COMMONWEALTH OF AUSTRALIA.

DEPARTMENT OF NATIONAL DEVELOPMENT.

BUREAU OF MINERAL RESOURCES GEOLOGY AND GEOPHYSICS.

RECORDS.

1961/101

GEOCHEMICAL PROSPECTING FOR COPPER IN THE TENNANT CREEK GOLD FIELD, NORTHERN TERRITORY.

by

N.J.McMillan and A.H.Debnam

GEOCHEMICAL PROSPECTING FOR COPPER IN THE TENNANT CREEK GOLD-FIELD, NORTHERN TERRITORY

by

N.J. McMillan and A.H. Debnam

RECORDS 1961/101

CONTENTS

CONTENTS (CONTD.)

ILLUSTRATIONS

SUMMARY

Geochemical surveys for copper in soil and bedrock were made over 6 magnetic anomalies in the Tennant Creek Gold-Field. Anomalous amounts of copper were found to be coincident with magnetic anomalies at Orlando and Golden Forty North.

Samples from the known ironstone bodies cropping out in the Tennant Creek 1-mile area were analysed for copper to determine the regional distribution of copper in ironstone. Statistical treatment of the results suggests that at least 8 of these bodies merit further attention.

During the course of the field work action was taken by Peko Mines N.L. to test the Orlando magnetic-geochemical anomaly and gold-copper mineralization has since been disclosed at depth.

Recommendations for drilling magnetic-geochemical anomalies at Golden Forty North and Cat's Whiskers, and for further geochemical prospecting, are made.

INTRODUCTION

Ivanac (1954) has summarized the earlier geological investigations in the Tennant Creek Gold-Field. He also gives a generalized description of the regional geology of the field, and accounts of the history, development, production, and geology of 49 mines and prospects.

The reports of the geophysical surveys carried out by the Aerial, Geological and Geophysical Survey of Northern Australia (A.G.G.S.N.A.) during 1935-1937, which were not fully published at that time, have been combined in a bulletin by Daly (1957). His report is confined mainly to geophysical aspects and refers only to the detection of magnetic bodies.

The main object of these surveys was to further the search for gold. Drilling by the Bureau of Mineral Resources in 1950 led to subsequent successful development of the Peko copper orebody and aroused interest in the copper potential of the field, with the result that new investigations were initiated by mining companies and the Bureau of Mineral Resources.

Preliminary geochemical investigations for copper were carried out in December 1955 (Debnam, 1956), and part of 1956.

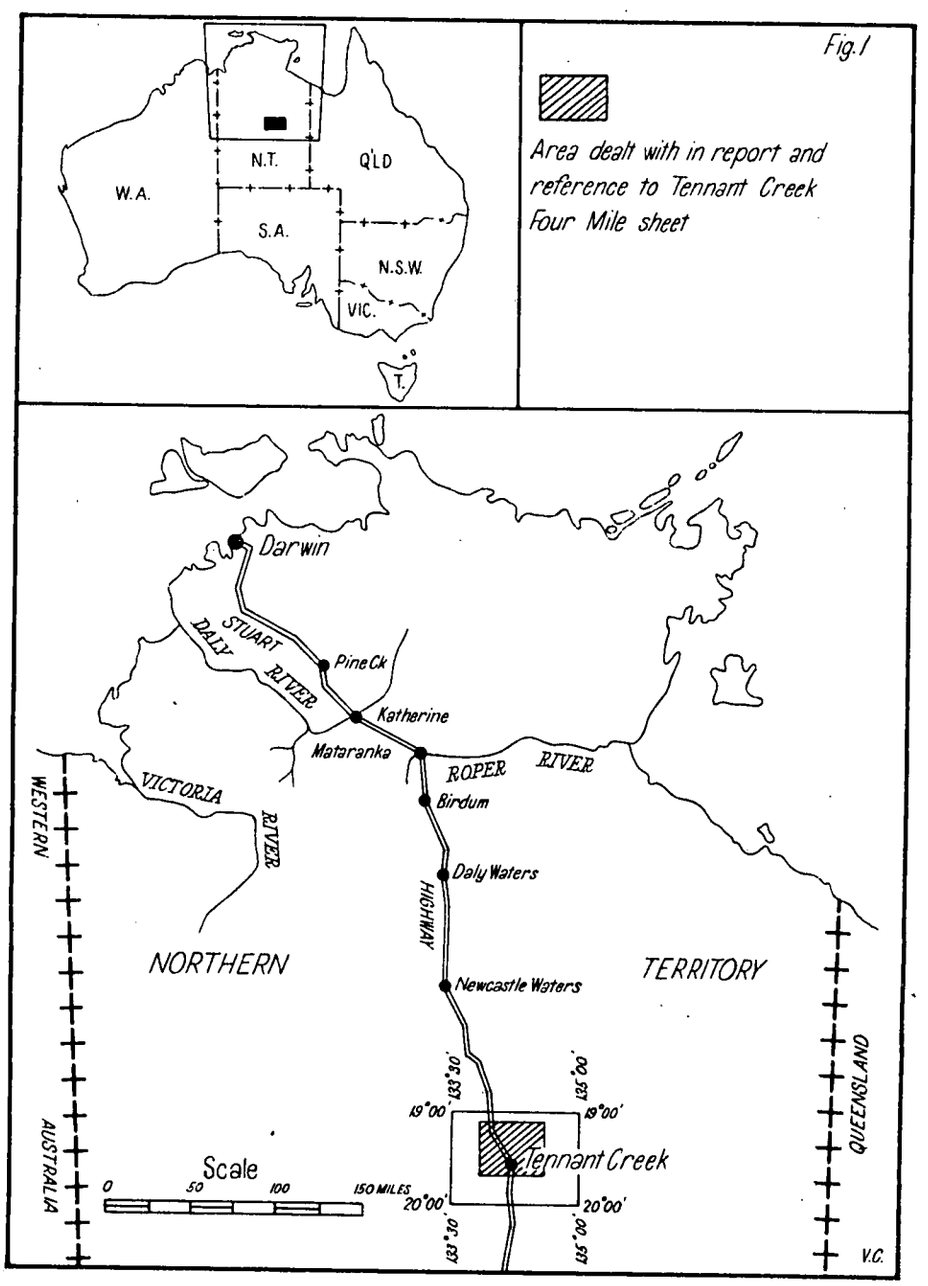
Geochemical work during the period June to October 1957 followed recommendations based on the 1955-1956 preliminary investigations. The general object of the survey was to determine the usefulness of geochemical prospecting in delineating copper-rich zones in the field. These could be further prospected by magnetic methods, the advantages of which are two-fold: they determine those areas where mineralization extends below the oxidized zone; and they provide drilling targets.

Two series of geochemical investigations were carried out. The first of these comprised the analysis of soil and bedrock samples taken at regular intervals over magnetic anomalies which were about to be drilled in the Orlando,

Golden Forty North, Black Angel-White Devil, Queen of Sheba, Eldorado-Rising Sun, and New Hope-Plumb areas. The second project involved the analysis of samples from the known ironstone bodies cropping out within the Tennant Creek one-mile area, in order to investigate the regional distribution of copper within these bodies and to select those most likely to warrant further investigation, e.g. by magnetic survey and diamond drilling.

In addition, the Bureau has recently conducted aerial and ground magnetic surveys, and detailed geological mapping of the Tennant Creek one-mile Sheet and adjacent areas.

Fig. 1 shows the area dealt with in the report with reference to the Tennant Creek 4-mile Sheet.



COPPER OCCURRENCES AT TENNANT CREEK

Most of the recorded copper occurrences in the Tennant Creek Gold-Field are closely associated with massive quartz-hematite or quartz-magnetite, or with zones of brecciated sediments containing disseminated hematite or magnetite. Such materials are locally known and referred to in this report as "ironstone". The main occurrences of this type are:

(i) Peko: the copper orebody discovery hole at the Peko mine intersected primary copper ore at a depth of 400 to 425 feet. This ore ranges from 4 to 11 percent copper and 1 to 25 dwt gold per ton.

(ii) North Star: a hole drilled at North Star early in 1957 (Chem. Engng Min. Rev., 1957) intersected sulphides between 967 and 977 feet and 986 and 998 feet inclined depth, averaging 4.05 and 2.84 percent copper respectively.

(iii) Wheal Doria: the A.G.G.S.N.A. No. 4a hole, on the Wheal Doria No. 1 anomaly, "after passing through weathered slate and bands of chert, showed siliceous hematite with disseminated sulphides, mostly chalcopyrite, between 167 and 174 feet." (A.G.G.S.N.A., 1936, p.9).

(iv) Pinnacles: about 50 (?) tons of hand-picked oxidized ore from a small copper lode in the Pinnacles mine were sent to Port Kembla in 1950.

(v) Eldorado: the A.G.G.S.N.A. No. 2 hole, drilled on the Eldorado No. 3 anomaly, "encountered talc-carbonate-magnetite formation", containing disseminated sulphides, between 413 and 452 feet inclined depth. Copper assays of the core recovered between 420 and 452 feet ranged from 0.38 to 0.88 percent. (A.G.G.N.S.A., 1936, p.9).

The main occurrences of copper mineralization not apparently associated with ironstone crop out in the Shamrock-Mary Lane area.

Other data, for the most part unpublished, have been collected by mining companies. The most important of these are:-

(i) a third of a mile west of the Skipper Extended mine a diamond drill hole, inclined towards the south at 70 degrees, passed through talc-chlorite-magnetite rock with sparsely disseminated pyrite and chalcopyrite between 823 and 1,001 feet inclined depth.

(ii) a hole drilled by an associate of the National Lead Co. to test magnetic anomalies Nos. 8 and 9 near the Golden Forty Mine intersected 41 feet of soft talc schist which yielded an average assay of 1.5 percent copper. Parts of this intersection contained up to 4 percent copper (R.D. Ellett, personal communication). The copper occurred as chalcopyrite in non-magnetic talc schist and the cause of the magnetic anomaly was not determined.

(iii) in another hole put down in the Golden Forty area, the lowest 374 feet (388 to 762 feet) contained talc-chlorite rock practically devoid of hematite or magnetite, but parts of the core contained numerous blebs and stringers of chalcopyrite.

GEOCHEMISTRY

Copper in Sedimentary Rocks

Copper which is found in the Warramunga sediments in the Tennant Creek field may have originated in one or more of the following ways:-

1. Syngenetically.
2. By deposition from hydrothermal solutions.
3. As a result of weathering and redistribution of copper originally introduced by one or other of these two processes.

Syngenetic Copper:

Samples of some sedimentary rocks taken from the surface and from drill cores contained between 2 and 10 parts per million (p.p.m.) of copper. These amounts probably represent a reliable estimate of the original copper content of the Warramunga sediments. So far, no beds have been found to contain consistently more than 10 p.p.m. of copper, but the possibility that such beds may exist should be borne in mind when interpreting geochemical anomalies in the sediments.

Hydrothermally Introduced Copper:

During the emplacement of an orebody, minor amounts of copper may be introduced into the country rock, especially if the latter is cut by fissures or fracture zones which facilitate the movement of solutions. For example, at Peko the average copper content of the sediments from a diamond drill hole was 60 p.p.m. (average of 18 determinations between depths of 200 and 1200 feet). See fig. 7.

Copper redistributed by Secondary Processes:

Two distinct processes are capable of producing a redistribution of copper in the zone of oxidation:

(a) Leaching of a copper orebody by supergene solutions may be followed by the re-precipitation of this copper in previously barren portions of the country rock. General experience shows that the greater part of this transport would be vertical rather than lateral, but it is to be expected that measurable lateral redistribution might take place under favourable circumstances, e.g. in the presence of flat-dipping fissures or fractures, tending to control the movement of solutions.

(b) Mechanical transport of particles of copper-bearing material may give rise to anomalous amounts of copper in soil downhill, downstream, or downwind of outcrops of such material, and subsequent weathering and re-precipitation may transfer some of this copper to the upper layers of the bedrock in these areas, thus producing a "superimposed" halo.

Copper in Ironstone

Copper now occurring in the oxidized portions of ironstone is believed to be derived from sulphides originally disseminated through these rocks. At Peko, several samples from the ironstone outcrop contain up to 0.37 percent copper, but no copper minerals are visible to the naked eye. This

suggests that any copper minerals present are in a very finely divided and disseminated form, and/or that the copper may be present as colloidal size particles of native copper trapped in hydrated oxides of iron, or partly as ions absorbed and adsorbed on the surface of the iron compounds.

Copper in "Soil"

The term "soil" as used in this report refers to all unconsolidated material above the bedrock, and includes alluvium, "bulldust", residual material, etc.

Anomalously large amounts of copper in unconsolidated material of various textures and grain sizes may originate in two ways in the Tennant Creek field. Firstly, the eroded debris of copper-bearing rocks may be transported and deposited some distance from the source. Secondly, any copper mineralization which exists in the bedrock may be transported upward through the soil. This is theoretically possible by the capillary rise of a copper-bearing solution or by the upward diffusion of the copper through the moisture in the soil.

Sampling and Analytical Procedures

Sampling

Initial experimental work at the Black Angel area showed that the optimum spacing for sampling over magnetic anomalies was at intervals of 100 feet on lines 200 feet apart. However, for expediency several deviations were made from this optimum spacing. At Golden Forty North, for example, the National Lead Co. had previously placed pegs at 100-foot intervals on lines 300 feet apart, so this spacing was used for the geochemical survey.

In outcrop areas a number of chips aggregating about one pound weight was collected from between 6 and 10 places within 10 feet of the sample point. In soil-covered areas, a hole was put down at the sample point to a depth of two feet, and a one pound sample of soil collected from this depth. If bedrock was encountered at a depth of less than two feet a bedrock sample was taken.

When investigating ironstone bodies, samples were collected every 50 feet along the trend of the outcrop, and each sample was made up of a number of chips in a way similar to those collected for outcrop samples in sediments. Three outcrops were subsequently sampled in greater detail to check the reliability of this method (Cat's Whiskers, Peko, and Outlaw bodies), and the averages obtained from the two series of samples were found to agree closely in every case.

Analytical Procedures

The sample was crushed so as to reduce the greater portion to minus 80 mesh, and 0.5 gm. of the finer fraction was used for analysis. A number of checks indicated that no significant error was introduced by discarding the small amount of oversize (plus 80 mesh) material. A fusion method of extracting the copper was used, following the procedure given by Almond (1955). Because of the larger samples used adjustments were made in the amounts of potassium bisulphate and hydrochloric acid used in the extraction, and it was also found necessary to increase the

amount of hydroxylamine hydrochloride to approximately 200 mgm. With these modifications, the normal procedure covered a range of 6 to 180 p.p.m. of copper, higher values being estimated by the reduction of the analysis aliquot.

During the testing period, June 14th to October 12th 1957, 3604 samples were analysed for copper. An average of 250 samples per week were processed after initial difficulties had been overcome.

To ensure the reliability of the analyses a total of 100 duplicate determinations were carried out during the survey. After three of these determinations, which gave anomalous results were discarded, a histogram of the remainder gave an almost normal distribution for the differences between respective pairs of determinations. The standard deviation derived from this curve was 6 p.p.m. in the range 1 to 200 p.p.m. of copper.

DISCUSSION OF RESULTS

A. Survey of Magnetic Anomalies

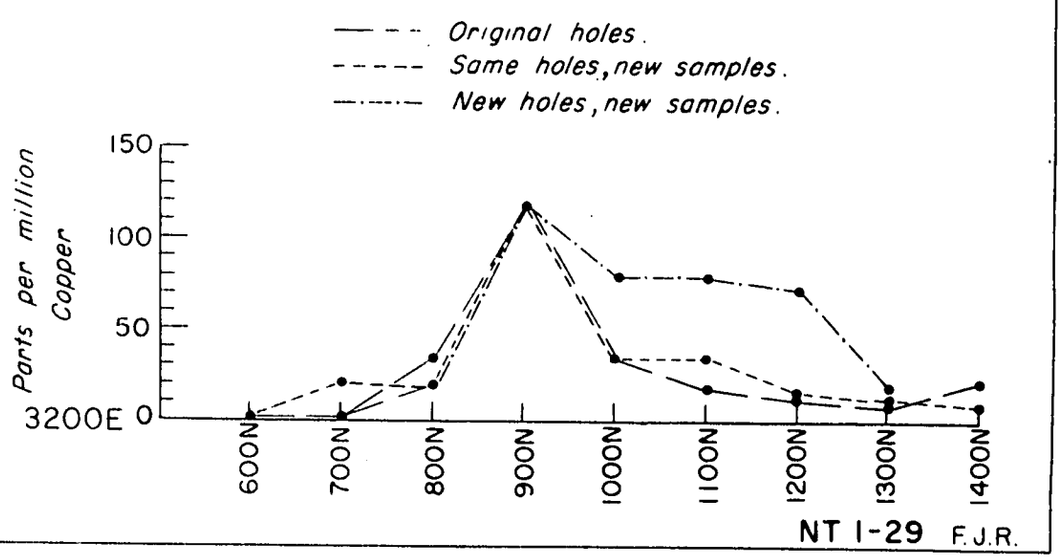
The magnetic anomalies selected for sampling were those about to be drilled by mining companies. These were chosen for the obvious advantage of obtaining a depth control for the interpretation of surface results.

Systematic testing of samples taken on a regular grid was carried out in the Orlando, Golden Forty North, Black Angel-White Devil, Queen of Sheba, Eldorado-Rising Sun, and New Hope-Plumb areas. The results are shown on Plate 1. Contour intervals have been drawn at copper contents of 22, 50, 80, 120, 180, 300, 500 p.p.m., the value of the laboratory standards. Values falling within the contour intervals 22 to 49, 50 to 79, etc., can be accepted with reasonable confidence. Very few samples within any of these ranges fall into the next range on reanalysis; and fewer still suggested an error of two intervals. Because of this, isolated abnormal readings were disregarded in drawing the contours.

In order to test the reliability of the results obtained in this work, a series of duplicate samples was taken from several stations in the Golden Forty North area. Original holes were placed at convenient positions near the surveyed stations on the grid. Samples were taken from these holes and analysed. Later, new samples were taken from the same holes, and finally new holes were dug, displaced a few feet from the original ones, but still near the surveyed stations, and a third set of samples was collected. The three sets of samples indicate a maximum amount of copper at 900N, 3200E, but there is considerable variation at some other stations (fig. 2). Thus although the values shown on Plate 1 could not be duplicated exactly, they undoubtedly show the correct general distribution and approximate magnitude of the geochemical anomalies.

FIG. 2

SAMPLING RELIABILITY TEST - "GOLDEN FORTY NORTH"



Eldorado-Rising Sun (Plate 1). This survey covered the area above a magnetic anomaly centred at 10,300E-330S on the A.G.G.S.N.A. grid (Daly 1957, Plate 3 Sheet 4). According to Daly, the body responsible for this anomaly is centred at a depth of 970 feet and has a vertical extent of about 440 feet.

About 80 soil samples and 220 bed-rock samples from this area were analysed, but only background (average about 4 p.p.m.) amounts of copper were obtained. The National Lead Company drilled two holes in this area, but neither encountered any magnetic material and the cores were found to contain only background amounts of copper.

These results indicate that there is little chance that copper mineralization of economic grade is associated with the body responsible for this magnetic anomaly. Therefore no further drilling is recommended in this area.

New Hope-Plumb Area (Plate 1). A large magnetic anomaly, extending in a north-north-west direction through the Plumb Mine, was delineated by the National Lead Company in this area. Several of the small exposed hematite bodies along this line yielded anomalous amounts of copper, but as these samples were selected from boxworks they cannot be regarded as representative.

About 200 soil samples and 40 bed-rock samples were analysed for copper, but only low values (average about 10 p.p.m.) were obtained. The magnetic anomaly was tested by two diamond drill holes but the results, believed to be discouraging, are not available for this report. For reasons similar to those given for the Eldorado-Rising Sun anomaly, no further work is recommended in this area.

Black Angel-White Devil Area (Plate 1). This area contains two of the most intense magnetic anomalies so far discovered in the Tennant Creek Gold-Field, as well as a number of prominent ironstone outcrops. About 200 samples of Warramunga sediments and numerous samples of ironstone were analysed for copper. The values obtained from the sediments are shown on Plate 1, and those from the largest ironstone outcrop (White Devil), centred at 600N, 2000E, are shown on fig. 6. Also shown on Plate 1 as spot highs, but not included in the contours, are figures for some of the smaller ironstone bodies.

An examination of the values and contours on the Black Angel-White Devil grid (Plate 1) shows:-

1. a disjointed contour pattern.

2. high values in the sediments near low values in ironstone.

3. low values in the sediments near high values in ironstone.

Furthermore two drill holes put down by Peko Mines N.L. disclosed only minor copper mineralization in the magnetic bodies at depth.

It is considered that this prospect may be intermediate in type between the highly anomalous area of Orlando and the low anomalies of Eldorado-Rising Sun and New Hope-Plumb, and as such does not warrant further investigation until more is known about other areas of stronger anomaly.

Queen of Sheba (Plate 1). A broad magnetic anomaly of low intensity was located in this area by the National Lead Co., and a geochemical survey was carried out along the surveyed grid laid down by this company. About 60 samples of bed-rock and 30 samples of soil were analysed. Copper values up to 180 p.p.m. were recorded from some of these samples, but these high values are thought to be largely the result of weathering of outcropping ironstone.

Orlando (Plate 1). A large ironstone body crops out on a low hill near the Orlando Mine and several smaller ones extend intermittently along a line trending a few degrees north of west. Away from these ironstone outcrops the sediments are overlain by an almost continuous soil cover. Two well-defined magnetic anomalies were discovered in this area in 1936 (Daly, 1957, p.27, plates 6 and 19) and are thought to be due to magnetic concentrations below water level on the same general structure as the outcropping ironstone bodies.

About 100 soil samples and 8 bed-rock samples were taken in this area. The ironstone at the surface contains up to 2,900 p.p.m. of copper (0.29 percent) and the copper content of the soil and sedimentary rock samples (as high as 900 p.p.m. close to the ironstone) shows a general decrease outwards from the ironstone, until at a distance of about 800 feet only background amounts of copper are present. This is thought to indicate that the copper in the soil is derived from the erosion products of the ironstone, and that the copper in the bed-rock has been derived in turn from this soil cover by downward percolation of solutions. As a direct result of the geochemical sampling Peko Mines N.L. went ahead with testing this prospect. The prospects of discovering significant amounts of copper mineralization at depth in this

SURFICIAL COPPER DISTRIBUTION

GOLDEN FORTY NORTH

RELATIONSHIP OF COPPER IN ALLUVIUM & BEDROCK

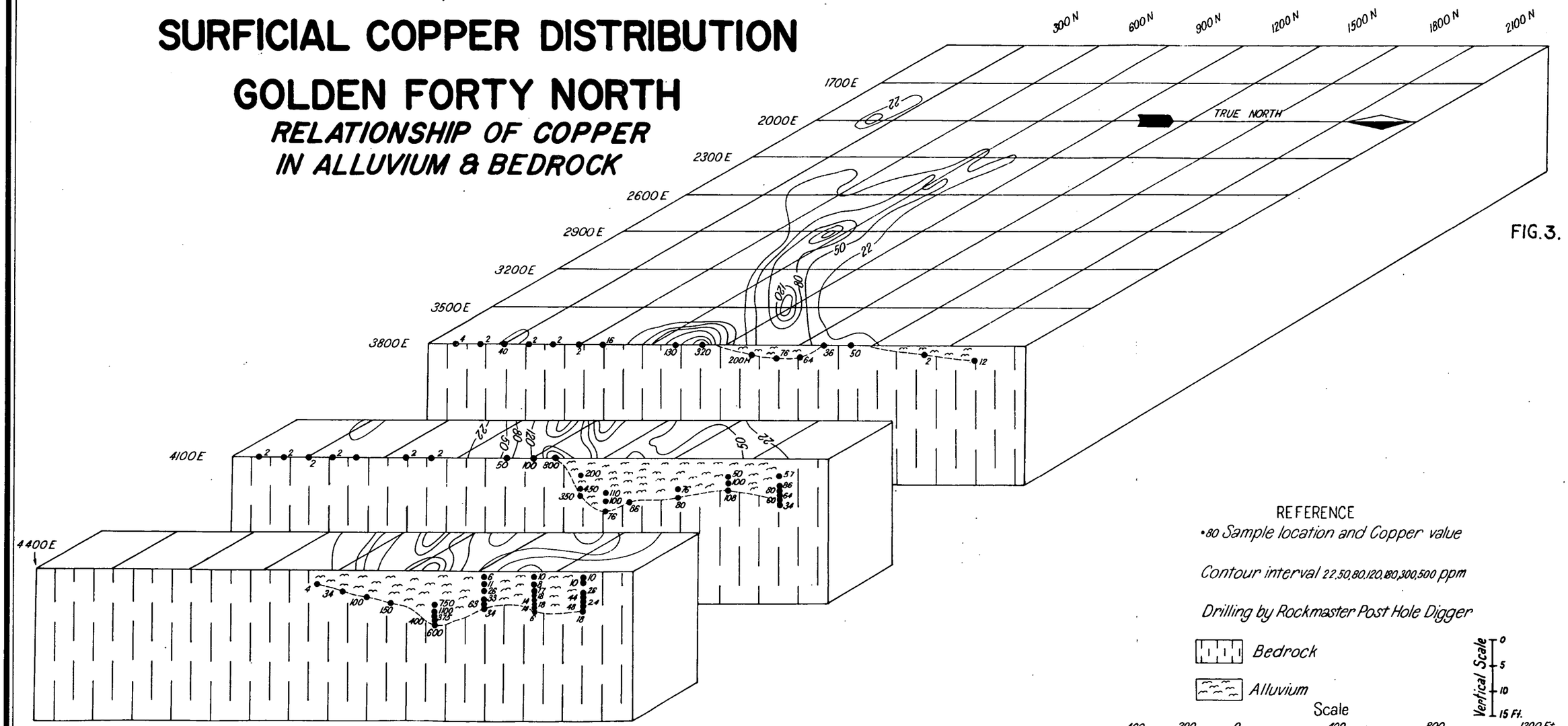


FIG. 3.

NT 1-36

Bureau of Mineral Resources, Geology and Geophysics. July 1961.

area are regarded as excellent. Since this statement was written (1957) Peko Mines N.L. has intensively investigated this prospect by means of drill holes and a shaft, and has discovered copper mineralization at depth confirming the favourable results of the geochemical survey.

Golden Forty North (Plate 1). Attention was first directed to this area by the finding of a small outcrop of talc-schist, with an average content of 300 p.p.m. of copper, by the National Lead Co. In addition the area contains outcrops of quartz, Warramunga sediments and minor ironstone, all in part covered by soil.

About 140 bed-rock and 50 soil samples from this area were analysed, and a geochemical anomaly with values up to 800 p.p.m. of copper over an area about 2,300 feet by 900 feet was established. Subsequently, a survey by the National Lead Co. delineated two well defined magnetic anomalies within the area of the geochemical anomaly.

At several stations in the soil-covered area, analyses of soil samples from different levels were made, and were compared with the copper contents of the underlying bed-rock (fig. 3). Generally the amounts of copper in the soil and the underlying bed-rock are comparable, and not related to the local topography. (National Lead Co. also conducted a topographic survey to enable these comparisons to be made). Moreover, anomalous amounts of copper (up to 800 p.p.m.) were found from the surface to a depth of 200 feet in a diamond drill hole (G.F.N., 11, fig. 7) drilled in this area by the National Lead Co. so that the copper in the bed-rock of this area is considered to be primary. The presence of the copper in the overlying soil may indicate that the copper was retained during the process of rock disintegration, or that copper has been subsequently introduced into the soil from the underlying bed-rock by capillarity.

The position of the drill hole is not known but it is understood that the drill was aimed to test the zone between the two inferred magnetic bodies. Furthermore the hole was not completed and did not reach the assumed target depth. Two other drill holes (GFN 12 and 13, fig. 7) were located outside the geochemical anomaly.

The area is considered to be a reasonably good prospect for copper, and the two magnetic anomalies should be tested by drilling. If details of National Lead Co.'s magnetic survey are not available, the Bureau should do a magnetic survey of the area so that the drill sites can be selected.

B. Surveys of Ironstone Outcrops

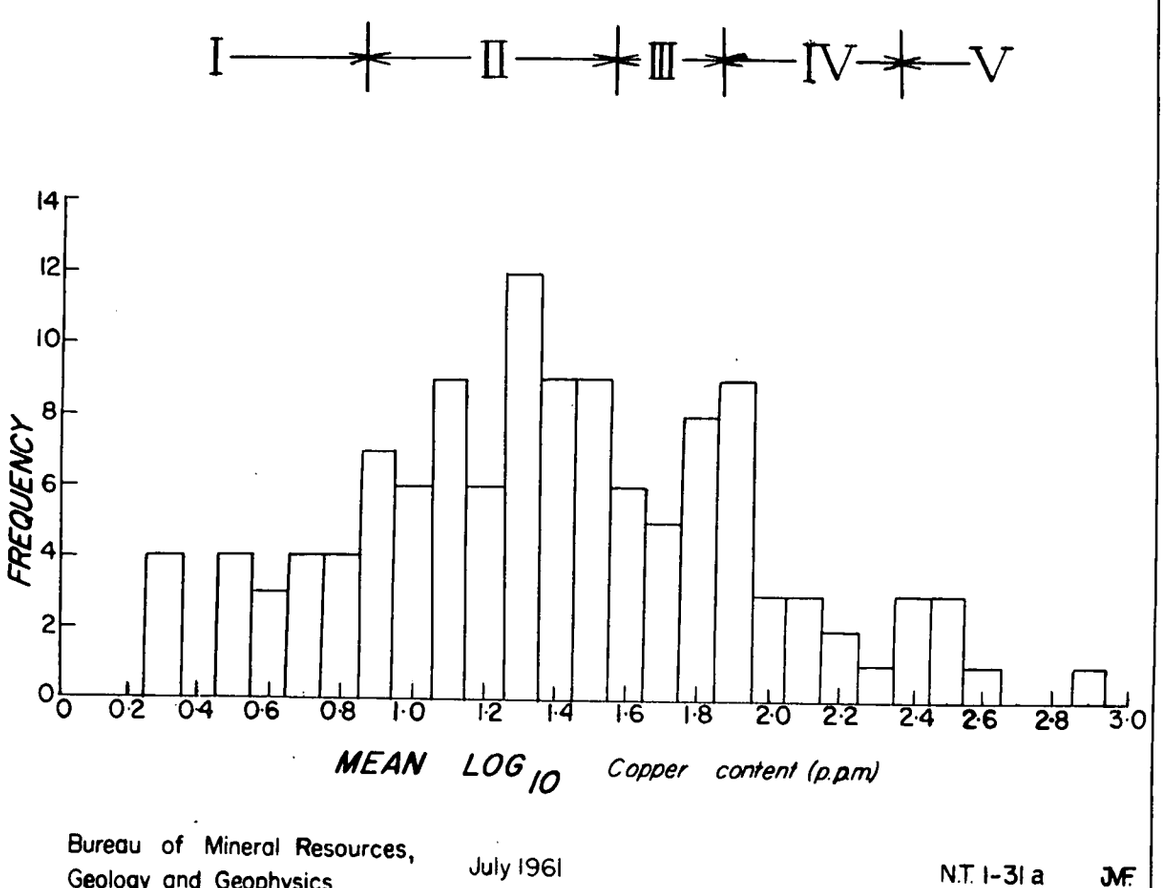
All the known ironstone outcrops of the Tennant Creek One-mile Sheet were sampled at approximately 50 foot intervals, and the results are summarized in Plate II.

It is evident from the detailed results shown in Plates IV to XVII that a wide spread of values occurs at some localities, and this caused some difficulty in devising a suitable form of summary. It was decided, on the suggestion of Dr. C. Leser, of the Australian National University, that the results within selected areas should be summarized by averaging the $\log_{10}$ of each copper value in parts per million and using the mean of these logs to determine into what category the area would fall. This method has the advantage of reducing the effect of isolated abnormally high or low

values within an area without ignoring them altogether.

The ironstones of the Tennant Creek One-mile Sheet were divided into 122 areas. This division was based mainly on structural relationships. A certain amount of subjective judgement is unavoidable in this process, but the frequency diagram of the values of mean $\log_{10}$ for each area is approximately a normal curve (fig. 4) which indicates that the selection was satisfactory in most cases. Each of these areas was appraised by two or more samples; the largest single area required the selection of 116 samples.

Fig. 4.



These areas were then classified into five groups or categories, based mainly on their mean $\log_{10}$ values and the form of the above histogram, but also giving consideration to the results of mining development and drilling of ironstone bodies throughout the field.

The following symbols are used in summarizing the results of the various areas: (See plates IV - XVII).

M_x - Mean of copper values in p.p.m.

σx - Standard deviation of copper values in p.p.m.

$M_{\log x}$ - Mean of $\log_{10}$ copper values in p.p.m.

$\sigma \log x$ - Standard deviation of $\log_{10}$ copper values in p.p.m.

Background has been determined by considering the peak of the curve of best fit on the histogram (fig. 4). This occurs approximately at the value Mean $_{\log x} = 1.5$, which is equivalent to 31.62 p.p.m. Thus, in round figures, background equals 30 p.p.m. The most common value is Mean $_{\log x} = 1.3$, i.e. 20 p.p.m.

In defining the limits of the five groups the following values of $M_{\log x}$ were used; equivalent antilog $M_{\log x}$ and background ranges are also shown.

Group	$M_{\log x}$	Antilog $M_{\log x}$	Background (multiple of)
I	0-0.8	0-6.3 p.p.m.	0-0.2 x
II	0.8-1.5	6.4-31.6	0.2-1
III	1.5-1.8	31.7-63.1	1-2
IV	1.8-2.3	63.2-199.8	2-6
V	$\geq$ 2.3	$\geq$ 199.8	> 6

Representative examples of these groups are shown in fig. 5.

FIG.5.

REPRESENTATIVE EXAMPLE OF GROUPS I-V SHOWN ON PLATE 2

GROUP	EXAMPLE (250 0 500 Ft. · 54 Sample Location and copper value (p.p.m))	MEAN
Mean Log_{10} in range 0-0.8 (0-0.2 x Background) I	1¼ miles south-west Mt. Cleland (Area 37)	M_x = 2.2 p.p.m. $M_{\log x}$ = 0.33
Mean Log_{10} in range 0.8-1.5 (0.2-1 x Background) II	½ mile west of Pinnacles (Area 82)	M_x = 33.33 p.p.m. $M_{\log x}$ = 1.43
Mean Log_{10} in range 1.5-1.8 (1-2 x Background) III	1¼ miles west of Jubilee (Area 62)	M_x = 47.25 p.p.m. $M_{\log x}$ = 1.56
Mean Log_{10} in range 1.8-2.3 (2-6 x Background) IV	¼ mile 240 South of Shamrock (Area 10)	M_x = 135 p.p.m. $M_{\log x}$ = 2.06
Mean Log_{10} in range >2.3 (> 6 x Background) V	(Area 83) Pinnacles	M_x = 353.3 p.p.m. $M_{\log x}$ = 2.47

NT 1-30

Bureau of Mineral Resources, Geology and Geophysics. July 1961.

From the analysis of the results of sampling the ironstone outcrops in the Tennant Creek 1-mile area these conclusions are presented:-

The 8 areas falling into Group V (see Plate III), if associated with magnetic bodies which persist below water table or zone of oxidation, may represent the surface expression of copper mineralization at depth. The 18 areas of Group IV (see Plate III) also deserve further investigation, and some of them may be associated with copper mineralization at depth. Certain portions of the Golden Forty area, for instance, could be separated from the remainder and made to fall into Group V, and such classification is supported by the occurrence of a 41 foot intersection averaging 1.5 percent copper in a diamond drill hole at this prospect.

In the case of Group III, the expense of further investigation is not regarded as justified at this time, although further work on the field may of course alter this state of affairs. Groups I and II certainly warrant no further work.

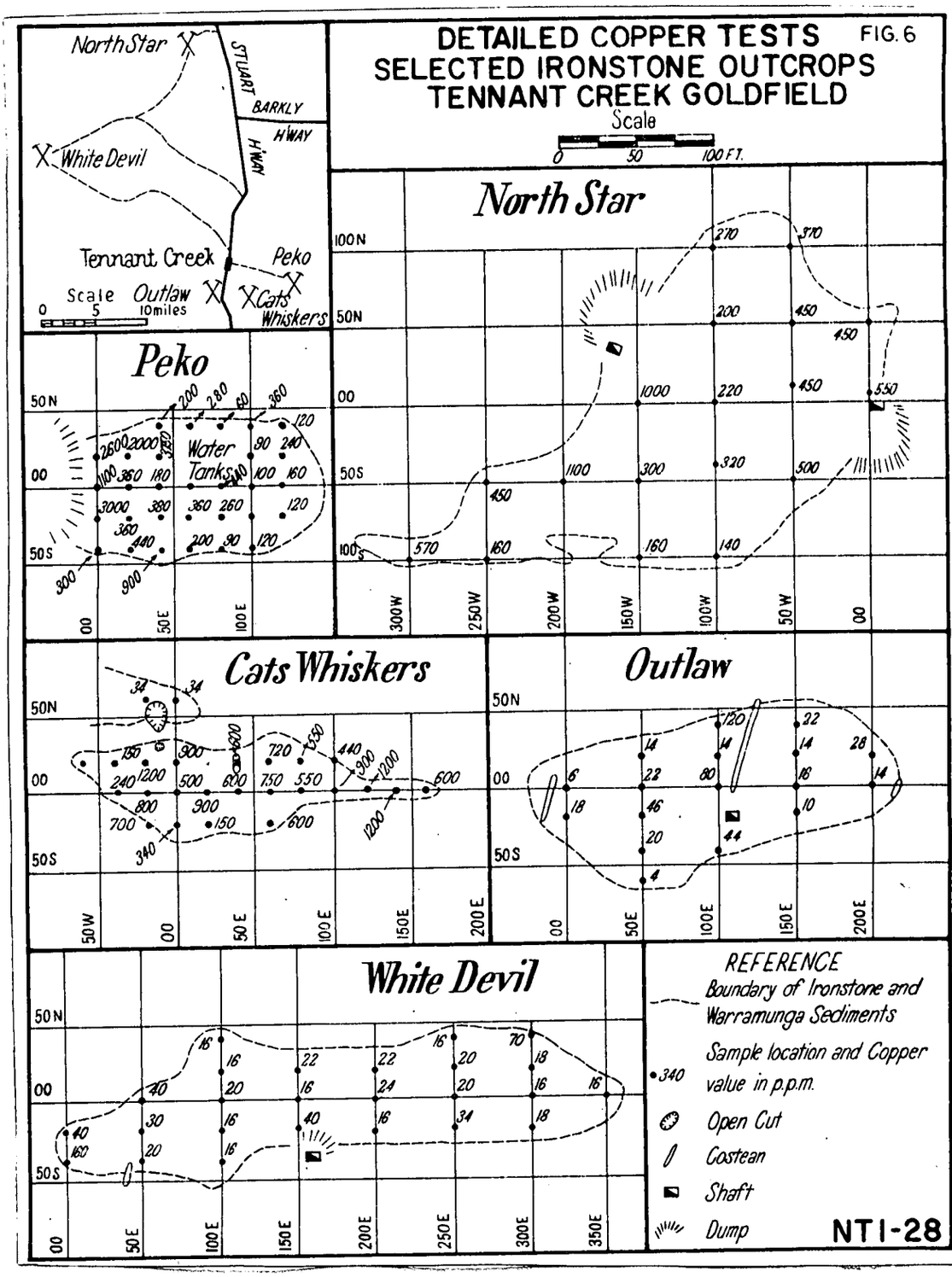


Fig. 6 shows the results of detailed sampling on selected ironstone outcrops in the Tennant Creek Gold ... The tests at Peko, Cat's Whiskers, and Outlaw were primarily carried out to check the reliability of 50 foot spacing of sampling along the trend of the ironstone outcrops. The North Star and White Devil tests were added because the extension of these bodies at depth had been tested by drilling.

When comparing the geochemical results with known information of the bodies at depth, the following points are of major significance in any consideration of the value of geochemistry as a prospecting technique in this field:

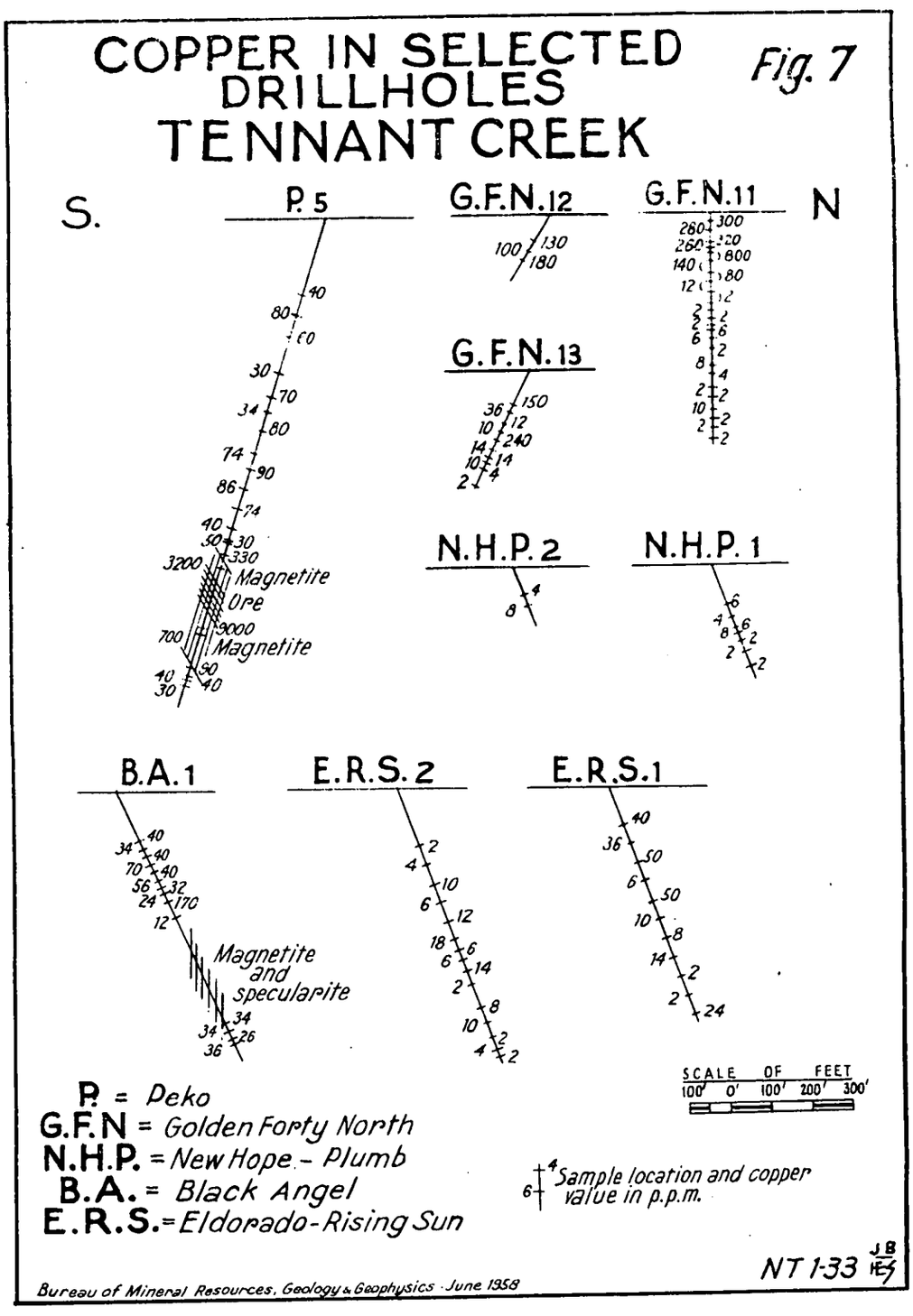
(i) The geochemical values at the surface consistently agree, relatively, with values obtained at depth by drilling and mining development. Peko and North Star outcrops both give high geochemical values which are consistent with proven copper mineralization at depth. On the other hand the Outlaw and White Devil outcrops give low geochemical values consistent with negative drilling results.

(ii) The Cat's Whiskers has high values at the surface but has not been explored at depth (an attempt was made by the Eldorado mining company but the equipment was inadequate for the task). A.G.G.S.N.A. defined a magnetic anomaly in the immediate vicinity of the Cat's Whiskers outcrop (Daly, 1957, Plate 3 sheet 3) thus indicating the persistence of the ironstone mineralization at depth. The clear inference of all this is that the Cat's Whiskers outcrop, like the Peko and North Star, can be expected to have copper mineralization at depth.

C. Diamond Drill Core Analyses

Only a limited amount of work has been done on diamond drill cores (fig. 7). Of the 9 sets of cores examined Peko No. 5 hole is the only one from which significant mineralization was recorded. On the assumption that primary haloes are generally associated with the Tennant Creek orebodies, it is suggested that areas in which drill cores contain only background amounts of copper, as in the vicinity of the Eldorado-Rising Sun magnetic anomaly, can be regarded as being devoid of major orebodies, even if the target of magnetic material has not been intersected.

At Golden Forty North, although no ore has been found, the top 200 foot section of core from G.F.N. 11 contains above-background amounts of copper. A comparison with Peko suggests, perhaps, that significant copper mineralization is present in the immediate vicinity of the G.F.N. 11 drill hole.



D. Relationship of Copper in Ironstone to Regional Magnetic Anomalies

The line of ironstone rich in copper comprising the Gibbet, Wheal Doria, Pinnacles, Peko, and Golden Forty areas coincides with the southern margin of a large regional magnetic anomaly, and the Lone Star area lies on the northern margin of the same anomaly (fig. 8). There are, however, comparatively few ironstones within the area of the anomaly itself. This arrangement is significant but the reason for it is not known.

That part of this area centred between Peko and the Lone Star mines is essentially a large "bulldust" plain with relatively few rock outcrops. The depth to bedrock is not accurately known. However, it is considered from general observations throughout the field (including drilling for geochemical samples in flat areas at Eldorado-Rising Sun, New Hope-Plumb, and Golden Forty North) that the depth to bedrock is less than 10 feet. Deep channels now filled with recent debris probably do exist but their areal extent would be limited. Such an area is ideally suited for geochemical testing of soil and bedrock.

REFERENCES

ALMOND, M., 1955 - Rapid field and laboratory method for the determination of copper in rocks. U.S. geol. Surv. Bull., 1936 - A.

Chem. Eng. Min. Rev., 1957. Vol. 49, No. 9, p.74.

DALY, J., 1957 - Magnetic Prospecting at Tennant Creek, Northern Territory, 1935 - 37. Bur. Min. Res. Aust. Bull., No. 44.

DEBNAM, A.H., 1956 - Geochemical Prospecting for Lead and Copper at Peko, Tennant Creek, N.T., 1955. Bur. Min. Res. Aust. Rec. No. 1956/4

EDWARDS, A.B., 1955 - The Composition of the Peko Copper Ore Body, Tennant Creek. Proc. Aust. Inst. Min. Met., 175, 55-82

HAWKES, H.E., 1957 - Principles of Geochemical Prospecting. U.S. geol. Surv. Bull., 1000 - F

IVANAC, J.F., 1954 - The Geology and Mineral Deposits of the Tennant Creek Gold Field, Northern Territory. Bur. Min. Res. Aust. Bull., No. 22

LOVERING, T.S., SOKOLOFF, V.P., and MORRIS, H.T., 1948 - Heavy metals in altered rock over blind ore bodies, East Tintic district, Utah. Econ. Geol., 43, 384.

McKEOWN, M.R., 1942 - The Tennant Creek Gold Field. Proc. Aust. Inst. Min. Met., 126, 177-199.

MORRIS, H.T., 1952 - Supergene and hydrothermal dispersion of heavy metals in wall rocks near ore bodies, Tintic district, Utah. Econ. Geol., 47, 698.

OWEN, H.B., 1942 - Report on the Tennant Creek Gold Field. Geol. Br., Dept. Int. Aust., (unpublished).

RICHARDSON, L.A., RAYNER, J.M., and NYE, P.B., 1936 - Magnetic Prospecting at Tennant Creek (1936) Aer. Surv. N. Aust., N. Terr. Rep. 23, Pts.1 and 2.

RICHARDSON, L.A., RAYNER, J.M., and NYE, P.B., 1937 - Magnetic Prospecting at Tennant Creek (1937). Aer. Surv. N. Aust., N. Terr. Rep. 41 (unpublished).

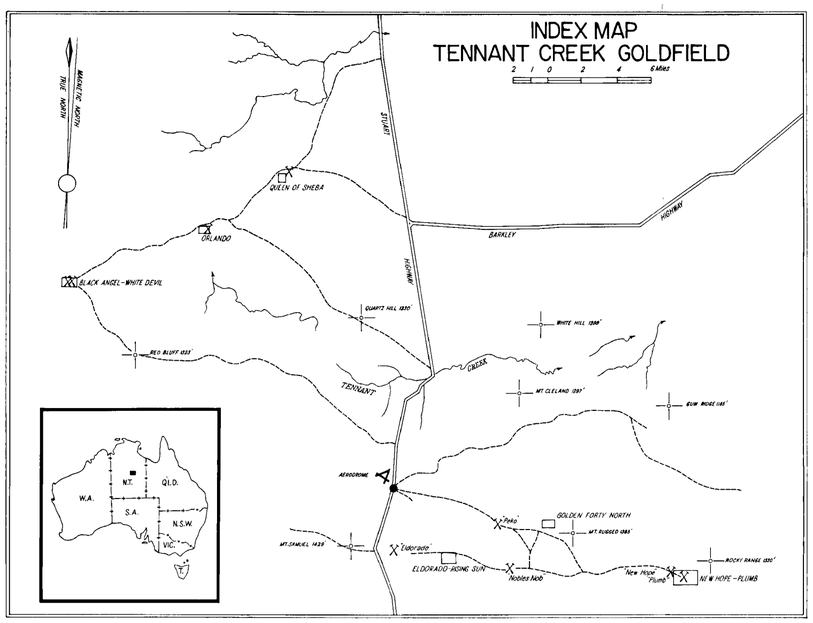
SERGEEV, E.A., 1941 - Geochemical method of prospecting for ore deposits (in Russian). English translation by V.P. Sokoloff: Selected Russian papers on geochemical prospecting for ores. pp. 15-87. U.S. geol. Surv., Feb. 1950.

STILLWELL, F.L., and EDWARDS, A.B., 1942 - The mineral assocation of Tennant Creek Gold Ores. Proc. Aust. Inst. Min. Met., 126, 139-146.

SULLIVAN, C.J. and IVANAC, J.F., 1953 - The Tennant Creek Gold Field. 5th Emp. Min. Met. Cong., Vol. I : The Geology of Australian Ore Deposits. pp. 305-316.

WOOLNOUGH, W.G., 1936 - Report on Tennant Creek Gold Field, N.T. Bull. N. Terr. Aust., No. 22.

SURFICIAL COPPER DISTRIBUTION OVER MAGNETIC BODIES
TENNANT CREEK



12● Location of bedrock sedimentary sample and copper value (ppm)

6• Location of alluvium scoopie and copper value (ppm)

20●H Location of ironstone (hematite) sample and copper value (ppm)

10 ⊙60 Diamond drill hole, direction and angle

Magnetic anomaly centre

Ironstone outcrop

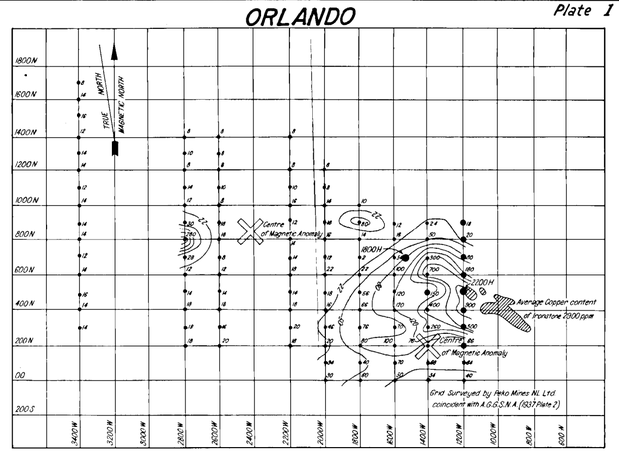
A.G.S.N.A. Aerial Geological and Geophysical Survey of North Australia (See text reference)

CONTOUR INTERVALS - 2,5,10,20,50,100,200,500 - BASED ON LABORATORY COLORIMETRIC STANDARDS

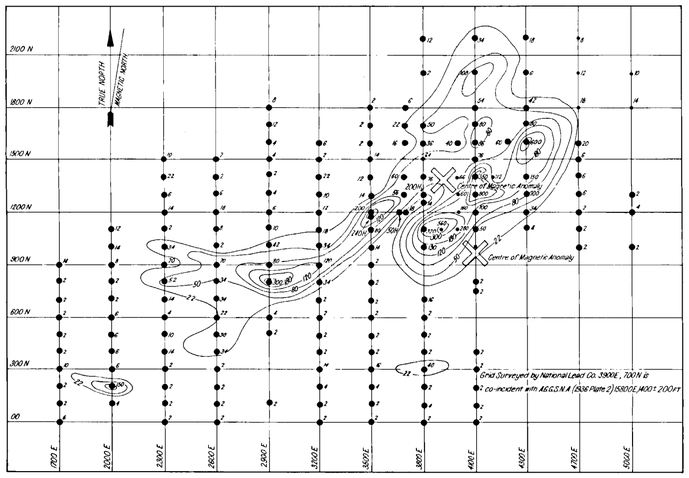
400 200 0 400 800 1200 FEET

ORLANDO

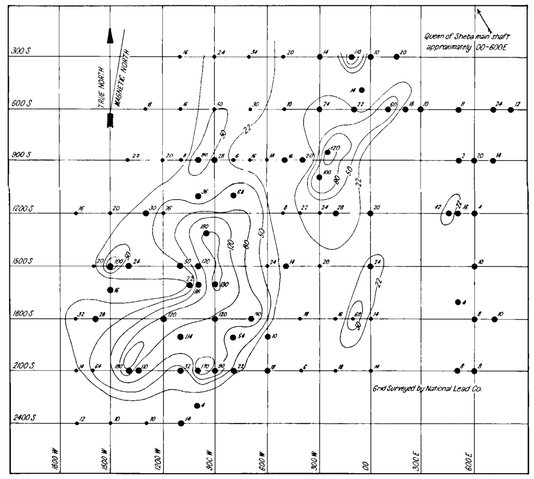
Plate 1



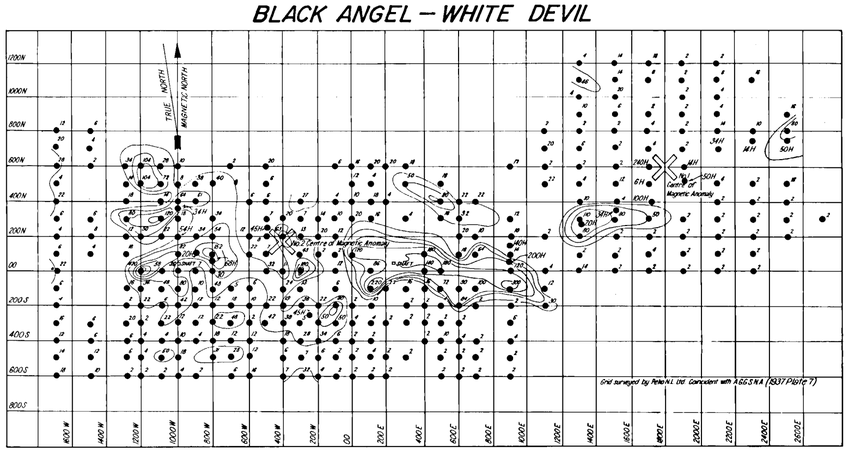
GOLDEN FORTY NORTH



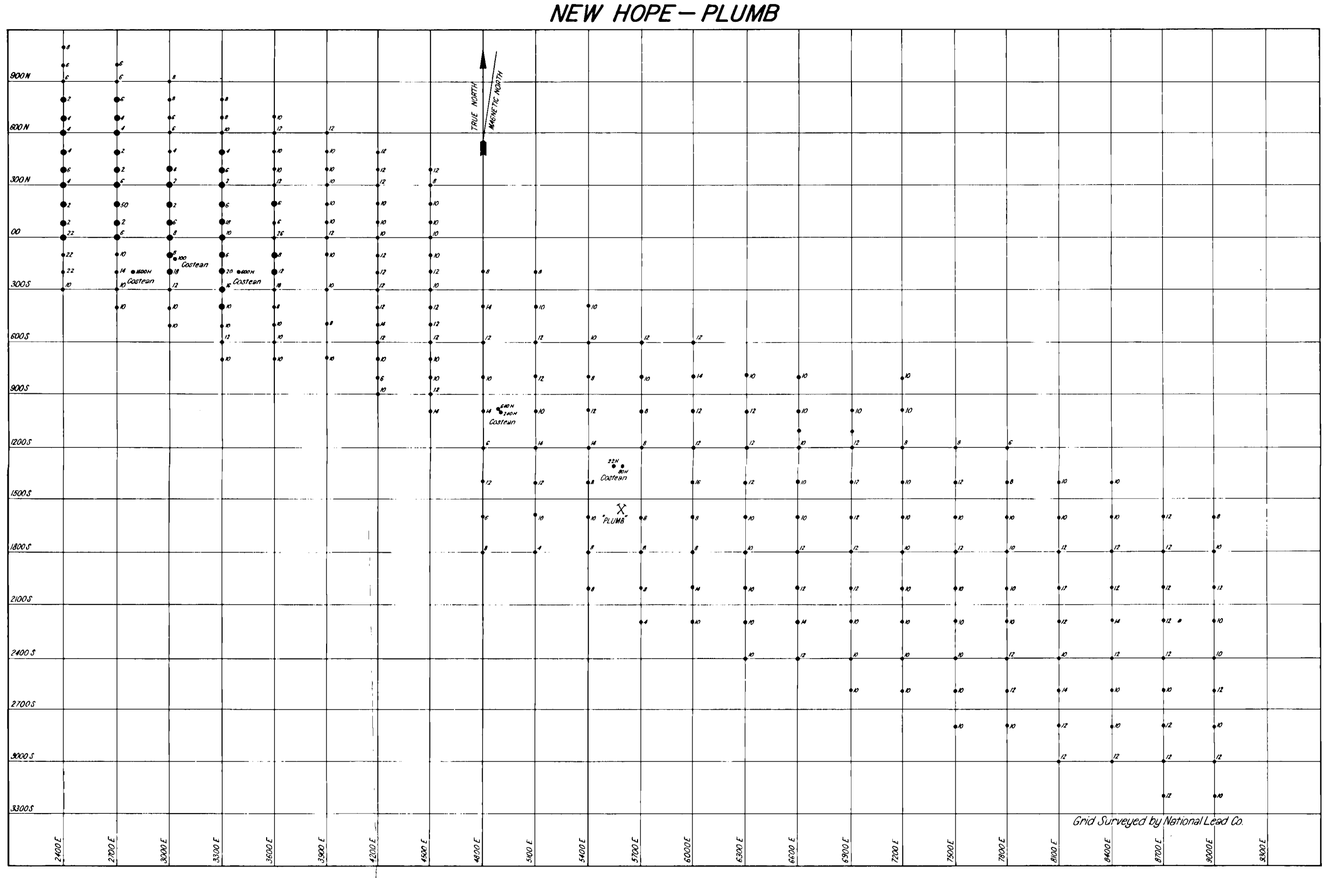
QUEEN OF SHEBA



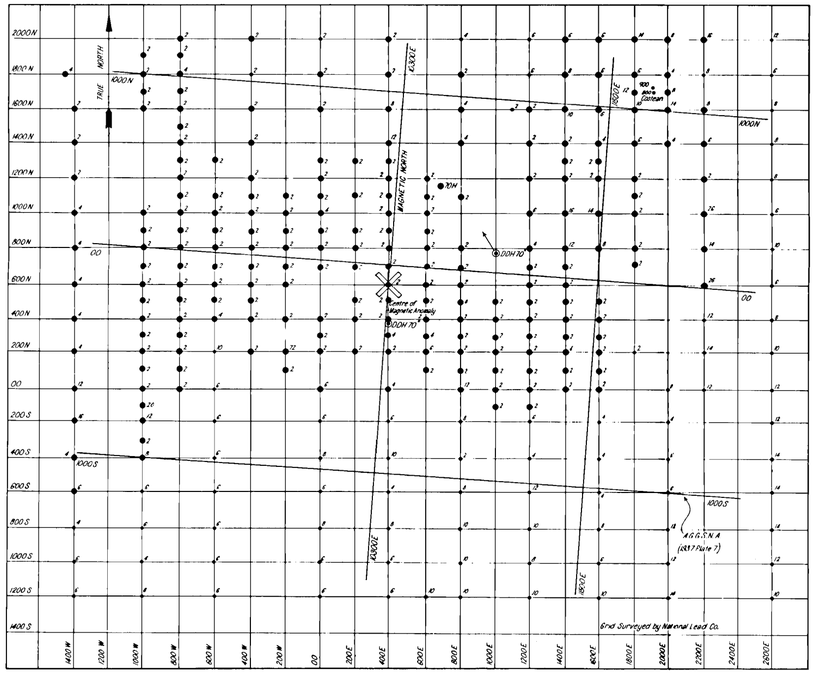
BLACK ANGEL — WHITE DEVIL



NEW HOPE — PLUMB



ELDORADO — RISING SUN



VEC

NT 1/37

COPPER DISTRIBUTION
IN
AREAS OF IRONSTONE OUTCROP
TENNANT CREEK
GOLD-FIELD
(Based on Geochemical Survey 1957).

SCALE OF MILES
1 ½ 0 1 2 3

Reference

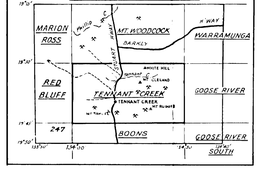
- Sealed road
- Track
- Mine
- Trig. stations

SAMPLE DENSITY
- Areas within which ironstone outcrops were sampled at approximately 50' intervals
- Single sample from small ironstone outcrop.

BACKGROUND = 30 parts of copper per million
- I 0 - 0·2 times background
- II 0·2 - 1 " "
- III 1 - 2 " "
- 2 - 6 " "
- >6 " "

LOCALITY MAPS

INDEX TO 1-MILE MAP STRIPS



WARRAMUNGA ABORIGINAL RESERVE

△Quartz Hill 1330'
△Station Hill 1419'
White Hill 1299'
Tennant Creek
Old Telegraph Station
△McCleland 1297'
Pigeon Hill
△Gum Ridge 1185'
HIGHWAY
"MARY LANE"
"HIDDEN MYSTERY"
"SHAMROCK"
"JUBILEE"
"BURNT SHIRT"
"ARIZONA"
Lone Star Hill 1392'
"LONE STAR"
"THE TRUMP"
"GREAT BEAR"
"MAMMOTH"
"MEM SAHIB"
"BLACK CAT"
"GIGANTIC"
"NEW MOON"
"HOPEFUL STAR"
"BLUE MOON"
METALLIC HILL
A/D
"WHEAL DORIA"
TENNANT CREEK
"GIBBET"
"BIG BEN"
"PINNACLES"
"SOUTHERN STAR"
"RENATE"
"GOLDEN MILE"
STUART
"SKIPPER"
"OUTLAW"
Mt Samuel 1429'
HAMMERJACK"
"ELDORADO"
"CATS WHISKERS"
"THE MOUNT"
"PEKO"
"GOLDEN KANGAROO"
"GOLDEN FORTY"
GREAT EASTERN
△Mt Rugged 1385'
"JOKER"
"NOBLES NOB"
"RISING SUN"
△Rocky Range 1330'
"NEW HOPE"

Bureau of Mineral Resources, Geology & Geophysics · Feb. 1958

NT 1-27 JMc HS

PLATE III

INDEX TO PLATES IV–XVII

Plate IV Fig. 2

Plate reference and area covered by plate or figure

70 Area number

SCALE OF MILES
1 ½ 0 1 2 3

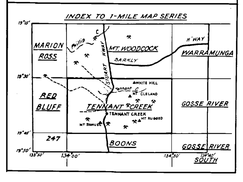
Reference

- Sealed road
- Track
- Mine
- Trig. stations

SAMPLE DENSITY
- Areas within which ironstone outcrops were sampled at approximately 50' intervals
- Single sample from small ironstone outcrop.

BACKGROUND = 30 parts of copper per million
- 0 - 0·2 times background
- II 0·2 - 1 " "
- III 1 - 2 " "
- IV 2 - 6 " "
- V > 6 " "

LOCALITY MAPS



WARRAMUNGA ABORIGINAL RESERVE

Quantz Hill 1330'
Station Hill 1419'
White Hill 1299'
McCleland 1297'
Lone Star Hill 1392'
Gum Ridge 1185'
Rocky Range 1330'
Mt Samuel 1429'
Mt Rugged 1385'
Old Telegraph Station
Tennant Creek
Pigeon Wy
TENNANT CREEK
STUART HIGHWAY
Adv

Plate IV Fig. 1
Plate IV Fig. 2
Plate IV Fig. 3
Plate IV Fig. 4
Plate IV Fig. 5
Plate IV Fig. 6
Plate IV Fig. 7
Plate IV Fig. 8
Plate IV Fig. 9
Plate IV Fig. 10
Plate IV Fig. 11
Plate V
Plate VI
Plate VII
Plate VIII
Plate IX
Plate X
Plate XI
Plate XII
Plate XIII
Plate XIV
Plate XV
Plate XVI
Plate XVII

MARY LANE
HIDDEN MYSTERY
SHAMROCK
JUBILEE
BURNT SHIRT
WHEAL DORA
GIBBET
BIG BEN
PINNACLES
SOUTHERN STAR
SKIPPER
OUTLAW
HAMMERJACK
ELDORADO
CATS WHISKERS
THE MOUNT
PEKO
GOLDEN KANGAROO
GOLDEN FORTY NORTH
GOLDEN FORTY
GREAT EASTERN
JOKER
NOBLES NOB
RISING SUN
NEW HOPE
SIGANTIC
BLUE MOON
METALLIC HILL
RENATE
GOLDEN MILE
BLACK CAT
NEW MOON
HOPEFUL STAR
MAMMOTH
MEM SAHIB
ARIZONA
LONE STAR
THE TRUMP
GREAT BEAR

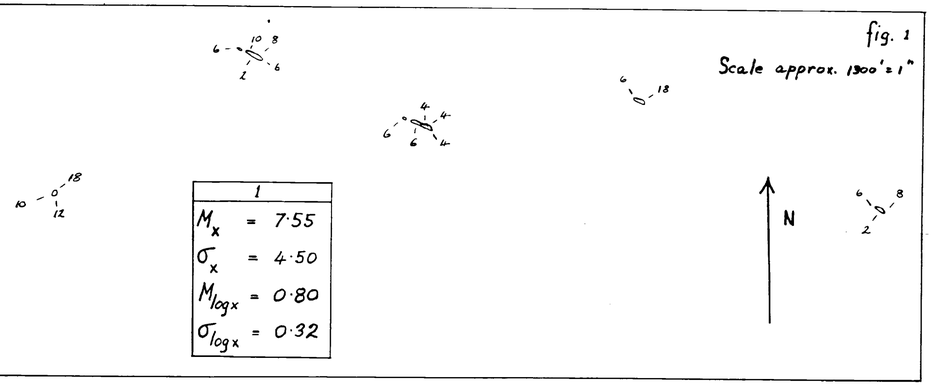
Bureau of Mineral Resources, Geology & Geophysics July 1961

NT 1-27a AMC 143

19°30' 134°00' 134°30' 19°45'

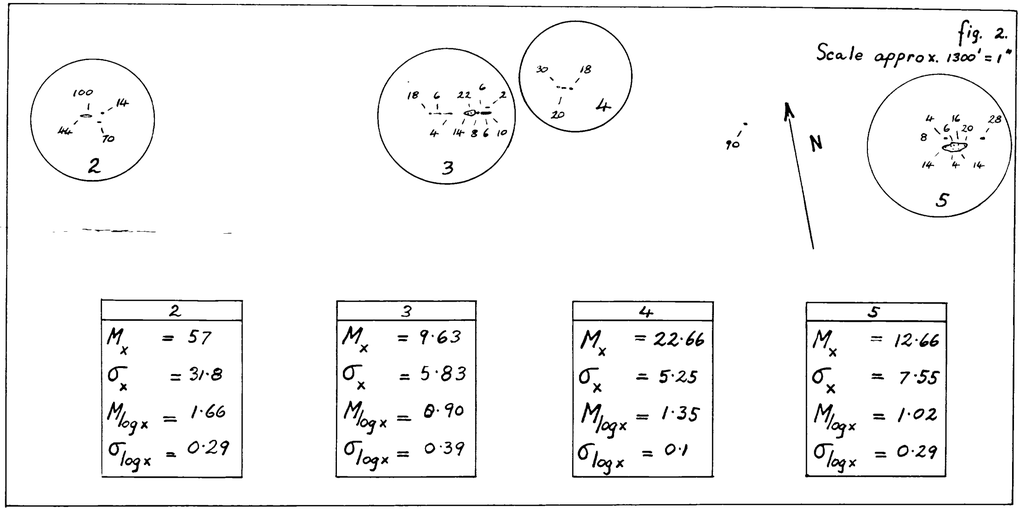
PLATE IV

fig. 1
Scale approx. 1300' = 1"



1	
M_x	= 7·55
σ_x	= 4·50
$M_{\log x}$	= 0·80
$\sigma_{\log x}$	= 0·32

fig. 2.
Scale approx. 1300' = 1"



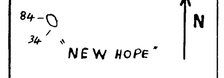
2	
M_x	= 57
σ_x	= 31·8
$M_{\log x}$	= 1·66
$\sigma_{\log x}$	= 0·29

3	
M_x	= 9·63
σ_x	= 5·83
$M_{\log x}$	= 0·90
$\sigma_{\log x}$	= 0·39

4	
M_x	= 22·66
σ_x	= 5·25
$M_{\log x}$	= 1·35
$\sigma_{\log x}$	= 0·1

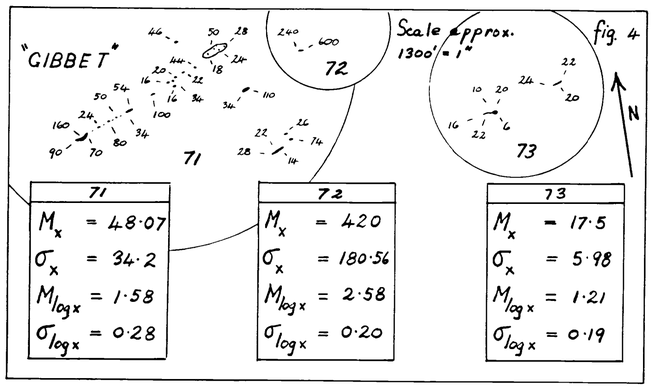
5	
M_x	= 12·66
σ_x	= 7·55
$M_{\log x}$	= 1·02
$\sigma_{\log x}$	= 0·29

fig. 3
Scale approx 1300' = 1"



100	
M_x	= 59
σ_x	= 25·0
$M_{\log x}$	= 1·73
$\sigma_{\log x}$	= 0·2

"GIBBET"
Scale approx.
1300' = 1"
fig. 4

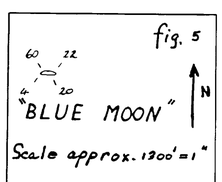


71	
M_x	= 48·07
σ_x	= 34·2
$M_{\log x}$	= 1·58
$\sigma_{\log x}$	= 0·28

72	
M_x	= 420
σ_x	= 180·56
$M_{\log x}$	= 2·58
$\sigma_{\log x}$	= 0·20

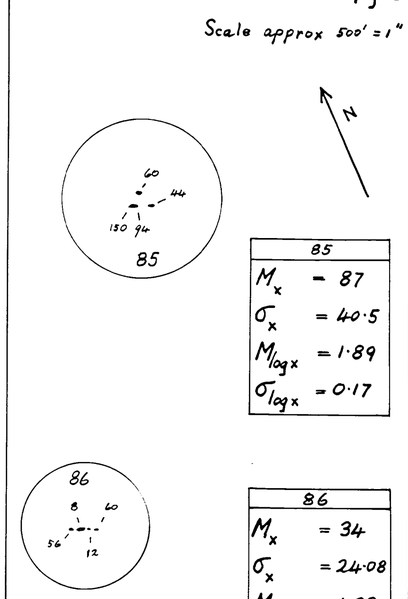
73	
M_x	= 17·5
σ_x	= 5·98
$M_{\log x}$	= 1·21
$\sigma_{\log x}$	= 0·19

fig. 5
"BLUE MOON"
Scale approx. 1300' = 1"



54	
M_x	= 28·5
σ_x	= 20·62
$M_{\log x}$	= 1·26
$\sigma_{\log x}$	= 0·42

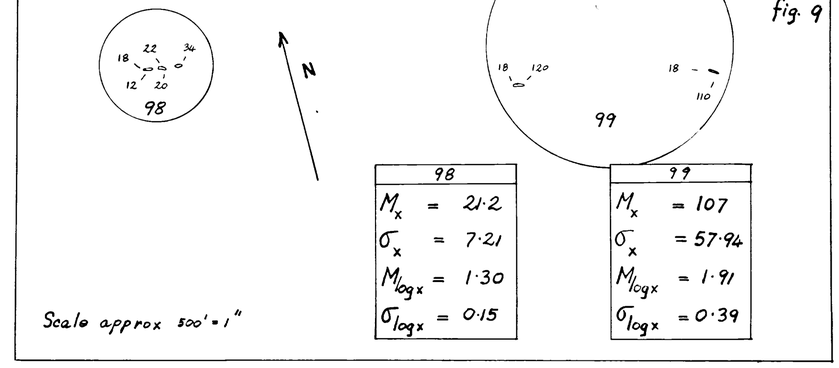
fig. 8
Scale approx 500' = 1"



85	
M_x	= 87
σ_x	= 40·5
$M_{\log x}$	= 1·89
$\sigma_{\log x}$	= 0·17

86	
M_x	= 34
σ_x	= 24·08
$M_{\log x}$	= 1·38
$\sigma_{\log x}$	= 0·39

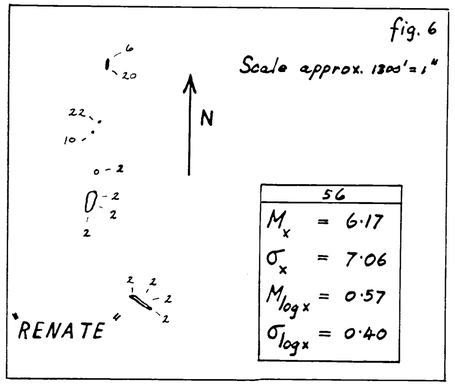
fig. 9



98	
M_x	= 21·2
σ_x	= 7·21
$M_{\log x}$	= 1·30
$\sigma_{\log x}$	= 0·15

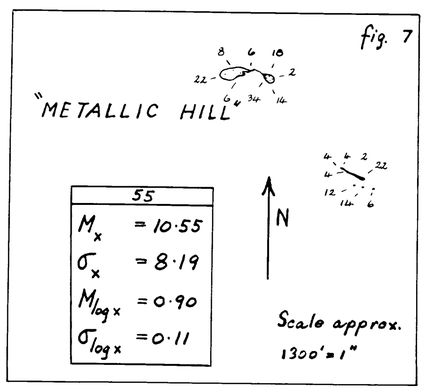
99	
M_x	= 107
σ_x	= 57·94
$M_{\log x}$	= 1·91
$\sigma_{\log x}$	= 0·39

fig. 6
Scale approx. 1300' = 1"



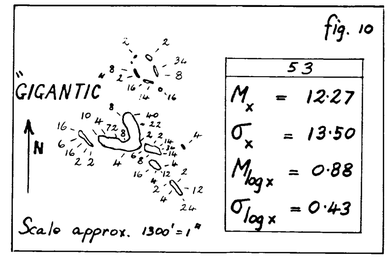
56	
M_x	= 6·17
σ_x	= 7·06
$M_{\log x}$	= 0·57
$\sigma_{\log x}$	= 0·40

fig. 7



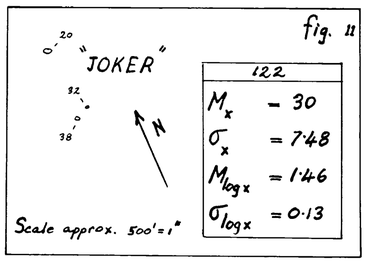
55	
M_x	= 10·55
σ_x	= 8·19
$M_{\log x}$	= 0·90
$\sigma_{\log x}$	= 0·11

fig. 10



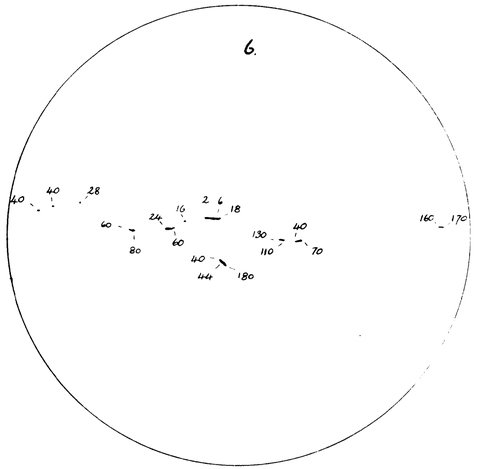
53	
M_x	= 12·27
σ_x	= 13·50
$M_{\log x}$	= 0·88
$\sigma_{\log x}$	= 0·43

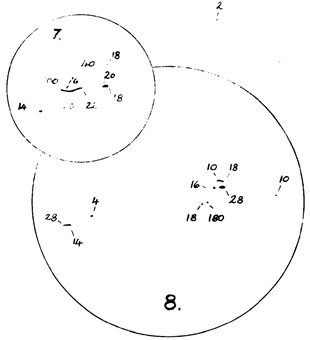
fig. 11

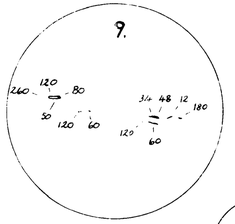


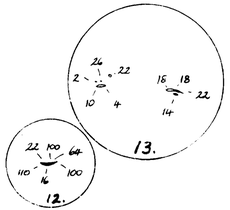
122	
M_x	= 30
σ_x	= 7·48
$M_{\log x}$	= 1·46
$\sigma_{\log x}$	= 0·13

PLATE V

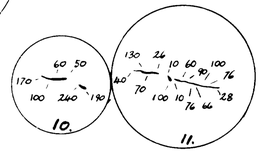


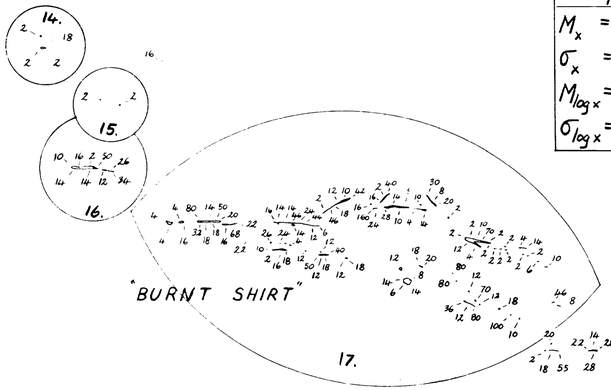






"SHAMROCK"





N

Scale 1" 1300' (Approx)

17
M_x = 22·03
σ_x = 25·12
$M_{\log x}$ = 1·11
$\sigma_{\log x}$ = 0·47

6
M_x = 65·9
σ_x = 53·79
$M_{\log x}$ = 1·63
$\sigma_{\log x}$ = 0·48

7
M_x = 36·4
σ_x = 28·97
$M_{\log x}$ = 1·45
$\sigma_{\log x}$ = 0·29

8
M_x = 32·6
σ_x = 49·66
$M_{\log x}$ = 1·26
$\sigma_{\log x}$ = 0·41

9
M_x = 95·3
σ_x = 42·59
$M_{\log x}$ = 1·86
$\sigma_{\log x}$ = 0·34

10
M_x = 135
σ_x = 118·5
$M_{\log x}$ = 2·06
$\sigma_{\log x}$ = 0·26

11
M_x = 63
σ_x = 34·96
$M_{\log x}$ = 1·70
$\sigma_{\log x}$ = 0·28

12
M_x = 68·66
σ_x = 39·96
$M_{\log x}$ = 1·77
$\sigma_{\log x}$ = 0·34

13
M_x = 15·11
σ_x = 7·85
$M_{\log x}$ = 1·07
$\sigma_{\log x}$ = 0·36

14
M_x = 6
σ_x = 6·93
$M_{\log x}$ = 0·54
$\sigma_{\log x}$ = 0·42

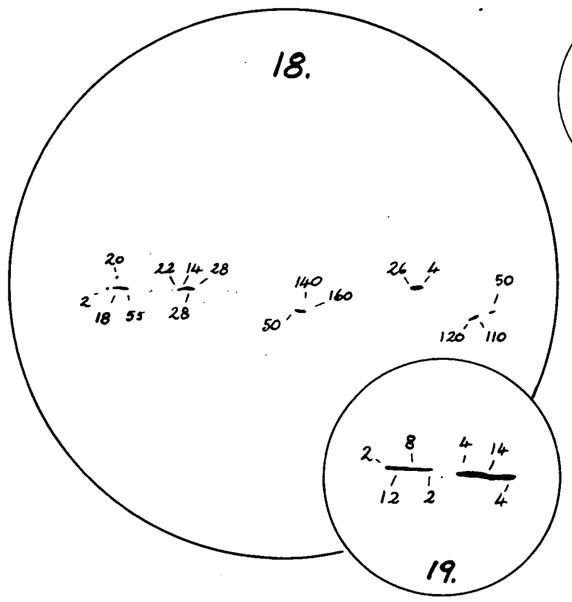
15
M_x = 2·0
σ_x = 0
$M_{\log x}$ = 0·30
$\sigma_{\log x}$ = 0

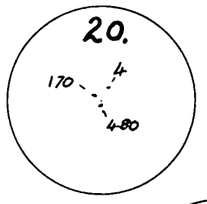
16
M_x = 19·77
σ_x = 13·76
$M_{\log x}$ = 1·17
$\sigma_{\log x}$ = 0·38

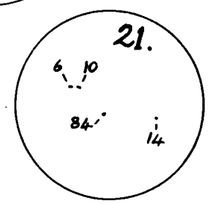
PLATE VI

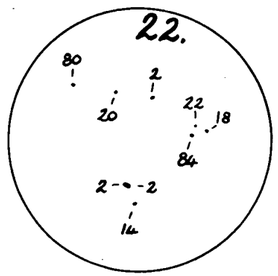
Scale approx. 1300' = 1"

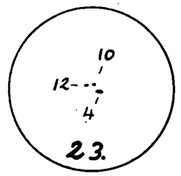
N

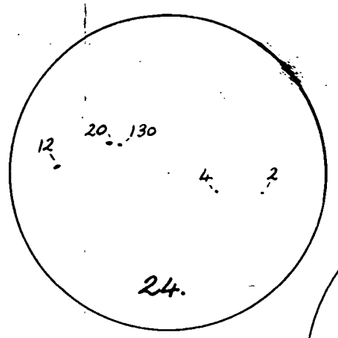


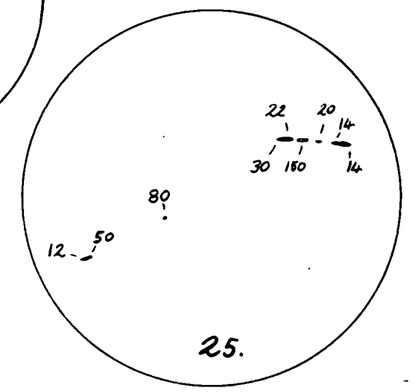












22	
M_x	= 27.1
σ_x	= 30.28
$M_{\log x}$	= 1.08
$\sigma_{\log x}$	= 0.61

23	
M_x	= 8.66
σ_x	= 3.39
$M_{\log x}$	= 0.89
$\sigma_{\log x}$	= 0.21

18	
M_x	= 52.94
σ_x	= 49.09
$M_{\log x}$	= 1.49
$\sigma_{\log x}$	= 0.51

19	
M_x	= 6.57
σ_x	= 4.49
$M_{\log x}$	= 0.70
$\sigma_{\log x}$	= 0.32

20	
M_x	= 218
σ_x	= 197.2
$M_{\log x}$	= 1.83
$\sigma_{\log x}$	= 0.89

21	
M_x	= 28.5
σ_x	= 32.2
$M_{\log x}$	= 1.22
$\sigma_{\log x}$	= 0.42

24	
M_x	= 33.60
σ_x	= 48.62
$M_{\log x}$	= 1.08
$\sigma_{\log x}$	= 0.62

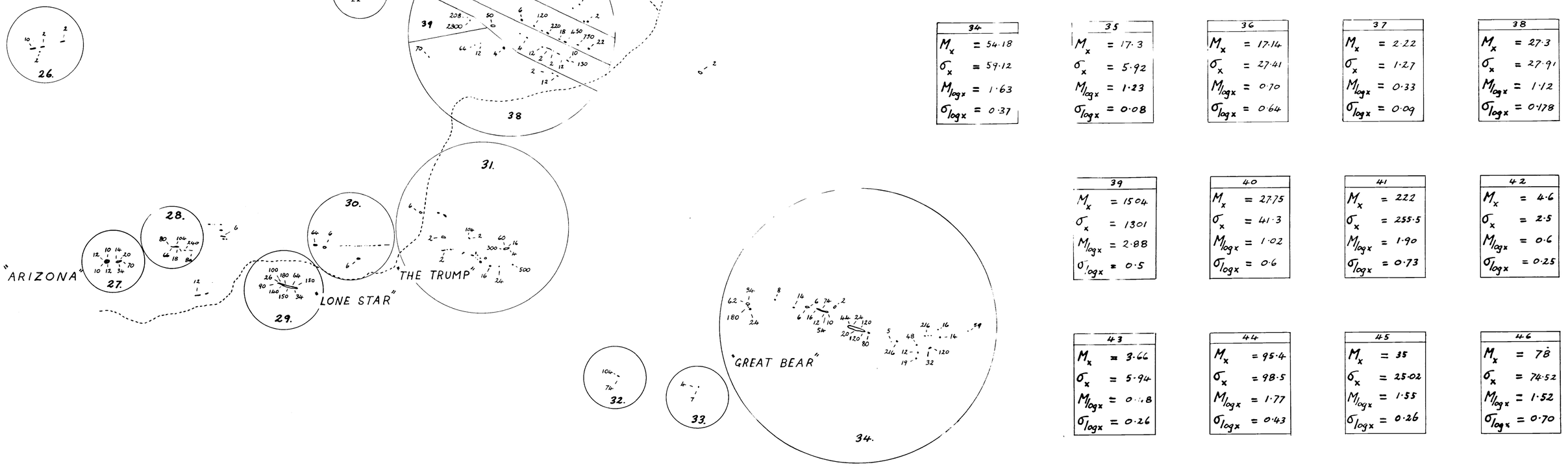
25	
M_x	= 43.55
σ_x	= 43.01
$M_{\log x}$	= 1.48
$\sigma_{\log x}$	= 0.36

PLEASE LEAVE LINCH MARGINAL

PLATE VII

Scale approx. 1300' = 1"

N



48	
M_x	= 2
σ_x	= 0
$M_{\log x}$	= 0.30
$\sigma_{\log x}$	= 0

52	
M_x	= 152.5
σ_x	= 143.4
$M_{\log x}$	= 2.03
$\sigma_{\log x}$	= 0.34

34	
M_x	= 54.18
σ_x	= 59.12
$M_{\log x}$	= 1.63
$\sigma_{\log x}$	= 0.37

35	
M_x	= 17.3
σ_x	= 5.92
$M_{\log x}$	= 1.23
$\sigma_{\log x}$	= 0.08

36	
M_x	= 17.14
σ_x	= 27.41
$M_{\log x}$	= 0.70
$\sigma_{\log x}$	= 0.64

37	
M_x	= 2.22
σ_x	= 1.27
$M_{\log x}$	= 0.33
$\sigma_{\log x}$	= 0.09

38	
M_x	= 27.3
σ_x	= 27.91
$M_{\log x}$	= 1.12
$\sigma_{\log x}$	= 0.178

39	
M_x	= 1504
σ_x	= 1301
$M_{\log x}$	= 2.88
$\sigma_{\log x}$	= 0.5

40	
M_x	= 27.75
σ_x	= 41.3
$M_{\log x}$	= 1.02
$\sigma_{\log x}$	= 0.6

41	
M_x	= 222
σ_x	= 255.5
$M_{\log x}$	= 1.90
$\sigma_{\log x}$	= 0.73

42	
M_x	= 4.6
σ_x	= 2.5
$M_{\log x}$	= 0.6
$\sigma_{\log x}$	= 0.25

43	
M_x	= 3.66
σ_x	= 5.94
$M_{\log x}$	= 0.18
$\sigma_{\log x}$	= 0.26

44	
M_x	= 95.4
σ_x	= 98.5
$M_{\log x}$	= 1.77
$\sigma_{\log x}$	= 0.43

45	
M_x	= 35
σ_x	= 25.02
$M_{\log x}$	= 1.55
$\sigma_{\log x}$	= 0.26

46	
M_x	= 78
σ_x	= 74.52
$M_{\log x}$	= 1.52
$\sigma_{\log x}$	= 0.70

26	
M_x	= 4.0
σ_x	= 3.46
$M_{\log x}$	= 0.48
$\sigma_{\log x}$	= 0.31

27	
M_x	= 22.75
σ_x	= 19.34
$M_{\log x}$	= 1.25
$\sigma_{\log x}$	= 0.28

28	
M_x	= 98.0
σ_x	= 68.9
$M_{\log x}$	= 1.88
$\sigma_{\log x}$	= 0.33

29	
M_x	= 103.8
σ_x	= 51.74
$M_{\log x}$	= 1.94
$\sigma_{\log x}$	= 0.42

30	
M_x	= 15.3
σ_x	= 27.35
$M_{\log x}$	= 1.12
$\sigma_{\log x}$	= 0.51

31	
M_x	= 86
σ_x	= 148.9
$M_{\log x}$	= 1.25
$\sigma_{\log x}$	= 1.16

32	
M_x	= 89
σ_x	= 15.0
$M_{\log x}$	= 1.95
$\sigma_{\log x}$	= 0.07

33	
M_x	= 5.5
σ_x	= 1.50
$M_{\log x}$	= 0.73
$\sigma_{\log x}$	= 0.12

47	
M_x	= 25
σ_x	= 25.98
$M_{\log x}$	= 1.30
$\sigma_{\log x}$	= 0.30

49	
M_x	= 37.75
σ_x	= 55.94
$M_{\log x}$	= 1.22
$\sigma_{\log x}$	= 0.53

50	
M_x	= 134.0
σ_x	= 158.1
$M_{\log x}$	= 1.82
$\sigma_{\log x}$	= 0.52

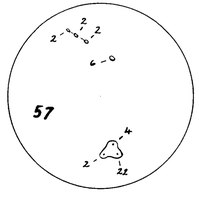
51	
M_x	= 36.40
σ_x	= 28.90
$M_{\log x}$	= 1.45
$\sigma_{\log x}$	= 0.29

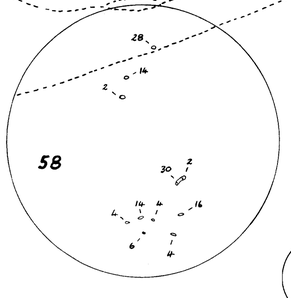
PLATE VIII

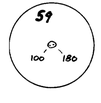
Scale approx. 500' = 1"

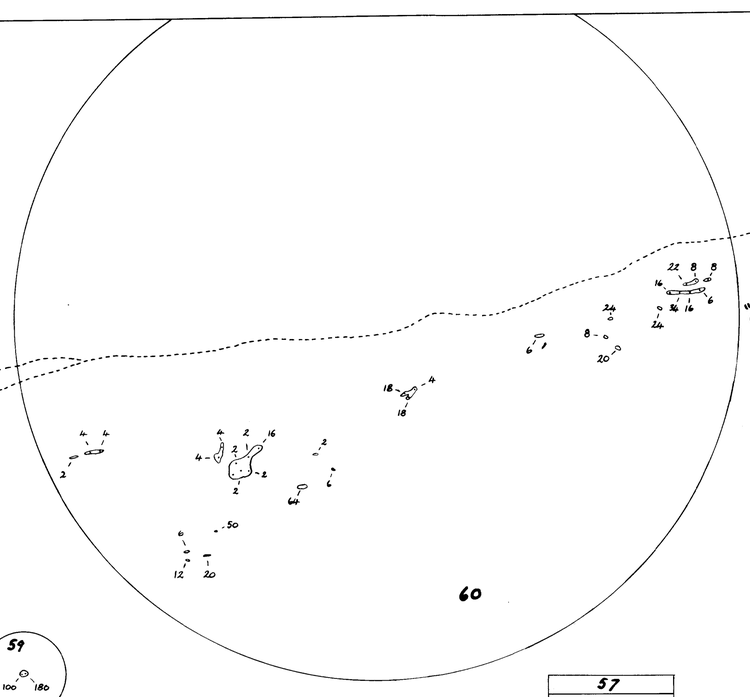
N

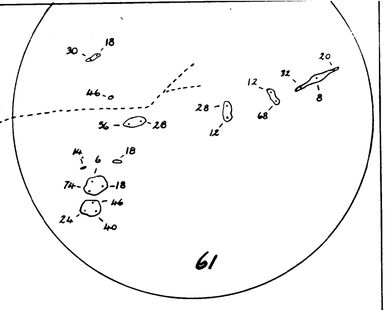
"GOLDEN MILE"











57	
M_x	= 5·71
σ_x	= 6·75
$M_{\log x}$	= 0·56
$\sigma_{\log x}$	= 0·37

58	
M_x	= 11·27
σ_x	= 9·65
$M_{\log x}$	= 0·87
$\sigma_{\log x}$	= 0·41

59	
M_x	= 140
σ_x	= 40
$M_{\log x}$	= 2·13
$\sigma_{\log x}$	= 0·14

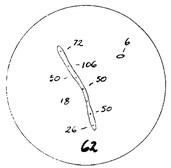
60	
M_x	= 13·56
σ_x	= 14·02
$M_{\log x}$	= 0·92
$\sigma_{\log x}$	= 0·44

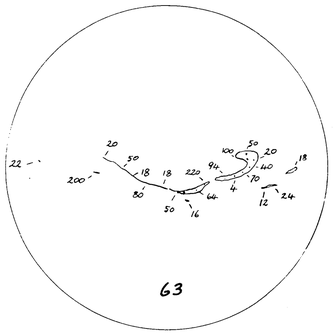
61	
M_x	= 29·9
σ_x	= 18·98
$M_{\log x}$	= 1·38
$\sigma_{\log x}$	= 0·92

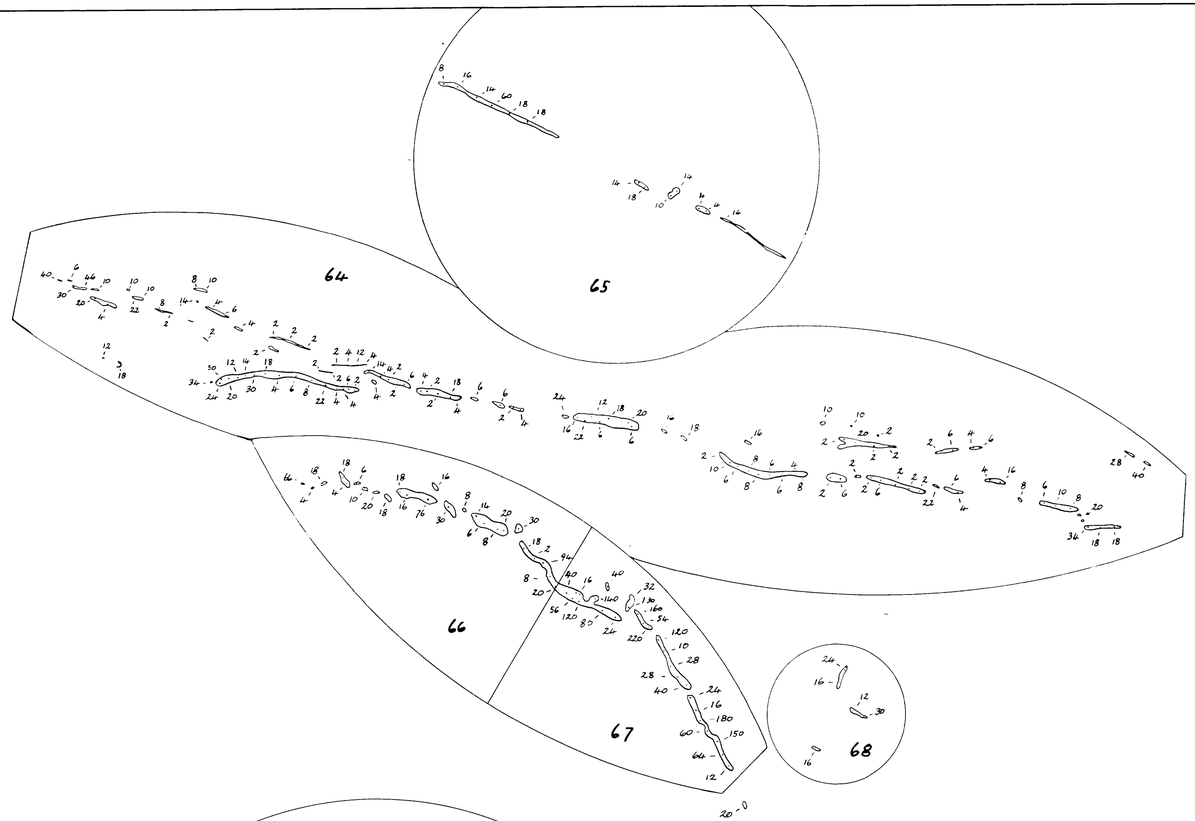
PLATE IX

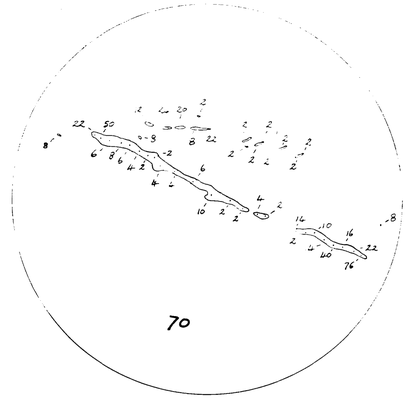
Scale approx 500' = 1"

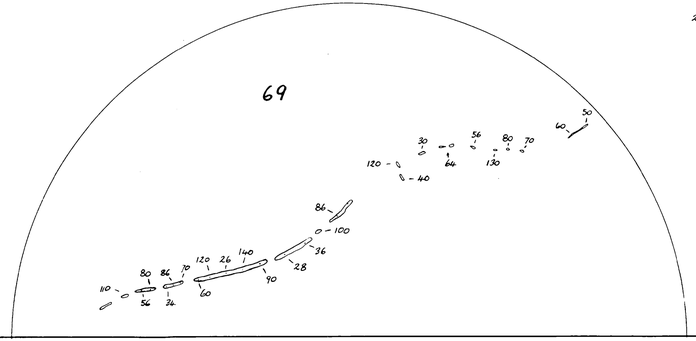
N











62	
M_x	= 47.25
σ_x	= 29.78
$M_{log x}$	= 1.56
$\sigma_{log x}$	= 0.38

63	
M_x	= 56.6
σ_x	= 58.21
$M_{log x}$	= 1.56
$\sigma_{log x}$	= 0.42

64	
M_x	= 11.11
σ_x	= 11.02
$M_{log x}$	= 0.85
$\sigma_{log x}$	= 0.41

65	
M_x	= 16.30
σ_x	= 13.45
$M_{log x}$	= 1.11
$\sigma_{log x}$	= 0.29

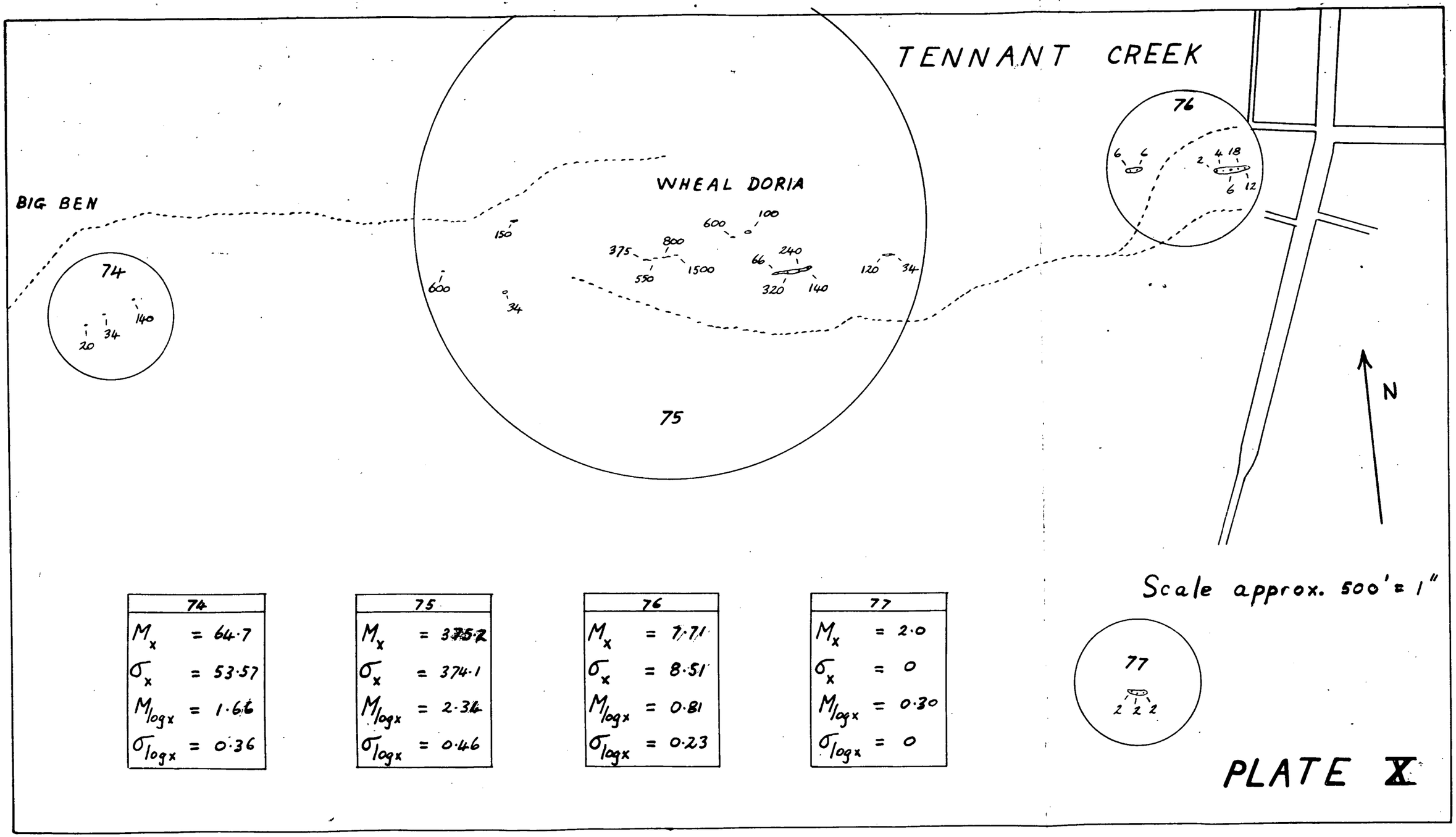
66	
M_x	= 21.92
σ_x	= 22.70
$M_{log x}$	= 1.17
$\sigma_{log x}$	= 0.39

67	
M_x	= 79.76
σ_x	= 59.74
$M_{log x}$	= 1.76
$\sigma_{log x}$	= 0.33

68	
M_x	= 19.6
σ_x	= 6.5
$M_{log x}$	= 1.27
$\sigma_{log x}$	= 0.14

69	
M_x	= 72.88
σ_x	= 32.6
$M_{log x}$	= 1.82
$\sigma_{log x}$	= 0.16

70	
M_x	= 11.17
σ_x	= 14.68
$M_{log x}$	= 0.79
$\sigma_{log x}$	= 0.46



74	
M_x	= 64·7
σ_x	= 53·57
$M_{\log x}$	= 1·66
$\sigma_{\log x}$	= 0·36

75	
M_x	= 375·2
σ_x	= 374·1
$M_{\log x}$	= 2·34
$\sigma_{\log x}$	= 0·46

76	
M_x	= 7·71
σ_x	= 8·51
$M_{\log x}$	= 0·81
$\sigma_{\log x}$	= 0·23

77	
M_x	= 2·0
σ_x	= 0
$M_{\log x}$	= 0·30
$\sigma_{\log x}$	= 0

PLATE X

78	
M_x	= 36·6
σ_x	= 13·42
$M_{\log x}$	= 1·29
$\sigma_{\log x}$	= 0·52

81	
M_x	= 601
σ_x	= 599
$M_{\log x}$	= 1·69
$\sigma_{\log x}$	= 1·39

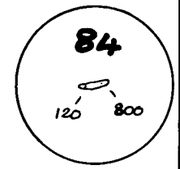
82	
M_x	= 33·33
σ_x	= 19·99
$M_{\log x}$	= 1·43
$\sigma_{\log x}$	= 0·30

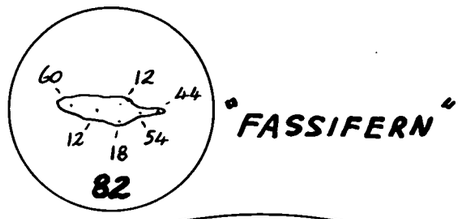
83	
M_x	= 353·3
σ_x	= 227·8
$M_{\log x}$	= 2·47
$\sigma_{\log x}$	= 0·34

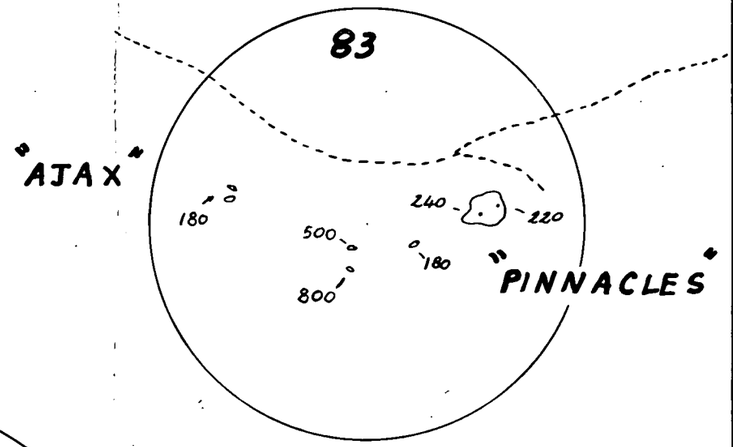
84	
M_x	= 460·0
σ_x	= 340
$M_{\log x}$	= 2·49
$\sigma_{\log x}$	= 0·41

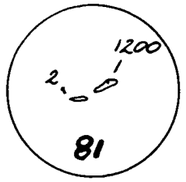
79	
M_x	= 140·2
σ_x	= 136·7
$M_{\log x}$	= 1·94
$\sigma_{\log x}$	= 0·45

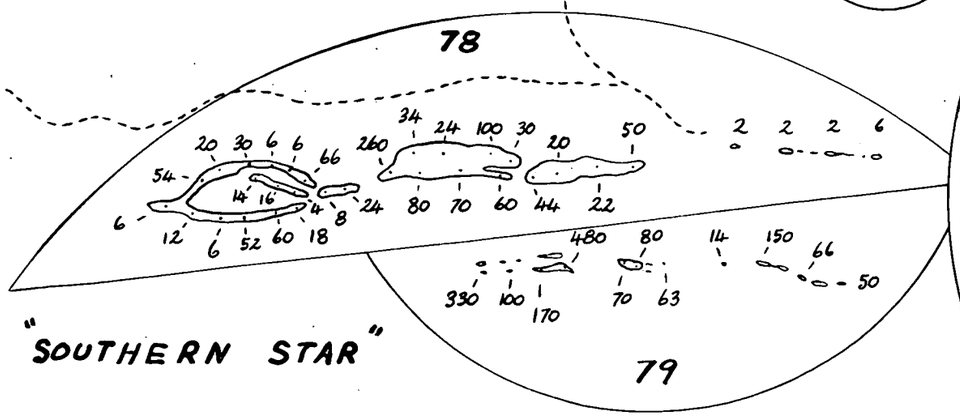
80	
M_x	= 171·3
σ_x	= 162·9
$M_{\log x}$	= 2·21
$\sigma_{\log x}$	= 0·13

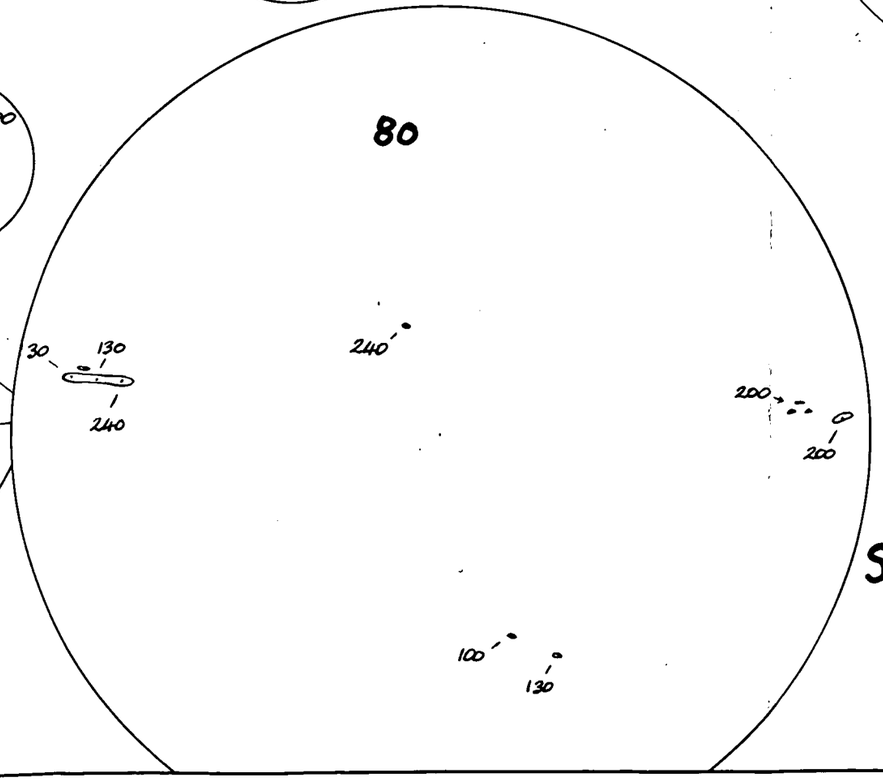








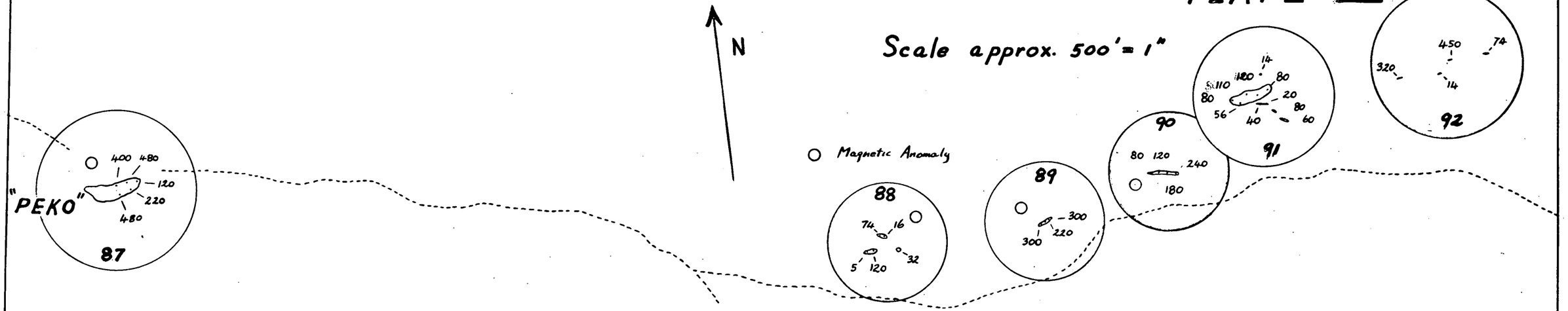




Scale approx. 500' = 1"

PLATE XI

PLATE XII



87	
M_x	= 340
σ_x	= 145·3
$M_{\log x}$	= 2·48
$\sigma_{\log x}$	= 0·24

88	
M_x	= 49·4
σ_x	= 42·38
$M_{\log x}$	= 1·47
$\sigma_{\log x}$	= 0·49

89	
M_x	= 273·3
σ_x	= 37·71
$M_{\log x}$	= 2·43
$\sigma_{\log x}$	= 0·08

90	
M_x	= 155
σ_x	= 60·63
$M_{\log x}$	= 2·18
$\sigma_{\log x}$	= 0·18

91	
M_x	= 71
σ_x	= 32·7
$M_{\log x}$	= 1·77
$\sigma_{\log x}$	= 0·29

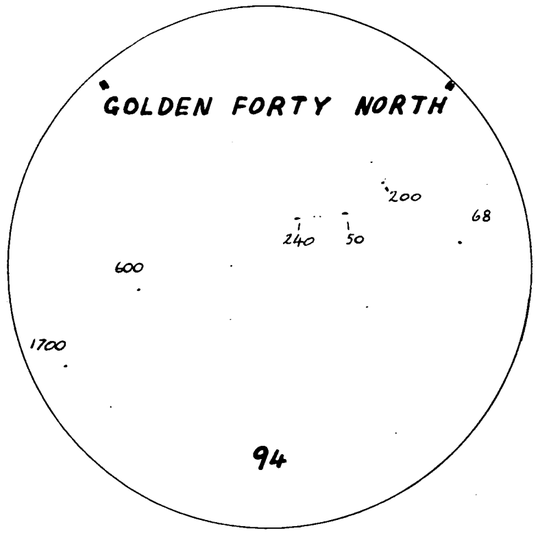
92	
M_x	= 214
σ_x	= 178
$M_{\log x}$	= 2·05
$\sigma_{\log x}$	= 0·60

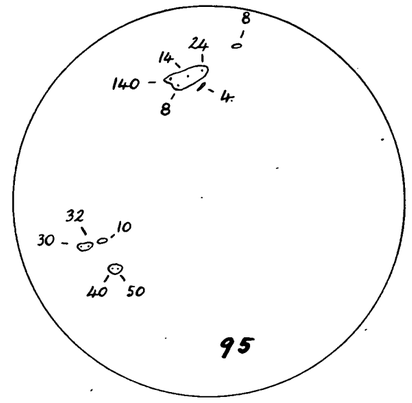
PLATE XIII

Scale approx. 500' = 1"

N

94	
M_x	= 477
σ_x	= 747·8
$M_{\log x}$	= 2·37
$\sigma_{\log x}$	= 0·53

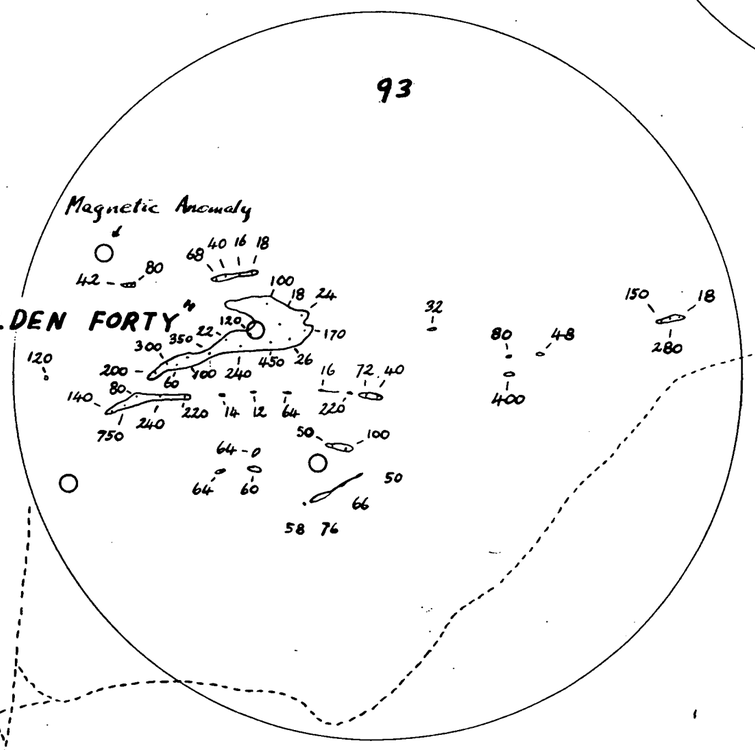




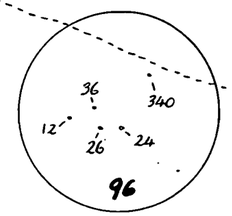
95	
M_x	= 32·73
σ_x	= 49·21
$M_{\log x}$	= 1·31
$\sigma_{\log x}$	= 0·49

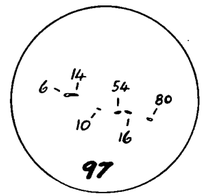
96	
M_x	= 87·6
σ_x	= 126·5
$M_{\log x}$	= 1·59
$\sigma_{\log x}$	= 0·49

97	
M_x	= 30
σ_x	= 27·39
$M_{\log x}$	= 1·29
$\sigma_{\log x}$	= 0·39



93	
M_x	= 123
σ_x	= 138
$M_{\log x}$	= 1·88
$\sigma_{\log x}$	= 0·43



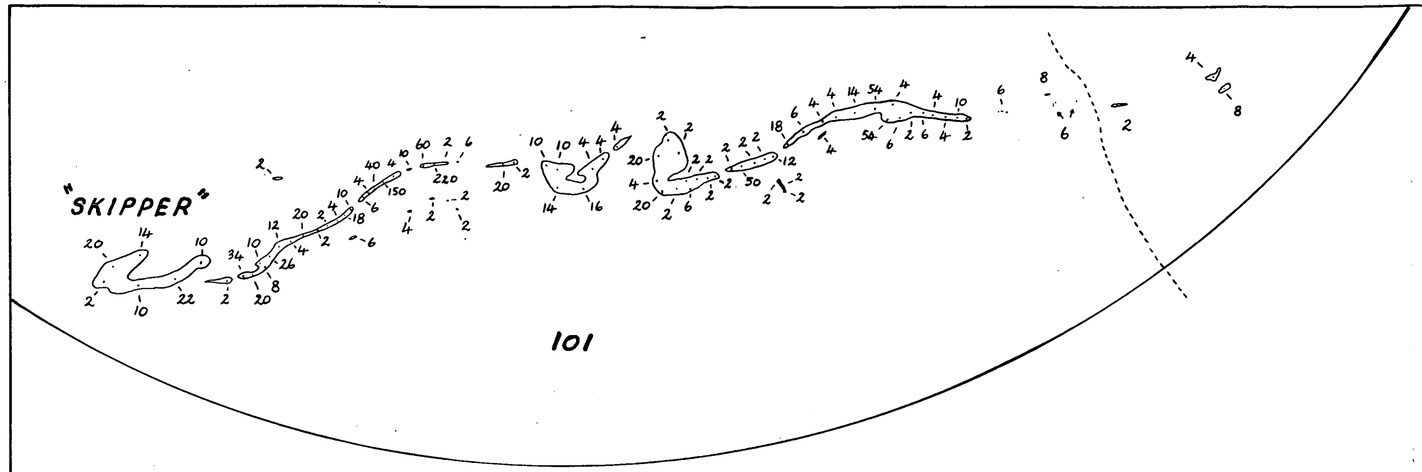


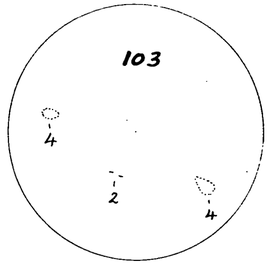
120

"GREAT EASTERN"

PLATE XIV

Scale approx. 500' = 1"





N

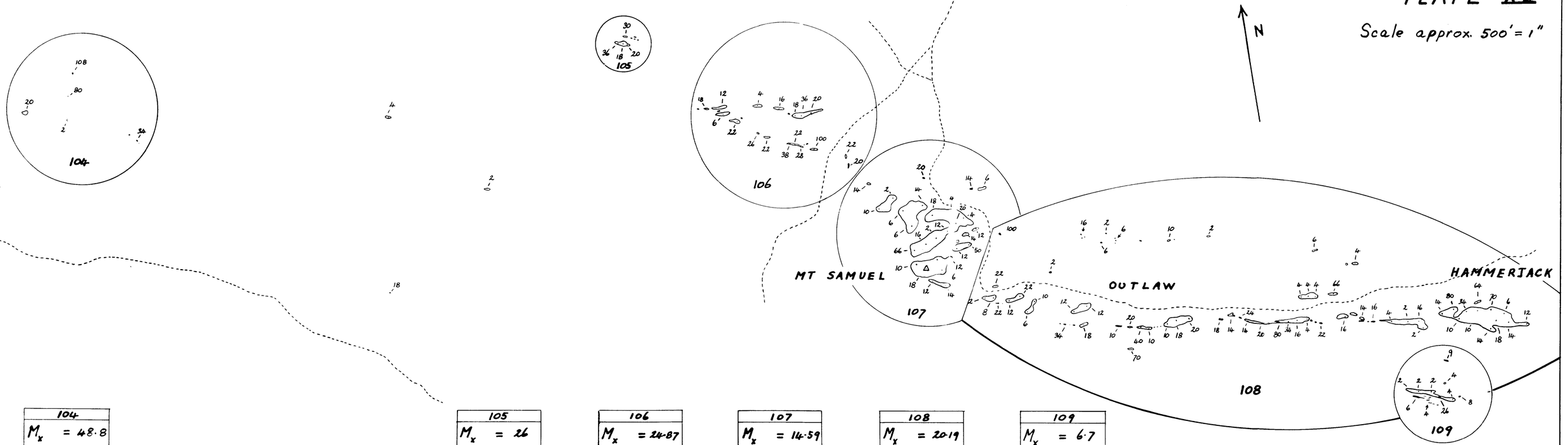
101	
M_x	= 14·28
σ_x	= 29·56
$M_{\log x}$	= 0·81
$\sigma_{\log x}$	= 0·47

102	
M_x	= 10
σ_x	= 10·76
$M_{\log x}$	= 0·97
$\sigma_{\log x}$	= 0·18

103	
M_x	= 3·33
σ_x	= 3·46
$M_{\log x}$	= 0·5
$\sigma_{\log x}$	= 0·14

PLATE XV

Scale approx. 500' = 1"



104	
M_x	= 48·8
σ_x	= 62·63
$M_{\log x}$	= 1·41
$\sigma_{\log x}$	= 0·61

105	
M_x	= 26
σ_x	= 7·34
$M_{\log x}$	= 1·40
$\sigma_{\log x}$	= 0·13

106	
M_x	= 24·87
σ_x	= 22·25
$M_{\log x}$	= 1·29
$\sigma_{\log x}$	= 0·31

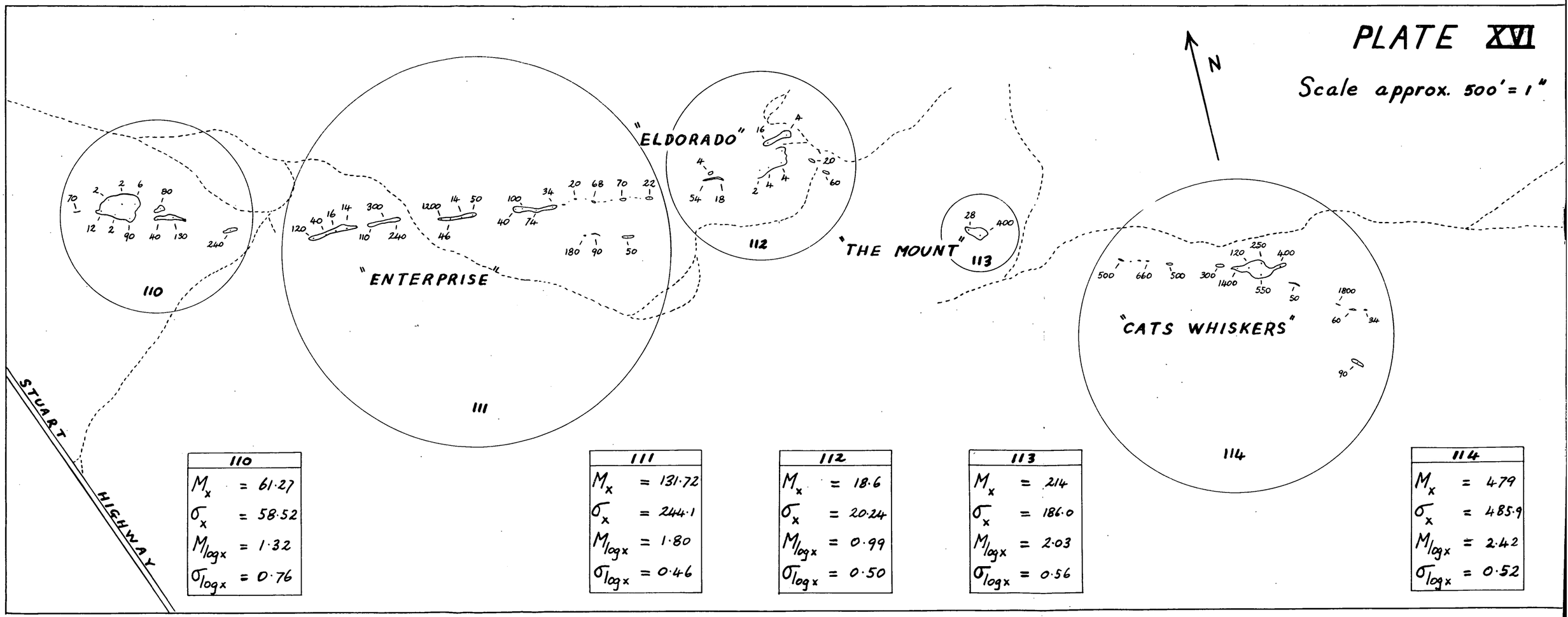
107	
M_x	= 14·59
σ_x	= 13·45
$M_{\log x}$	= 1·03
$\sigma_{\log x}$	= 0·34

108	
M_x	= 20·19
σ_x	= 21·65
$M_{\log x}$	= 1·12
$\sigma_{\log x}$	= 0·41

109	
M_x	= 6·7
σ_x	= 6·85
$M_{\log x}$	= 0·67
$\sigma_{\log x}$	= 0·35

PLATE XVI

Scale approx. 500' = 1"



110	
M_x	= 61.27
σ_x	= 58.52
$M_{\log x}$	= 1.32
$\sigma_{\log x}$	= 0.76

111	
M_x	= 131.72
σ_x	= 244.1
$M_{\log x}$	= 1.80
$\sigma_{\log x}$	= 0.46

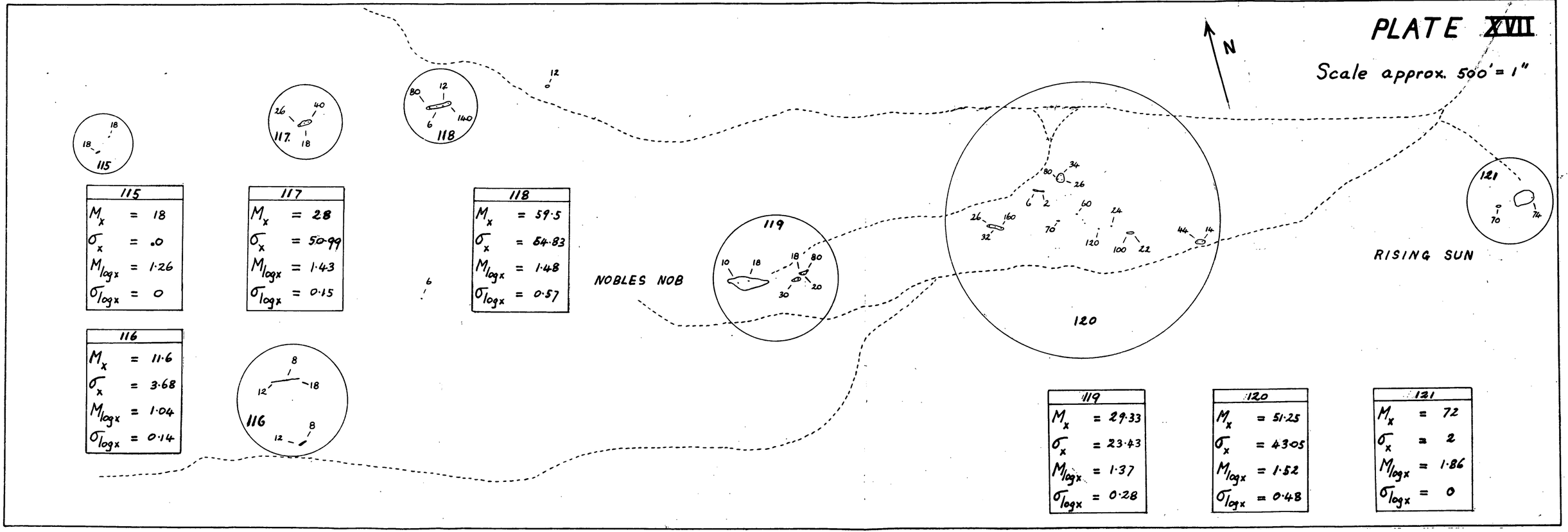
112	
M_x	= 18.6
σ_x	= 20.24
$M_{\log x}$	= 0.99
$\sigma_{\log x}$	= 0.50

113	
M_x	= 214
σ_x	= 186.0
$M_{\log x}$	= 2.03
$\sigma_{\log x}$	= 0.56

114	
M_x	= 4.79
σ_x	= 485.9
$M_{\log x}$	= 2.42
$\sigma_{\log x}$	= 0.52

PLATE XVII

Scale approx. 500' = 1"



115	
M_x	= 18
σ_x	= .0
$M_{\log x}$	= 1.26
$\sigma_{\log x}$	= 0

117	
M_x	= 28
σ_x	= 50.99
$M_{\log x}$	= 1.43
$\sigma_{\log x}$	= 0.15

118	
M_x	= 59.5
σ_x	= 64.83
$M_{\log x}$	= 1.48
$\sigma_{\log x}$	= 0.57

116	
M_x	= 11.6
σ_x	= 3.68
$M_{\log x}$	= 1.04
$\sigma_{\log x}$	= 0.14

119	
M_x	= 29.33
σ_x	= 23.43
$M_{\log x}$	= 1.37
$\sigma_{\log x}$	= 0.28

120	
M_x	= 51.25
σ_x	= 43.05
$M_{\log x}$	= 1.52
$\sigma_{\log x}$	= 0.48

121	
M_x	= 72
σ_x	= 2
$M_{\log x}$	= 1.86
$\sigma_{\log x}$	= 0