AERIAL, GEOLOGICAL AND
GEOPHYSICAL SURVEY
OF
NORTHERN AUSTRALIA.

REPORT

NORTHERN TERRITORY No. 42.

GEOPHYSICAL REPORT ON THE HENBURY METEORITE CRATERS,

CENTRAL AUSTRALIA

BY

J. M. RAYNER, B.Sc.

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

992.

LIST OF PUBLICATIONS.

PERIODICAL REPORTS.

Report for Period Ended 30th June, 1935 } In one publication.
Report for Period Ended 31st December, 1935 }
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.

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No. 37, (*a*) Notes on the Geology of the Big Bell Area, by K. J. Finucane, M.Sc. } One publication.
(*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.
*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.
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†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.
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AERIAL, GEOLOGICAL AND GEOPHYSICAL SURVEY OF NORTHERN AUSTRALIA.

GEOPHYSICAL REPORT ON THE HENBURY METEORITE CRATERS, CENTRAL AUSTRALIA.

I. INTRODUCTION.

This report describes a search by the methods of Applied Geophysics for large meteorites beneath the spectacular craters at Henbury in Central Australia. The field tests are compared with tests made on an actual meteorite under laboratory conditions. Finally, conclusions are drawn concerning the mode of formation of the craters.

The craters are situated about 115 miles south-west of Alice Springs, Northern Territory, and about 7 miles west-south-west of the Henbury cattle station. The site can be reached comfortably in one day by car from Alice Springs over fairly good bush tracks.

Public interest concerning the Henbury craters was first aroused in 1931, when Mr. B. Bowman of Tempe Downs and Mr. J. M. Mitchell of Oodnadatta informed Professor Kerr Grant of the presence of craters with scattered iron fragments near Henbury cattle station. On the advice of Sir Douglas Mawson, the South Australian Museum sent Dr. A. R. Alderman, assisted by Mr. F. L. Winzor, to make an examination of the area. A little later in 1931 and again in 1932, expeditions were made to the craters by Mr. R. Bedford of the Kyancutta Museum. The use of geophysical methods at Henbury was first suggested by Sir Edgeworth David, Sir Douglas Mawson and Dr. A. R. Alderman, but it was not until late in 1937 that arrangements could be made to carry out the survey described in this report.

The survey was made with staff and equipment of the Aerial, Geological and Geophysical Survey of Northern Australia, but by arrangement half the expenses were paid by the Australian and New Zealand Association for the Advancement of Science, which had advocated the survey for some time previously. Under the author's technical supervision, the arduous field work was carried out by Mr. J. Daly, M.Sc., and laboratory tests were made in Sydney by Mr. L. A. Richardson as well as by Mr. J. Daly.

Papers on the survey of the craters have already been published—one in a report of the Australian Association for the Advancement of Science,[1] and the other elsewhere.[2] The present report does not differ in any material way from the former papers.

II. GEOLOGY.

A. General.

The district consists largely of wide alluvial plains, but at Henbury there are ridges of sandstone and quartzite of Ordovician age. To the south of the ground under consideration there is a high siliceous ridge. The craters are situated partly on a low sandstone ridge and partly on flatter ground to the north thereof.

B. Description of the Craters.

Within an area of about a quarter of a square mile, thirteen craters have been discovered (*see* Plate 1), but one of them, No. 9, is rather indefinite. The largest crater is about 660 feet in its greatest diameter and some 45 feet in depth. The smallest crater is about 30 feet in diameter. For further information concerning the craters, reference may be made to papers by Dr. A. R. Alderman.[3] [4]

C. Meteoritic Iron.

In the vicinity of the craters fragments of meteoritic iron have been collected ranging in weight from a fraction of an ounce up to 170.5 lb., the total weight amounting to well over half a ton. Dr. Alderman's party collected some 800 pieces of iron, the largest weighing 52.5 lb.

(1) Rayner, J. M. Examination of the Henbery Meteorite Craters, by the Methods of Applied Geophysics. Rept. Aust. Assn. Adv. Sc., XXIV., Canberra, 1939, pp. 72–78.
(2) Rayner, J. M. The Henbury Meteorite Craters and Geophysical Prospecting, Aust. Jour. Sc., Vol. I., No. 3, 1938, p. 93.
(3) Alderman, A. R. The Meteorite Craters, at Henbury, Central Australia Mineralogical Magazine, Vol. XXII, No. 136, 1932, pp. 19–32.
(4) Alderman, A. R. The Henbury (Central Australia) Meteoric Iron. Rec. S. Aust. Mus., Vol. IV., No. 4, 1932.

Mr. Bedford's first expedition collected about 550 pieces of iron ranging up to 170.5 lb. in weight. On his second expedition, Mr. Bedford excavated three of the craters (Nos. 10, 11 and 13) mentioned above and another supposed crater nearby but not mentioned by Dr. Alderman. In one of these (No. 13) he found at a depth of 7 feet below the floor, bodies of iron consisting of two large and some smaller fragments, totalling in weight about 400 lb. The other craters are reported to have yielded some iron shale (being mainly limonite and probably formed by weathering of the meteoritic iron) but no meteorites. It might also be noted that Dr. Alderman bored to a depth of 8 feet below the floor of crater No. 5, but no meteorite was encountered.

From a preliminary examination, Dr. F. L. Stillwell, Mineragraphist to the Council for Scientific and Industrial Research, stated that the meteorite was similar to that at Annaheim.[5]

Chemical analyses of meteorites from Henbury have been made by Dr. Alderman and Messrs. Hey and Hodge Smith and the results are given in the following table :—

	I. Alderman.	II. Hey.	III. Hodge Smith.
Fe	91.54	93.04	92.78
Ni	7.54	7.26	7.46
Co	0.37	0.22	0.23
Cu	..	0.044	trace
Cr	..	nil	..
Pt	..	trace	trace
S	0.01	0.06	0.03
P	0.08	nil	nil
Cl	..	trace	..
C	0.013	trace	trace
Insoluble	0.03	0.06	0.05(*a*)
	99.58	100.68	100.55
Fe : Ni	12.1	12.8	12.4
Sp. Gr.	7.53	7.69	7.67

(*a*) The insoluble includes the traces of Pt., C. and SiO_2. The silica appears to be irregularly distributed. In three 5-gram samples only one contained any silica. No one else records the presence of silica.

Mr. T. Hodge Smith's analysis was made as a result of an application by the Survey and represents an analysis of the 39 lb. meteorite found by the Survey at Henbury and used in the control tests described in this report.

III. NATURE OF THE PROBLEM.

Large craters due to meteorites are rare and it would appear that those at Henbury are among the largest and most interesting yet discovered. The question naturally arose as to whether or not there are large bodies of meteoritic iron lying beneath the larger craters. Some were inclined to believe that such bodies would be of the order of many tons, perhaps hundreds of tons, in weight. On the other hand, it has been pointed out, particularly by Dr. L. J. Spencer, that there is a significant absence of meteorites from several large craters in other parts of the world.

It appeared that geophysical methods of prospecting were well suited to examine the craters. The principal objects of the survey were to determine whether or not there are large bodies of iron lying at depth in the vicinity of the craters and to throw some light on the mode of formation of the craters.

IV. METHOD USED.

It was decided to use the magnetic method of prospecting since tests showed that fragments of meteorites from Henbury were very magnetic.

For those not familiar with geophysical methods, it might be pointed out briefly that the magnetic method depends upon the fact that most rocks and many types of ore are more or less magnetic to a degree depending primarily upon their content of such magnetic minerals as magnetite, ilmentite, pyrrhotite, &c. Some rocks are permanently magnetized and display polarity while in other types of rocks the magnetism is induced by the present magnetic field of the Earth. It is well known that an ordinary compass will show anomalous effects in the vicinity of iron ore deposits or outcrops of basic rocks such as basalt, &c. Sensitive and robust magnetometers or magnetic variometers have been developed, however, which can detect the magnetic effects arising from rock types containing quite small amounts of iron oxides even when such rocks

(5) Johnston and Ellsworth. Proc. Roy. Soc. Can. 3rd Ser., Vol. XV., Sect. IV., p. 69.

lie beneath considerable thicknesses of overburden. This development has led to the economic application of the method in tracing magnetic horizons under cover (and which act as key horizons for structural studies) and also in directly detecting covered ore-bodies in which magnetic minerals are associated with the economic minerals.

Most of the survey at Henbury was carried out with a Vertical Magnetic Force Variometer (scale value 32.5 gammas) constructed by Watts, London. For a small portion of the survey a Horizontal Magnetic Force Variometer (scale value 19.5 gammas) also constructed by Watts was used. Both instruments were compensated for temperature and the observations were corrected for diurnal variation. Both instruments can be read with great accuracy, but after reduction it appears that the probable error of the results is for vertical force $\pm$ 3 gammas and for horizontal force $\pm$ 5 gammas. The regional values of the vertical and horizontal components of the Earth's magnetic field at Henbury are approximately Z = 45130 gammas, H = 30110 gammas.

The magnetic observations were made along a series of traverse lines which were laid out so that most of the craters were crossed by two traverses intersecting at right angles at the centre of the crater. This pattern was varied somewhat for the two largest craters. Along each traverse the interval between observation points was generally 12.5 feet inside the craters and 25 feet outside. The station interval was kept at 25 feet when examining the three largest craters.

From theoretical considerations the observations along a traverse passing over a meteorite should plot to give a bell-shaped curve. For a meteorite very close to the surface the curve is high but very narrow. For a meteorite at greater depth the curve has a much smaller maximum value, but is much broader. Thus the shape of the curve is an indication of the depth of a meteorite and it would be possible to calculate the approximate depth. Knowing the magnetic susceptibility and the density of the material it would also be possible to estimate roughly the size and weight of the meteorite.

The actual mathematical expression for the magnetic anomaly (dZ) arising from a sphere of magnetic material magnetized by induction in the Earth's field is

$$dZ = 3VZ \cdot \frac{K}{1 + \frac{4\pi K}{3}} \cdot \left[\frac{z^2}{r^5} - \frac{1}{3r^3} + \frac{xz}{r^5 \tan I}\right]$$

where dZ is vertical component of magnetic anomaly (gammas)
V is volume of the sphere (cubic centimetres)
K is magnetic susceptibility of the material
z is depth to centre of sphere (centimetres)
x is horizontal distance of observation point from centre of sphere (centimetres)
r is radial distance of observation point from centre of sphere (centimetres)
I is inclination of Earth's magnetic field (degrees)
Z is vertical component of Earth's magnetic field (gammas)

From the above it might be noted that it is simpler to detect a large meteorite at some little depth rather than a smaller meteorite very close to the surface, since the magnetic effect due to the latter is so local that it might be passed over between observation points on a traverse. The station intervals for the present survey were adopted with a view to the location of large meteorites at some depth, if such exist. It is possible that the survey has passed over many small sharp anomalies due to small iron fragments lying just beneath the surface. To make sure of picking up all such sharp anomalies, it would have been necessary to make observations at intervals of 2 feet or so, which was impracticable in view of the time available.

V. RESULTS.

A. Field Results. (*See* Plates 1 and 2.)

Magnetic observations were made at some 540 stations. This network covered twelve of the craters. The crater numbered 9 by Dr. A. R. Alderman could not be located with certainty. Dr. Alderman refers to this crater as "ill defined and doubtful".

A number of magnetic anomalies of small intensity, ranging up to 35 gammas and of both positive and negative sign, was found. These anomalies were all of the local type, few extending over more than 40 feet in width. Such magnetic anomalies would arise from small bodies of magnetic material at comparatively shallow depths.

No important magnetic anomalies such as would arise from large meteorites of the order of many tons in weight, either near the surface or at some depth, were obtained. It was noted that the larger craters were reasonably free of even small anomalies of any significance. The magnitude of the anomalies to be expected under different conditions are further discussed in the following section.

Some 26 anomalies of the small and local type mentioned above were discovered. Of these anomalies, ten fall within the craters, eight fall in the immediate vicinity of the crater walls and eight fall well outside the craters. The anomalies falling within the craters were positive in sign with only one exception, and included the most intense anomalies found. Some of them may well be due to comparatively small meteorites or fragments of iron. The most significant anomalies were obtained over craters Nos. 5, 13 and 12.

The cause of the first of these anomalies, i.e. the crater No. 5 was found to be a meteorite weighing about 39 lb., which was collected by the Survey's officers and brought back to Sydney for the carrying out of model tests. It was found embedded in the soil near the centre of the crater.

It was from crater No. 13 that Mr. R. Bedford obtained some 400 lb. of meteoritic iron prior to the survey. The magnetic anomaly obtained makes it appear likely that there is still a small body of iron remaining at shallow depth in the crater.

According to the magnetic effects obtained above crater No. 12, there appears to be a reasonable chance of obtaining a small amount of meteoritic material by excavating to a shallow depth in that crater.

It is remarkable that all of the eight anomalies falling in the vicinity of crater walls were of negative sign. The magnetic intensities ranged from -15 to -30 gammas. It is possible that these anomalies are associated with iron shale in the crater walls.

The remaining eight anomalies were scattered away from the craters, were mostly positive in sign, and ranged up to 30 gammas in intensity. They may be due to very small fragments of iron.

B. Control Tests on a Meteorite.

It is necessary to consider the magnitude of the magnetic anomalies that would arise at Henbury from meteorites of various sizes and at various depths from the surface, if such meteorites existed. This was done by carrying out tests on the small meteorite that was found at Henbury and brought to Sydney.

The meteorite was scarcely spherical in shape but resembled rather an ellipsoid of revolution. The weight of the meteorite was 17721 gm. and its volume 2278 c.c. giving a density of 7.78 gm. per c.c. It was found to have a high magnetic susceptibility but did not show any polarity. Thus its magnetization is due practically entirely to induction in the Earth's magnetic field.

Traverses were made with a magnetometer across the meteorite to measure accurately the vertical magnetic anomaly arising from it. The observations along a traverse when plotted gave the usual bell-shaped curve which could be fitted very closely to the curve plotted from the mathematical expression for the vertical magnetic anomaly arising from a spherical body of magnetic material magnetized by induction in the Earth's field.

This expression is

$$dZ = 3VZK' \cdot \left[\frac{z^2}{r^5} - \frac{1}{3r^3} + \frac{xz}{r^5 \tan I}\right] \quad . \quad . \quad . \quad . \quad . \quad (1)$$

$$\text{where } K' = \frac{K}{1 + \frac{4\pi K}{3}}, \text{ K being the magnetic susceptibility}$$

dZ is vertical component of magnetic anomaly,
V is volume of the sphere,
z is depth to centre of sphere,
x is horizontal distance of observation point from centre of sphere,
r is radial distance of observation point from centre of sphere,
I in inclination of Earth's magnetic field,
Z is vertical component of Earth's magnetic field.

The expression (1) can be used to calculate the magnetic anomalies due to hypothetical meteorites at Henbury. It is necessary, however, to know the susceptibility factor K' and this was obtained readily from the tests in Sydney in the following manner.

The curve plotted from (1) has a well-defined maximum and, by differentiation of the expression and solving the resulting equation, the position of the maximum is given by $x = 0.15z$. Substituting this in (1) and also putting

dZ = 350 gammas, given by tests as maximum anomaly,
V = 2278 c.c.,
z = 67 cm. as arranged in tests,
Z = 52100 gammas at Sydney,
I = 63° 43′ at Sydney,

it is found that $K' = 0.428$.

Now the maximum anomaly above a hypothetical meteorite at Henbury is obtained by putting $x = 0.15z$ and $I = 56° 17'$ in (1). This gives dZ max. $= 2.1558 \cdot \frac{VZK'}{z^3}$

Putting Z = 45130 gammas as at Henbury and K' = 0.428 it follows that

$$dZ \text{ max.} = \frac{81.5W}{z^3} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

where W is weight of meteorite in pounds, and
z is depth to centre of meteorite in feet.

Using the relation (2), calculations have been made of the maximum anomalies that would arise from meteorites weighing 50 lb., 5,000 lb., 10 tons, 100 tons and 500 tons at various depths beneath the surface.

Although the calculations were made for depths down to 140 feet it is unlikely that even large meteorites would have penetrated to that depth. Statistical examination shows that meteorites are retarded very quickly after impact. For example, one of the largest meteorites ever seen to fall weighed 547 lb. and penetrated to a depth of only 11 feet.

It is necessary to consider also the widths of the small magnetic anomalies since as previously indicated they afford a means of determining the depth of origin of the anomalies. Using equation (1) curves can be plotted for different values of z. The field curves can then be compared with these and when a good fit is obtained the corresponding value of z gives the depth required. It has not been necessary to go through this process for the several small and rather indefinite anomalies obtained at Henbury since a consideration of such curves affords a ready method of estimating the depth. If on both sides of the anomaly curve the ordinates are marked where the anomaly has fallen to half its maximum value, then the distance between the ordinates gives a rough measure of the depth.

Each of the small anomalies obtained at Henbury has been considered in the light of this section. The depth of the origin was estimated then by reference to the curves in which depth of origin is plotted against maximum anomaly, the weight of the supposed meteorite was read off, assuming that all the anomalies are due to meteorites. It was evident that in no case would the meteorite be large.

These results may be contrasted with the anomalies which, according to the calculations, would arise from large meteorites. For example a meteorite weighing 100 tons at a depth of 40 feet would give rise to an anomaly of some 285 gammas and the total width of the anomaly would exceed 80 feet. The same meteorite at a depth of 80 feet would give rise to an anomaly of some 36 gammas which would exceed 160 feet in width. Similarly a meteorite weighing 500 tons at a depth of 120 feet would give rise to an anomaly of 50 gammas exceeding 240 feet in width.

VI. CONCLUSIONS.

It is concluded from this survey that it is most improbable that there are any large meteorites of the order of many tons in weight lying beneath the Henbury craters. This follows from (i) the definite absence of magnetic anomalies of a type that would arise from large meteorites at likely depths, (ii) the fact that statistical considerations make it improbable that large meteorites would have penetrated to depths so great as to take them beyond the range of detection by the magnetic method.

From a study of the small and local anomalies that were obtained, it appears that some of the craters may well have small meteorites, fragments of iron or iron shale associated with them. The most significant anomaly of this type was found above crater No. 12.

It appears, therefore, that at any rate the larger craters at Henbury have not been formed simply by the pitting action of large meteorites penetrating the surface. More likely they have been formed by the excavating action of an explosive impact in which the meteorites were largely shattered to fragments.

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Sydney, 6th February, 1939.

By Authority: L. F. JOHNSTON, Commonwealth Government Printer, Canberra.

LIST OF PUBLICATIONS—*continued.*

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.
No. 5, The Mount Todd Auriferous Area, Pine Creek District, by V. M. Cottle.
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
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.
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.
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.
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.
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.
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.)
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.
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.
*No. 31, Second Report on the Mount Todd Auriferous Area, Pine Creek District, by P. S. Hossfeld, M.Sc. (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.
*No. 35, The Maranboy Tin-field, Pine Creek District, by T. V. Lewis, B.C.E.
*No. 36, Geophysical Report on the Maranboy Tin-field, Pine Creek District, by R. F. Thyer, B.Sc., J. M. Rayner, B.Sc.
*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.
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).
*No. 44, The Mineral Deposits of the Yeuralba Area, near Katherine, by P. S. Hossfeld, M.Sc.
*No. 45, The Brock's Creek Areas (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.
*No. 48, Geophysical Report on the Granites Gold-field, Central Australia, by R. F. Thyer, B.Sc., J. M. Rayner, B.Sc.
*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.

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.
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.
No. 10, The Silver Ridge Auriferous Lodes, Cloncurry District, by E. O. Rayner, B.Sc. } In one publication.
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.
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.
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.
*No. 17, Geophysical Report on the Trekelano Area, Cloncurry District, by J. M. Rayner, B.Sc. (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.

LIST OF PUBLICATIONS—*continued.*

QUEENSLAND—*continued.*

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.
*No. 25, The Felsite Auriferous Area, Croydon Gold and Mineral Field, by R. J. S. Clappison, B.Sc., and S. B. Dickinson.
*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.
*No. 28, The Watsonville Tin Lodes, Herberton District, by M. L. Wade.
*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, B.Sc.
†No. 32, The Maytown Auriferous Area, Palmer River District, by R. J. S. Clappison, B.Sc.
†No. 33, The Cannibal Creek Tin Lodes, Palmer River District, by R. J. S. Clappison, B.Sc.
} In one publication.
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 of Mount Coolon Gold Mine, by B. P. Oakes, B.Sc., J. M. Rayner, B.Sc.
*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, B.Sc. (Supplementary to Q. No. 25.)
*No. 39, The Hodgkinson District, by H. I. Jensen, D.Sc.
*No. 40, The Herberton District, by H. I. Jensen, D.Sc.
*No. 41, Geophysical Report on the Herberton Deep Lead, Herberton District, by R. F. Thyer, B.Sc., J. M. Rayner, B.Sc.
*No. 42, Geophysical Report on the Herberton Tin Lodes, Herberton District, by R. F. Thyer, B.Sc., J. M. Rayner, B.Sc.
*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.
*No. 44, Geophysical Report on the Croydon-Golden Gate Area, Croydon Gold and Mineral Field, by L. A. Richardson, J. M. Rayner, B.Sc. (Supplementary to Q. No. 9.)
*No. 45, The Palmer River District, by H. I. Jensen, D.Sc.
*No. 46, The Lawn Hill Lead-Zinc-Silver Field, Lawn Hill-Wollogorang District, by H. I. Jensen, D.Sc.
No. 47, Report of 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. 19.)
No. 49, Geophysical Report on the Blair Athol Coal-field, by R. F. Thyer, B.Sc., and J. M. Rayner, B.Sc.
No. 50,
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.)

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.

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MAGNETIC SURVEY OF HENBURY METEORITE CRATERS

CENTRAL AUSTRALIA

SCALE IN FEET

100 00 100 200 300 400

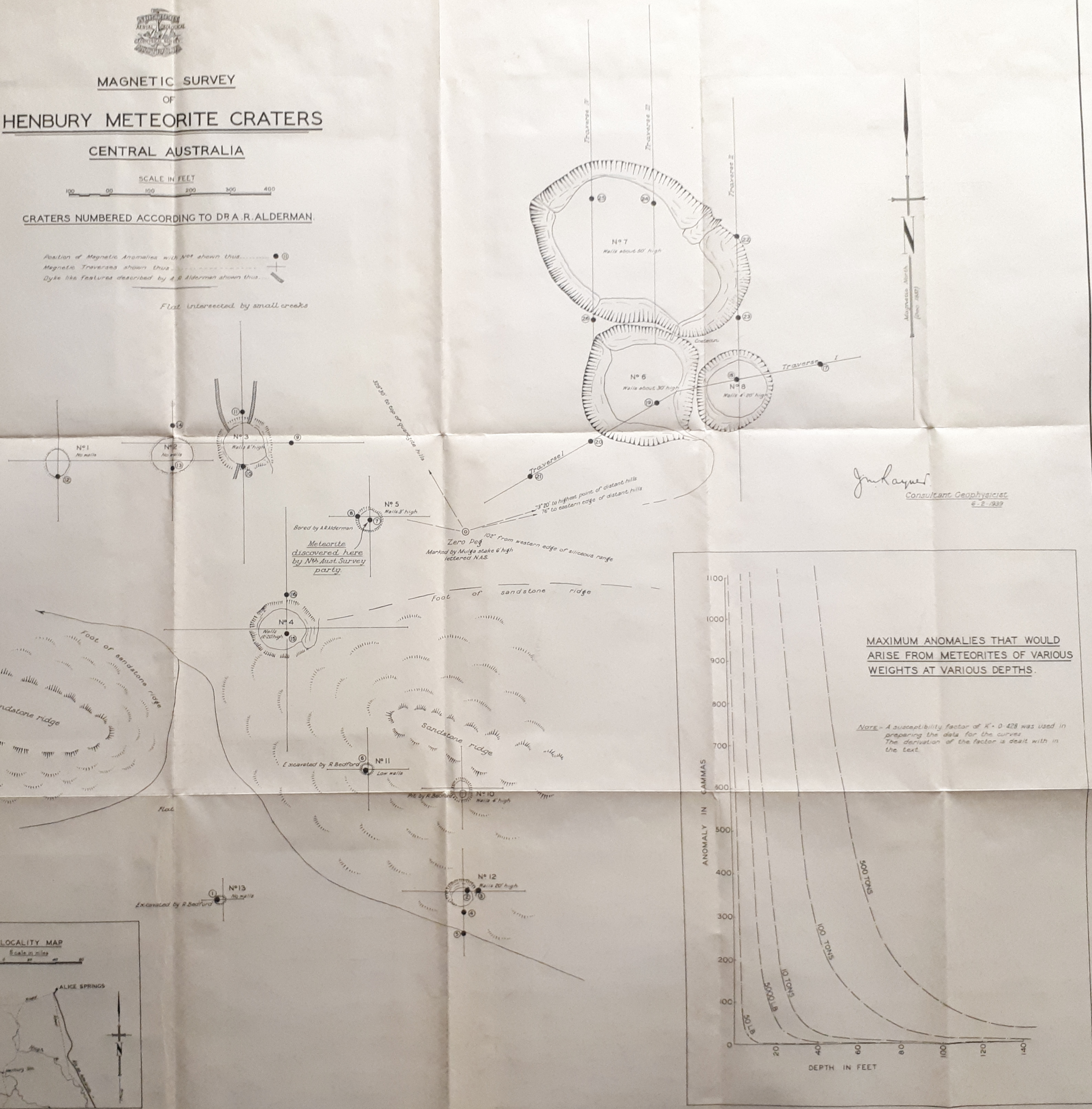
CRATERS NUMBERED ACCORDING TO DR. A. R. ALDERMAN.

Position of Magnetic Anomalies with Nos shewn thus ● 11

Magnetic Traverses shown thus

Dyke like features described by A. R. Alderman shown thus

Flat intersected by small creeks



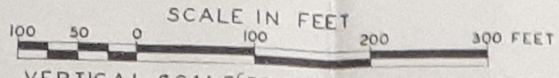
J. W. Rayner
Consultant Geophysicist
6-2-1939

MAGNETIC PROFILES

HENBURY METEORITE CRATERS

CENTRAL AUSTRALIA

SCALE IN FEET

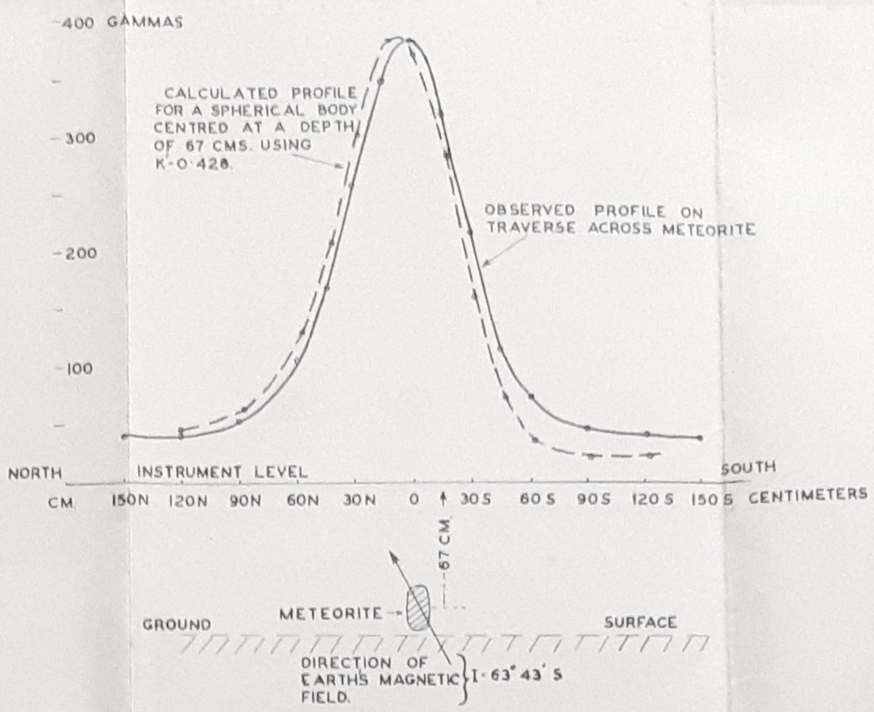


VERTICAL SCALE { 50 GAMMAS TO 1 INCH
= 5 GAMMAS PER DIVISION

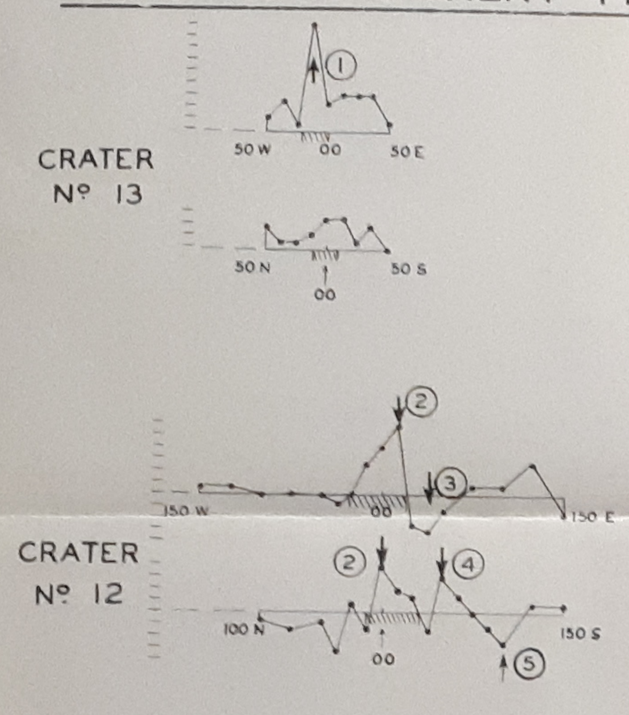
EXTENT OF CRATERS SHOWN
ANOMALIES WITH NUMBERS ↓ (7)

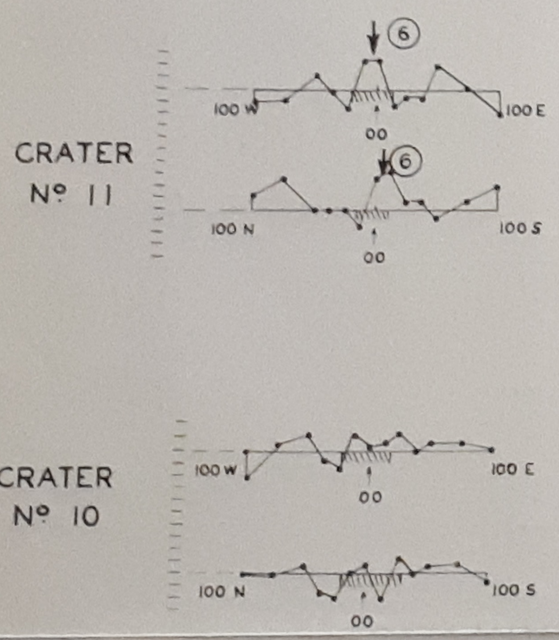
J. H. Rayner
CONSULTANT GEOPHYSICIST
6TH FEB. 1939

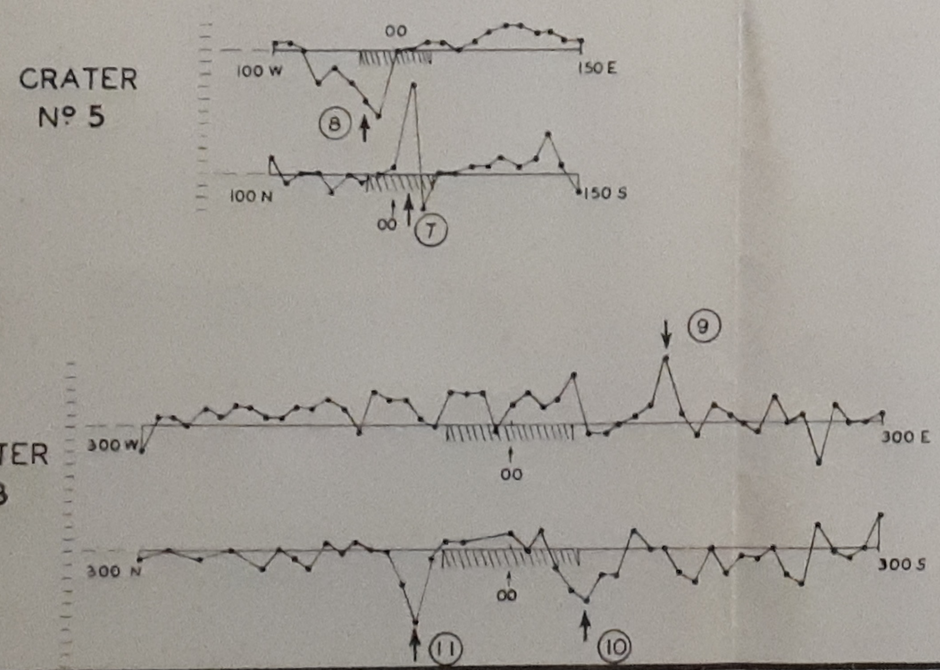
OBSERVED AND CALCULATED PROFILES SHOWING ANOMALY IN VERTICAL MAGNETIC INTENSITY ABOVE A HENBURY METEORITE



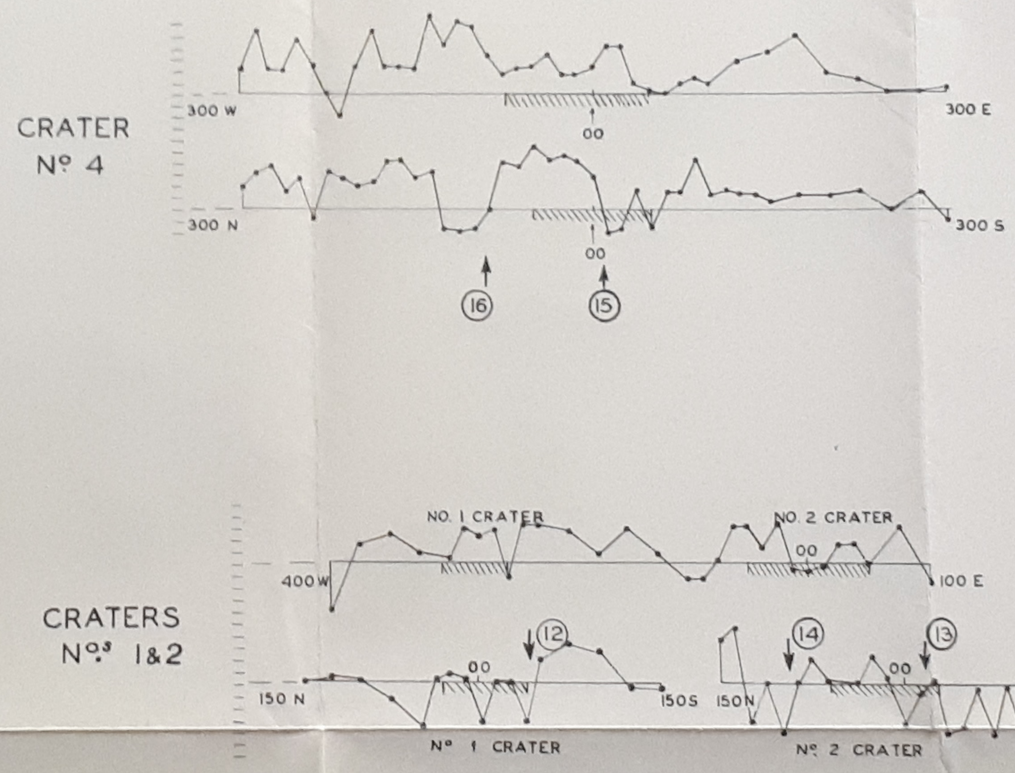
VERTICAL COMPONENT PROFILES







HORIZONTAL COMPONENT PROFILES



LARGE CRATERS 6,7 & 8