecting at Tennant Creek, by L. A. Richardson and J. M. Rayner, B.Sc. (see also Nos. 4, 23 and 41).

LIST OF PUBLICATIONS—continued.

QUEENSLAND.

- No. 1, The Mount Freda-Canteen Area, Soldiers Cap, Cloncurry District, by C. S. Honman, B.M.E.
- No. 2, The Gilded Rose Area, Cloncurry District, by C. S. Honman, B.M.E.
- No. 3, The Geophysical Methods of the Electrical Prospecting Company of Sweden, used in the Aerial, Geological and Geophysical Survey of Northern Australia, by Sepp Horvath.
- No. 4, Geophysical Report on the Soldiers Cap Area, Cloncurry District, by J. M. Rayner, B.Sc., and P. B. Nye, M.Sc., B.M.E.
- No. 5, Geophysical Report on the Trekelano Area, Cloncurry District, by J. M. Rayner, B.Sc., and P. B. Nye, M.Sc., B.M.E. (see also No. 17).
- No. 6, Geophysical Report on the Dobbyn Area, Cloncurry District, by J. M. Rayner, B.Sc., and P. B. Nye, M.Sc., B.M.E.
- No. 7, Geophysical Report on the Dugald River Silver-lead Lodes, Cloncurry District, by J. M. Rayner, B.Sc., and P. B. Nye, M.Sc., B.M.E.
- No. 8, The Dugald River Silver-Lead Lodes, Cloncurry District, by C. S. Honman, B.M.E.
- No. 9, Geophysical Report on the Croydon-Golden Gate Area, Croydon Gold and Mineral Field, by J. M. Rayner, B.Sc., and P. B. Nye, M.Sc., B.M.E. (see also No. 44).
- No. 10, The Silver Ridge Auriferous Lodes, Cloncurry District, by E. O. Rayner, B.Sc.
- No. 11, Geophysical Report of the Silver Ridge Auriferous Lodes, Cloncurry District, by J. M. Rayner, B.Sc., and P. B. Nye, M.Sc., B.M.E. } In one publication.
- No. 12, The Claudie River Gold and Mineral Field, Portland Roads District, Cape York Peninsula, by E. Broadhurst, M.Sc., and E. O. Rayner, B.Sc. (see also No. 30).
- No. 13, Geophysical Report on the Iron Range Area, Claudie River Gold and Mineral Field, by C. A. Jarman, B.Sc., J. M. Rayner, B.Sc., and P. B. Nye, M.Sc., B.M.E.
- No. 14, The Hampden Copper Mines, Kuridala, Cloncurry District, by E. Broadhurst, M.Sc.
- No. 15, The Mount Oxide Copper Mine, Cloncurry District, by C. S. Honman, B.M.E. (In same publication as Q. No. 20.)
- No. 16, The Croydon-Golden Gate (Granite) Area, Croydon Gold and Mineral Field, by C. S. Honman, B.M.E. (see also No. 26).
- *No. 17, Second Geophysical Report on the Trekelano Area, Cloncurry District, by R. F. Thyer, B.Sc., J. M. Rayner, B.Sc., and P. B. Nye, M.Sc., B.M.E. (Supplementary to Q. No. 5.)
- (No. 18, The Soldiers Cap Area, Cloncurry District, by C. S. Honman, B.M.E. (with portions by R. J. S. Clappison, B.Sc., and E. O. Rayner, B.Sc., and Appendix by A. C. Booth, on Methods of Mapping with the aid of Aerial Photographs).
- No. 19, The Bower Bird Auriferous Area, Cloncurry District, by C. S. Honman, B.M.E. (see also No. 48).
- No. 20, The Mount Oxide Area, Cloncurry District, by C. S. Honman, B.M.E. (In same publication as Q. No. 15.)
- *No. 21, The Ballara Area, Cloncurry District, by C. S. Honman, B.M.E. (with portions by M. L. Wade).
- No. 22, The Mount Elliott-Hampden Area, Cloncurry District, by C. S. Honman, B.M.E.
- No. 23, The Tin Deposits of the Stanhills Area, Croydon Gold and Mineral Field, by R. J. S. Clappison, B.Sc. (In same publication as Q. No. 51.)
- No. 24, Geophysical Report on the Lolworth Area, Charters Towers District, by R. F. Thyer, B.Sc., J. M. Rayner, B.Sc., and P. B. Nye, M.Sc., B.M.E. (see also No. 55).
- No. 25, The Felsite Auriferous Area, Croydon Gold and Mineral Field, by R. J. S. Clappison, B.Sc., and S. B. Dickinson (see also No. 38).
- *No. 26, The Croydon-Golden Gate (Granite) Area, Croydon Gold and Mineral Field, by S. B. Dickinson. (Supplementary to Q. No. 16.)
- *No. 27, The Herberton Tin Lodes, Herberton District, by E. Broadhurst, M.Sc. (see also Nos. 40 and 42).
- *No. 28, The Watsonville Tin Lodes, Herberton District, by M. L. Wade (see also Nos. 40 and 43).
- *No. 29, The Tyrconnell-General Grant Auriferous Area, Hodgkinson District, by S. B. Dickinson.
- No. 30, The Claudie River Gold and Mineral Field, Portland Roads District, Cape York Peninsula, by E. O. Rayner, B.Sc. (Supplementary to Q. No. 12.)
- No. 31, The Auriferous Conglomerates Area, Palmer River District, by R. J. S. Clappison, M.Sc. }
- No. 32, The Maytown Auriferous Area, Palmer River District, by R. J. S. Clappison, M.Sc. } In one publication (see also No. 45).
- No. 33, The Cannibal Creek Tin Lodes, Palmer River District, by R. J. S. Clappison, M.Sc.
- No. 34, The Cobalt Deposits of the Cloncurry District, by E. O. Rayner, B.Sc.
- No. 35, The Cloncurry Copper Deposits, with Special Reference to the Gold-Copper Ratios of the Ores, by P. B. Nye, M.Sc., B.M.E., and E. O. Rayner, B.Sc.
- No. 36, Geophysical Report on the Area south east of Mount Coolon Gold Mine, by B. P. Oakes, B.Sc., B.E., J. M. Rayner, B.Sc., and P. B. Nye, M.Sc., B.M.E.
- No. 37, The Lochness Area, Cloncurry District, by H. I. Jensen, D.Sc.
- (No. 38, The Felsite Auriferous Area, Croydon Gold and Mineral Field, by R. J. S. Clappison, M.Sc. (Supplementary to Q. No. 25.)
- (No. 39, The Hodgkinson District, by H. I. Jensen, D.Sc. (see also No. 50).
- No. 40, The Herberton District, by H. I. Jensen, D.Sc., (see also Nos. 27, 28, 41, 42 and 43.)
- *No. 41, Geophysical Report on the Herberton Deep Lead, Herberton District, by R. F. Thyer, B.Sc., J. M. Rayner, B.Sc., and P. B. Nye, M.Sc., B.M.E. (see also No. 40).
- *No. 42, Geophysical Report on the Herberton Tin Lodes, Herberton District, by R. F. Thyer, B.Sc., J. M. Rayner, B.Sc., and P. B. Nye, M.Sc., B.M.E. (see also Nos. 27 and 40).
- *No. 43, Geophysical Report on the United North Australian Group of Mines, Watsonville, Herberton District, by R. F. Thyer, B.Sc., J. M. Rayner, B.Sc., and P. B. Nye, M.Sc., B.M.E. (see also Nos. 28 and 40).
- *No. 44, Geophysical Report on the Croydon-Golden Gate Area, Croydon Gold and Mineral Field, by L. A. Richardson, J. M. Rayner, B.Sc., and P. B. Nye, M.Sc., B.M.E. (Supplementary to Q. No. 9.)
- *No. 45, The Palmer River District, by H. I. Jensen, D.Sc. (see also Nos. 31 and 32).
- *No. 46, The Lawn Hill Silver-Lead-Zinc-Field, Lawn Hill-Wollogorang District, by H. I. Jensen, D.Sc.
- No. 47, Report on Portion of North-Western Queensland adjacent to the Northern Territory Border, by H. I. Jensen, D.Sc.
- No. 48, The Eastern Portion of the Bower Bird Area, Cloncurry District, by H. I. Jensen, D.Sc. (See also Q. No. 13.)
- *No. 49, Geophysical Report on the Blair Athol Coal-field, by R. F. Thyer, B.Sc., and J. M. Rayner, B.Sc.
- No. 50, The Antimony Deposits of the Hodgkinson District, by H. I. Jensen, D.Sc. (see also No. 39).
- No. 51, The Tin Deposits of the Stanhills Area, Croydon Gold and Mineral Field, by H. I. Jensen, D.Sc. (In same publication as Q. No. 23.)
- No. 52, The Manganese Deposits of the Cairns District, by H. I. Jensen, D.Sc.
- *No. 53, The Chillagoe District, by H. I. Jensen, D.Sc.
- *No. 54, (a) Geophysical Report on Supposed True Blue Deep Lead, Croydon Gold-field, by R. F. Thyer, B.Sc., and J. M. Rayner, B.Sc. }
- (b) Geophysical Report on Potential Ratio Survey in the Croydon Gold-field, by R. F. Thyer, B.Sc., and J. M. Rayner, B.Sc. } In one publication.
- *No. 55, Second Geophysical Report on Lolworth Area, Charters Towers District, by R. F. Thyer, B.Sc., and J. M. Rayner, B.Sc. (see also No. 24).

In the above list—

* denotes reports prepared and in course of being edited;

† denotes reports prepared, edited and forwarded to the Printer, but not yet published.

Absence of any mark before a report number indicates that such report has been published.

PLAN OF
GEOPHYSICAL LAYOUT
— SHOWING —
VERTICAL COMPONENT
ISOANOMALY LINES
— IN VICINITY OF —
FLOW I—FLOW II CONTACT

— LEGEND —

- 500-600 Gammas
- 400-500 -
- 300-400 -
- 200-300 -
- 100-200 -
- Strongly and irregularly disturbed magnetic field.
- Main magnetic marker, indicating apparent centre of strongly magnetic Zone B or Flow I shown on plan below.
- Magnetic indications A, B & C representing faulting or bending.

INSTRUMENTS —
Rull's Vertical Variometer No 15887, Scale value, 31.1 gammas.
16128, 34.5

WILUNA MAGNETIC SURVEY

— SCALE —

FEET 0 500 1000 1500 2000

L. Richardson
Party Leader
1-2-39
J. M. Kayner
Consultant Geophysicist
31-5-39

CONDENSED LOGS FOR D.D. HOLES IN VICINITY OF 7000 S, 4000 E W.G.M. CO-ORDS.					REMARKS
Nº	CO-ORDS	DEPTH	DIP		
621	7173 S, 4063 E	197'	90°		Flow II, 2" Quartz at 113'
623	7215 S, 4682 E	213'	90°		0'-30' Q.D.G.?, 30'-130' Sand, no core; 130'-197' probably Q.D.G.; 197'-213' Q.D.G.
625	6601 S, 3700 E	29'	90°		Flow I.
626	6751 S, 3959 E	90'	90°		Flow I.
628	6823 S, 4090 E	87'	90°		Probably Q.D.G.
630	6951 S, 4275 E	352'	45°		0-60' indefinite; 60'-149' Q.D.G. ? 149'-310' Q.D.G.; 310'-333' Flow II; 333'-352' Flow I.
634	7281 S, 4165 E	164'	50°		Q-45' Q.D.G. or Flow II ?; 45'-75' Flow I or II ?
635	7236 S, 4527 E	158'	50°		75'-158' Flow I.
636	6945 S, 4375 E	694'	50°		0-140' Q.D.G.; 140'-372' ? Flow II or Q.D.G.; 372'-409' ? somewhat actinolitic; 409'-694' Flow I.

PLAN OF
AREA SURVEYED
— SHOWING —
MAIN FEATURES, GEOLOGY
— AND —
GEOPHYSICAL LAYOUT

— LEGEND —

- Flow III (Actinolite and hornblende rocks with several beds of siltite and some spherulitic lava)
- Flow II (Porcelaneous lava, pillow and greenstone types)
- Flow I (Spherulitic lava, pillow and greenstone types)
- Porphyrite
- At surface
- Faults and Shears
- In D.D. holes
- Quartz porphyry
- Felsite
- Quartz
- Ore bodies
- Vertical D.D. holes by Wiluna Gold Mines
- Inclined D.D. hole sites recommended by Nth Aust. Survey

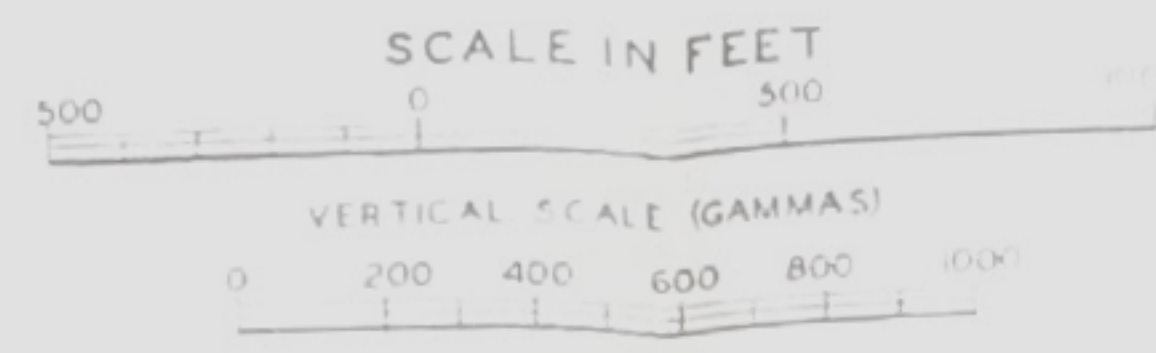
Note: Geology and drilling information supplied by Wiluna Gold Mines Ltd during 1938

Wiluna Gold Mines co-ordinate system shown thus

GEOPHYSICAL EXPLANATION

- Area with strongly and irregularly disturbed magnetic field
- Main magnetic marker (Position taken from contour plan above)
- Magnetic indications A, B & C representing faulting or bending
- Inferred position of Flow I—Flow II contact
- Boundaries of magnetic zones A, B & C of Flow I.

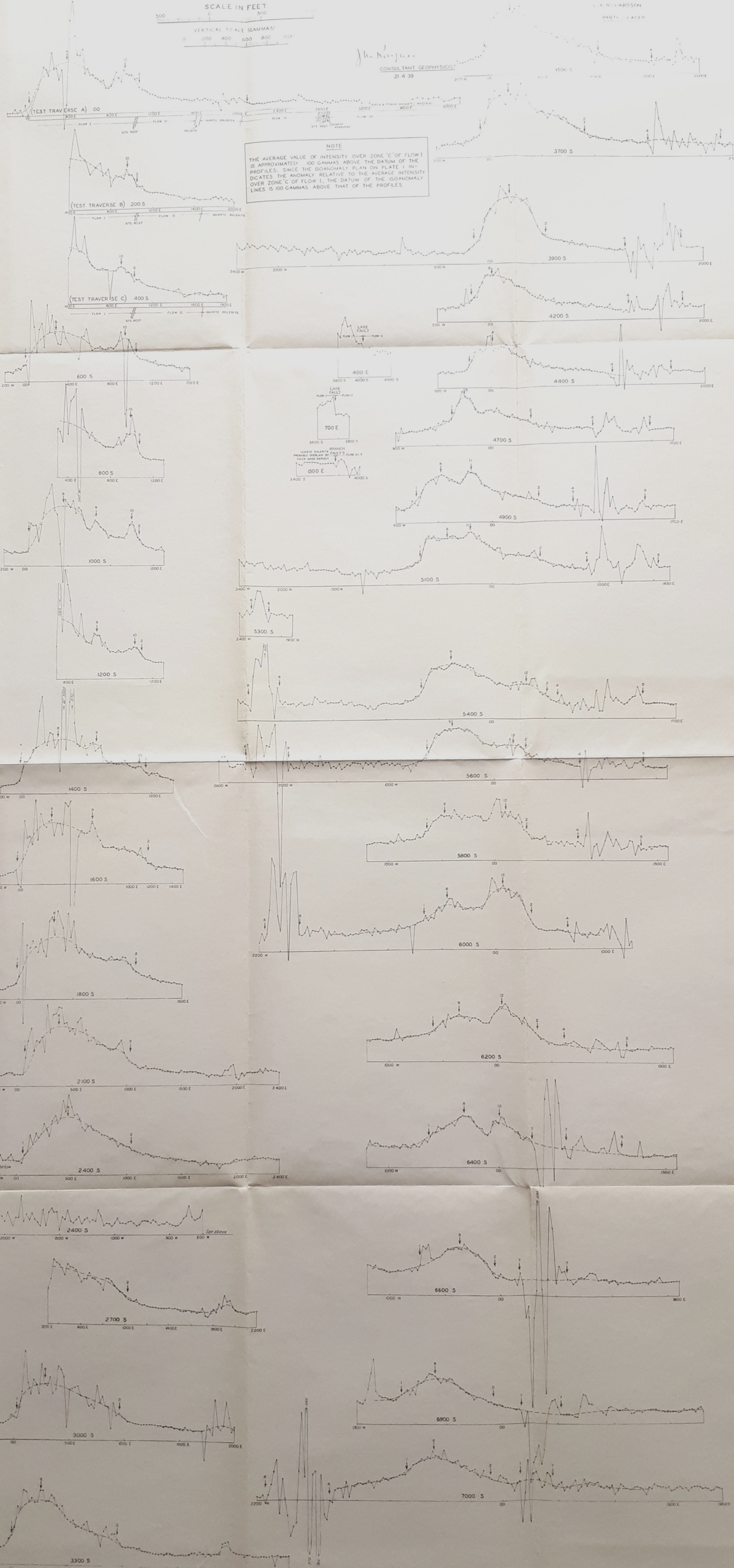
PROFILES OF THE VERTICAL COMPONENT OF THE MAGNETIC FIELD



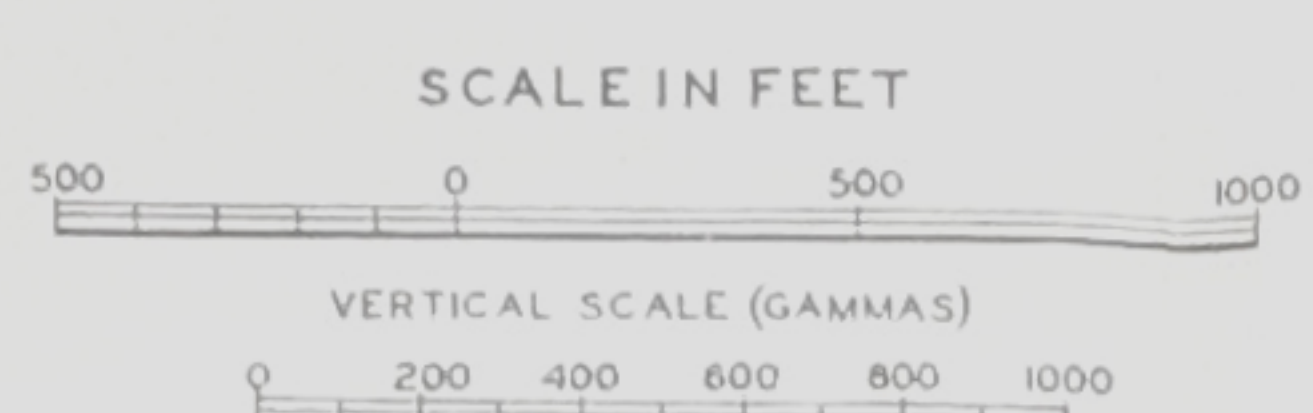
John K. Rogers
CONSULTANT GEOPHYSICIST
21 4 39

L. A. RICHARDSON
PARTY - LATER

NOTE
THE AVERAGE VALUE OF INTENSITY OVER ZONE 'C' OF FLOW I IS APPROXIMATELY 100 GAMMAS ABOVE THE DATUM OF THE PROFILES. SINCE THE ISOANOMALY PLAN ON PLATE 1 INDICATES THE ANOMALY RELATIVE TO THE AVERAGE INTENSITY OVER ZONE 'C' OF FLOW I, THE DATUM OF THE ISOANOMALY LINES IS 100 GAMMAS ABOVE THAT OF THE PROFILES.

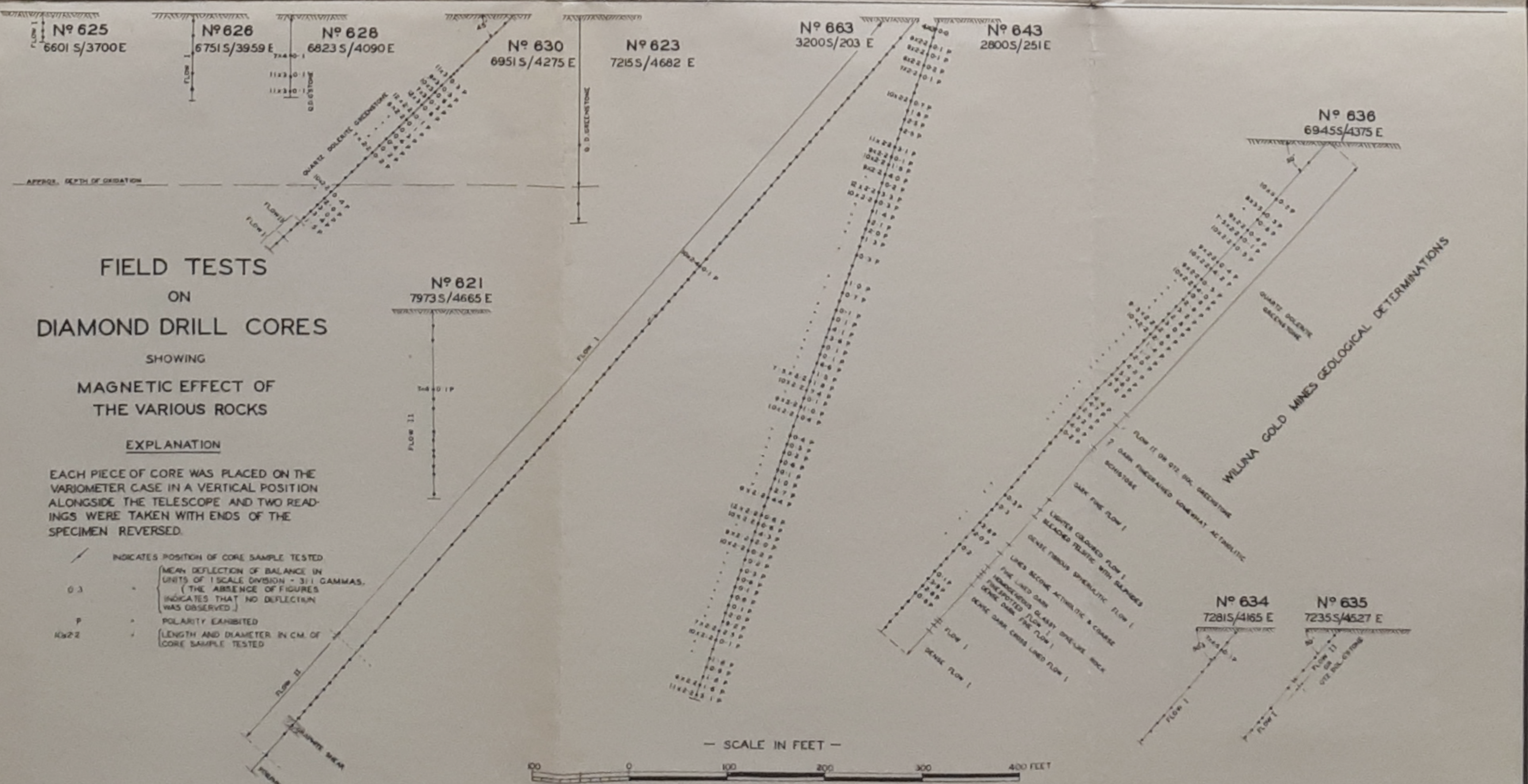
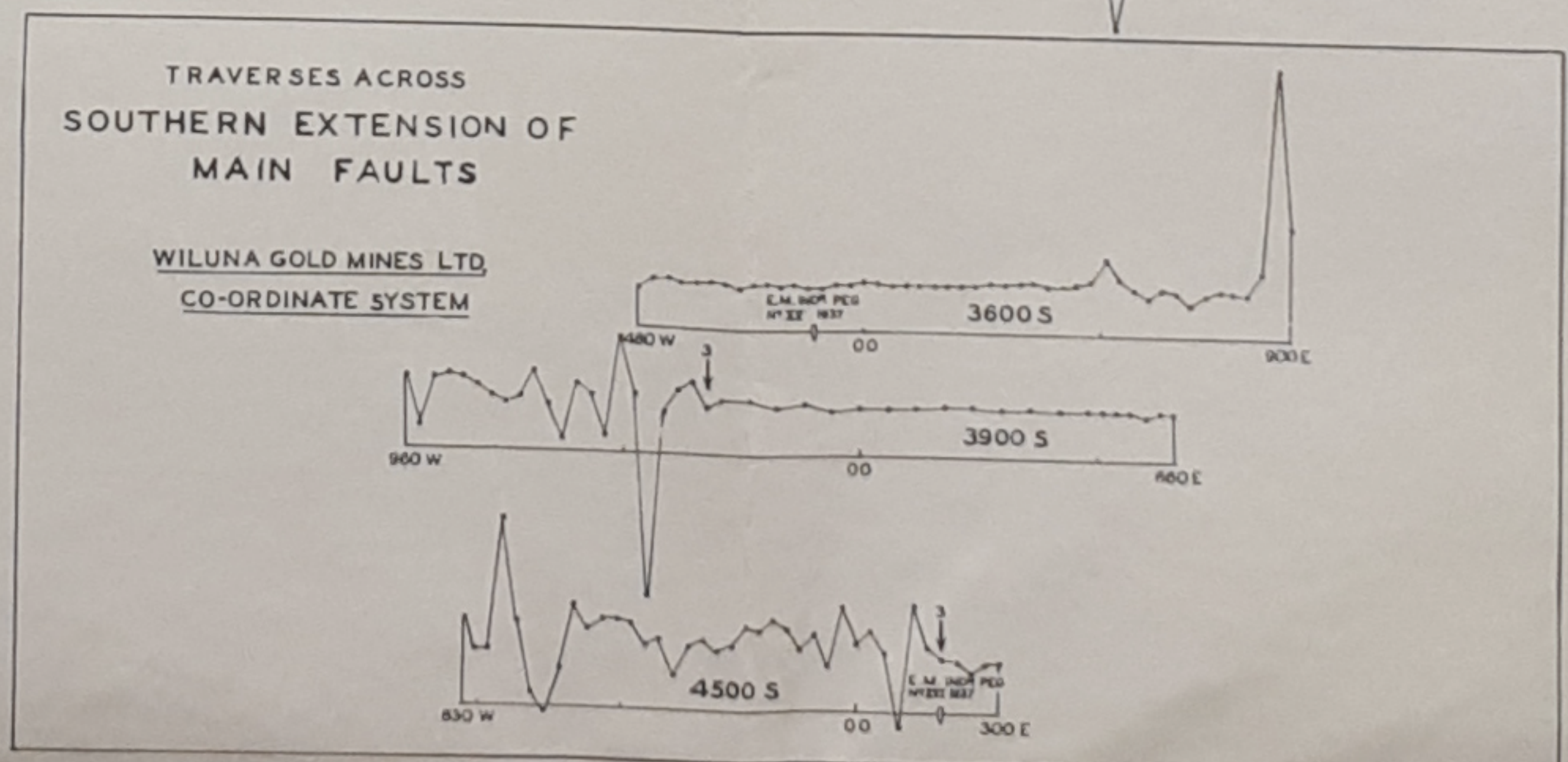
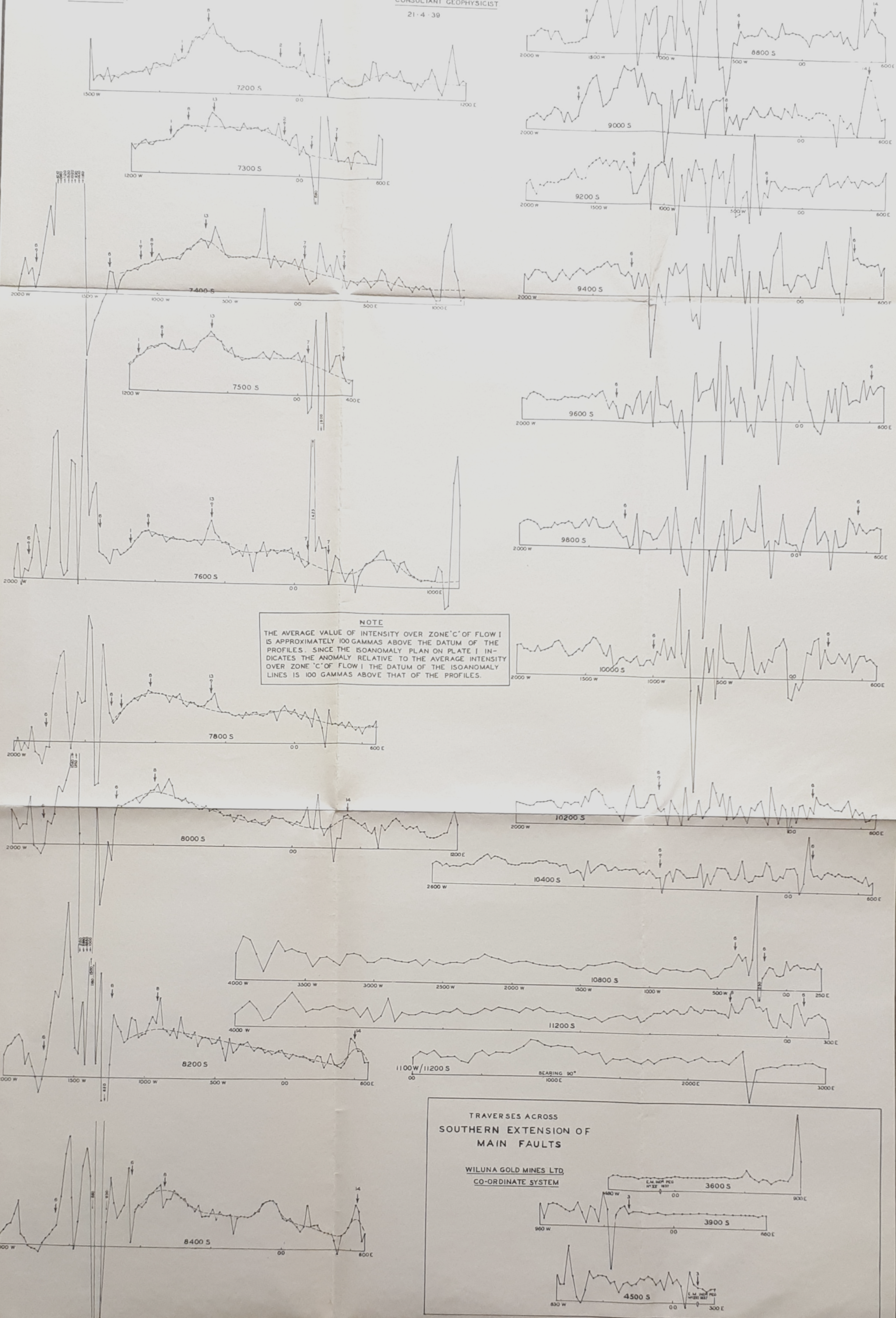


WILUNA MAGNETIC SURVEY
PROFILES OF THE VERTICAL COMPONENT
OF THE
MAGNETIC FIELD



L. A. RICHARDSON
PARTY LEADER

John Rayner
CONSULTANT GEOPHYSICIST
21.4.39



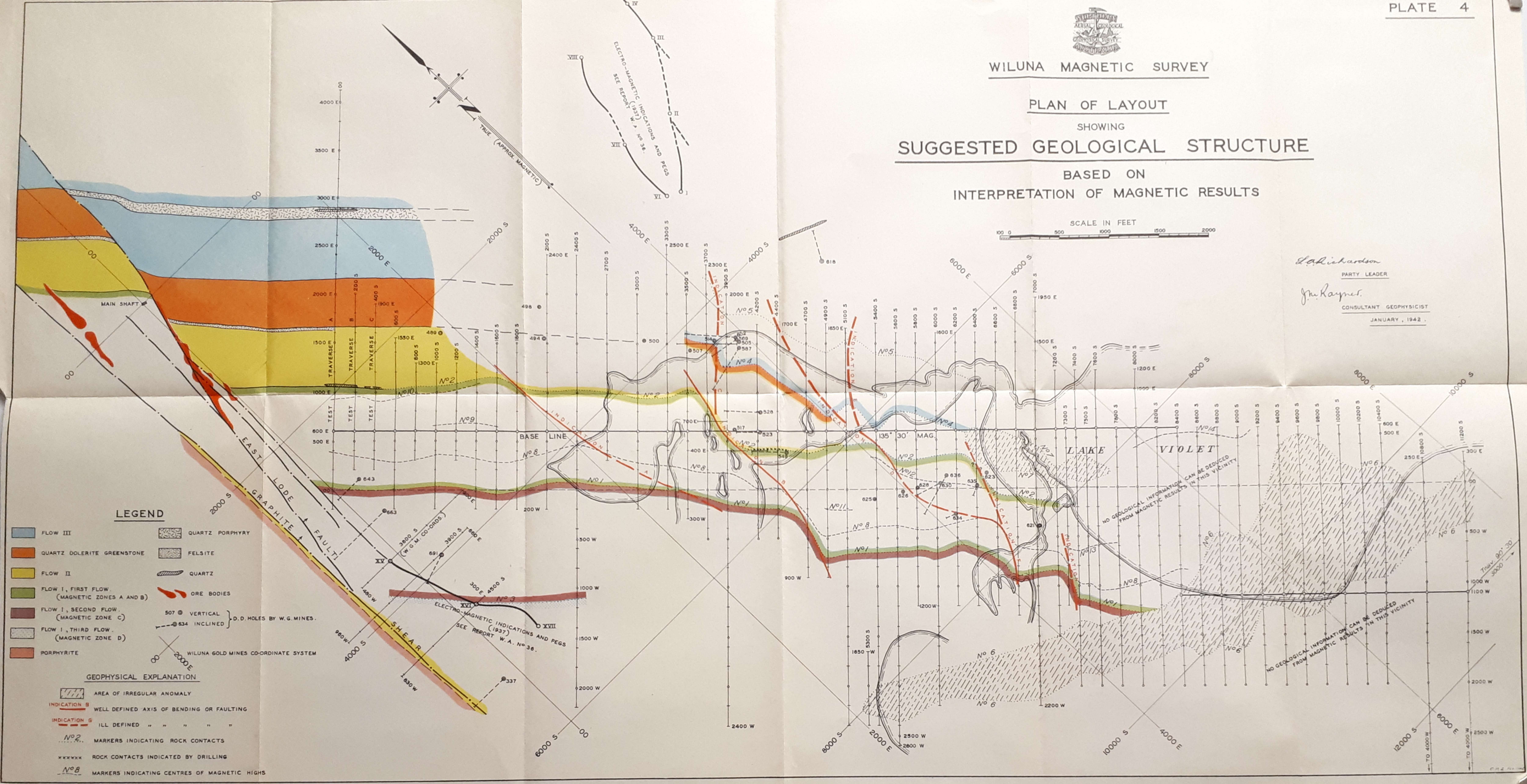


WILUNA MAGNETIC SURVEY

PLAN OF LAYOUT
SHOWING
SUGGESTED GEOLOGICAL STRUCTURE
BASED ON
INTERPRETATION OF MAGNETIC RESULTS

SCALE IN FEET
0 500 1000 1500 2000

L. Richardson
PARTY LEADER
J. R. Kayser
CONSULTANT GEOPHYSICIST
JANUARY, 1942.



LEGEND

- FLOW III
- QUARTZ DOLERITE GREENSTONE
- FLOW II
- FLOW I, FIRST FLOW. (MAGNETIC ZONES A AND B)
- FLOW I, SECOND FLOW. (MAGNETIC ZONE C)
- FLOW I, THIRD FLOW. (MAGNETIC ZONE D)
- PORPHYRITE
- QUARTZ PORPHYRY
- FELSITE
- QUARTZ
- ORE BODIES
- 507 @ VERTICAL
- 634 @ INCLINED
- D.D. HOLES BY W.G. MINES.
- WILUNA GOLD MINES CO-ORDINATE SYSTEM

GEOPHYSICAL EXPLANATION

- AREA OF IRREGULAR ANOMALY
- INDICATION B WELL DEFINED AXIS OF BENDING OR FAULTING
- INDICATION S ILL DEFINED " " " " " "
- Nº2 MARKERS INDICATING ROCK CONTACTS
- XXXXXX ROCK CONTACTS INDICATED BY DRILLING
- Nº8 MARKERS INDICATING CENTRES OF MAGNETIC HIGHS