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GEOCHEMICAL INVESTIGATIONS AT THE NORTHERN STAR GOLD MINE, TENNANT CREEK, NORTHERN TERRITORY.

by

D.Dunnet

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GEOCHEMICAL INVESTIGATIONS AT THE NORTHERN STAR GOLD MINE, TENNANT CREEK, N.T.

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SUMMARY

During 1964 the Bureau of Mineral Resources contracted 3000 feet of hammer and waggon drilling on the No.2 and No.3 Ironstone lodes at the Northern Star Gold Mine, Tennant Creek to study selected trace element distribution. Forty four holes were drilled on approximately 80 foot centres to a maximum depth of 120 feet. Geochemical samples were collected over 3 foot intervals in each hole and analysed for copper, cobalt, zinc, lead, molybdenum and bismuth. Gold assays were also undertaken.

Statistical analysis of the results indicates three populations for the elements copper, cobalt, zinc and molybdenum. Isochemical contours, drawn at the upper limit of each population, define areas of similar genesis. Distribution of the higher copper population ($>$1200 p.p.m.) defines two anomalous areas, which form a dumb-bell shaped anomaly at depth, in the centre of the No.2 Ironstone. This anomaly is closely related, in space, to a limonitic, cellular hematite, produced by replacement of hematite shale and to massive manganiferous hematite. The former is thought to represent the leached cap of a magnetite/sulphide orebody.

Copper and cobalt concentrations tend to increase with depth, suggesting that the dumb-bell-shaped anomaly may be related to a secondary enriched copper deposit above the water table (600 feet). From previous diamond drilling, copper and iron sulphides are known to be present below the water table.

The geochemical analyses show copper concentrations up to 1% in part of the No.2 Ironstone, but no significant metal values in the No.3 Ironstone. Cobalt, and to a lesser degree zinc and molybdenum, grades vary directly with the copper concentrations. Gold assays available to date range from nil up to 1.1 dwt/ton; the majority of samples are less than 0.2 dwt.

During the drilling programme the Geophysical Branch of the Bureau completed a detailed aeromagnetic survey over the Northern Star leases. This survey indicates a magnetic anomaly, similar in shape and trend to the copper anomaly, and apparently due to a magnetic body situated below and slightly to the north of the geochemical anomaly. Structural information suggests that the mangetic anomaly is produced by the primary magnetite phase of

the No.2 Ironstone.

The geochemical results suggest untested copper mineralization at depth, probably associated with the body producing the magnetic anomaly. Further geochemical investigations and diamond drill exploration of the magnetic anomaly are recommended.

INTRODUCTION

PURPOSE OF PROJECT

During 1964 the Bureau of Mineral Resources undertook a waggon drilling/geochemical sampling programme at the Northern Star Gold Mine, Tennant Creek. The main object was to study the three dimensional distribution of copper, cobalt, zinc, lead, molybdenum, bismuth and gold in virtually untested ironstone masses south of the old mine workings. It was thought possible that an economic mineral deposit of copper, gold or bismuth might be present in one of these ironstones, or its extension in depth, but that its surface expression might have been removed by leaching or concealed by oxidation.

In addition the programme was designed to develop the technique of profile geochemical sampling with rapid, inexpensive spectrographic analyses as a means of cheap exploration of ironstone bodies and to study its usefulness in planning deeper drilling programmes.

To assist the geochemical studies, the B.M.R. Geophysical Branch undertook a low altitude (250 feet) aeromagnetic survey to supplement the geochemical programme.

LOCATION AND ACCESS

The Northern Star Gold Mine is situated approximately 22 miles north of Tennant Creek township, and is reached by travelling north along the Stuart Highway for 23 miles and thence due west along an all-weather road for 2½ miles. It is one of the most northerly mines on the Tennant Creek Field.

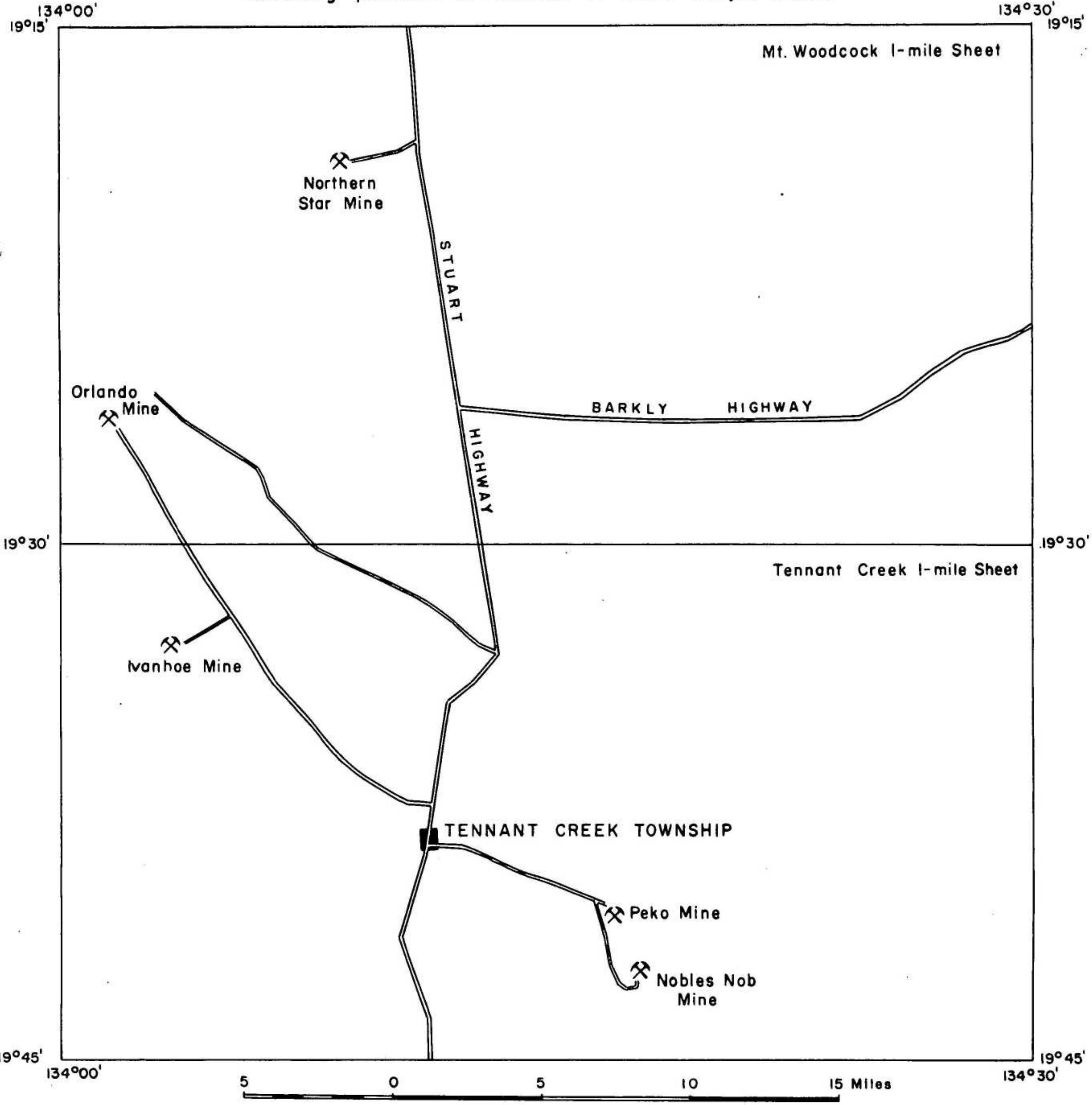
HISTORY AND PRODUCTION

The Northern Star leases were first worked as a gold mine in 1934-35. A shaft was sunk in the No.1 Ironstone in 1937 to a depth of 240 feet where the gold shoot was cut off by a south-east dipping fault; the Higgins Fault. The mine was closed during the War but was reopened in 1947 by Northern Star (T.C.) Gold Mines N.L. Production ceased in 1952 and most of the plant has since been removed. Gold extraction averaged 6.95 dwt/ton with 2.73 dwt left in the tailings prior to the War. Ivanac (1954) lists full production figures and history up to 1951. Various private companies have since examined

LOCATION MAP - NORTHERN STAR TENNANT CREEK

Fig. 1

Showing position in relation to other major mines



Bureau of Mineral Resources, Geology and Geophysics. March 1965 To accompany Record 1965/48 E53/A14/83 JK the mine and carried out some diamond drilling programmes.

PREVIOUS EXPLORATION

Sixteen diamond drill holes have been put down in an attempt to intersect mineralization in the North Star - Northern Star area. Of these holes, D.D.H.4 and 5 intersected highly leached ironstone of the No.2 Ironstone body at shallow depth and two were drilled to intersect the No.1 Ironstone: D.D.H.8 intersected a narrow band of jasper at approximately 500 feet and D.D.H.10 intersected some secondary copper on an apparent extension of the No.1 Ironstone beneath the Higgins Fault (Plate 16). However the most interesting results were in D.D.H.14, put down by Peko Mines N.L., which intersected 22 feet of 3.3% copper at 959 feet (Elliston, 1957) and in D.D.H.15 put down by Metals Exploration N.L., which intersected good gold values at 997 feet. Both holes are to the east of the No.2 Ironstone body (Plate 3).

These two deep holes (D.D.H.14 & 15) were drilled for a target indicated by a ground magnetic survey of the Aerial Geological and Geophysical Survey of North Australia in 1937 (Daly, 1957). This target is situated in the vicinity of 300S, 700E (Plate 3) at approximately 950 feet depth. The ground survey was not completed to the west due to extraneous surface magnetic disturbances. This western area, in the vicinity of the No.1 and 2 Ironstones, was surveyed successfully in 1964 by aeromagnetic methods. This survey is fully discussed by Milsom and Finney (1965). A peak of an intense magnetic anomaly was defined about 500 feet to the west of the 1937 A.G.G.S.N.A. anomaly. This western anomaly is interpreted as being due to a magnetic ironstone body situated slightly to the north of the No.2 Ironstone, its centre being at 200S, 200E at a depth of 700 feet (see Correlation of Structure, Magnetics and Geochemistry). The position of the main low associated with the high indicates the magnetic body is dipping steeply to the north (Milsom & Finney, 1965). This main anomaly has not been tested to date.

No previous systematic geochemical survey has been undertaken. McMillan and Debnam (1957), in a reconnaissance survey of the ironstones of the Tennant Creek area, found the North Star ironstones, 1000 feet to the east of Northern Star, to be anomalously rich in copper. The samples fell within their Group V range (≤6X background) and they recommended further geochemical work on the North Star - Northern Star ironstones.

GEOLOGY

REGIONAL SETTING

The Northern Star Gold Mine is situated near the northern limit of the area of outcrop of the Warramunga Group of Proterozoic miogeosynclinal sediments. This Group overlies (?) Archean gneisses to the south and is unconformably overlain by the Proterozoic Hayward Creek Beds about four miles to the north of Northern Star. The exact stratigraphic position of the Warramunga Group rocks which crop out at Northern Star is unknown. They appear to be stratigraphically lower than the rocks that are mineralised in the vicinity of Tennant Creek township, but include a 'hematite shale' lithology similar to the hematite shale marker bed found in the Mt. Samual - Eldorado area (Crohn & Oldershaw, 1964; Dunnet & Harding, 1965).

DETAILED GEOLOGY

Sedimentary rocks at Northern Star include four main rock types:

(1) Hematite Shale. The hematite shale is a thinly bedded ferruginous shale, consisting of alternating laminae of hematite-rich and hematite-poor quartz siltstone, commonly with a micro-crenulate fabric and distinctive blocky outcrop (Oldershaw, 1961). The micro-crenulate fabric appears to be due to an incipient strain-slip cleavage.

(2) Pink and Red Siltstones. The siltstones are interbedded with the hematite shale and together constitute the main sedimentary rocks associated with the mineralisation.

(3) Greywacke and Shale. Interbedded greywacke and shale, dominantly shale, constitute the main lithology of the Warramunga Group in the area. Beds range from less than one inch to several feet thick.

(4) Tuffaceous Sandstone. A soft, white friable sandstone, which contains rock fragments and feldspar, underlies the finer grained sediments ((1) and (2) above). It is thought to be of tuffaceous origin.

The regional strike of the area is north-east with dips between 30° and 60° to the south-east. Dolomitic siltstones and small lenses of dolomite (29% $CaCO_3$, 20% $MgCO_3$) crop out several miles to the south-west along strike from Northern Star. These may be present in the Northern Star sequence: crystalline dolomite has been noted in drill core (D.D.H. 15) at about 1000 feet. Rocks resembling silicified carbonates crop out to the east of Northern Star. These rocks may have provided a favourable bed for mineralization. The carbonates may be recrystallised and remobilised sediments, or may be secondary carbonates associated with the ironstone mineralisation. It is interesting to note that a body of carbonate rocks is situated in the hanging wall of the Orlando Mine (J. Elliston, pers. comm.).

A full understanding of the stratigraphy of the Northern Star area is restricted by poor outcrop and complex structure.

IRONSTONE MINERALIZATION

The area investigated in this drilling programme includes the central and southern (No.2 and No.3) of three ironstone bodies which crop out on the Northern Star leases. These ironstones are similar to the ironstones throughout the Tennant Creek Field (Ivanac, 1954); they are largely quartz-hematite bodies derived by oxidation of quartz-magnetite replacement bodies above the watertable.. Through most of the Gold Field favourable beds (mudstone, shale, hematite shale) and/or favourable structure (shear zones, brecciation zones) have controlled mineralization. Northern Star is a structurally controlled replacement lode, the ironstone types reflecting the sediments replaced.

Ivanac (1954) mapped four ironstone types at Northern Star:

Type A. Limonite-rich hematite with lozenge-shaped boxwork and ribwork which superficially resembles a leached sulphide gossan.

Type B. Dense massive quartz-hematite.

Type C. Massive quartz-jasper hematite.

Type D. Botryoidal and mammillary goethite.

These varieties are distinguished on fabric differences. This survey has reclassified the ironstones on a genetic basis; three groups are recognised, an intrusive phase, a replacement phase and a secondary alteration phase. The intrusive and replacement phases are essentially contemporaneous. The intrusive phase consists of massive forms of ironstone containing varying quantities of quartz and manganese and which appear to be implaced by mechanical intrusion into the sedimentary rocks, with subordinate replacement of country rocks. The replacement phase consists mainly of silica - or iron-replaced sedimentary rocks, replaced in situ by mineralizing solutions, and contains subordinate intrusive veins and dykes.

The following forms are recognised:

(1) Primary Intrusive Ironstones

Emplaced ironstones are the products of low temperature hydrothermal solutions which carried the sulphide phase. Two types can be distinguished in the field:

(a) Quartz-hematite. The quartz-hematite phase consists of massive blue-black hematite cut by veinlets of quartz and specular hematite (Ivanac's Type B).

(b) Manganiferous quartz-hematite and massive pyrolusite. These forms are similar to (a) but with a large proportion of manganese oxides (pyrolusite, manganite, psilomelane) in place of hematite. Field relations indicate that these post-date the quartz-hematite phase in most instances.

(2) Replacement Ironstones

Replacement ironstones consist largely of replaced sedimentary rocks with minor intrusive quartz-hematite. In some cases the initial fabric is retained due to differential replacement of the various sedimentary beds. The two subdivisions mainly reflect initial differences in rock type:

(a) Quartz-hematite jasper. (Type C of Ivanac's classification). In this rock type, varying proportions of quartz, hematite and specularite form veins in a pink to bright red siliceous jasper. The jasper is a replacement, by silicification, of the pink to red siltstones. Brecciation of the siltstone produces fractures which are healed by quartz and specularite. The degree of silicification ranges from almost unaltered siltstone to a dense red jasper. Replacement by iron is subordinate except where hematite shale is present. The specularite veins are a late phase of the replacement. Quartz veins are of at least two periods, the earlier set is associated with the replacement process, and may represent primary quartz veins or quartz derived from the sediment during replacement.

(b) Cellular hematite. (Type A of Ivanac's classification). This rock type is formed when hematite shale is completely or partly replaced by iron and manganese oxides along bedding, cleavage or fractures. A considerable quantity of intrusive material is generally present as veinlets, transgressing or parallel to bedding. Cellular hematite commonly contains little quartz. Differential weathering of the soft, unreplaced sediment, limonite and manganese wad relative to the massive hematite and pyrolusite produces an open cellular rock superficially resembling a sulphide gossan.

The two replacement rock types reflect their different origins in their geochemistry: the cellular hematite has a higher concentration of copper, cobalt, zinc and molybdenum than does the quartz-hematite jasper.

In most cases there is a direct relationship between sedimentary rock type and replacement product so that jasper is formed from siltstone and cellular hematite from hematite shale. Iron replacement of siltstone is uncommon but silicification of hematite shale was noted on the eastern end of the No.2 Ironstone body.

(3) Secondary Ironstone

(Type D of Ivanac's classification). These rocks consist of the oxidation products of primary ironstones: mainly hydrous iron and manganese minerals in botryoidal and mammillary forms which tend to obliterate the primary fabric. They occur on the No.2 and No.3 Ironstones in the vicinity of shear zones and faults. The main minerals are goethite, limonite and manganese wad, derived from quartz-hematite, quartz-manganese-hematite and cellular hematite. Due to the great depth of oxidation in this area (400 - 600 feet) these secondary oxidation minerals may constitute a significant part of the ironstone even at depth.

Atomic absorbtion spectrophotometric analyses indicate up to 5000 p.p.m. copper and 800 p.p.m. cobalt in manganese wad, suggesting a strong tendency for these secondary minerals to absorb metal irons.

STRUCTURAL GEOLOGY

The regional trend of bedding in the Northern Star area is 060° and bedding dips between 30° and 70° to the south-east. Northern Star is situated half a mile to the north of a strong photo lineament with a trend of 055° parallel to the trend of the magnetic contours (Plate 14). Regional stratigraphy indicates that this lineament coincides with a major structural break between the north-and west-dipping volcanic sequence of the basal Warramunga Group, and the south-east dipping Northern Star sequence.

The small ironstone bodies half a mile south of the Northern Star leases are structurally controlled; they are situated on the intersection of cleavage (strike 210° - 230°) and favourable beds (regional strike 240° - 260°) and, in particular in anticlinal cores.

Regional mapping of the Mt. Woodcock 1-mile Sheet area during 1964 (Dunnet & Harding, 1965) indicated the structural history listed below -

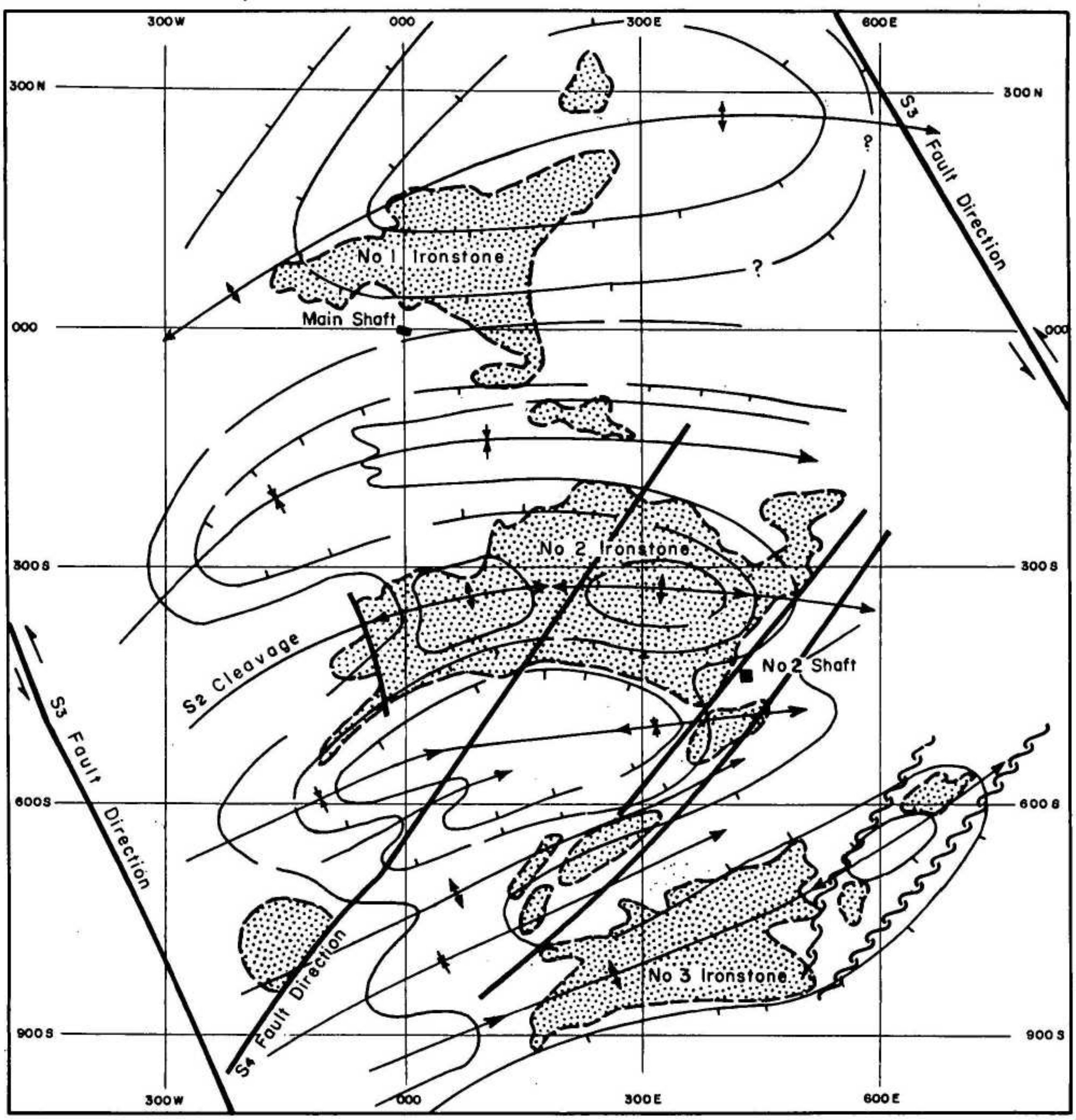
(1) Broad warping and folding of the geosynclinal sediments about an east-west axis with no cleavage developed. Folds plunge shallowly to the west.

(2) Intrusion of granite and intrusive porphyry possibly synchronous with phase 1.

(3) Regional deformation and metamorphism to produce low-grade greenschist facies rocks and a slaty or strainslip cleavage (S_2).

NORTHERN STAR TENNANT CREEK

Diagrammatic Structural Interpretation



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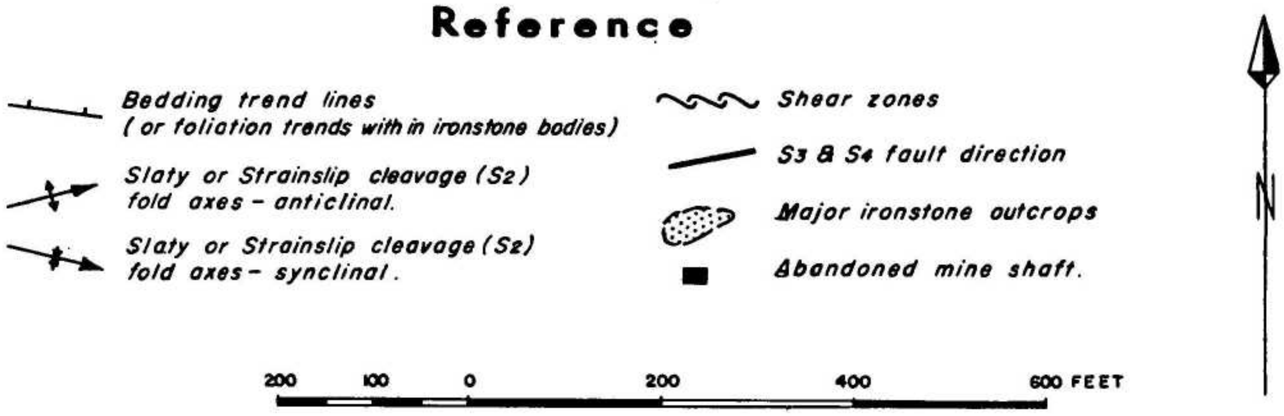

Diagram illustrates the inferred structure of the Northern Star area, derived from limited available structural data. Bedding (S_1) trend lines do not necessarily parallel bedding planes over any distance. Traces of (S_2) axial planes are only approximate. Note close correllation between ironstone position and anticlinal structures. S_3 faults from photo lineaments only.

Folds occur in zones of more intense deformation and in incompetent rocks, these folds may plunge either east or west; the plunge is controlled by the initial attitude of the bedding. The bedding trends between 220° and 270°, and dips steeply north or south; the trend directions are probably modified by phase 4.

(4) Fracture cleavage and faults (S_3) with a 330° trend and a consistent sense of movement over broad areas produce chevron-style folds with a very steep to vertical plunge parallel to the S_1/S_3 intersection; S_1/S_3 and S_2/S_3 intersections are always steep. The movement on S_3 features in the Northern Star area is sinistral.

(5) Faults and fracture cleavage with an 040° trends (S_4) are possibly conjugate locally to S_3.

(6) Ironstone mineralization structurally controlled by the intersection of favourable lithology and the more intense S_2, S_3 or S_4 structural zones.

Structural control is apparent at Northern Star; the three ironstone are situated on S_2 anticlinal crests and tend to be terminated by S_3 or S_4 fault zones (Fig. 2). These anticlines are minor structures within a regional east plunging anticlinorium. The mineralization post-dates the main fold movement (S_2) and is either contemporaneous with or post-dates the north-east fault system (S_4). Some late movement on S_2 has locally sheared the ironstone.

GEOCHEMISTRY

GENERAL

The geochemistry of the Northern Star lodes was investigated to determine:

(a) The three-dimensional distribution of elements within the ironstone.
(b) The relationship between the various ironstone types.
(c) The distribution and control of copper mineralization.
(d) The usefulness of waggon drilling as a low cost geochemical prospecting tool.

The geochemical sampling was divided into two sections.

(a) Regional sampling involved the collection of rock chips from outcrops around the Northern Star lodes, together with samples of soils from colluvial deposits and streams draining the Northern Star-North Star group of hills. This was part of a regional geochemical sampling programme to cover the Mt. Woodcock 1-mile Sheet area.

(b) Detailed sampling of hammer and waggon drill cuttings formed the major part of the programme, and involved a total of 3066 feet of hammer and waggon drilling in 44 holes spaced at approximately 80 feet intervals (see Plate 3). The depth of each hole was intended to exceed 100 feet, but difficult drilling conditions necessitated a reduction to 60 feet on many holes.

The total cost of drilling was £4,892; approximately 32/- per foot. Considering the small size of the contract and the drilling difficulties due to cavernous ground, this is probably not excessive. The drilling rate averaged 600 feet per fortnight.

DRILLING METHODS

Associated Diamond Drillers Pty. Ltd., were contracted to supply two air-operated drills; at first they used Halco Stenuick hammer drills operating a 4 inch diameter hammer, or in some cases, a 3 inch hammer. Two compressors of 300 c.f.m. capacity operated the drills at 75-100 lb/sq. in..

The cavernous nature of the cellular hematite made it necessary to case the holes; NX casing was lowered to the back of the 4 inch hammer, but casing could not be used effectively with the 3 inch hammer. The method of the casing following the hammer was not ideal, and contamination, cave-ins and jamming of the hammer resulted.

In drilling most rock types the 300 c.f.m. compressors maintained an air supply which was just adequate to return cuttings. However, when drilling broken quartz-hematite or cellular hematite, loss of air into the country rocks caused insufficient air flow to return cuttings effectively. In deep holes($<$ 60 feet) penetrating ironstone, the inadequate air return produced differentiation of cuttings, so that only small and light cuttings rose to the collar. Casing of holes did not appreciably reduce air loss and contamination of samples, and the larger and heavier ironstone cuttings still remained in the hole. Contamination was at least 5% and in some instances as much as 30%.

A Climax Coventry KIMP-154A waggon drill with 3 inch bit, was available for the latter part of the contract. Although not tested on all types of ironstone, it was a more efficient drilling machine for geochemical sampling. The drilling rate was almost double that of the hammer drill and contamination was negligible. Australian Development N.L. utilise waggon drills in ironstone to depths of 250 feet, far in excess of the hammer drill capacity.

With both drills the 300 c.f.m., 75 - 100 lb/sq. in. air supply was not adequate for all ironstone drilling conditions, and a 600 c.f.m. compressor per rig appears to be necessary. Waggon drills are preferable to hammer drills.

SAMPLING METHODS

Drill cuttings and dust were collected over 3 foot drilling intervals in the following manner:

(a) A sampling drum (Fig.3) was constructed from a 44-gallon drum. The collar pipe protrudes above the base of the drum so that dust and chips fall into the drum when the air flow velocity is reduced at the collar. This method was very efficient with little loss of material, and was far superior to a dust collecting hopper and venturi pipe arrangement.

(b) Before the beginning of each 3 foot run the collecting drum was cleaned and placed in position. After 3 feet of drilling the hole was blown clean for several minutes and the drum then emptied into a container with the footage interval marked.

(c) Each sample was split using a large Jones sample splitter, until a suitable volume remained.

(d) 4 samples of this material were bagged and labelled; one sample and duplicate for spectrographic analysis, one sample for gold assay and one sample for panning and binocular microscope determination of rock type.

(e) The sample container and splitter were cleaned with a brush after use. Samples were not crushed or sieved.

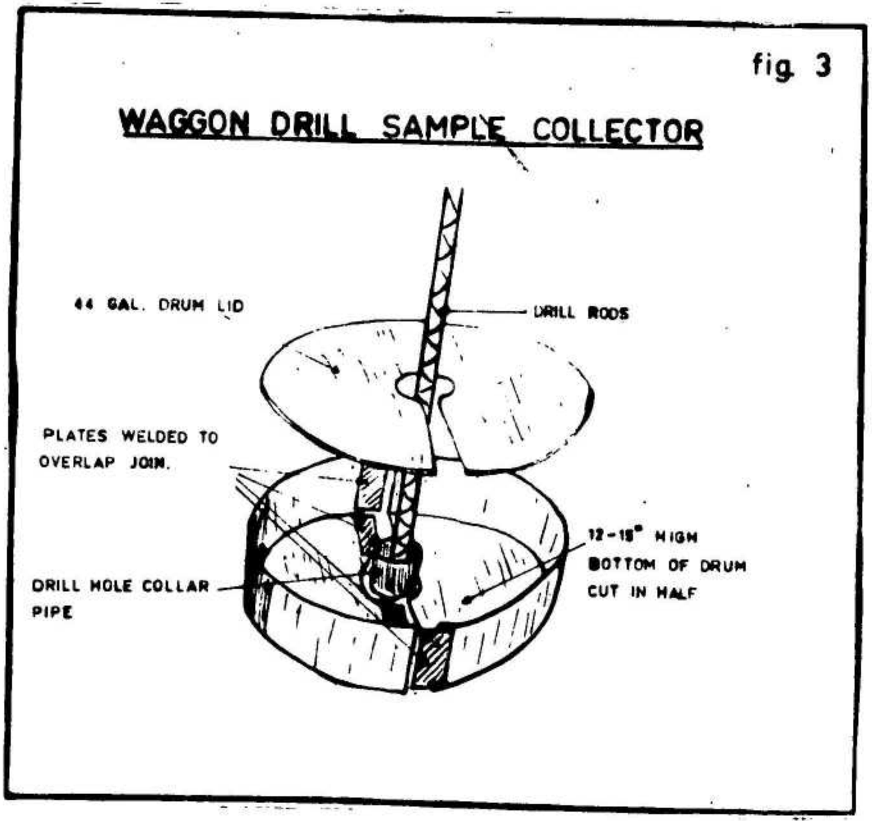

Figure 3
Waggon Drill Sample Collector.

ANALYSIS OF SAMPLES

Samples for spectrographic analysis were forwarded to the Australian Mineral Development Laboratory (A.M.D.L.) in Adelaide for semi-quantitive spectrographic analysis of copper, cobalt, zinc, lead, molybdenum and bismuth. This was carried out on a Baird 3 metre grating spectrograph. Analyses were returned to the field geologist about 4 weeks after the samples left the field.

Gold assays were done by the Government Battery, Tennant Creek. Samples were first crushed in a pulveriser to less than 80 mesh; the pulveriser was cleaned after each sample.

Samples were described after identification of minerals and rock types under a binocular microscope. This description enabled a check on the amount of contamination and a direct correlation between rock types and trace element concentrations.

ACCURACY OF RESULTS

The spectrographic analysis technique used by A.M.D.L. is semi-quantitive and results are normally given with a precision of 50%. Copper cannot be determined accurately by this method when concentrations exceed 4000 p.p.m.. A check by A.M.D.L., using wet chemical methods, of 25 samples in excess of 4000 p.p.m. copper showed that the spectrograph results were high by a factor of 1.5 to 2.5; spectrographic determinations of 10,000 p.p.m. copper did not exceed 8000 p.p.m. when determined by wet chemical methods.

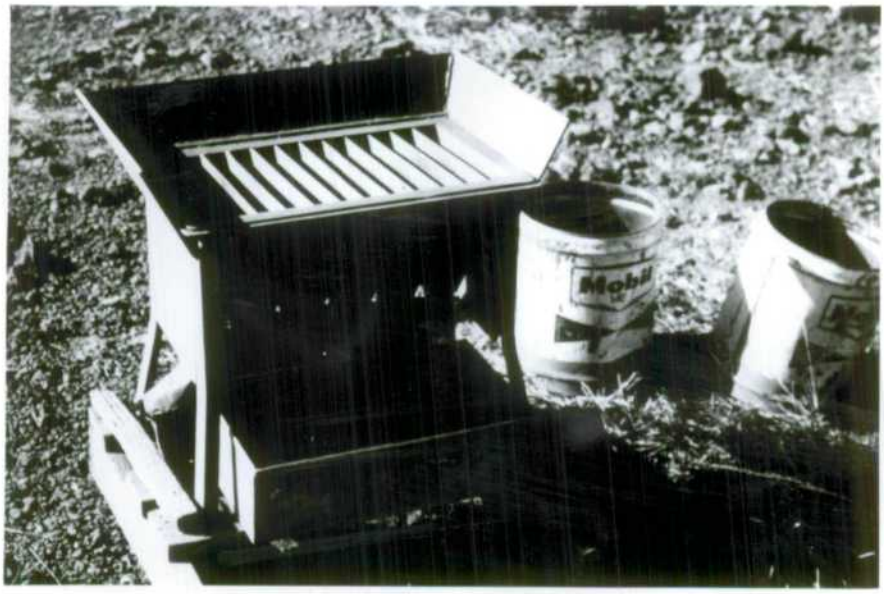

Figure 4

Large Jones splitter and sample drums, used for splitting geochemical waggon drill sample to a size suitable for packing for analysis.

Figure 5

Outcrop of quartz-hematite (Q) and limonite-manganese wad (M) in the Northern Star shales (S) in a shear zone on the eastern end of the No.3 Ironstone. The Field Assistant is standing on the axis of the No.3 Ironstone anticline.

Two factors in the sample collection and preparation influence accuracy. Firstly, contamination of sample material collected from waggon drills may be as high as 30%, because of cave-in and material left in the hole after drilling the previous sample interval. Secondly, A.M.D.L. analyse the minus 80 mesh fraction of the samples. In mixed samples with components such as shale and hematite or pyrolusite/hematite and manganese wad/limonite a higher proportion of the soft rock or mineral will occur in the minus 80 mesh fraction, so that sieving will produce a compositional bias.

Furthermore, the majority of ironstone samples are rich in iron and titanium, which produce a dark background to spectrographic plates, and are difficult to read. Analyses are determined by comparison with silica matrix standards, but the matrix effect of iron may differ from that of silica and produce variations in line density.

A number of the Northern Star samples were re-analysed and found to differ considerably; copper from 1 to 6 times and cobalt from $\frac{1}{4}$ to 4 times, the original analyses. These differences indicate that the geochemical assays given in this report are probably not reliable for statistical analysis; this should be kept in mind when conclusions are drawn from the results. Only trends in element distribution can be considered and this makes it difficult to assess the significance of the base metal distribution in the ironstones. However, it is clear from the geochemical distribution in individual holes that the current analyses and sampling techniques are sufficiently accurate to assess the major geochemical domains and to attempt a general discussion of the significance of populations.

The complete suite of samples are currently being re-analysed by Atomic Absorption Spectrophotometric methods to check the suitability of spectrographic analyses of iron matrix samples. These results should be available by August, 1965.

STATISTICAL ANALYSIS OF GEOCHEMICAL DATA

The distribution of elements in igneous and metamorphic rocks approaches a lognormal rather than normal distribution, (Shaw, 1961). Tennant and White (1959) have shown that several populations in a suite of samples can be recognised from the shape of the cumulative frequency distribution of the sample plotted on probability paper. These graphs are plotted by obtaining the frequency of each value in a suite of samples and converting this to a percentage frequency. These are then plotted as a cumulative percentage frequency on logarithmic probability paper.

The resultant plot of a lognormally distributed population is a straight line whose slope is related to the dispersion of the population. Two overlapping populations will produce a double stepped line, the gradient changes defining the limits of the populations.

This technique can be used for analysis of any suite of samples and the boundaries between populations used as contour values to define the limits of like populations (Pritchard, 1964). It has been developed and used by J. Barrio in the Bureau of Mineral Resources for the analysis of geological, geochemical and geophysical data.

DETAILED DISCUSSION OF ELEMENTS

Copper

The geochemistry of copper shows concentrations from 10 to 10,000 p.p.m.. These fall within four populations as set out below.

Population	Concentration Range	Max. % of Suite
1	less than 25 p.p.m.	4%
2	25 to 90 p.p.m.	16%
3	90 to 1,200 p.p.m.	55%
4	greater than 1,200 p.p.m.	25%

The first population ($<$25 p.p.m.) is the background range in soils and country rocks in the vicinity of Northern Star. Investigation of rock types containing the second population (25-90 p.p.m.) suggest they result from either primary (see below), or secondary dispersion into sediments (for example hole No.42).Population three (90-1200 p.p.m.) contains the major portion of samples and includes representatives of all ironstone types. The main rock types included in this population are the quartz-hematite jasper and sediments adjacent to the No.2 ironstone (Holes 5 and 6) but concentrations in this range are also common in the more leached portions of the cellular hematite lode. The population thus appears to represent primary replacement in jasper, primary dispersion of copper in sediments (?) and strongly leached portions of primary ironstone.

Population four ($>$1200 p.p.m.) is the primary intrusive and replacement population, modified by leaching. Concentrations in this range are thought to be related to the initial distribution of copper sulphides and the boundaries of this population are regarded as the limits of the initial sulphide orebody. The majority of concentrations in this range are in manganiferous ironstone or limonitic cellular replacement ironstone and a few are in quartz-hematite jasper. Projection of the gradient of the frequency distribution line for this population indicates a maximum copper concentration of 4%. From D.D.H.14 the maximum copper grade is 6.2% in the primary sulphide zone. It is not clear whether the population being considered here is representative of the original copper values, or whether we are dealing with an initially richer grade subsequently modified by leaching. If the latter is correct, a secondary enriched body could be present at depth.

The distribution of copper is shown in Plates 1, 2, 6, 7, 8 and 9. Nearly 50% of the No.2 Ironstone apparently contains anomalous copper concentrations (>1200 p.p.m.) but the highest copper concentration near the surface does not exceed 0.7% copper.

In the majority of drill holes the copper concentration increases with depth, independant of the rock type: thus hole No.11 intersects a constant quartz-hematite jasper from 15 to 66 feet, in this interval copper increases from 700 to 5000 p.p.m. with only minor fluctuations. This style of increase is so consistent that it must reflect a redistribution of elements by groundwater action, either by direct leaching from the surface to depth, or by migration in the deep weathering profile.

The watertable in the Northern Star area is of the order of 600 feet, compared to 300 feet in other parts of the Tennant Creek Field. At Peko Mine a secondary enrichment zone of copper was encountered directly above the watertable, with virtually no copper above it. A similar profile probably exists at Northern Star.

The deep weathering profile (probably not a true laterite profile) may also influence the distribution of metallic elements. The exact position of the profile at Northern Star is unknown; it is thought that waggon drill holes intersected the lower part of the B horizon. This may be a zone of enrichment for most metallic elements, so that their concentrations may decrease in the leached C horizon, and then increase again as the watertable is approached.

Copper minerals are not visible in drill cuttings under the binocular microscope with the exception of hole No.18 which contains visible copper carbonates in the interval 96 - 120 feet. Elsewhere, copper must occur as submicroscopic particles held within the ironstone lattice or adsorbed on the surface of the hydrated minerals (limonite, pyrolusite and manganese wad).

Even in zones of high copper concentration no definite sulphide boxworks were noted; the determination of boxworks is difficult because of the similarity with structures found in the limonitic, cellular ironstone. In some of the manganiferous and cellular hematite, a fine dark yellow to red-brown limonite is thought to be sulphide boxwork. A mineragraphic examination of the ironstones is warranted to determine the characteristics of the boxworks and the manner in which the secondary copper is fixed.

Cobalt.

Cobalt concentrations range from 1 to 700 p.p.m. and, from the cumulative frequency distribution diagrams, fall into three populations. 60% of results are less than 40 p.p.m., 24% between 40 and 130 p.p.m. and 16% greater than 130 p.p.m.. The frequency distribution diagram indicates the similarity in copper and cobalt distribution, both in gradient (dispersion), and in the percentages represented in each population.

The three populations appear to represent (a) background in sediments, (b) primary mineralisation in jasper and secondary dispersion into sediments and jasper, and (c) leached mineralization, similar to the copper populations.

Spectrographic analyses of 50 high copper-cobalt samples in the B.M.R. laboratory (Appendix II) indicated the nickel content to be less than 5 p.p.m..

No cobalt minerals have been recognised. Three manganese specimens contained up to 800 p.p.m. cobalt, possibly in asbolite in the manganese wad.

No cobalt analyses are available from the Peko ore, but 'cobalt bloom' is known from the Peko Mine. The copper/cobalt ratio of lode material from both Peko and Orlando mines is similar to that at Northern Star (A.L. Mather, B.M.R. pers. comm.), as shown below.

Sample No.	Mine	Cu p.p.m.	Co p.p.m.	Zn p.p.m.	Pb p.p.m.
63/ 011009	Peko	1500	200	300	a
63/ 011014	Orlando	5000+	300	50	50
63/ 011015	"	5000	150	5000	1500
63/ 011016	"	500	100	700	1000
63/ 011018	"	5000+	500	700	100
63/ 011021	"	4000	100	400	a
63/ 011022	"	1500	80	200	10
63/ 011023	"	5000++	2000+	300	500

a equals absent.

Analyses by D. Haldane, 17/4/64, B.M.R.

Cobalt was also found to be anomalous in the Warramunga Group rocks of Aeromagnetic Ridge (Harding, 1965); in part cobalt anomalies are directly related to copper anomalies in space but not in concentration. However, high cobalt concentrations also occur independently of copper.

Cobalt can be used as a reliable 'path finder' element for copper mineralisation in the Northern Star area, both in soil and weathered or leached rock. It is thought that a check of the copper/cobalt ratio in ironstones throughout the Tennant Creek field may delimit those associated with sulphide mineralization (Dunnet & Harding, 1965).

Zinc

Results of zinc analyses spectrographically determined by A.M.D.L. did not agree well with check determinations carried out by B.M.R. (Appendix II).

The lower limit of detection for zinc by A.M.D.L. is 20 p.p.m.. The frequency distribution of A.M.D.L. results for zinc is shown in Plate 4 and exhibits a similar overall gradient to the copper and cobalt curves. The curve defines four populations as shown below:

Population	Concentration Range	Max.% of Suite
1	less 20 p.p.m.	16%
2	20 - 600 p.p.m.	83%
3	30 -1200 p.p.m.	68%
4	400 -2000 p.p.m.	3%

The large overlap of populations may be due to unreliable analyses. However, the populations appear to represent (1) background of sedimentary rocks, (2) secondary dispersion and jasper mineralization, (3) leached mineralization in ironstone and replaced ironstone, and (4) mineralization in leached manganese-rich replacement ironstone and manganiferous ironstone. A close relationship also exists between concentrations of zinc and those of copper and cobalt. As with cobalt, zinc can therefore be used as a 'path finder' element in this association. The relationship between manganese minerals and zinc concentrations is most striking.

Lead

The distribution of lead in no way compares with the distribution of copper, cobalt or zinc. Three populations are represented in the suite of samples. The lowest population (1-7 p.p.m.) is 18% of the total suite, and the upper population (30-400 p.p.m.) only 8% of the suite. The middle population (3-80 p.p.m.) contains a possible 96% of the suite. This is a very shallow frequency distribution gradient compared to the other elements, and there is no apparent correlation of lead concentrations or populations with the other elements analysed.

Lead is not a mobile element, which may explain its distribution. However, in dealing with a leached ore body, its lack of mobility should be reflected in the different rock types.

It appears therefore that virtually no lead was associated with the sulphide mineralization and the two lower populations reflect the inherent concentrations in the sedimentary rocks and ironstones. The upper population is apparently related to micaceous hematite in hole No.11, the only hole where copper, cobalt, zinc and lead exhibit similar variation. High lead concentrations are also associated with manganiferous hematite (holes 7 and 10).

Lead is not a useful 'path finder' element for copper in this area.

Molybdenum

The molybdenum concentrations range from <1 p.p.m. to 500 p.p.m.; three populations being represented in the suite, as shown below:

Population	Concentration Range	Max.% of Suite
1	less than 1-12 p.p.m.	52%
2	5 -200 p.p.m.	60%
3	80 -500 p.p.m.	4%

The range 200-500 p.p.m. is 1½% of the suite. The style and gradient of the molybdenum curve is similar to copper, cobalt and zinc, but not lead. Molybdenum concentrations clearly reflect rock types, e.g., hole No. 9 exhibits up to 5 p.p.m. in hematite shale and <1 p.p.m. in micaceous siltstones; there is a marked increase at the contact of the quartz-hematite jasper from <1 p.p.m. to 50 p.p.m. over a 6 foot interval (Plate 12).

Population 1 (<1-12 p.p.m.) is the background for country rocks, and is comparable with Aeromagnetic Ridge results (Harding, 1965). Population 2 (5-200 p.p.m.) represents the mineralized population: in places molybdenum concentrations of 8 p.p.m. occur in association with up to 1200 p.p.m. copper. The significance of population 3 (80-500 p.p.m.) is not clear; most of these results occur in hole No.2 which gives high results for all elements. For the purpose of the survey, molybdenum is therefore divided into only two populations: <1-12 p.p.m. and 5-500 p.p.m.

The relationship between molybdenum concentrations and rock types is obscure and the variation in copper and cobalt concentrations is not always reflected in molybdenum. This lack of consistency and the large overlap in populations make molybdenum a poor 'path finder' element for copper.

However, there is a broad correlation of copper and molybdenum concentrations in many of the profiles (Plates 10, 11, 12, 13). This type of association is known from porphyry copper deposits and may be significant as an element association at Northern Star.

Bismuth

Bismuth concentrations range from <1 to 800 p.p.m. in two populations: <1 to 100 p.p.m., a possible 98% of the suite, and 20 to 700 p.p.m., a possible 7% of the suite. 12% are less than 1 p.p.m.. Bismuth concentrations are independant of copper, cobalt and zinc, and in most cases the bismuth varies independantly of rock type. There is a tendency in some holes for bismuth to vary inversely with copper (Nos 2 & 14), and in others to vary directly (No.9). The broad overlap in populations makes it difficult to assess individual results and relate populations to rock types.

Sullivan (1942), in an unpublished report, records the results of a survey for bismuth at Northern Star, where the highest assay was 1.12% (11,200 p.p.m.) from the 200 foot level. There appears to be a gradual increase of grade with depth; the highest assay for any sample from the 50 foot level being 0.15% (1500 p.p.m.) (after Ivanac, 1954). These figures are far in excess of any obtained during the current survey.

Bismuth had previously been considered a possible 'path finder' element for gold. In holes No.2 and No.13 some correlation apparently exists between gold and bismuth concentrations. In hole No.13 a maximum of 0.9 dwt gold corresponds to a maximum of 80 p.p.m. bismuth. However, hole No.7 exhibits no correlation between a 0.7 dwt gold assay and bismuth values ranging up to 25 p.p.m.. Similarly in hole No.9, bismuth concentrations rise from <1 to 30 p.p.m. with no gold present.

Results available from D.D.H.15 indicate a close gold/bismuth association (N.T. Administration, Mines Branch, unpublished records), with bismuth concentrations in the range 140 to 10,000 p.p.m.. In general the low bismuth concentrations obtained in this survey conform to the low gold assays for the No.2 Ironstone lode.

Gold

Insignificant gold mineralisation is present in the upper part of the No.2 Ironstone. Less than half of the gold assays are available to date (443 assays). The majority of these indicate less than 0.2 dwt; the maximum grade is 3 feet of 1.1 dwt/ton.

Visible gold occurs adjacent to the No.2 shaft around 450S, 450E, in brecciated red siltstones near the No.2 lode. The gold is in fine flakes on joint planes, and is associated with thin quartz veins healing the brecciation. Therefore much of the gold appears to be secondary; the location of primary gold is thought to have been controlled by the degree of brecciation and proximity to the adjacent ironstone (Ivanac, 1954).

1022 waggon drill samples were panned, but only two samples contained visible gold (hole No. 19: 9–12 and 15–18 feet). This gold, similar to the surface occurrence, was in a red micaceous shale.

Traces of gold are present in holes No. 7, 8, 10, 13, 15, 16, 17, 18 and 19; of these only Nos. 7, 13, 17, 18 and 19 gave assays in excess of 0.7 dwt. In most of these holes the gold is associated with manganiferous hematite which has high copper and cobalt concentrations.

SIGNIFICANCE OF POPULATIONS AND GENERAL GEOCHEMICAL RELATIONSHIPS

Plates 4 and 5 show the cumulative frequency distribution of copper, cobalt, zinc, lead, molybdenum and bismuth in the Northern Star suite of samples. These indicate four populations for copper and zinc, three for cobalt, lead and molybdenum and two for bismuth. A comparison of concentrations in waggon drill holes indicates that population 3 for cobalt is equivalent to population 4 for copper and zinc. Populations 2 and 3 for copper and zinc, the dispersion populations, are represented by only one population (2) in cobalt and molybdenum. The upper population of copper, cobalt and zinc is considered to represent the leached portion of the mineralized ironstone.

The geochemistry of the ironstones is a function of one or more of the following factors:

(1) Primary intrusive mineralization.
(2) Primary replacement mineralization.
(3) Primary ionic and solution dispersion.
(4) Secondary leaching or enrichment by ground water action.
(5) Secondary dispersion by mechanical means.

Ground water action may consist of oxidation and leaching above the watertable, and/or migration in the laterite profile. Both these factors may be superimposed on the primary factors. In replacement and primary dispersion the inherent background value is also a factor.

From results obtained in holes bordering the No. 2 Ironstone, e.g., hole No. 9, primary ionic and solution dispersion is not an important factor in the distribution of metallic elements (see Plate 12).

Hole No. 8 intersects cellular, limonitic, replacement hematite and massive manganiferous hematite to a depth of 87 feet, where the hole was abandoned due to the extremely leached nature of the rocks. The copper values are all above 1200 p.p.m. with a maximum of 8000 p.p.m., thus falling in the mineralisation population. From the distribution of copper in section (Plate 9) it is apparent that hole No.8 intersects the leached part of the main orebody. Hole No.9 is situated 80 feet to the south of No.8 and 40 feet to the south of the No.2 Ironstone. The hole was inclined at 75° north in order to intersect the ironstone at 75 feet depth. At this depth 6 feet of manganiferous hematite was intersected, followed by 40 feet of jasper. As can be seen from Plate 12, the copper concentrations in the sediments from the surface to 57 feet range from 80 to 200 p.p.m., they then rise rapidly to 6000 p.p.m. at the contact and average about 2000 p.p.m. in the jasper. Cobalt, zinc, molybdenum and bismuth exhibit a similar increase, indicative of a dispersion halo of 11½ feet for copper and 6 feet for the other elements. This dispersion halo may be primary (ionic or solution dispersion during mineralization) or secondary (transport by ground water solutions after mineralization), in either case the narrow aureole indicates the minor role played by dispersion in element distribution.

The relative concentration of elements and their association with rock types is clearly shown in Plates 10, 12 and 13. The following generalisations can be drawn from these diagrams:

(1) Statistically, copper, cobalt and zinc concentrations are directly homologous; the copper/cobalt ratio is approximately 10.

(2) High copper, cobalt and zinc concentrations occur in cellular hematite, manganiferous hematite, quartz hematite and in some quartz-hematite jasper.

(3) Zinc concentrations are generally high in the manganiferous ironstones, although check analyses indicate that this relationship may not always be correct (see Appendix 11).

(4) Lead distribution is apparently unrelated to the copper/cobalt/zinc concentrations, and does not vary greatly with rock types.

(5) In most cases molybdenum is not an important indicator. Its range in concentration is low and the overlap of population ranges is large. Hole No.9 is an exception; in this hole molybdenum concentrations clearly reflect the mineralised jasper and the dispersion halo.

(6) Bismuth distribution is variable and difficult to assess. In hole No.2 bismuth concentrations vary inversely with copper/cobalt/zinc, and high concentrations (up to 50 p.p.m.) are associated with the sedimentary rocks. Hole No.9 exhibits similar relatively high (30 p.p.m.) bismuth concentrations in the sediments, and these show some affinities with the molybdenum concentrations. Bismuth has been reported to show a strong association with gold in the Tennant Creek Field. Insufficient concentrations of either metal were present at Northern Star to substantiate the association

with the exception of hole No.13. Here gold assays up to 0.9 dwt occur together with bismuth concentrations of up to 80 p.p.m., the Bi/Au ratio being statistically constant. In the primary mineralization zones, a direct relationship may exist. Results from D.D.H.15 suggest that this is so (N.T. Administration, Mines Branch, unpublished records). Much higher concentrations of bismuth are found in the primary zone; a single analysis of core from D.D.H.15 gave 500 p.p.m. copper and greater than 10,000 p.p.m. bismuth.

(7) There has undoubtedly been considerable redistribution of trace elements by secondary ground water action. As different elements have different mobilities, controlled by Eh and Ph of solutions etc., it is difficult to ascertain original primary associations, especially as precipitation and adsorption on the hydrated iron and manganese minerals can result in secondary dispersion patterns unrelated to primary distribution.

DISTRIBUTION OF ELEMENTS

Regional

The results of regional sampling of copper and cobalt in the vicinity of the North Star - Northern Star leases is shown in Plates 1 and 2. These results were obtained as part of a regional geochemical investigation on the Mt. Woodcock 1-mile Sheet area; soils, rocks and ironstone bodies were sampled. The frequency distribution diagrams for this suite of samples were statistically identical to the waggon drill suite.

The background contours for copper and cobalt delimit the North Star-Northern Star area. The copper distribution indicates ironstones anomalous in copper extending to the north-east, but these are not anomalous in cobalt. These ironstones are close to a minor magnetic peak and the trend of the copper anomaly is the same as the magnetic trend (Plate 14) and bedding trend.

Waggon Drill

The analyses of samples from waggon drill holes are listed in Appendix 1. Two sections AB and CD (Plates 8 and 9) indicate the distribution of elements in the anomalous areas. (Sections for bismuth and lead were not constructed). The isochemical boundaries used in these sections are derived from the upper limits of populations as indicated in the frequency distribution diagrams, so that they define areas of like geochemical population. Despite this there is not a close correlation between geochemistry and rock type. A broad correlation exists between copper, cobalt and zinc concentrations and occurrences of cellular hematite and manganiferous ironstone (see Plates 3 and 7) and the sections clearly show the structural double dome of the No.2 Ironstone lode.

The sample intervals in the holes are very much shorter than the distance between holes, and the depth of holes is of the same order as the distance between holes, so that undue bias may have been placed on the sub-horizontal distribution of elements (e.g. Plates 8 & 9). However, this distribution would be expected in a leached orebody, and in individual holes copper concentrations generally tend to increase with depth.

The distribution of copper in plan (Plate 7) is derived from the mean of copper analyses over the upper 48 feet of each hole; this is done to restrict any bias due to copper increase with depth. The distribution indicates two anomalous areas at either end of the No.2 ironstone (>1200 p.p.m.). The anomalous holes in the east (Nos. 8, 10, 11, 13) and in the west (Nos. 1, 2, 3, 4, 12, 18) intersect mainly cellular hematite and manganiferous hematite. Exceptions to this are holes No.4 and No.12, which intersect jasper and cellular hematite, and hole No.18 which intersects manganiferous hematite and hematite shale. This was the only copper-bearing unreplaced hematite shale encountered, and was the one hole exhibiting visible copper carbonates. The lack of iron replacement of these copper bearing sedimentary rocks is not understood; possibly primary or secondary dispersion may account for the high copper values. Untested copper mineralization may therefore extend to the north of hole No.18 in the hematite shale.

The distribution of copper shown in the eastern zone may be unduly biased by samples from a lode of almost pure pyrolusite which extend from hole No.10 to hole No.13 and which is rich in copper (> 2000 p.p.m.). A similar rock was intersected in hole No.2; this rock type may thus be the main primary intrusive associated with the copper bearing solutions.

Plate 6 is a plan of copper distribution as indicated by surface samples, which include rock chip samples and the upper 3 feet of waggon drill holes. The similarity in results to those illustrated in Plate 7 for subsurface sampling clearly indicates the reliability of surface sampling in this type of prospecting. In Plate 6 the surface samples indicate that the anomalous copper concentrations extend to the north of hole No.18. As with Plate 7, undue emphasis results from the pyrolusite samples; H32, H34, H36 are pyrolusite and manganese wad, both rich in copper. In polished section no copper minerals are visible, but atomic absorption spectrophotometric analysis of three manganese rich samples indicated high copper and cobalt concentrations, apparently absorbed or coprecipitated with the manganese oxides.

Sample	Description	Cu	Co	Mo	Sn	Pb	Ag
4	Powdery manganese wad.	1000+	800	150	100	50	2
5	Massive pyrolusite (H36)	500	300	70	-	-	7
6	Powdery manganese wad.	2000+	800	20	50	20	30

Analysis by N. Marshall, Atomic Absorbtion Spectrometer.

SUMMARY

The central part of No.2 Ironstone is anomalous in copper and is characterised by two rock types, cellular limonitic hematite and manganiferous ironstone. The cellular hematite appears to represent, in part, the oxidised cap of a sulphide lode. It is highly leached and contains up to 0.7% copper. The parts of the lode around holes 1, 2, 8, 13 and 18 show increasing copper content with depth and yield the highest assay results in the area, apart from the manganiferous ironstone. The copper content of the manganiferous ironstone ranges from 500-5000 p.p.m.; this is thought to be the rock type most closely associated with the primary mineralization processes. Sulphide boxworks were not observed.

The importance of leaching in redistribution of the copper is not known; if it is important, the copper content will probably continue to increase with depth. The available evidence suggest that the limonite - rich cellular hematite is derived, in part, from a sulphide deposit, which should contain a secondary enriched zone near the watertable level and pass into sulphides below this level. This is supported by the intersection in a nearby drill hole of up to 6.2% copper as chalcopyrite at 958 feet depth.

CORRELATION OF STRUCTURE, MAGNETICS AND GEOCHEMISTRY

Mineralization in this area may be controlled by a combination of a favourable bed and an anticlinal crest, or by an anticlinal axial plane only. If mineralization takes place only along favourable beds the surface lodes can be expected to have limited depth, and mineralization at depth would be controlled by the combination of another favourable bed with the anticlinal crests. On the other hand, if axial plane shears were the only effective control, continuous pipe-like lodes with a very steep north or north-east plunge would be expected to result.

Diamond drill holes 14 & 15, intersected ironstone in chloritic schist between 800 and 1000 feet. (N.T. Administration, Mines Branch, unpublished records). This chloritic schist has no known equivalent at the surface. D.D.H.15 intersected quartz - calcite - magnetite at about 1000 feet depth. From regional mapping, dolomite crops out along cleavage strike to the south - west of Northern Star. If these two carbonate bodies are related, a 15 degree regional plunge to the east is indicated, and this favourable carbonate bed may control the mineralization at depth beneath Northern Star. This is the first known occurrence of carbonate rocks in the Warramunga Group and which possibly act as favourable beds for mineralization (Dunnet & Harding, 1965). This plunge is supported by the plunge of mesoscopic S_2 folds in the area. The diamond drill information does not indicate whether the No.2 Ironstone is continuous from the surface to 1000 feet or if discontinuous ironstone lenses lie in the same shear plane (see Plate 15).

The No.3 Ironstone occupies an anticlinal core in a younger part of the sequence than the No.2 Ironstone. The No.1 and No.2 Ironstones appear to occupy nearly the same stratigraphic position, but a continuation of the trend between Nos. 3 and 2, i.e. a south-dipping 'Faultenspiegel' or enveloping surface (Turner & Weiss, 1963, p.111) would suggest the No.1 Ironstone is somewhat lower in the sequence than the No.2 body. Assuming this, we may predict possible ironstone occurrences on favourable bed/structure intersections as follows:

(1) Repetition of the ironstone indicated at 1000 feet beneath No.2 body, beneath No.1 at a shallower depth.

(2) Repetition of No.1 beneath No.2.

(3) Repetition under No.3 is not considered likely because of the weak structural control.

The lack of magnetic indication of these two predicted ironstones suggest that both are completely oxidised and above the water table.

Several conclusions may be drawn from the low altitude magnetometer survey (Milsom & Finney, 1965).

(1) Only one anomaly is indicated by the survey; the anomaly is produced by a magnetic body lying to the north of the No.2 Ironstone at a depth of about 700 feet.

(2) The trend of the anomaly parallels the trend of bedding and cleavage and has a similar shape and limits to those of No.2 Ironstone.

(3) The east-west limits of the anomaly trend north-west (S_3) and the eastern limit coincides with the anomaly previously defined by the A.G.S.S.N.A. ground magnetic survey. The latter anomaly is probably a subsidiary peak on the main anomaly.

(4) There is a magnetic low and steeper gradient to the south of the main peak; indicative of a steep north plunge to the body.

(5) The shape of the anomaly suggests that it is due to a dyke-like body, rather than a spherical body. This dyke would have the same trend as the No.2 Ironstone body and dip steeply (80°) north or north-east. The width would be less than 100 feet, and the depth to the top of the body approximately 700 feet. Its projection to the surface almost coincides with the No.2 Ironstone.

(6) If the body is spherical and if Daly's 1954 figures for Tennant Creek are used in the calculations, the centre of the body would be situatedat approximately 1250 feet depth and the radius of the body would be about 250 feet. It would lie directly beneath the No.2 Ironstone with its centre at approximately 220S, 150E.

The evidence available does not enable the shape or position of the magnetic body which produces the anomaly to be determined exactly, although this could probably be clarified by a low altitude aeromagnetic survey flown on north/south lines over the anomalous area. At present the author considers the most likely shape to be a lenticular pipe-like body extending more or less continuously from the No.2 Ironstone to a magnetic section beneath the water table i.e. an axial plane control on ironstone mineralization. The shape of the body is probably largely controlled by the cleavage and modified by replacement of favourable lithologies. The vertical extension of the ironstone will be controlled by the intensity of the shear zones, the continuity of the anticline and the presence of favourable beds for replacement. However, the alternative possibilities must be considered in planning an exploratory drilling programme.

The central part of the No.2 Ironstone consists of leached copper-rich ironstone which extends to at least 150 feet (D.D.H. 4 & 5), and gold tends to be concentrated at the eastern end of the No.2 body. The diamond drill evidence indicates a similar relationship at 800 to 1000 feet; gold occurs at the eastern end (D.D.H.15), and copper towards the center of the magnetic anomaly (D.D.H.14). The magnetic anomaly has not been tested west of D.D.H.14; if the indicated correlation between magnetics and geochemistry is valid, substantial concentrations of copper may be present west of this drill hole intersection. (Plate 15).

The possibility of a pipe-like orebody in the No.2 Ironstone is supported by the shape of the gold lode in the No.1 Ironstone which, although tabular at the surface, is pipe-like and pitching very steeply north-east at depth (150 to 250 feet).

Discussion:

The following facts and assumptions suggest that an economic copper lode at depth might exist beneath the watertable at Northern Star.

(1) The geochemistry indicates copper mineralisation in the No.2 Ironstone at the surface.

(2) The aeromagnetic survey indicates a magnetic body beneath and to the north of the No.2 Ironstone.

(3) Structural evidence suggests the magnetic body is an extension of the No.2 Ironstone beneath the watertable.

(4) The eastern end of the magnetic body has been drilled previously and gold and copper in economic grades were intersected in two separate holes.

(5) It is a reasonable assumption that the untested ironstone indicated by the aeromagnetic anomaly is an extension of the body drilled in the east, and therefore will contain some copper mineralization.

(6) If the ironstone/copper relationship is similar to that of the No.2 Ironstone, and if the grade is similar to the intersection in D.D.H.14 an economic grade and tonnage can be expected.

RECOMMENDATIONS FOR FUTURE WORK

Further geochemical investigation and exploratory diamond drilling in the North Star - Northern Star area is recommended. The following programme is suggested.

(a) Auger drilling to weathered bedrock to sample the bulldust flats to the north-east of Northern Star (the area defined by the 30 p.p.m. isochemical contour on Plate 1). Drilling should be on a 100 foot grid spacing and samples should be analysed for copper, cobalt, zinc, molybdenum, manganese and bismuth.

(b) Surface rock chip sampling of the No.1 Ironstone lode at Northern Star and the whole of the North Star lode on a 20 foot grid spacing.

(c) Waggon drilling of anomalous areas defined by (b) and areas of cellular hematite outcrops. Waggon drilling of the area directly north of hole No.18 to delimit the northern extension of the copper anomaly found by this survey. An 80 foot grid is adequate but a closer spacing is recommended. A 5 foot sample interval is sufficient, and holes should be as deep as possible.

(d) Diamond drilling of the magnetic anomaly body and the downward extension of the No.2 Ironstone copper anomaly, together with any areas of significance defined by (b) and (c). At least three holes are recommended to test the No.2 Ironstone at depth, to delimit its shape and structure and to locate the copper extension at depth. Three suggested diamond drill holes are shown on section G-H (Plate 16) as follows:

Hole	Collar Position	Inclination	Bearing	Length
D.D.H. 'A'	150S, 170E	65	170	800
D.D.H. 'B'	170N, 20E	80	155	1300
D.D.H. 'C'	200N, 150E	75	155	1200

D.D.H. 'A' should be drilled to delimit the northern extension of the copper anomaly, define the northward plunge of the No.2 Ironstone, check the continuity of the copper anomaly and No.2 Ironstone at depth and check the possible occurrence of a secondary enriched copper orebody above the water table. It is planned to intersect the No.2 Ironstone down dip in the vicinity of the water table.

D.D.H. 'B' should be drilled irrespective of results of D.D.H.'A'. It will define the position and approximate size of the magnetic body and will intersect any sulphide zone associated with the magnetic body. Information from D.D.H.'s 'A' and 'B' should also determine the position and structural importance of the Higgins Fault, which on present evidence appears to be a low-angle reverse fault of post-mineralization age.

D.D.H. 'C' will depend partly on information derived from 'A' and 'B'. If 'B' is successful in intersecting both the magnetic body and sulphide mineralisation, 'C' should be drilled 100 to 150 feet behind (i.e. north-east) of the section G-H to test the eastern extension of the orebody and its possible relationship with the copper intersection in D.D.H.14. If 'B' is unsuccessful it may have missed the orebody to the west; 'C' will check this possibility.

D.D.H. 'B' and 'C' will also check the possible extension of the gold lode in the No.1 Ironstone.

(e) A detailed ground magnetic survey or low altitude aeromagnetic survey flown on north-south lines may enable the peak of the magnetic body to be defined more precisely. This could be supplemented by a detailed gravity survey.

REFERENCES

CROHN, P.W., & OLDERSHAW, W.,- 1965 - The Geology of the Tennant Creek 1-mile Sheet. Bur. Min. Resour. Aust. Rep. No. 83 (unpubl.).

DALY, J., - 1957 - Magnetic Prospecting at Tennant Creek, 1935-1937. Bur. Min. Resour. Aust. Bull. 44.

ELLISTON, J., - 1956 - Geological Report of the North Star - Northern Star Prospect, Tennant Creek. Peko Mines N.L. Company Report. (Unpubl.).

ELLISTON, J., - 1957 - Geological Report supplementary to Report on North Star - Northern Star. Peko Mines N.L. Company Report. (Unpubl.).

HARDING, R.R., - 1965 - Geochemical Investigations of Aeromagnetic Ridge, Tennant Creek Goldfield N.T. Bur. Min. Resour. Aust. Rec. 1965/27.

HARE, R., - 1960 - The Northern Star Prospect Tennant Creek. N.T. R. Hare & Associates Company Report. (Unpubl.).

HARE, R., - 1961 - Summary of Proposed Diamond Drilling Programme on the Northern Star Prospect, Tennant Creek. R. Hare & Associates Company Report. (Unpubl.).

IVANAC, J.F., - 1954 - Geology and Mineral Deposits of the Tennant Creek Goldfield, N.T. Bur. Min. Resour. Aust. Bull. 22.

MILSOM, J.S., & FINNEY, W.A., 1965 - Tennant Creek Detailed Aeromagnetic Survey, N.T., 1964. Bur. Min. Resour. Aust. Rec. 1965/50.

MINES BRANCH, N.T.A., Logs and Assay Results of Core from D.D.H. 15 & 15A. File Note, Northern Star File, Tennant Creek.

McMILLAN, N.J., & DEBNAM, A.H., 1961- Geochemical Prospecting for Copper in the Tennant Creek Goldfield. Bur. Min. Resour. Aust. Rec. 1961/101.

OLDERSHAW, W., - 1961 - The Hematite Shale at Tennant Creek, N.T., Bur. Min. Resour. Aust. Rec. 1961/8.

PRITCHARD, P.W., - 1964 - The Rum Jungle Geochemical Survey 1963 - The Rum Jungle Copper Mine. Bur. Min. Resour. Aust. Rec. 1964/125.

SHAW, D.M., - 1960 - Element Distribution Laws in Geochemistry. Geochim. et Cosmochim. Acta. 23 116-134.

TENNANT, C.B., & WHITE, N.L. - 1959 - Study of the Distribution of some Geochemical Data. Econ. Geol. 54, 1281-1290.

TURNER, J.F., & WEISS, L.E., - 1963 - Structural Analysis of Metamorphic Tectonites. McGraw Hill Book Co. Inc. N.Y.

WHITTLE, A.W.G., - 1963 - Northern Star Mine: Preliminary Examination of the Lode Intersection in D.D.H.15. Uni. Adelaide, Dept. of Econ. Geol. (Unpubl. Report).

GEOCHEMICAL SAMPLING - NORTHERN STAR, TENNANT CREEK.

GEOCHEMICAL RESULTS - HOLE NO.1,380S, 60E

Sample No.	Depth	Gold dwt/ton	Copper p.p.m.	Cobalt p.p.m.	Zinc p.p.m.	Lead p.p.m.	Molybdenum p.p.m.	Bismuth p.p.m. *
050007	0-3	-	600	10	50	25	10	5
001	3-6	-	500	8	50	20	8	4
002	6-9	-	500	10	100	20	15	5
003	9-12	-	700	10	250	20	15	8
004	12-15	-	5000	150	500	15	25	8
005	15-18	-	4000	200	250	15	50	25
006	18-21	-	4000	400	250	25	50	5
008	21-24	-	5000	80	600	25	50	8
009	24-27	-	8000	150	400	5	60	2
010	27-30	-	1500	15	150	10	25	3
011	30-33	-	2500	12	500	15	20	8
012	33-36	-	2000	12	250	12	40	10
013	36-39	-	2000	25	250	20	40	15
014	39-42	-	3000	50	500	25	60	10
015	42-45	-	1500	20	200	40	40	20
016	45-48	-	3000	120	200	50	80	15
017	48-51	-	3000	100	200	40	70	15
018	51-54	-	2500	100	150	40	80	20
019	54-57	-	2000	70	50	50	80	25
020	57-60	-	5000	80	150	30	70	20
021	60-63	-	5000	80	150	20	30	10
022	63-66	-	5000	150	200	20	50	8
023	66-69	-	7000	250	400	40	50	10
024	69-72	-	4000	200	500	20	60	12
025	72-75	-	5000	150	500	25	70	18
026	75-77	-	5000	400	500	25	150	20

* All results set out in the same order.

GEOCHEMICAL SAMPLING - NORTHERN STAR, TENNANT CREEK.

GEOCHEMICAL RESULTS - HOLE NO.2, 300S, 60E

050027	0-3	Trace	400	40	25	15	20	15
028	3-6	Trace	2000	120	80	50	30	15
029	6-9	Nil	1500	80	150	60	20	3
030	9-12	Nil	800	30	30	6	5	2
031	12-15	Nil	800	60	200	12	15	2
032	15-18	Nil	2500	50	200	30	50	18
033	18-21	Nil	1200	40	100	18	25	15
034	21-24	Nil	1500	50	100	30	25	20
035	24-27	Nil	1200	40	100	25	30	20
036	27-30	Trace	1000	10	40	25	25	40
037	30-33	Nil	250	15	30	40	40	30
038	33-36	Nil	300	8	25	20	100	50
039	36-39	Trace	4000	250	200	80	50	5
040	39-42	Nil	2500	200	150	30	25	20
041	42-45	Trace	6000	150	200	30	60	20
042	45-48	Trace	2500	80	30	200	60	30
043	48-51	Nil	700	7	20	15	40	20
044	51-54	Nil	250	8	20	15	15	10
045	54-57	Nil	1500	50	40	18	20	15
046	57-60	Nil	700	15	20	40	15	12
047	60-63	Nil	1500	50	25	50	50	20
048	63-66	Nil	4000	250	100	25	60	15
049	66-69	Nil	8000	400	200	20	60	25
050	69-72	Nil	10000	300	500	25	60	15
051	72-75	Nil	8000	400	600	15	60	10
052	75-78	Nil	-10000	500	600	15	50	4
053	78-81	Nil	8000	300	600	15	40	3
054	81-84	Nil	7000	600	600	10	15	2
055	84-87	Nil	-10000	500	500	10	20	6
056	87-90	Nil	3000	150	300	8	8	10
057	90-92	Nil	2000	50	150	8	10	30

- trace equals 0.3 dwt/ton

GEOCHEMICAL SAMPLING - NORTHERN STAR, TENNANT CREEK.

GEOCHEMICAL RESULTS - HOLE NO.3, 340S, 140E

050058	0-3	Nil	400	10	150	30	8	15
059	3-6	Nil	600	15	200	30	12	10
060	6-9	Nil	400	10	60	25	10	4
061	9-12	Nil	500	10	100	20	8	2
062	12-15	Nil	300	25	80	20	20	2
063	15-18	Trace	600	15	70	15	10	3

064	18-21	Trace	800	30	200	20	30	5
065	21-24	Trace	2000	15	800	25	15	10
066	24-27	Trace	3000	15	1200	30	30	6
067	27-30	Trace	2000	10	3900	15	30	6
068	30-33	Nil	400	5	80	10	5	3
069	33-36	Nil	3000	10	500	15	25	6
070	36-39	Nil	2500	60	400	15	30	3
071	39-42	Nil	4000	20	500	12	20	3
072	42-45	Nil	1200	12	250	10	8	4
073	45-48	Nil	2000	15	500	8	10	4
076	48-51	Nil	1800	12	800	12	8	6

GEOCHEMICAL SAMPLING - NORTHERN STAR, TENNANT CREEK.

GEOCHEMICAL RESULTS - HOLE NO.4, 260S, 140E

050077	0-3	Nil	50	20	30	15	5	6
079	3-6	Nil	400	60	250	20	15	2
078	6-9	Nil	80	12	100	10	4	4
080	9-12	Nil	800	12	500	10	12	5
081	12-15	Nil	250	40	150	25	20	1
082	15-18	Nil	1200	20	80	25	25	5
083	18-21	Nil	600	8	50	10	5	3
084	21-24	Trace	1200	15	60	10	20	4
085	24-27	Trace	800	15	60	10	25	6
086	27-30	Trace	800	20	150	18	20	5
087	30-33	Trace	500	25	100	25	30	4
088	33-36	Trace	2000	50	60	20	50	4
089	36-39	Trace	2000	40	50	25	40	5
090	39-42	0.3	2500	60	40	30	50	3
091	42-45	Trace	6000	100	80	20	60	4
092	45-48	Trace	5000	60	50	30	60	5
093	48-51	Nil	4000	150	80	30	60	6
094	51-54	Nil	3000	60	60	20	50	10
095	54-57	Nil	7000	150	60	20	50	12
096	57-60	Nil	3000	60	30	15	30	4
097	60-63	Nil	2000	70	80	18	40	7
098	63-66	Nil	4000	100	150	20	50	5
099	66-69	Nil	6000	100	150	20	60	3
050100	69-72	Nil	8000	100	100	8	25	- 1
101	72-75	Nil	5000	80	80	8	25	6
102	75-78	Nil	7000	80	80	12	30	4
103	78-81	Nil	8000	60	60	10	50	2
104	81-84	Nil	8000	60	60	12	60	7
105	84-87	Nil	10000	60	60	12	80	10
106	87-90	Nil	4000	50	50	10	40	7

107	90-93	Nil	7000	60	60	15	300	10
108	93-96	Nil	4000	30	30	12	200	8
109	96-99	Nil	4000	100	100	12	60	7
110	99-102	Nil	5000	100	80	12	60	5

GEOCHEMICAL SAMPLING - NORTHERN STAR, TENNANT CREEK.

GEOCHEMICAL RESULTS - HOLE NO.5 380S, 140E

050111	0-3	Nil	250	20	40	40	25	12
112	3-6	Nil	800	10	40	30	25	15
113	6-9	Nil	250	20	30	20	12	4
114	9-12	Nil	100	8	30	18	20	- 1
115	12-15	Nil	250	20	50	25	20	- 1
116	15-18	Nil	400	7	20	20	12	3
117	18-21	Nil	300	6	20	20	15	2
118	21-24	Nil	300	5	20	15	8	3
119	24-27	Nil	250	5	20	15	8	3
120	27-30	Nil	200	15	30	15	20	2
121	30-33	Nil	500	25	40	15	25	5
122	33-36	Nil	400	12	80	20	25	2
123	36-39	Nil	250	40	50	25	25	- 1
124	39-42	Nil	250	20	50	15	25	- 1
125	42-45	Nil	80	15	30	12	25	- 1
126	45-48	Nil	250	25	50	8	15	5
127	48-51	Nil	700	20	60	15	12	3
128	51-54	Nil	600	10	50	12	8	3
129	54-57	Nil	1000	70	100	10	15	- 1
130	57-60	Nil	250	50	150	18	20	- 1
131	60-63	Nil	250	40	200	15	12	- 1
132	63-66	Nil	300	50	200	12	30	1
133	66-69	Nil	150	40	200	10	20	- 1

GEOCHEMICAL SAMPLING - NORTHERN STAR, TENNANT CREEK.

GEOCHEMICAL RESULTS - HOLE NO.6, 340S, 20W

050134	0-3	Nil	500	30	150	50	25	8
135	3-6	Nil	1000	25	400	25	40	20
136	6-9	Nil	600	20	150	40	20	20
137	9-12	Nil	450	12	50	40	20	15
138	12-15	Nil	80	10	30	15	15	12
139	15-18	Nil	400	15	80	20	20	20
140	18-21	Nil	250	18	100	20	20	15
141	21-24	Nil	300	25	200	15	8	7
142	24-27	Nil	200	20	200	20	20	8
143	27-30	Nil	400	12	80	50	25	12

144	30-33	Nil	500	15	50	25	25	18
145	33-36	Nil	200	7	25	25	10	12
146	36-39	Nil	80	7	20	15	4	7
147	39-42	Nil	100	6	- 20	10	5	7
148	42-45	Nil	100	10	- 20	6	4	6
149	45-48	Nil	500	12	20	10	8	6
150	48-51	Nil	1200	18	40	15	25	8
151	51-54	Nil	1200	25	40	18	15	20
152	54-57	Nil	1200	50	40	6	15	15
153	57-60	Nil	500	25	50	10	5	3
154	60-63	Nil	2000	12	50	20	25	2
155	63-66	Nil	400	25	30	20	3	4
156	66-69	Nil	250	20	25	25	2	- 1
157	69-72	Nil	300	15	25	10	2	- 1
158	72-75	Nil	1000	25	30	6	5	1
159	75-78	Nil	1500	40	150	10	10	2
160	78-81	Nil	1500	50	150	25	12	10
161	81-84	Nil	800	25	30	8	8	4
162	84-87	Nil	1200	80	60	10	8	3
163	87-90	Nil	1000	70	30	6	6	10
164	90-93	Nil	1200	60	100	7	2	3
165	93-96		1200	80	100	10	3	4
166	96-99		1000	60	25	5	3	8
167	99-102		1200	15	30	3	4	2

GEOCHEMICAL SAMPLING - NORTHERN STAR, TENNANT CREEK.

GEOCHEMICAL RESULTS - HOLE NO.7, 420S, 20W

050168	0-3	Nil	100	20	25	25	6	8
169	3-6	Nil	150	4	25	30	8	20
170	6-9	Trace	40	5	- 20	15	10	20
171	9-12	Trace	200	25	80	40	20	15
172	12-15	Trace	250	20	200	40	25	12
173	15-18	0.3	60	12	80	25	10	20
174	18-21	0.4	80	25	150	30	25	15
175	21-24	Nil	80	25	60	25	50	7
176	24-27	Trace	40	8	40	18	10	8
177	27-30	0.2	150	12	250	15	30	12
178	30-33	Trace	1500	80	500	80	60	18
179	33-36		1000	60	600	50	50	12
180	36-39	Trace	300	70	400	70	50	7
181	39-42	Trace	2500	20	30	25	40	7
182	42-45	Trace	2500	25	50	30	50	6
183	45-48	Trace	3000	25	30	60	50	6
184	48-51	Trace	1000	30	40	40	30	8

185	51-54	Trace	1200	50	25	25	25	20
186	54-57	0.2	2000	70	50	18	30	15
187	57-60	0.2	2000	80	50	15	25	3
188	60-63	Trace	6000	100	250	12	20	2
189	63-66	0.7	6000	200	200	15	40	4
190	66-69	Trace	2500	50	80	10	15	- 1
191	69-72	Trace	3000	250	100	10	15	- 1
192	72-75	0.3	600	20	30	8	4	1
193	75-78	0.3	800	50	100	25	12	2
194	78-81	Trace	1500	70	100	15	20	10
195	81-84	Trace	800	30	80	10	15	4
196	84-87	Trace	1000	60	40	20	8	3
197	87-90	Trace	2500	80	150	15	10	10
198	90-93		1000	60	200	15	10	3
199	93-96	Trace	700	70	150	18	20	4
200	96-99	Trace	1000	60	200	20	25	8

GEOCHEMICAL SAMPLING - NORTHERN STAR, TENNANT CREEK.

GEOCHEMICAL RESULTS - HOLE NO.8, 420S, 300E

050201	0-3	3000	80	40	20	30	12
202	3-6	2000	70	50	25	40	12
203	6-9	2000	80	30	25	40	20
204	9-12	2000	50	30	20	50	15
205	12-15	2000	70	30	30	60	12
206	15-18	1500	70	25	20	50	4
207	18-21	1500	60	20	18	20	3
208	21-24	1200	40	20	18	40	3
209	24-27	2500	150	40	18	60	2
210	27-30	2000	80	30	18	60	2
211	30-33	1500	25	- 20	20	60	7
212	33-36	700	6	- 20	15	20	5
213	36-39	1200	10	- 20	15	25	10
214	39-42	1000	8	- 20	15	15	10
215	42-45	1200	30	40	20	30	8
050250	45-48	800	25	- 20	12	25	6
251	48-51	2000	25	80	18	25	6
252	51-54	600	25	60	25	25	6
050264	54-57	3000	60	100	15	25	6
265	57-60	7000	500	100	20	50	2
266	60-63	1800	25	150	15	20	6
267	63-66	2500	30	100	15	25	10
268	66-69	2000	30	150	20	30	6
269	69-72	5000	250	400	20	60	4
270	72-75	8000	500	500	20	50	4

050277	75-78	0.4	4000	400	300	18	50	2
278	78-81		4000	300	200	25	40	8
279	81-84		7000	250	300	25	60	2
280	84-87		5000	300	500	25	50	4

GEOCHEMICAL SAMPLING - NORTHERN STAR, TENNANT CREEK

GEOCHEMICAL RESULTS - HOLE NO.9, 500S, 300E

050216	0-3	Nil	70	7	30	30	5	30
217	3-6	Nil	70	5	50	30	4	20
218	6-9	Nil	60	3	30	30	2	15
219	9-12	Nil	50	3	70	30	2	20
220	12-15	Nil	50	4	60	25	1	15
221	15-18	Nil	60	4	80	40	2	15
222	18-21	Nil	60	5	70	25	1	12
223	21-24	Nil	30	6	60	40	1	10
224	24-27	Nil	40	6	80	50	3	10
225	27-30	Nil	60	6	70	40	2	10
226	30-33	Nil	150	7	60	25	2	8
227	33-36	Nil	150	12	50	25	3	8
228	36-39	Nil	70	8	40	25	- 1	7
229	39-42	Nil	50	3	200	20	- 1	1
230	42-45	Nil	60	6	150	20	1	2
231	45-48	Nil	50	4	80	20	- 1	3
232	48-51	Nil	50	4	30	15	- 1	1
233	51-54	Nil	120	2	25	15	- 1	2
234	54-57	Nil	250	3	50	18	- 1	1
235	57-60	Nil	700	4	70	10	- 1	1
236	60-63	Nil	600	2	- 20	8	- 1	2
237	63-66	Nil	800	6	25	8	- 1	1
238	66-69	Nil	1200	20	200	12	- 1	5
239	69-72	Nil	1000	15	80	12	4	7
240	72-75	Nil	2500	80	100	20	15	12
241	75-78	Nil	6000	25	200	12	40	10
242	78-81	Nil	3000	200	300	12	40	5
243	81-84	Nil	3000	300	200	15	50	6
244	84-87	Nil	2000	150	250	8	40	12
245	87-90	Nil	2000	100	200	15	50	15
246	90-93	Nil	800	60	250	8	60	3
247	93-96	Nil	5000	200	250	10	70	10
248	96-99	Nil	1500	80	200	10	30	5
249	99-102	Nil	700	80	30	10	25	8
050253	102-105	Nil	2000	100	150	15	30	20
254	105-108	Nil	2000	70	500	18	30	20

255	108-111	Nil	2500	250	200	20	40	10
256	111-114	Nil	2000	300	250	18	50	5
257	114-117	Nil	2000	80	100	18	40	6
258	117-120	Nil	2500	100	200	15	40	4

GEOCHEMICAL SAMPLING - NORTHERN STAR, TENNANT CREEK.

GEOCHEMICAL RESULTS - HOLE NO.10, 460S, 380E

050259	0-3		250	20	40	70	60	700?
260	3-6		300	18	40	50	4	15
261	6-9		1800	100	200	60	25	6
262	9-12		600	18	25	70	8	30
263	12-15		2000	70	30	100	15	20
050271	15-18		1200	80	50	30	25	25
272	18-21		1200	100	40	25	40	15
273	21-24		800	50	25	25	20	18
274	24-27		600	60	50	20	20	20
275	27-30		600	50	50	20	30	20
276	30-33		1000	150	60	30	30	20
050281	33-36		1200	50	30	20	20	15
282	36-39		800	70	80	25	40	5
283	39-42		1500	100	80	40	50	10
284	42-45		2000	80	80	40	50	15
285	45-48		2500	50	50	40	50	25
286	48-51		1000	15	80	25	12	20
287	51-54		800	15	200	25	12	20
288	54-57		2500	100	200	25	20	20

GEOCHEMICAL SAMPLING - NORTHERN STAR, TENNANT CREEK.

GEOCHEMICAL RESULTS - HOLE NO.11, 340S, 300E

050289	3-6	Nil	700	60	80	50	25	10
290	6-9	Nil	1200	400	80	70	25	10
291	9-12	Nil	700	25	25	40	15	4
292	12-15	Nil	600	40	50	40	60	5
293	15-18	Nil	1000	30	60	50	25	4
294	18-21	Nil	1500	150	80	300	25	6
295	21-24	Nil	700	50	80	50	25	2
296	24-27	Nil	1000	30	60	30	20	2
297	27-30	Nil	2000	150	150	70	50	5
298	30-33	Nil	1500	40	200	40	25	5
050311	33-36	Nil	2000	80	100	50	25	4
312	36-39	Nil	1500	15	80	25	10	8
313	39-42	Nil	2000	40	60	60	18	10
314	42-45	Nil	3000	60	200	80	20	15

050315	45-48	Nil	4000	150	250	40	25	1
316	48-51	Nil	2500	70	250	50	25	3
317	51-54	Nil	3000	100	500	200	40	7
318	54-57	Nil	3000	80	600	200	50	2
050321	57-60	Nil	4000	80	2000	400	60	2
322	60-63	Nil	5000	400	2000	200	70	1
323	63-66	Nil	5000	300	1500	250	70	2

GEOCHEMICAL SAMPLING - NORTHERN STAR, TENNANT CREEK.

GEOCHEMICAL RESULTS - HOLE NO.12, 420S, 140E

050299	0-3	Nil	400	8	25	15	4	8
300	3-6	Nil	1500	15	30	20	12	7
301	6-9	Nil	4000	40	150	20	5	3
302	9-12	Nil	2500	40	60	40	15	2
303	12-15	Nil	1700	50	60	40	20	1
304	15-18	Nil	2000	40	80	25	25	8
305	18-21	Nil	500	10	20	6	3	2
306	21-24	Nil	1500	40	60	10	15	3
307	24-27	Nil	1200	50	200	12	10	- 1
308	27-30	Nil	1200	50	100	18	15	2
309	30-33	Nil	1200	30	80	20	15	2
310	33-36	Nil	700	25	40	15	18	1
050319	36-39		1000	50	80	30	25	1
320	39-42		1000	40	150	25	20	1
050324	42-45	Nil	1200	60	150	25	20	2
325	45-48	Nil	700	15	100	18	18	4
326	48-51	Nil	600	18	60	15	15	6
050330	51-54		800	30	80	15	18	5
050343	54-57		50	20	20	12	18	- 1
344	57-60		200	20	25	15	40	2
345	60-63		800	40	150	18	40	4

** See Page 27 for results of hole No.13.

GEOCHEMICAL SAMPLING - NORTHERN STAR, TENNANT CREEK.

GEOCHEMICAL RESULTS - HOLE NO.14, 300S, 220E

050351	0-3		150	8	50	20	25	5
352	3-6		150	20	600	30	25	10
353	6-9		150	15	150	25	25	6
354	9-12		300	8	30	20	25	5
050346	12-15		300	12	200	25	25	2
347	15-18		100	20	40	15	30	4
348	18-21		400	8	50	20	25	5
349	21-24		1000	15	150	15	20	4
350	24-27		1500	60	200	15	25	4

050355	27-30	3000	250	500	15	50	3
050366	30-33	5000	100	700	10	40	- 1
367	33-36	1000	10	100	10	10	4
368	36-39	200	10	100	10	8	3
369	39-42	400	25	600	15	25	2
370	42-45	250	40	600	15	25	1
050373	45-48	200	30	250	20	50	5
374	48-51	200	15	250	20	60	8
375	51-54	200	40	300	12	60	8
376	54-57	2000	20	50	30	70	15
377	57-60	2000	200	50	15	50	4
378	60-63	2000	60	40	15	25	4
379	63-66	1500	80	150	20	60	5
380	66-69	2500	70	200	25	30	4
381	69-72	2000	20	400	20	40	4
382	72-75	2000	12	80	12	20	6
383	75-78	4000	50	200	20	70	5
384	78-81	3000	50	100	20	70	4
385	81-84	6000	60	100	25	60	10
386	84-87	5000	50	60	25	70	10
387	87-90	4000	50	60	25	70	10
388	90-93	6000	80	50	20	60	8
389	93-96	6000	60	40	20	50	7
390	96-99	1000	10	20	15	15	6
391	99-102	2500	80	25	15	50	5
392	102-105	7000	700	150	18	50	10

GEOCHEMICAL SAMPLING - NORTHERN STAR, TENNANT CREEK.

GEOCHEMICAL RESULTS - HOLE NO.15 300S, 300E

050393	0-3	Nil	500	30	60	20	40	8
394	3-6	Nil	500	30	40	25	150	3
395	6-9	Nil	500	30	40	25	100	4
396	9-12	Nil	150	15	25	25	60	4
397	12-15	Nil	500	15	25	25	150	3
398	15-18	Nil	80	8	25	25	80	3
399	18-21	Nil	250	30	40	40	40	3
400	21-24	Nil	400	30	30	30	60	5
054210+	27-30	Nil	250	50	40	20	25	1
211	30-33	Nil	600	50	40	20	20	4
212	33-36	Nil	600	40	30	25	40	8
054205	36-39	Nil	200	30	30	30	25	2

+ 24-27' not sampled.

054206	39-42	Nil	300	30	40	30	25	5
207	42-45	Trace	250	40	50	20	25	1
208	45-48	Nil	500	30	40	18	25	1
209	48-51	Trace	500	40	50	10	20	1
054227	51-54	Trace	1000	60	50	20	15	3
228	54-57	Trace	2000	80	150	12	40	2
229	57-60	Trace	3000	100	150	15	40	-1
230	60-63	Trace	1000	60	40	15	20	2
232	63-66	0.2	600	50	20	15	20	2
231	66-69	0.3	3000	150	100	25	50	3
233	69-72	Nil	1200	70	60	25	40	2
054238	72-75	Nil	1500	50	500	25	30	1
239	75-78	Trace	700	50	150	18	20	2
240	78-81	Trace	150	50	30	5	6	1
241	81-84	Trace	3000	60	150	20	40	1
054247	84-87	Trace	2000	60	200	18	25	2
248	87-90	Trace	2000	80	200	20	30	1
249	90-93	Trace	2000	70	200	15	50	1
250	93-96	Trace	1500	60	250	25	60	6
054101	96-99	Trace	1500	50	50	20	15	2
102	99-102	0.3	3000	40	80	15	10	3
103	102-105	Nil	7000	100	250	15	10	2
104	105-108	0.3	2500	30	200	18	15	7
105	108-111	0.3	4000	40	200	18	25	8
106	111-114	Trace	3000	50	200	15	25	2
107	114-117	0.4	7000	150	250	15	40	3
108	117-120	Trace	5000	70	250	15	25	2

GEOCHEMICAL SAMPLING - NORTHERN STAR, TENNANT CREEK.

GEOCHEMICAL RESULTS - HOLE NO.16, 260S, 200E

054213	0-3	Trace	100	20	20	20	15	7
214	3-6		1200	100	50	20	80	6
215	6-9	Nil	300	60	60	15	60	10
216	9-12		400	50	80	15	70	8
217	12-15		600	80	30	18	60	15
218	15-18	Trace	300	70	50	10	60	8
219	18-21	Trace	1000	100	100	8	50	8
220	21-24		1000	70	100	8	60	15
221	24-27	Trace	2500	600	200	12	80	20
222	27-30	Trace	1500	150	150	12	250	25
223	30-33	Trace	1500	60	150	15	150	50
224	33-36	Trace	1200	200	100	20	150	80
225	36-39	Trace	1000	70	400	15	150	40
226	39-42	Trace	800	40	200	15	60	40

054234	42-45		600	60	50	25	60	50
235	45-48	Trace	700	50	200	20	80	30
236	48-51		2000	60	40	18	60	100
237	51-54		2500	200	150	25	150	70
054242	54-57	Trace	2500	500	100	20	150	150
243	57-60	Trace	5000	400	40	25	150	150
244	60-63	Trace	2500	600	50	20	150	150
245	63-66		1500	400	40	20	300	50
050401	66-69		700	200	30	15	300	80
402	69-72		600	250	40	15	500	60
403	72-75		1200	250	50	15	500	50
404	75-78		3000	500	40	15	300	70
054005	78-81		2000	100	30	15	80	80
006	81-84		2000	300	30	15	100	250
007	84-87		1500	400	30	15	200	60
008	87-90		2000	400	40	15	200	40
009	90-93		1800	250	40	15	250	60
010	93-96		2500	50	50	18	250	500
011	96-99		2000	50	50	15	200	300
012	99-102		3000	400	250	15	200	80
013	102-105		4000	500	200	20	250	80
014	105-108		2500	250	300	20	250	40
015	108-111		2000	300	250	20	250	50
016	111-114	Trace	1800	100	300	18	200	40

GEOCHEMICAL SAMPLING - NORTHERN STAR, TENNANT CREEK.

GEOCHEMICAL RESULTS - HOLE NO.17, 260S, 300E

054109	0-3	Nil	600	12	50	20	15	3
110	3-6		800	25	50	25	20	2
111	6-9		500	15	50	25	20	2
112	9-12		250	20	250	20	15	1
113	12-15		300	20	200	25	20	2
114	15-18		500	20	80	30	20	2
115	18-21		1000	25	200	15	30	1
116	21-24	Nil	2000	80	250	15	50	1
117	24-27		3000	200	400	15	70	2
118	27-30		700	25	30	12	50	1
119	30-33		1200	40	30	15	80	3
120	33-36		150	12	25	10	50	1
121	36-39		500	20	30	15	80	2

GEOCHEMICAL SAMPLING - NORTHERN STAR, TENNANT CREEK.

GEOCHEMICAL RESULTS - HOLE NO.18, 220S, 220E

054017	0-3	1600	100	200	20	70	12
018	3-6	2000	20	400	15	60	10
019	6-9	1800	15	50	15	30	15
020	9-12	2500	150	500	20	50	10
021	12-15	500	200	400	20	50	5
022	15-18	700	250	80	30	70	10
023	18-21	2000	250	600	20	60	2
024	21-24	1200	70	300	15	60	3
025	24-27	3000	80	500	15	30	1
026	27-30	2000	400	600	15	70	2
027	30-33	1200	80	500	12	30	3
028	33-36	3000	200	600	15	70	2
029	36-39	4000	250	700	12	80	3
030	39-42	1800	70	400	10	40	2
031	42-45	2000	80	400	12	60	4
032	45-48	2500	70	600	10	60	1
054033	48-51	250	50	100	6	6	1
034	51-54	400	30	150	18	8	3
035	54-57	150	10	60	8	4	2
036	57-60	500	20	60	15	10	5
037	60-63	1500	150	200	8	20	8
038	63-66	2500	250	200	6	40	4
039	66-69	1000	70	50	15	20	3
040	69-72	250	60	100	15	15	1
041	72-75	150	30	60	8	6	1
042	75-78	1000	50	40	6	6	3
043	78-81	2000	60	70	15	5	3
044	81-84	3000	80	150	12	3	4
045	84-87	2500	60	100	5	2	2
046	87-90	3000	80	150	6	2	3
047	90-93	4000	60	100	7	4	6
048	93-96	4000	15	100	4	3	4
049	96-99	5000	30	200	5	3	2
050	99-102	4000	15	20	8	4	1
051	102-105	3000	25	100	5	3	1
052	105-108	2500	40	50	4	4	1
053	108-111	2500	40	50	8	5	2
054	111-114	4000	20	70	10	6	4
055	114-117	4000	50	150	15	8	5
056	117-120	5000	100	150	12	15	8

GEOCHEMICAL SAMPLING - NORTHERN STAR, TENNANT CREEK.

GEOCHEMICAL RESULTS - HOLE NO.19, 260S, 500E

054122	0-3		400	70	80	15	50	20
123	3-6		1500	50	50	15	50	20
124	6-9		1200	60	60	12	25	20
125	9-12	Nil	1000	10	100	10	20	5
126	12-15	Nil +	1200	12	250	15	30	6
127	15-18	Nil +	1500	12	200	8	30	4
128	18-21		1700	100	300	15	50	10
129	21-24		2500	400	100	8	80	20
130	24-27		2000	150	80	30	80	15
131	27-30		2500	500	300	15	50	5
132	30-33		4000	600	400	18	50	4
133	33-36		1200	100	80	12	30	7
134	36-39		1000	50	30	10	20	6
135	39-42		1200	60	30	12	40	4
136	42-45		1200	60	30	10	30	3
137	45-48		800	80	50	10	15	4
138	48-51		600	50	40	6	15	1
139	51-54		500	200	30	15	15	2
140	54-57		2000	500	150	8	30	2
141	57-60		1000	300	150	15	100	4
142	60-63		800	400	150	8	25	3
143	63-66		300	150	40	15	20	4
144	66-69		200	70	200	10	15	3
145	69-72		200	70	150	15	15	4

\+ Gold tail in dish < 0.5 dwt/ton.

GEOCHEMICAL SAMPLING - NORTHERN STAR, TENNANT CREEK.

GEOCHEMICAL RESULTS - HOLE NO.20, 340S, 460E

054146	0-3	Nil	200	3	30	5	4	2
147	3-6	Nil	500	5	- 20	5	5	5
148	6-9	Nil	500	70	20	15	15	15
149	9-12	Nil	400	70	20	18	20	8
150	12-15	Nil	400	100	20	10	30	3
151	15-18	Nil	200	100	- 20	8	12	3
152	18-21	Nil	100	50	- 20	10	10	3
153	21-24	Nil	250	200	20	8	15	2
154	24-27	Nil	500	100	50	15	50	4
155	27-30	Nil	400	100	- 20	10	20	3
156	30-33	Nil	150	50	70	15	10	2
157	33-36	Nil	200	60	60	18	12	4
158	36-39	Nil	200	50	30	15	10	5
159	39-42	0.2	200	20	40	8	8	5

054160	42-45	Trace	250	70	150	10	15	6
161	45-48	Trace	500	200	60	30	30	4
162	48-51	Nil	500	250	250	30	50	6
163	51-54	Nil	300	25	100	15	12	3
164	54-57	Nil	600	200	300	30	25	5
165	57-60	Nil	400	200	300	30	25	2
166	60-63	Nil	800	400	500	30	25	8

GEOCHEMICAL SAMPLING - NORTHERN STAR, TENNANT CREEK.

GEOCHEMICAL RESULTS - HOLE NO.21, 300S, 380E

054057	0-3	100	25	- 20	8	3	3
058	3-6	400	50	- 20	20	12	10
059	6-9	200	50	20	12	12	8
060	9-12	20	50	- 20	5	5	5
061	12-15	150	30	20	15	15	10
062	15-18	200	50	25	20	25	15
063	18-21	400	150	50	30	40	15
064	21-24	150	60	40	30	25	10
065	24-27	1000	150	70	40	50	12
066	27-30	700	70	100	50	25	12
067	30-33	200	60	40	15	25	10
068	33-36	250	70	20	15	30	8
069	36-39	180	80	- 20	8	25	5
070	39-42	200	40	20	15	25	12
071	42-45	800	100	30	15	25	12
072	45-48	80	30	20	15	15	3
073	48-51	250	40	20	15	25	4
074	51-54	150	50	25	18	20	4
075	54-57	50	60	20	15	15	2

GEOCHEMICAL SAMPLING - NORTHERN STAR, TENNANT CREEK.

GEOCHEMICAL RESULTS - HOLE NO.22, 380S, 380E

054167	0-3	Nil	200	20	20	30	10	15
168	3-6	Trace	300	15	20	30	8	20
169	6-9	Trace	250	8	25	50	20	40
170	9-12	Trace	150	15	20	50	20	15
171	12-15	Trace	400	15	40	30	20	15
172	15-18	Nil	150	50	20	15	15	20
173	18-21	Nil	300	60	30	25	20	10
174	21-24	Nil	200	100	25	10	12	10
175	24-27	Nil	500	180	30	12	12	12
176	27-30	Nil	250	25	30	15	10	12
177	30-33	Nil	200	25	40	15	15	8

054178	33-36	Nil	1200	80	50	20	40	5
179	36-39	Nil	1200	80	50	12	30	5
180	39-42	Nil	800	70	50	15	30	5
181	42-45	Nil	700	50	40	40	25	7
182	45-48	Nil	700	50	50	25	15	5
183	48-51	Nil	800	100	60	30	20	8

GEOCHEMICAL SAMPLING - NORTHERN STAR, TENNANT CREEK.

GEOCHEMICAL RESULTS - HOLE NO.23, 380S, 300E

054076	0-3		250	150	25	25	6	10
077	3-6		200	150	25	12	5	7
078	6-9	Nil	300	300	25	12	7	10
079	9-12		200	150	-20	12	5	6
080	12-15	Nil	300	150	20	10	4	8
081	15-18		400	250	-20	15	6	8
082	18-21	Nil	500	250	20	8	6	6
083	21-24	Nil	400	150	25	12	20	6
084	24-27	Nil	400	60	20	8	10	15
085	27-30	Nil	1500	200	20	8	8	6
086	30-33		1000	100	25	8	6	8
087	33-36		400	50	40	6	8	4
088	36-39		300	60	25	8	4	3
089	39-42	Nil	1000	150	40	8	5	15
090	42-45		800	100	50	18	10	6
091	45-48	Nil	600	60	40	12	8	8
092	48-51	Nil	1500	300	50	15	20	6
093	51-54	Nil	1200	200	60	40	20	12
094	54-57	Trace	800	200	50	12	15	8

GEOCHEMICAL SAMPLING - NORTHERN STAR, TENNANT CREEK.

GEOCHEMICAL RESULTS - HOLE NO.24, 340S, 100E

054184	0-3	Nil	150	20	30	25	10	10
185	3-6	Nil	150	25	30	25	10	15
186	6-9	Nil	100	5	30	15	5	4
187	9-12		100	10	30	15	4	3
188	12-15	Nil	250	40	150	30	30	4
189	15-18	Nil	250	15	150	40	50	8
190	18-21	Nil	500	40	70	10	15	2
191	21-24		1500	150	200	10	15	2
192	24-27	Nil	400	15	200	10	8	3
193	27-30		400	15	150	10	10	2

054194	30-33	Nil	2000	250	150	15	25	4
195	33-36	Nil	1500	250	150	15	15	6
196	36-39		1500	150	200	15	10	2
197	39-42	Nil	2000	80	200	8	3	2
198	42-45	Nil	2000	20	200	8	5	3
199	45-48		500	6	40	3	- 1	- 1
200	48-51		700	8	50	2	- 1	- 1
201	51-54		800	8	80	3	- 1	- 1
202	54-57		800	8	100	7	1	- 1
203	57-60		1500	20	200	10	3	2
204	60-63		2500	60	100	15	6	2

GEOCHEMICAL SAMPLING - NORTHERN STAR, TENNANT CREEK.

GEOCHEMICAL RESULTS - HOLE NO.25, 640S, 300E

054095	0-3	80	5	20	6	2	5
096	3-6	150	7	25	5	6	8
097	6-9	70	7	20	8	8	5
098	9-12	150	6	25	8	4	4
099	12-15	200	7	30	8	5	8
054100	15-18	100	5	20	5	6	4
101	18-21	100	4	20	6	6	4
102	21-24	40	4	20	5	2	3
103	24-27	60	4	20	5	2	3
104	27-30	50	4	20	5	2	2
105	30-33	40	3	20	4	2	1
106	33-36	50	5	20	4	3	-1
107	36-39	150	10	25	5	5	6
108	39-42	400	10	40	15	4	8
109	42-45	300	40	30	4	6	3
110	45-48	300	30	50	4	5	4
111	48-51	500	80	70	5	5	7
112	51-54	500	60	50	7	5	6
113	54-57	400	30	30	5	5	2

GEOCHEMICAL SAMPLING - NORTHERN STAR, TENNANT CREEK.

GEOCHEMICAL RESULTS - HOLE NO.26, 560S, 300E

050414	0-3	30	5	20	20	4	8
415	3-6	25	4	20	12	3	5
416	6-9	25	3	20	10	1	3
417	9-12	20	3	20	8	1	3
418	12-15	25	3	25	12	1	7
419	15-18	15	4	25	12	-1	2
420	18-21	25	4	25	12	-1	3

050421	21-24	40	5	25	15	1	3
422	24-27	30	4	30	15	1	3
423	27-30	30	3	30	15	1	2
424	30-33	40	4	40	15	1	3
425	33-36	25	3	25	10	1	2
426	36-39	40	4	25	8	-1	3
427	39-42	30	4	25	10	-1	2
428	42-45	50	5	30	15	1	3
429	45-48	25	5	25	15	-1	2
430	48-51	25	6	25	10	1	3
431	51-54	20	6	25	15	1	4
432	54-57	20	5	25	18	2	5
433	57-60	15	6	30	18	1	5

GEOCHEMICAL SAMPLING - NORTHERN STAR, TENNANT CREEK.

GEOCHEMICAL RESULTS - HOLE NO.27, 540S, 380E

050434	0-3	200	5	25	12	4	7
435	3-6	150	4	20	15	3	10
436	6-9	200	4	20	12	3	8
437	9-12	80	4	-20	15	3	8
438	12-15	100	3	20	15	-1	4
439	15-18	60	2	20	15	-1	3
440	18-21	80	2	20	25	-1	5
441	21-24	150	2	20	25	-1	3
442	24-27	80	3	20	25	-1	4
443	27-30	100	3	20	20	-1	2
444	30-33	60	2	20	6	-1	3
445	33-36	50	3	25	5	2	2
446	36-39	40	3	25	10	2	2
447	39-42	25	2	25	10	1	2
448	42-45	25	3	30	10	4	2
449	45-48	50	7	30	12	6	2
450	48-51	25	5	25	12	5	3
451	51-54	20	5	25	10	5	3
452	54-57	25	7	25	10	5	4
453	57-60	20	6	30	12	4	4

GEOCHEMICAL SAMPLING - NORTHERN STAR, TENNANT CREEK.

GEOCHEMICAL RESULTS - HOLE NO.28, 660S, 400E

050454	0-3	15	4	25	10	-1	2
455	3-6	50	1	40	8	1	3
456	6-9	40	2	40	8	-1	3
457	9-12	30	1	30	8	-1	2
458	12-15	60	1	60	10	3	3
459	15-18	80	2	80	12	1	3
460	18-21	150	1	150	10	2	3
461	21-24	50	1	50	6	-1	1
462	24-27	40	1	30	8	-1	2
463	27-30	150	2	50	12	4	3
464	30-33	80	1	40	10	2	2
465	33-36	50	1	25	15	-1	2
466	36-39	70	3	30	20	2	3
467	39-42	200	1	50	10	2	-1
468	42-45	80	1	25	15	3	2
469	45-48	60	2	20	20	-1	2
470	48-51	50	1	25	20	-1	1
471	51-54	50	5	25	20	2	3
472	54-57	40	3	20	15	4	1
473	57-60	60	3	20	12	3	2

GEOCHEMICAL SAMPLING - NORTHERN STAR, TENNANT CREEK.

GEOCHEMICAL RESULTS - HOLE NO.29, 720S, 300E

050474	0-3	40	8	30	8	4	3
475	3-6	50	4	40	10	10	3
476	6-9	30	7	25	15	10	3
477	9-12	40	7	25	12	8	3
478	12-15	25	6	25	12	10	3
479	15-18	25	7	30	25	4	4
480	18-21	60	6	50	25	4	5
481	21-24	50	4	40	10	1	3
482	24-27	30	2	50	15	3	2
483	27-30	20	2	30	15	2	2
484	30-33	25	1	30	12	-1	-1
485	33-36	20	1	30	15	-1	-1
486	36-39	50	1	30	12	-1	1
487	39-42	25	2	40	15	1	-1
488	42-45	25	2	80	12	2	-1
489	45-48	30	2	150	8	2	-1
490	48-51	30	1	100	6	2	-1
491	51-54	25	-1	200	5	-1	-1

050492	54-57	50	1	150	5	3	-1
493	57-60	80	1	80	5	8	-1

GEOCHEMICAL SAMPLING - NORTHERN STAR, TENNANT CREEK.

GEOCHEMICAL RESULTS - HOLE NO.30, 760S, 400E

050494	0-3	25	5	-20	8	-1	4
495	3-6	50	10	25	15	15	4
496	6-9	100	10	30	15	20	5
497	9-12	100	5	25	12	8	10
498	12-15	80	6	30	10	10	5
499	15-18	80	8	60	12	12	5
050500	18-21	50	8	50	12	10	4
501	21-24	30	20	25	8	10	3
502	24-27	200	8	80	15	12	4
503	27-30	100	7	40	15	12	3
504	30-33	100	5	30	18	15	3
505	33-36	100	6	30	20	20	3
506	36-39	250	4	200	60	40	4
507	39-42	250	4	400	50	25	4
508	42-45	250	10	300	50	25	8
509	45-48	300	10	500	70	25	10
510	48-51	200	12	200	30	25	8

GEOCHEMICAL SAMPLING - NORTHERN STAR, TENNANT CREEK.

GEOCHEMICAL RESULTS - HOLE NO.31, 800S, 450E

050511	0-3	70	5	25	8	2	5
512	3-6	60	5	20	7	2	4
513	6-9	100	6	25	15	12	1
514	9-12	200	15	50	15	10	2
515	12-15	300	3	60	6	5	2
516	15-18	500	10	50	12	12	2
517	18-21	400	2	70	5	4	-1
518	21-24	600	3	60	6	8	1
519	24-27	500	4	70	10	12	2
520	30-33	250	5	80	8	15	5
521	33-36	300	6	70	8	15	8
522	36-39	300	10	100	8	18	10

GEOCHEMICAL SAMPLING - NORTHERN STAR, TENNANT CREEK.

GEOCHEMICAL RESULTS - HOLE NO.32, 660S, 500E

050523	0-3	40	5	50	10	3	12
524	3-6	40	4	100	8	4	8
525	6-9	50	3	200	8	3	6
526	9-12	50	5	80	8	5	6
527	12-15	60	5	200	12	7	7
528	15-18	60	8	60	7	10	4
529	18-21	50	7	100	8	8	4
530	21-24	100	5	150	7	10	3
531	24-27	80	3	100	7	10	4
532	27-30	80	3	100	5	5	3
533	30-33	80	2	100	5	4	5

GEOCHEMICAL SAMPLING - NORTHERN STAR, TENNANT CREEK.

GEOCHEMICAL RESULTS - HOLE NO.33, 600S, 600E

050534	0-3	100	10	150	25	6	5
535	3-6	100	3	100	20	4	5
536	6-9	200	3	150	20	3	8
537	9-12	300	3	250	20	10	7
538	12-15	100	5	150	25	7	4
539	15-18	200	5	200	15	6	7
540	18-21	250	4	150	8	3	5
541	21-24	250	20	150	60	12	12
542	24-27	200	4	100	18	5	10
543	27-30	200	15	150	25	5	7
544	30-33	300	50	80	40	7	12
545	33-36	500	10	150	15	3	5
546	36-39	300	40	150	15	3	5
547	39-42	300	30	80	10	4	5
548	42-45	250	50	80	18	6	5
549	45-48	700	300	150	15	4	5
550	48-51	250	40	50	18	3	4
551	51-54	300	60	100	18	5	5
552	54-57	500	150	200	15	5	4
553	57-60	300	50	100	8	2	3

GEOCHEMICAL SAMPLING - NORTHERN STAR, TENNANT CREEK.

GEOCHEMICAL RESULTS - HOLE NO.34, 700S, 200E

050554	0-3	200	12	50	10	2	2
555	3-6	100	2	40	7	-1	4
556	6-9	70	1	30	5	-1	4
557	9-12	200	3	30	7	3	10
558	12-15	250	2	30	7	8	20
559	15-18	200	4	30	10	12	25
560	18-21	200	3	-20	8	8	15
561	21-24	250	8	20	12	10	30
562	24-27	150	5	25	10	5	50
563	27-30	200	2	20	5	-1	10
564	30-33	200	3	25	6	-1	5
565	33-36	250	1	20	5	-1	- 1
566	36-39	250	1	20	4	-1	- 1
567	39-42	300	3	30	4	-1	1
568	42-45	300	10	50	4	4	- 1
569	45-48	150	5	50	4	2	- 1
570	48-51	150	5	60	3	4	- 1
571	51-54	300	6	80	4	6	- 1

GEOCHEMICAL SAMPLING - NORTHERN STAR, TENNANT CREEK.

GEOCHEMICAL RESULTS - HOLE NO.35, 740S, 120E

050572	0-3	400	8	25	6	3	3
573	3-6	80	6	30	3	2	-1
574	6-9	300	30	80	2	2	-1
575	9-12	250	50	70	2	2	-1
576	12-15	300	50	80	1	4	-1
577	15-18	500	60	150	1	6	-1
578	18-21	400	40	100	2	6	-1
579	21-24	300	30	150	2	5	-1
580	24-27	250	25	100	2	5	-1
581	27-30	200	20	150	1	5	-1
582	30-33	400	15	200	1	4	-1
583	33-36	200	15	100	1	4	-1
584	36-39	600	60	250	2	6	-1
585	39-42	300	40	250	2	7	-1
586	42-45	400	10	200	5	10	-1
587	45-48	500	30	200	7	10	-1
588	48-51	300	15	180	8	8	1
589	51-54	400	40	150	8	8	2
590	54-57	200	8	80	7	12	1
591	57-60	500	60	200	15	7	2

GEOCHEMICAL SAMPLING - NORTHERN STAR, TENNANT CREEK.

GEOCHEMICAL RESULTS - HOLE NO.36, 800S, 000E

050592	0-3	40	4	50	6	6	3
593	3-6	50	3	60	5	7	5
594	6-9	50	2	50	5	2	2
595	9-12	30	1	100	5	1	3
596	12-15	25	2	50	4	1	2
597	15-18	20	1	70	3	2	2
598	18-21	15	1	60	7	2	3
599	21-24	30	1	60	5	1	2
600	24-27	40	1	50	4	2	2
601	27-30	50	1	50	7	2	3
602	30-33	30	1	60	10	2	2
603	33-36	60	1	80	10	2	2
604	36-39	120	1	80	7	-1	2
605	39-42	100	1	70	7	3	2
606	42-45	60	1	80	7	4	2
607	45-48	60	4	150	7	5	2
608	48-51	30	1	100	5	4	2
609	51-54	30	1	120	6	6	2
610	54-57	40	1	100	7	4	3
611	57-60	40	2	80	8	5	3

GEOCHEMICAL SAMPLING - NORTHERN STAR, TENNANT CREEK.

GEOCHEMICAL RESULTS - HOLE NO.37, 800S, 100W

050612	0-3	50	4	50	15	5	5
613	3-6	40	3	80	12	5	4
614	6-9	30	1	20	8	5	4
615	9-12	10	1	- 20	7	4	2
616	12-15	25	1	30	10	2	4
617	15-18	25	1	40	7	-1	2
618	18-21	80	3	60	20	2	5
619	21-24	25	1	20	10	2	3
620	24-27	50	2	40	12	5	4
621	27-30	40	1	50	8	-1	1
622	30-33	40	1	60	8	3	3
623	33-36	50	2	60	8	4	3
624	36-39	70	2	50	8	5	5
625	39-42	60	3	30	8	3	10
626	42-45	50	1	150	8	2	4
627	45-48	60	2	120	7	6	3
628	48-51	60	1	120	6	5	3
629	51-54	70	2	70	8	3	6

050630	54-57	70	3	70	8	3	4
631	57-60	70	3	100	8	5	5

GEOCHEMICAL SAMPLING - NORTHERN STAR, TENNANT CREEK.

GEOCHEMICAL RESULTS - HOLE NO.38, 800S, 200W

050632	0-3	70	3	60	7	-1	3
633	3-6	60	5	100	6	-1	2
634	6-9	50	4	70	5	-1	-1
635	9-12	60	6	120	5	-1	-1
636	12-15	80	8	120	8	2	-1
637	15-18	100	50	60	8	2	1
638	18-21	80	20	60	8	-1	1
639	21-24	200	50	60	15	3	2
640	24-27	600	10	150	10	3	7
641	27-30	500	8	400	25	3	30
642	30-33	600	10	300	20	3	7
643	33-36	300	3	300	12	4	4
644	36-39	300	5	300	10	2	2
645	39-42	800	50	400	25	3	4
646	42-48	150	5	100	8	2	2
647	48-51	50	5	50	10	4	-1
648	51-54	120	7	250	7	3	2
649	54-57	120	5	150	12	3	2
650	57-60	150	4	180	7	5	3

GEOCHEMICAL SAMPLING - NORTHERN STAR, TENNANT CREEK.

GEOCHEMICAL RESULTS - HOLE NO.39, 650S, 100E

050651	0-3	40	3	20	8	5	6
652	3-6	70	1	40	8	6	3
653	6-9	80	-1	40	7	5	3
654	9-12	80	-1	50	6	6	2
655	12-15	70	-1	40	8	6	2
656	15-18	60	-1	40	8	5	2
657	18-21	60	-1	60	10	6	2
658	21-24	50	-1	50	8	3	2
659	24-27	60	1	25	5	3	3
660	27-30	70	1	30	4	-1	2
661	30-33	80	1	30	5	1	3
662	33-36	70	1	30	5	2	3
663	36-39	120	1	25	5	2	2
664	39-42	70	1	-20	7	-1	1
665	42-45	80	2	20	5	-1	3
666	45-48	120	7	25	5	-1	2

050667	48–51	150	7	-20	6	-1	2
668	51–54	200	8	25	5	3	2
669	54–57	250	10	-20	6	-1	2
670	57–60	250	8	-20	7	2	1

GEOCHEMICAL SAMPLING - NORTHERN STAR, TENNANT CREEK.

GEOCHEMICAL RESULTS - HOLE NO.40, 460S, 60E

050691	0–3	70	8	20	15	4	7
692	3–6	80	7	100	10	3	2
693	6–9	70	2	100	10	2	1
694	9–12	60	10	100	15	7	3
695	12–15	60	3	50	8	7	5

GEOCHEMICAL SAMPLING - NORTHERN STAR, TENNANT CREEK.

GEOCHEMICAL RESULTS - HOLE NO.41, 420S, 60E

050671	0–3	25	5	20	8	3	8
672	3–6	100	5	70	7	5	3
673	6–9	100	6	70	8	5	2
674	9–12	80	6	30	8	4	3
675	12–15	100	5	20	8	4	2
676	15–18	100	4	20	7	5	3
677	18–21	150	2	40	6	5	4
678	21–24	150	2	50	7	4	2
679	24–27	100	4	60	8	5	2
680	27–30	80	6	25	8	4	3
681	30–33	200	12	60	10	4	1
682	33–36	300	20	100	12	7	1
683	36–39	300	25	80	8	7	2
684	39–42	200	25	60	8	7	1
685	42–45	200	20	50	7	6	3
686	45–48	700	40	30	5	5	1
687	48–51	700	70	40	4	7	1
688	51–54	150	25	100	5	7	4
689	54–57	400	60	40	10	12	4
690	57–60	700	200	25	12	12	5

GEOCHEMICAL SAMPLING - NORTHERN STAR, TENNANT CREEK.

GEOCHEMICAL RESULTS - HOLE NO.42, 240S, 20W

050696	0-3	40	4	-20	12	4	7
697	3-6	40	4	80	15	5	7
698	6-9	60	5	20	20	5	5
699	9-12	50	6	25	20	7	5
700	12-15	30	3	20	20	6	5
701	15-18	30	2	25	15	5	4
702	18-21	25	2	20	8	4	3
703	21-24	60	2	20	10	5	2
704	24-27	60	1	-20	8	4	2
705	27-30	100	2	-20	10	7	3
706	30-33	50	1	-20	10	3	2
707	33-36	30	1	-20	8	3	2
708	36-39	50	1	-20	8	2	2
709	39-42	70	10	-20	7	5	2
710	42-45	80	15	-20	8	5	2
711	45-48	80	25	-20	7	5	3
712	48-51	100	60	-20	7	6	2
713	51-54	30	5	-20	6	5	2
714	54-57	25	2	-20	7	7	2
715	57-60	20	1	-20	6	5	3

GEOCHEMICAL SAMPLING - NORTHERN STAR, TENNANT CREEK.

GEOCHEMICAL RESULTS - HOLE NO.43, 450N, 200E

050716	0-3	80	30	40	2	4	1
717	3-6	100	15	50	2	4	-1
718	6-9	200	12	60	1	4	-1
719	9-12	150	25	50	2	4	-1
720	12-15	150	30	20	3	5	4
721	15-18	250	30	20	5	7	7
722	18-21	250	50	20	4	7	6
723	21-24	200	4	20	4	5	4
724	24-27	250	7	20	5	5	5
725	27-30	80	10	-20	4	2	-1
726	30-33	150	10	-20	6	6	12
727	33-36	100	4	20	5	5	8
728	36-39	250	5	20	5	12	10
729	39-42	250	2	20	4	4	2
730	42-45	300	4	25	4	6	3
731	45-48	200	2	-20	3	5	2
732	48-51	80	4	-20	2	5	4
733	51-54	150	3	-20	4	5	6

050734	54-57	100	4	20	4	5	8
735	57-60	200	15	20	7	5	40

GEOCHEMICAL SAMPLING - NORTHERN STAR, TENNANT CREEK.

GEOCHEMICAL RESULTS - HOLE NO.44, 400N, 250E

050636	0-3	500	100	20	5	12	8
637	3-6	600	80	20	-1	15	8
638	6-9	800	80	30	4	12	25
639	9-12	200	40	-20	3	8	15
640	12-15	150	80	20	4	8	5
641	15-18	200	70	20	4	8	2
642	18-21	200	100	20	2	10	1
643	21-24	200	100	20	3	20	1
644	24-27	300	70	20	3	15	3
645	27-30	70	60	20	4	15	-1
646	30-33	150	50	-20	5	15	5
647	33-36	100	10	-20	5	15	4
648	36-39	200	15	-20	6	20	3
649	39-42	200	10	-20	3	20	6
650	42-45	250	25	-20	6	25	8
651	45-48	300	40	20	6	25	15
652	48-51	500	50	20	6	30	15
653	51-54	500	50	20	6	30	12
654	54-57	500	150	25	6	30	7
655	57-60	600	80	20	6	40	10

GEOCHEMICAL SAMPLING - NORTHERN STAR, TENNANT CREEK.

GEOCHEMICAL RESULTS - HOLE NO.13, 380S, 220E

050327	0-3	800	15	100	15	8	12
328	3-6	1500	40	100	40	40	10
329	6-9	1000	15	25	15	5	15
331	9-12	2000	30	50	30	15	25
332	12-15	800	25	40	25	20	20
333	15-18	1200	30	50	30	25	15
334	18-21	1000	20	80	20	12	40
335	21-24	700	25	50	25	10	25
336	24-27	1200	50	200	50	20	15
337	27-30	1500	60	250	60	25	25
338	30-33	1500	30	100	30	25	30
339	33-36	2000	30	300	30	20	25
340	36-39	2000	30	300	30	40	50
341	39-42	2500	25	150	25	30	80

050342	42-45		2500	25	200	25	50	80
050356	45-48	0.3	1500	25	200	20	20	60
357	48-51	0.8	3000	150	200	25	20	50
358	51-54	0.9	5000	150	250	25	20	40
359	54-57	0.7	4000	400	250	20	25	50
360	57-60	0.4	5000	250	200	20	20	50
361	60-63	0.6	2500	200	300	25	30	30
362	63-66	Trace	1500	15	200	25	18	20
363	66-69	Trace	2000	20	200	25	18	25
364	69-72	Trace	2000	15	200	20	18	25
365	72-75	Nil	2000	20	300	20	15	25
050371	75-83	Nil	1000	15	150	15	10	20
372	83-84	Nil	2000	15	500	20	15	25

APPENDIX 2

COMPARISON OF A.M.D.L. AND B.M.R. ANALYSES

Sample No.	Grid Coord.		Depth	COPPER AMDL Spec	COPPER B.M.R. AAS	COPPER B.M.R. Spec	COBALT AMDL Spec	COBALT B.M.R. AAS	COBALT B.M.R. Spec	ZINC AMDL Spec	ZINC B.M.R. AAS	ZINC B.M.R. Spec	LEAD AMDL Spec	LEAD BMR. AAS
050130	380S	140E	57-60	250	240	200	50	40	40	150	60		18	<20
050076+	340S	140E	48-51	1800	1100	1500	12	50	40	800	180		12	<20
050289	340S	300E	3-6	700	280	200	60	60	40	80	40		50	40
292			12-15	600	220	200	40	50	30	50	20		40	<20
293			15-18	1000	350	300	30	50	40	60	40		50	40
294 +			18-21	1500	240	200	150	45	40	80	40		300	30
295			21-24	700	270	200	50	55	40	80	45		50	30
296			24-27	1000	280	200	30	65	70	60	45		30	<20
297			27-30	2000	550	500	150	100	70	150	60		70	<20
298			30-33	1500	600	500	40	110	70	200	75		40	<20
312			36-39	1500	430	500	15	65	50	80	50		25	<20
313			39-42	2000	920	800	40	160	150	60	50		60	100
314			42-45	3000	1000	1500	60	160	150	200	65		80	90
315 +			45-48	4000	1300	1000	150	240	200	250	70		40	<20
316			48-51	2500	1100	1000	70	200	150	250	90		50	30
317			51-54	3000	860	800	100	170	150	500	150		200	110
318			54-57	3000	1100	1000	80	90	50	600	160		200	160
321 +			57-60	4000	1400	1000	80	210	200	2000	300		400	280
322 +			60-63	5000	1400	1000	400	220	150	2000	300		200	210
323			63-66	5000	1600	1000	300	220	150	1500	240		250	150
050186	420S	20W	54-57	2000	880	1000	70	60	70	50	25		18	<20
187			57-60	2000	1100	1500	80	70	80	50	55		15	<20
188			60-63	6000	2900	3000	100	180	100	250	20		12	<20
189			63-66	6000	3200	3000	200	230	150	200	95		15	<20
190			66-69	2500	1400	1500	50	80	70	80	40		10	<20
191 +			69-72	3000	700	1000	250	50	50	100	30		10	<20
192			72-75	600	380	500	20	30	40	30	25		8	<20
193			75-78	800	410	500	50	50	70	100	35		25	<20
194			78-81	1500	400	300	70	40	40	100	40		15	<20
195			81-84	800	320	300	30	35	30	80	25		10	<20
196			84-87	1000	250	500	60	25	40	40	20		20	<20
198			90-93	1000	400	300	60	70	40	200	40		15	<20
199			93-96	700	320	300	70	50	50	150	45		18	<20
200			96-99	1000	480	300	60	65	70	200	65		20	<20
050201 +	420S	300E	0-3	3000	1600	1500	80	290	300	40	50		20	<20
202 +			3-6	2000	1500	1000	70	230	150	50	50		25	<20
203			6-9	2000	1500	1500	80	270	200	30	50		25	<20
204			9-12	2000	1100	500	500	260	150	30	50		20	<20
205			12-15	2000	680	700	70	170	150	30	30		30	<20
206 +			15-18	1500	1100	700	70	310	200	25	35		20	<20
207			18-21	1500	1500	1000	60	370	300	20	50		18	<20
208			21-24	1200	770	500	40	170	80	20	30		18	<20
265			57-60	7000	4000	5000	500	350	300	100	100		20	<20
267 +			63-66	2500	2400	3000	30	280	300	100	90		15	<20
268			66-69	2000	1100	2000	30	160	200	150	80		20	<20
269			69-72	5000	2500	2000	250	320	300	400	100		20	30
278			78-81	4000	2500	1500	300	280	100	200	110		25	<20
279			81-84	7000	4500	3000	250	400	150	300	200		25	<20
280			84-87	5000	3900	2000	300	330	300	500	190		25	<20

\+ Sent to A.M.D.L. for recheck.

APPENDIX 2

COMPARISON OF A.M.D.L. AND B.M.R. ANALYSES

Sample No.	Grid Coord.		Depth	COPPER AMDL Spec	COPPER AMDL AAS	COPPER B.M.R. Spec	COBALT AMDL Spec	COBALT AMDL AAS	COBALT B.M.R. Spec	ZINC AMDL Spec	ZINC AMDL AAS	ZINC B.M.R. Spec	LEAD AMDL Spec	LEAD BMR. AAS
050130	380S	140E	57–60	250	240	200	50	40	40	150	60		18	<20
050076+	340S	140E	48–51	1800	1100	1500	12	50	40	800	180		12	<20
050289	340S	300E	3–6	700	280	200	60	60	40	80	40		50	40
292			12–15	600	220	200	40	50	30	50	20		40	<20
293			15–18	1000	350	300	30	50	40	60	40		50	40
294 +			18–21	1500	240	200	150	45	40	80	40		300	30
295			21–24	700	270	200	50	55	40	80	45		50	30
296			24–27	1000	280	200	30	65	70	60	45		30	<20
297			27–30	2000	550	500	150	100	70	150	60		70	<20
298			30–33	1500	600	500	40	110	70	200	75		40	<20
312			36–39	1500	430	500	15	65	50	80	50		25	<20
313			39–42	2000	920	800	40	160	150	60	50		60	100
314			42–45	3000	1000	1500	60	160	150	200	65		80	90
315 +			45–48	4000	1300	1000	150	240	200	250	70		40	<20
316			48–51	2500	1100	1000	70	200	150	250	90		50	30
317			51–54	3000	860	800	100	170	150	500	150		200	110
318			54–57	3000	1100	1000	80	90	50	600	160		200	160
321 +			57–60	4000	1400	1000	80	210	200	2000	300		400	280
322 +			60–63	5000	1400	1000	400	220	150	2000	300		200	210
323			63–66	5000	1600	1000	300	220	150	1500	240		250	150
050186	420S	20W	54–57	2000	880	1000	70	60	70	50	25		18	<20
187			57–60	2000	1100	1500	80	70	80	50	55		15	<20
188			60–63	6000	2900	3000	100	180	100	250	20		12	<20
189			63–66	6000	3200	3000	200	230	150	200	95		15	<20
190			66–69	2500	1400	1500	50	80	70	80	40		10	<20
191 +			69–72	3000	700	1000	250	50	50	100	30		10	<20
192			72–75	600	380	500	20	30	40	30	25		8	<20
193			75–78	800	410	500	50	50	70	100	35		25	<20
194			78–81	1500	400	300	70	40	40	100	40		15	<20
195			81–84	800	320	300	30	35	30	80	25		10	<20
196			84–87	1000	250	500	60	25	40	40	20		20	<20
198			90–93	1000	400	300	60	70	40	200	40		15	<20
199			93–96	700	320	300	70	50	50	150	45		18	<20
200			96–99	1000	480	300	60	65	70	200	65		20	<20
050201 +	420S	300E	0–3	3000	1600	1500	80	290	300	40	50		20	<20
202 +			3–6	2000	1500	1000	70	230	150	50	50		25	<20
203			6–9	2000	1500	1500	80	270	200	30	50		25	<20
204			9–12	2000	1100	500	500	260	150	30	50		20	<20
205			12–15	2000	680	700	70	170	150	30	30		30	<20
206 +			15–18	1500	1100	700	70	310	200	25	35		20	<20
207			18–21	1500	1500	1000	60	370	300	20	50		18	<20
208			21–24	1200	770	500	40	170	80	20	30		18	<20
265			57–60	7000	4000	5000	500	350	300	100	100		20	<20
267 +			63–66	2500	2400	3000	30	280	300	100	90		15	<20
268			66–69	2000	1100	2000	30	160	200	150	80		20	<20
269			69–72	5000	2500	2000	250	320	300	400	100		20	30
278			78–81	4000	2500	1500	300	280	100	200	110		25	<20
279			81–84	7000	4500	3000	250	400	150	300	200		25	<20
280			84–87	5000	3900	2000	300	330	300	500	190		25	<20

\+ Sent to A.M.D.L. for recheck.

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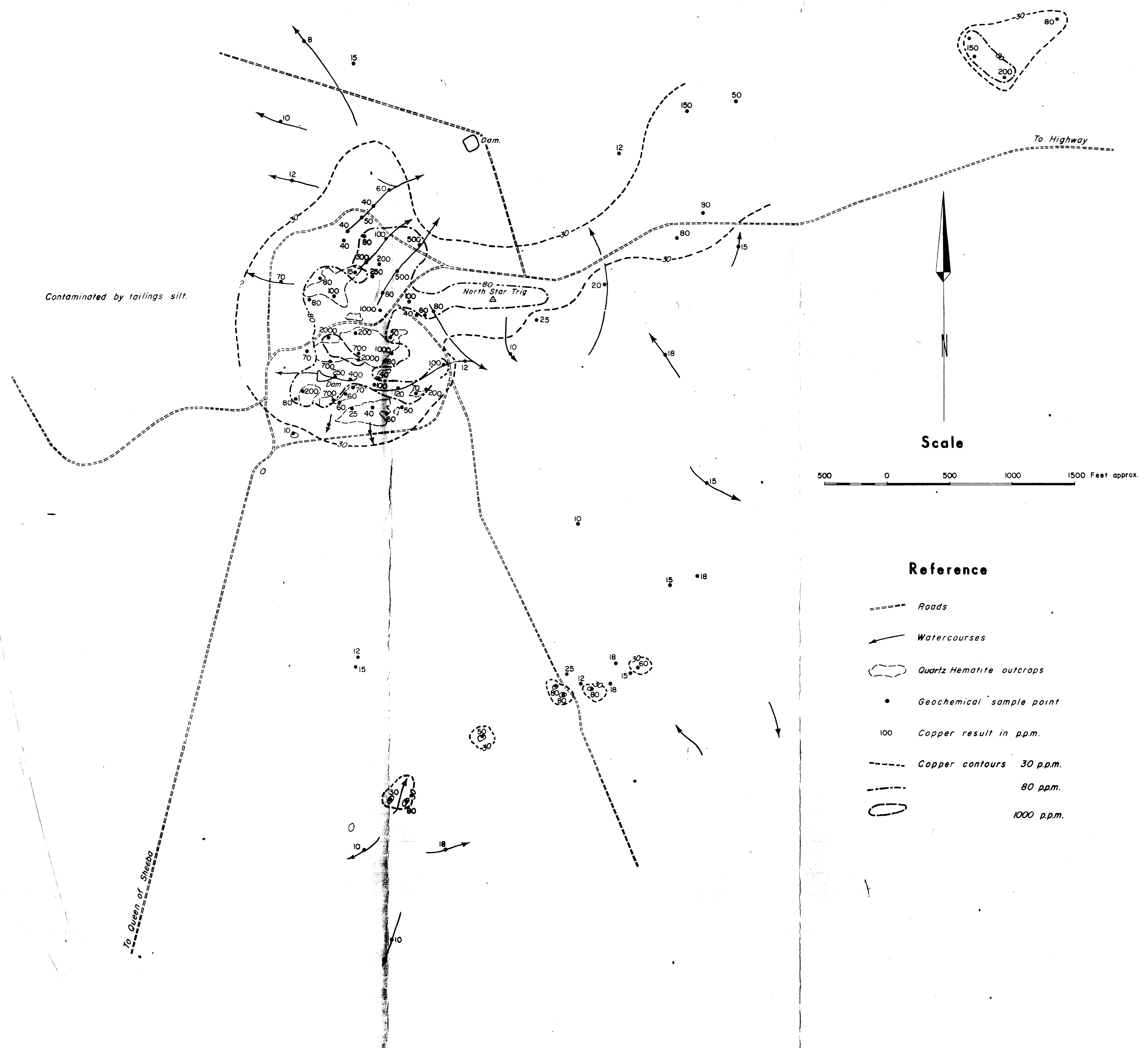
Plate I

GEOCHEMICAL SAMPLES NORTHERN STAR
TENNANT CREEK 1964
REGIONAL COPPER DISTRIBUTION



Bureau of Mineral Resources, Geology and Geophysics. January 1965 To accompany Record 1965/48 E53/A14/72 JK

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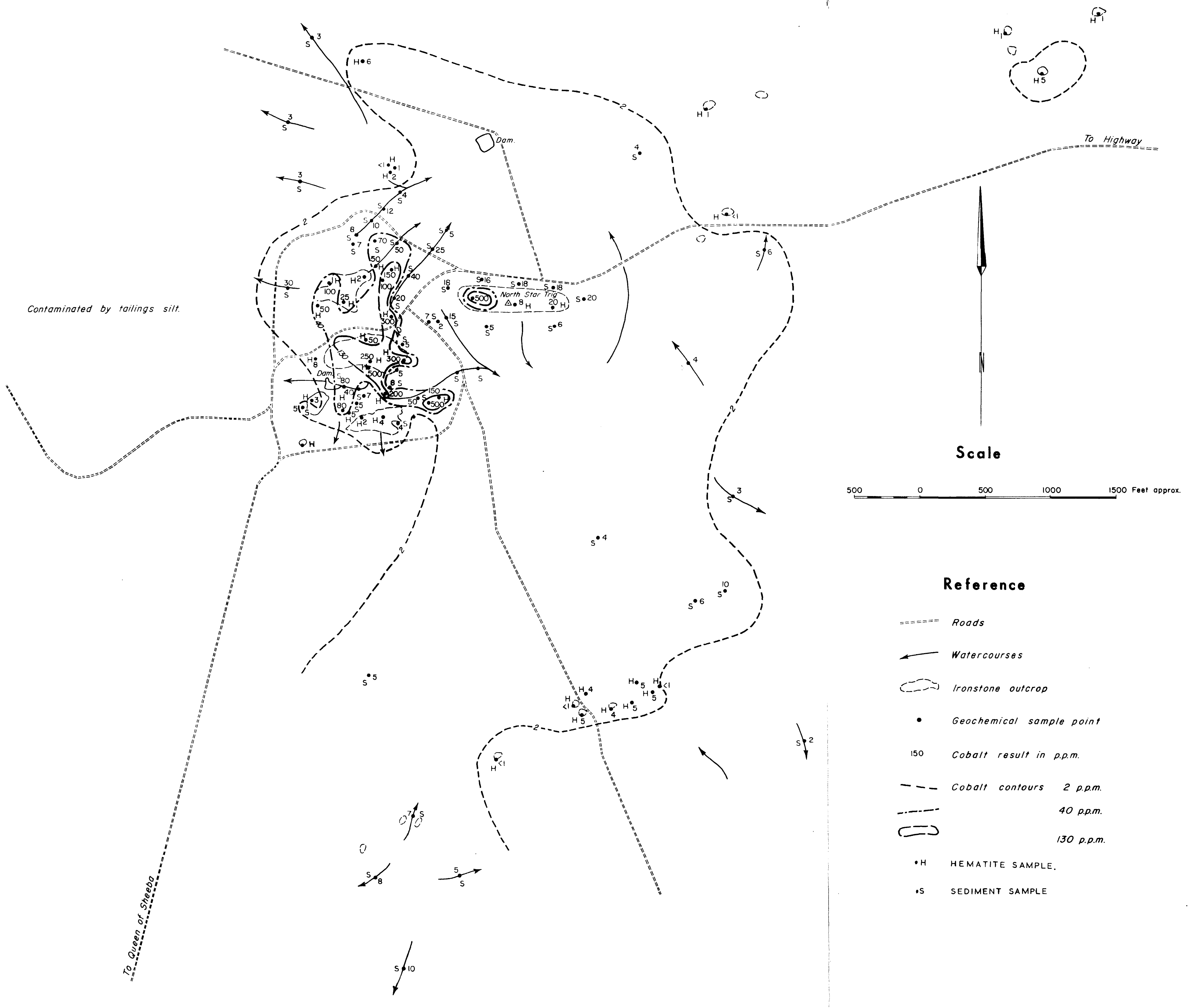
Plate 2

GEOCHEMICAL SAMPLES NORTHERN STAR
TENNANT CREEK 1964
REGIONAL COBALT DISTRIBUTION



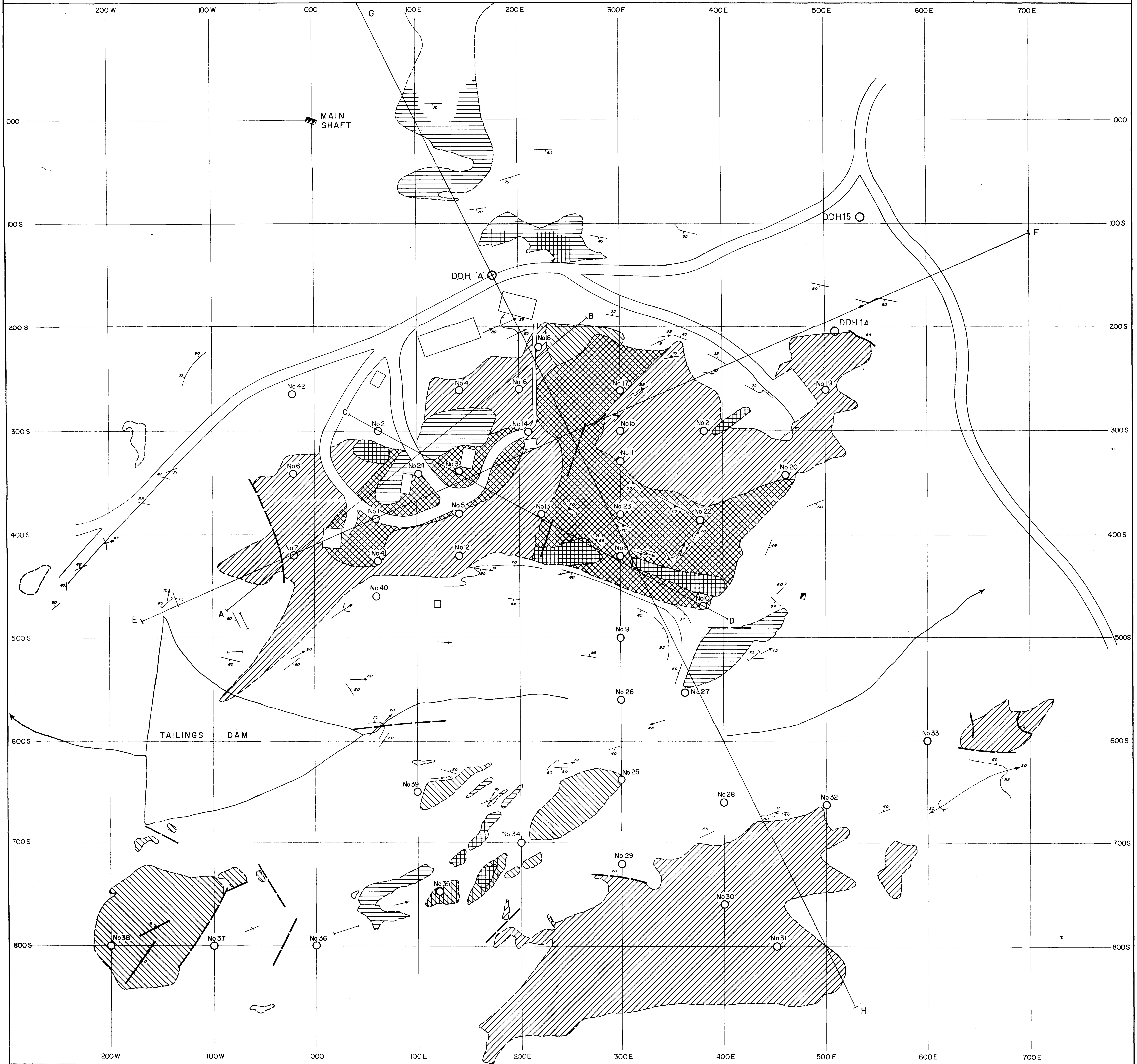
Bureau of Mineral Resources, Geology and Geophysics January 1965 To accompany Record 1965/48 E53/A14/73 JK

Plate 3

NORTHERN STAR GOLD MINE, TENNANT CREEK, N.T.

WAGGON DRILLING AND GEOCHEMISTRY OF IRONSTONES

Ironstone Types and Position of Holes



Reference

Primary intrusive ironstone
- Massive quartz hematite
- Massive quartz hematite and manganiferous hematite

Replaced sediments
- Quartz jasper hematite (replaced and silicified pink siltstone)
- Cellular hematite - lozenge shaped boxwork and ribwork in hematite (partly replaced hematite shale.)

Secondary ironstone
- Botryoidal and mammillary hematite, limonite and goethite
- Sedimentary rocks, hematite shale, siltstone, greywacke and tuffaceous sandstone

- No 26 — Collar and number of Waggon drill hole.
- Geological boundary
- Fault
- Quartz veins or dyke.
- Bedding trend with dip of bed.
- Cleavage trend with dip of cleavage.
- Cleavage trend with vertical dip.
- Plunge of lineation parallel to fold axis.

- Plunge of minor syncline
- Plunge of minor anticline
- Relic foliation in replaced sediment (bedding or cleavage)
- Mine shaft (not accessible)
- Concrete base of old building.
- Road
- Stream
- A——B Geochemical section line

40 20 0 40 80 120 160 200 FEET

Plate 4
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NORTHERN STAR - GEOCHEMISTRY
CUMULATIVE FREQUENCY DISTRIBUTION DIAGRAM

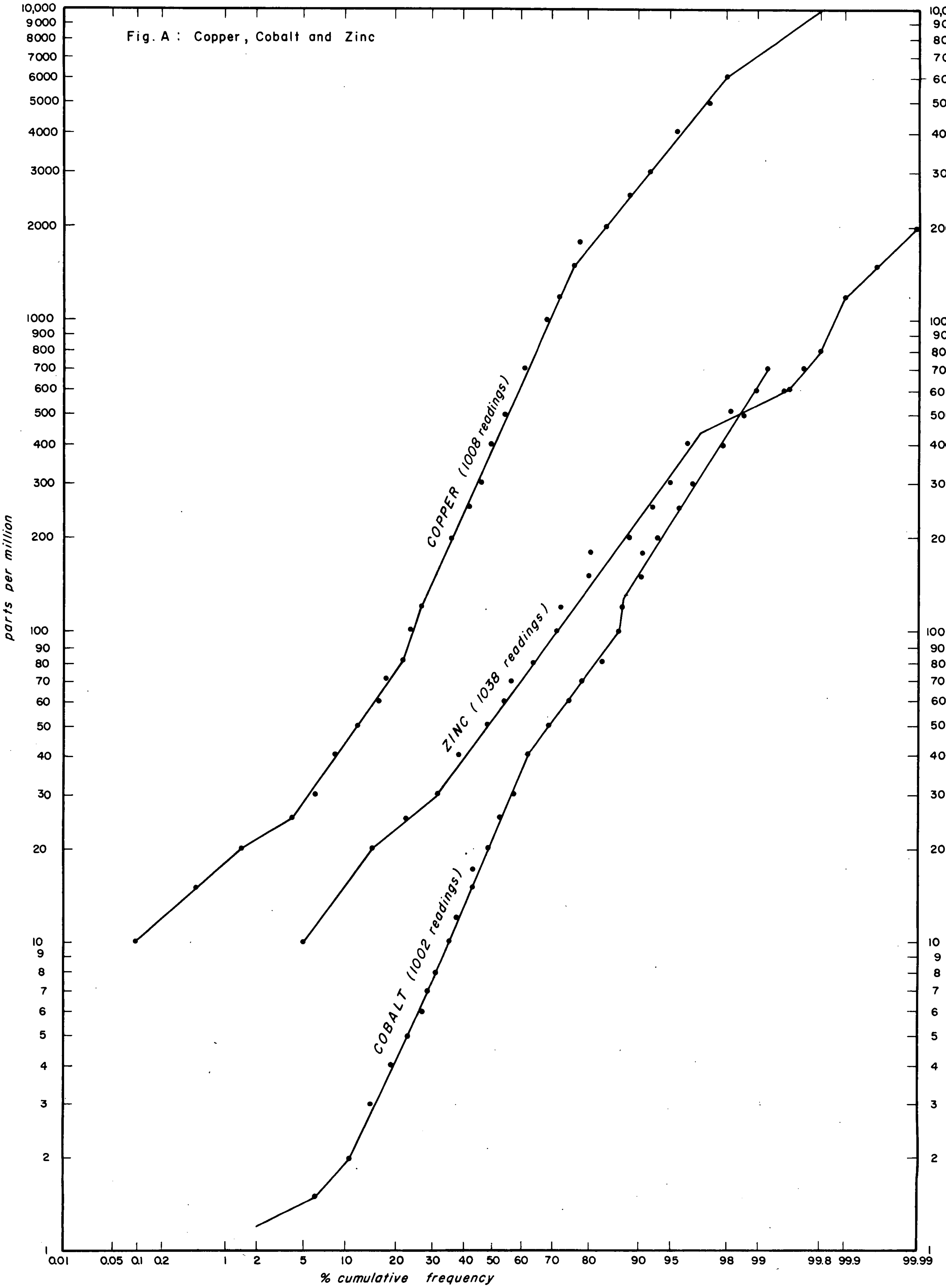
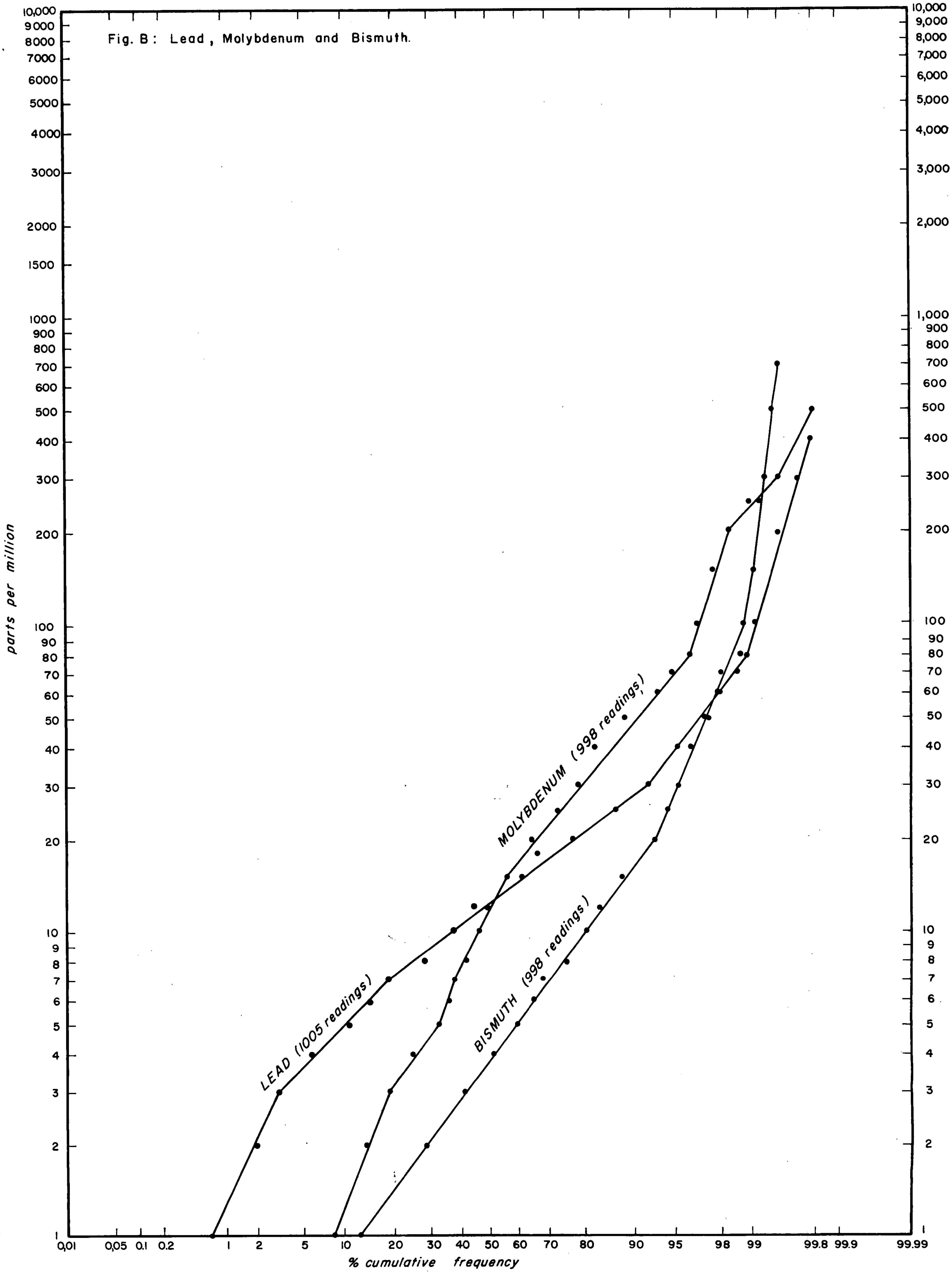


Plate 5

010674

NORTHERN STAR - GEOCHEMISTRY

CUMULATIVE FREQUENCY DISTRIBUTION DIAGRAM



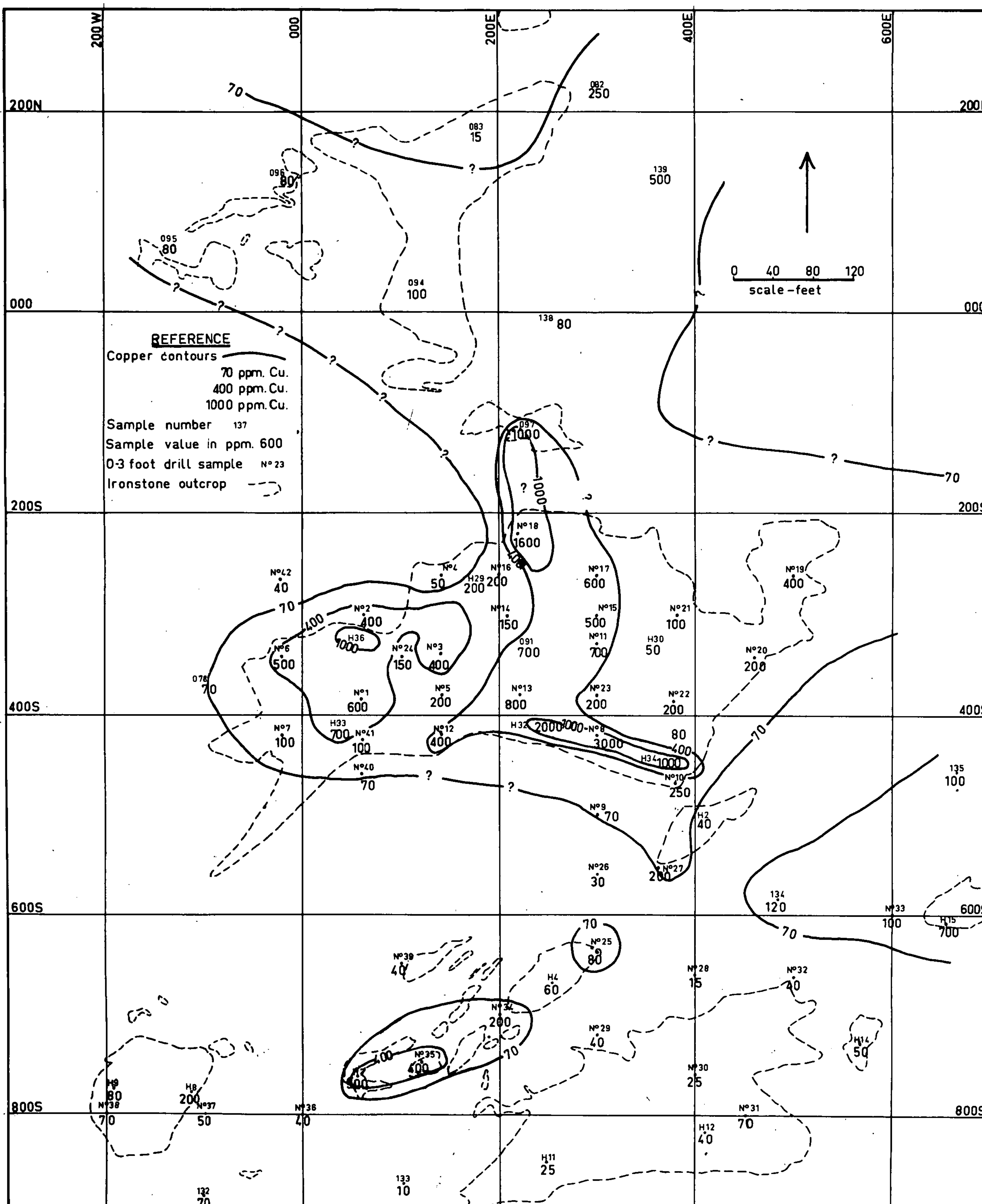
Bureau of Mineral Resources, Geology and Geophysics. December 1964 To accompany Record 1965/48

E 53/A14/76

010674

PLATE 6.

NORTHERN STAR COPPER DISTRIBUTION - SURFACE SAMPLES



Bureau of Mineral Resources, Geology and Geophysics. March, 1965. To accompany Record 1965/48

E 53/A14/89

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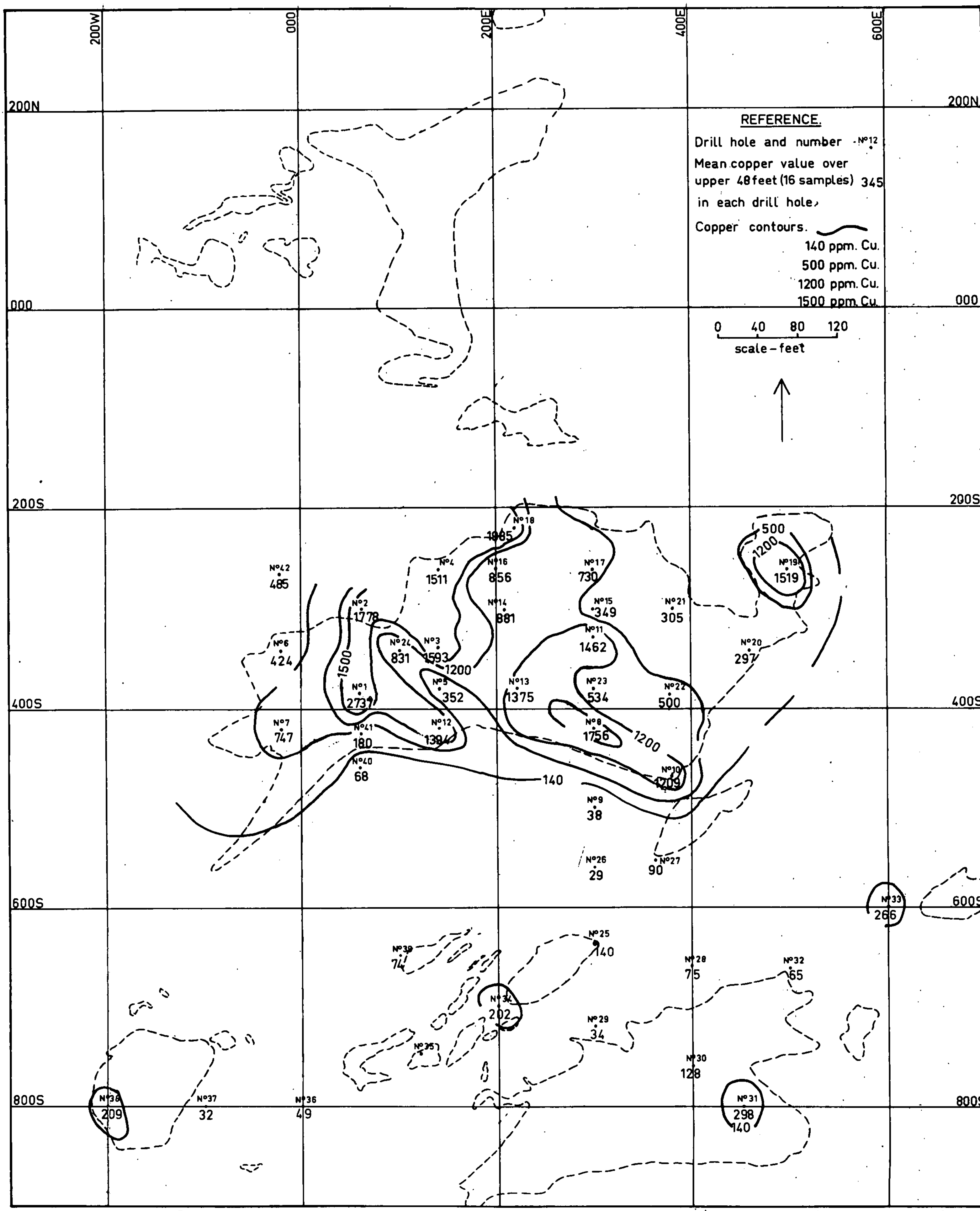
PLATE

NORTHERN STAR COPPER DISTRIBUTION - MEAN OF WAGGON DRILL SAMPLES.

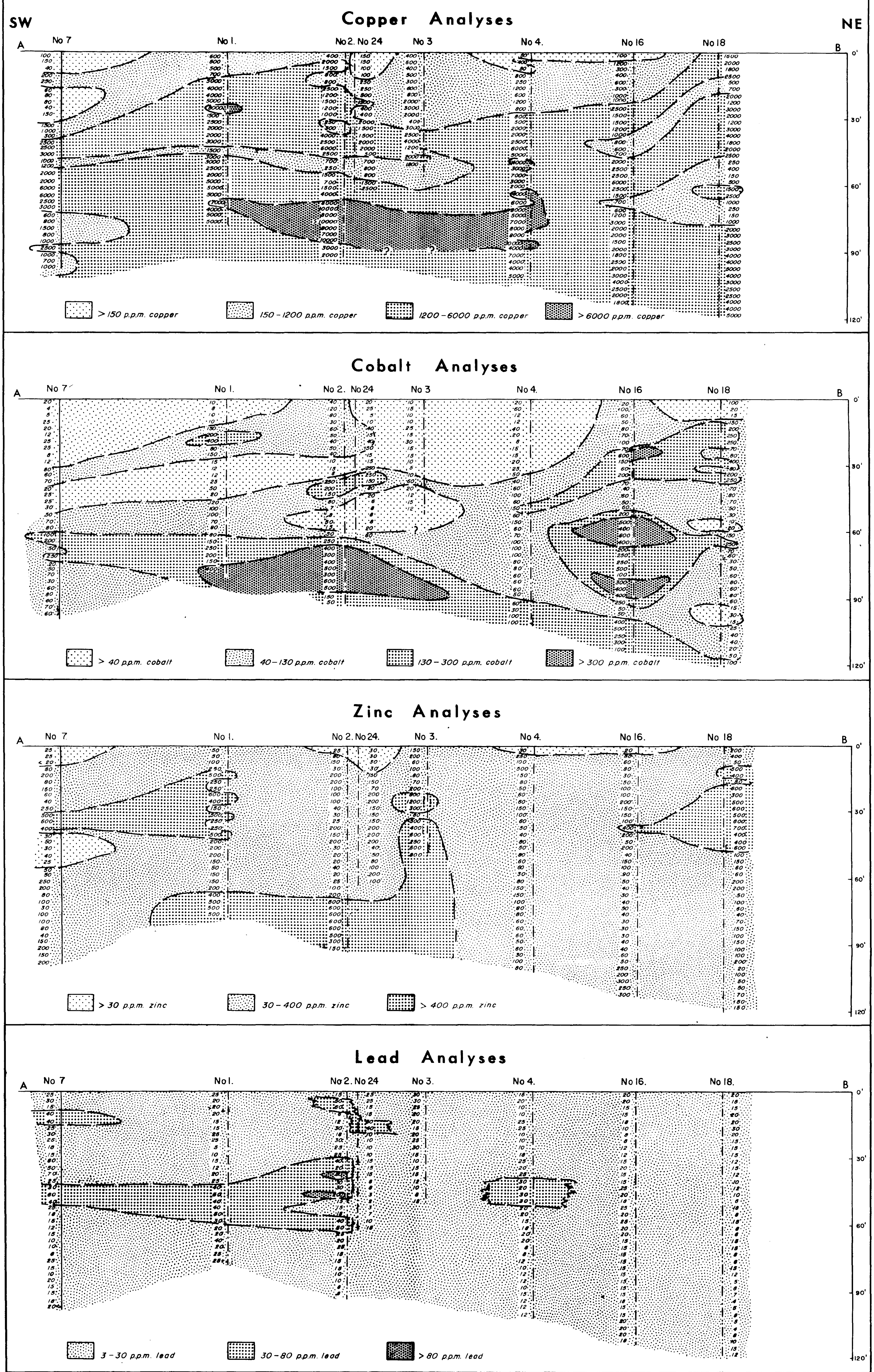


Bureau of Mineral Resources, Geology and Geophysics. March 1965 To accompany Record 1965/48

E53/A14/90

Plate 8

NORTHERN STAR - SECTION AB
GEOCHEMICAL ANALYSES FROM WAGGON DRILL HOLES



Hole No 7 – On section
Hole No 1 – Projected 22 feet N.W.
Hole No 2 – Projected 40 feet S.E.
Hole No 24 – Projected 10 feet N.W.
Hole No 3 – Projected 40 feet N.W.
Hole No 4 – Projected 22 feet S.E.
Hole No 16 – Projected 15 feet N.W.
Hole No 18 – Projected 8 feet S.E.

Waggon drill hole on section with geochemical analyses of 3 foot interval in parts per million.

Waggon drill hole projected from near side with geochemical analyses of 3 feet interval in parts per million.

Waggon drill hole projected from far side with geochemical analyses of 3 feet interval in parts per million.

All results in parts per million spectrographically analysed by A.M.D.L. Adelaide.

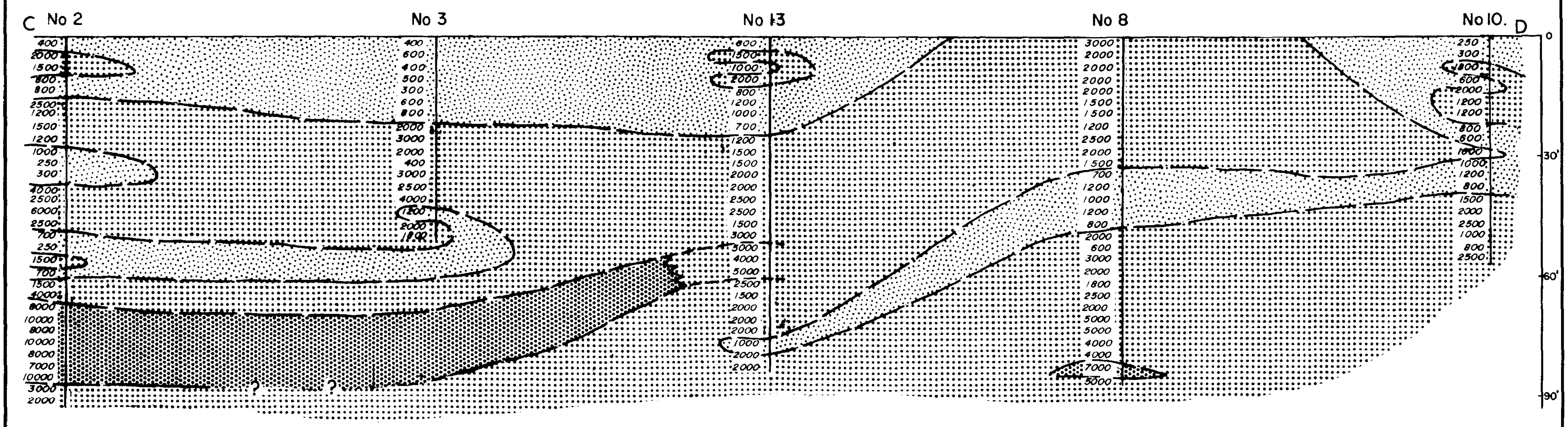
30 0 30 60 feet

Plate 9

NORTHERN STAR - SECTION CD
GEOCHEMICAL ANALYSES FROM WAGGON DRILL HOLES

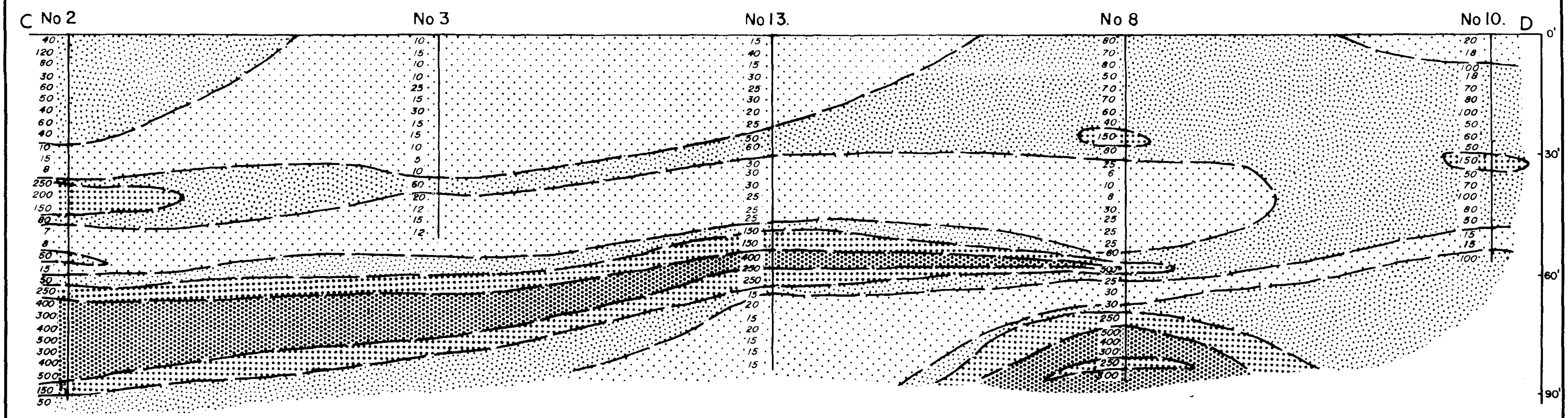
Copper Analyses

NW SE



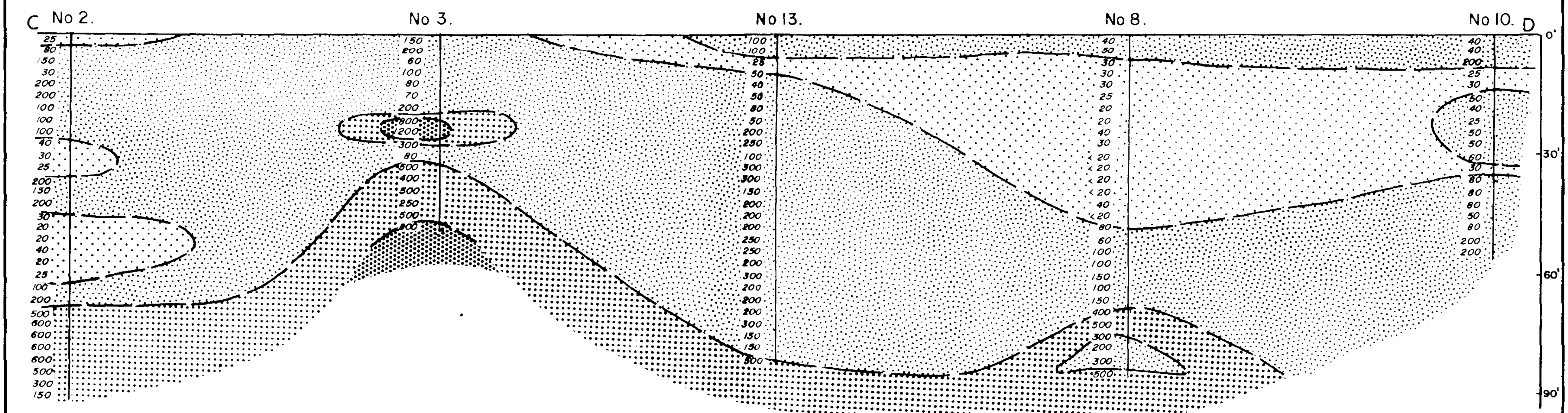
< 150 p.p.m. copper | 150 – 1200 p.p.m. copper | 1200 – 6000 p.p.m. copper | > 6000 p.p.m. copper

Cobalt Analyses



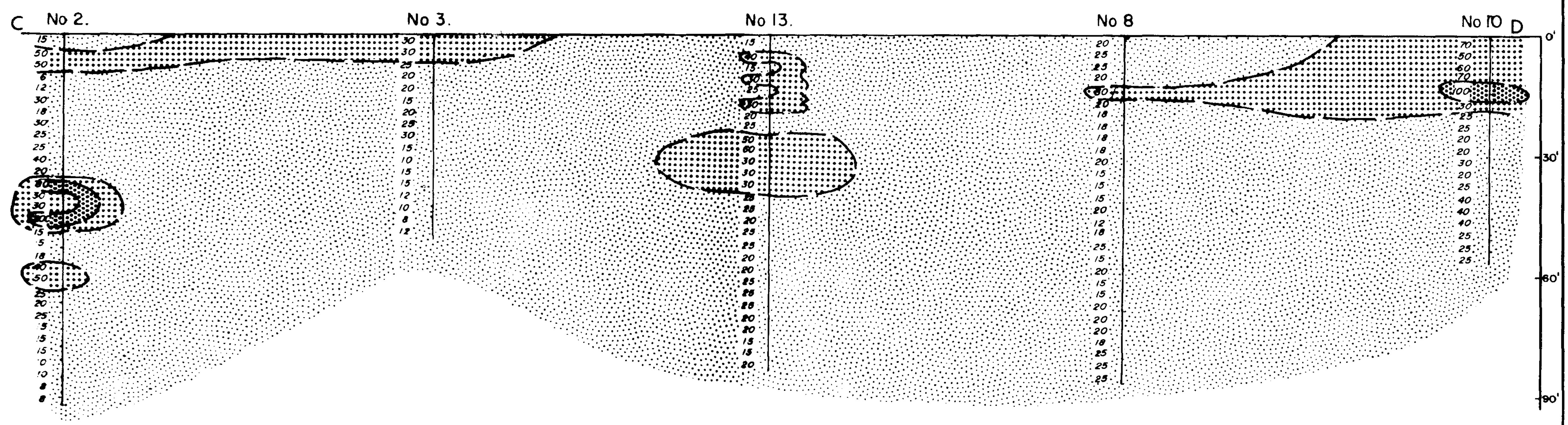
> 40 p.p.m. cobalt | 40 – 130 p.p.m. cobalt | 130 – 300 p.p.m. cobalt | > 300 p.p.m. cobalt

Zinc Analyses



>30 p.p.m. zinc | 30 – 400 p.p.m. zinc | 400 – 800 p.p.m. zinc | > 800 p.p.m. zinc

Lead Analyses



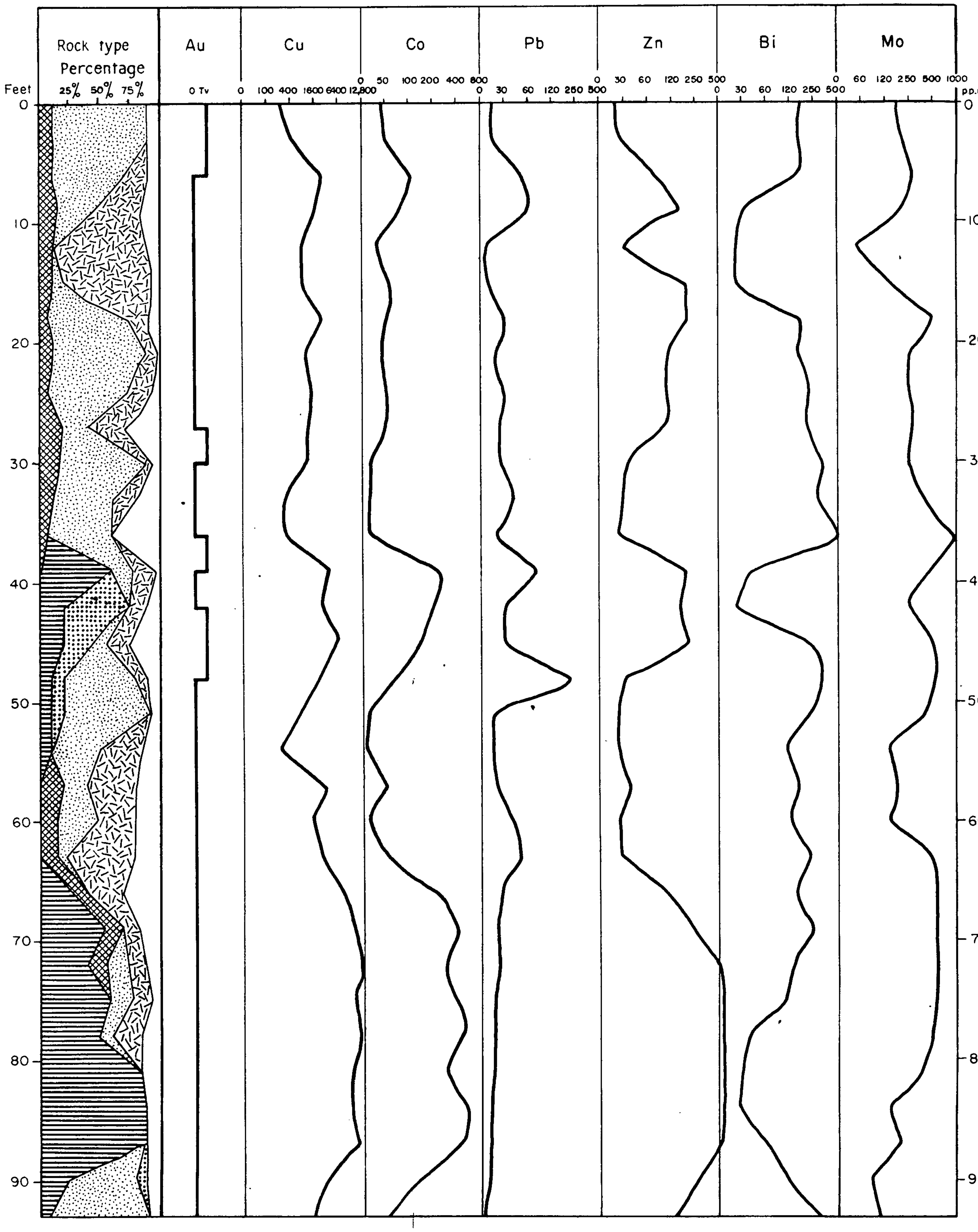
> 3 p.p.m. lead | 3 – 30 p.p.m. lead | 30 – 80 p.p.m. lead | > 80 p.p.m. lead

Waggon drill hole with geochemical analyses of 3 feet interval in parts per million.

30 0 30 60 feet.

NORTHERN STAR HOLE No 2 300S 60E

LOG OF GEOCHEMICAL RESULTS



Quartz

Jasper and silicified pink siltsone

Pink and red siltstone and shale

Micaceous (specular) hematite

Massive non-metallic manganiferous hematite (in part botryoidal, in part martite)

Red hematite shale (in part replaced by massive hematite)

Hole logged from waggon drill chips sampled at 3 feet intervals, by visual % estimation using binocular microscope. Gold assays by the Tennant Creek Government Battery. Trace is less than 0·3 dwt/ton. Other elements by spectrographic analysis at A.M.D.L.

Bureau of Mineral Resources, Geology and Geophysics. December 1964. To accompany Record 1965/48 E53/A14/79 JK

NORTHERN STAR - HOLE No 4 260S 140E - GEOCHEMISTRY

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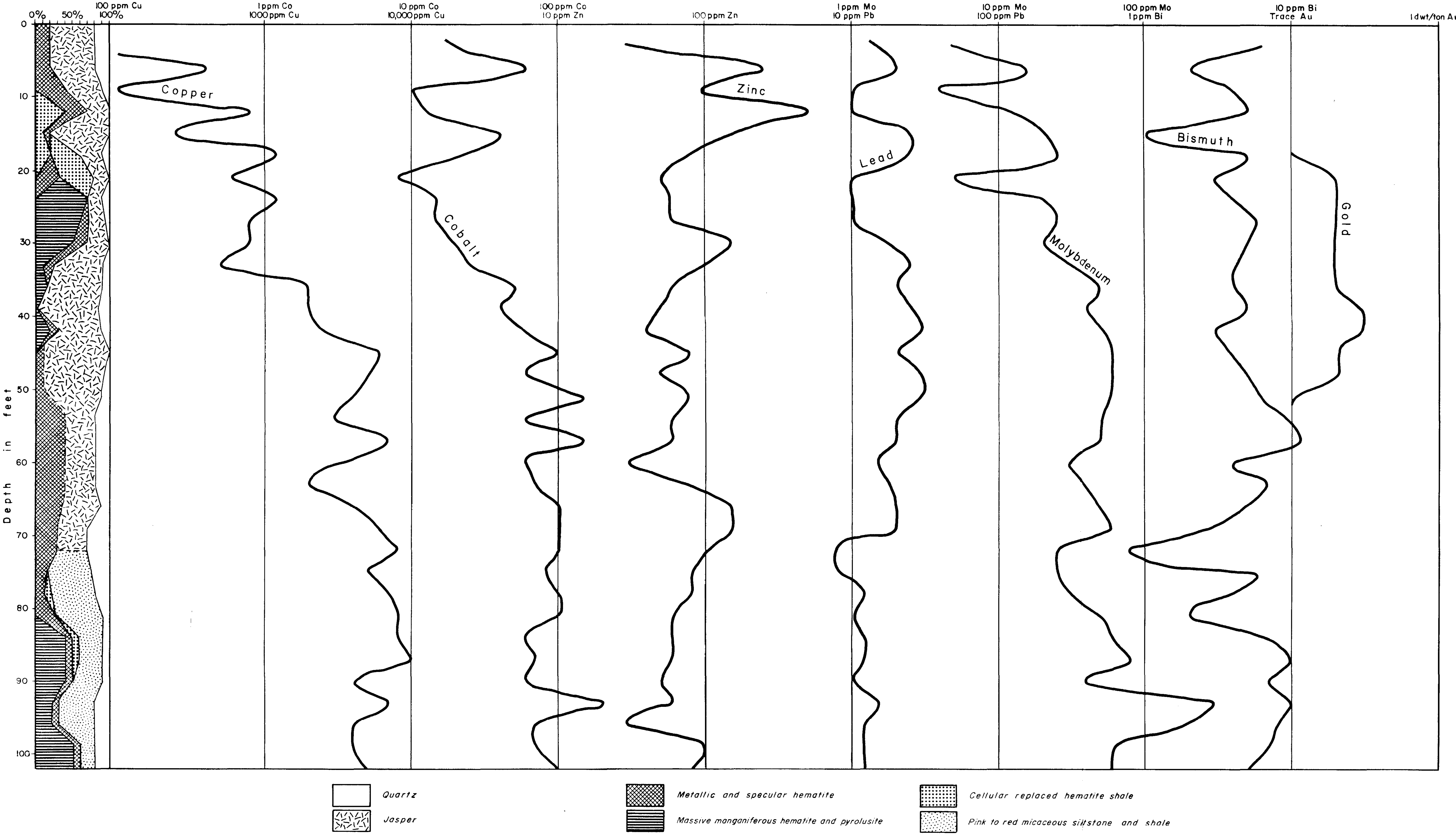
Plate II

Comparison of lithology and geochemical Distribution



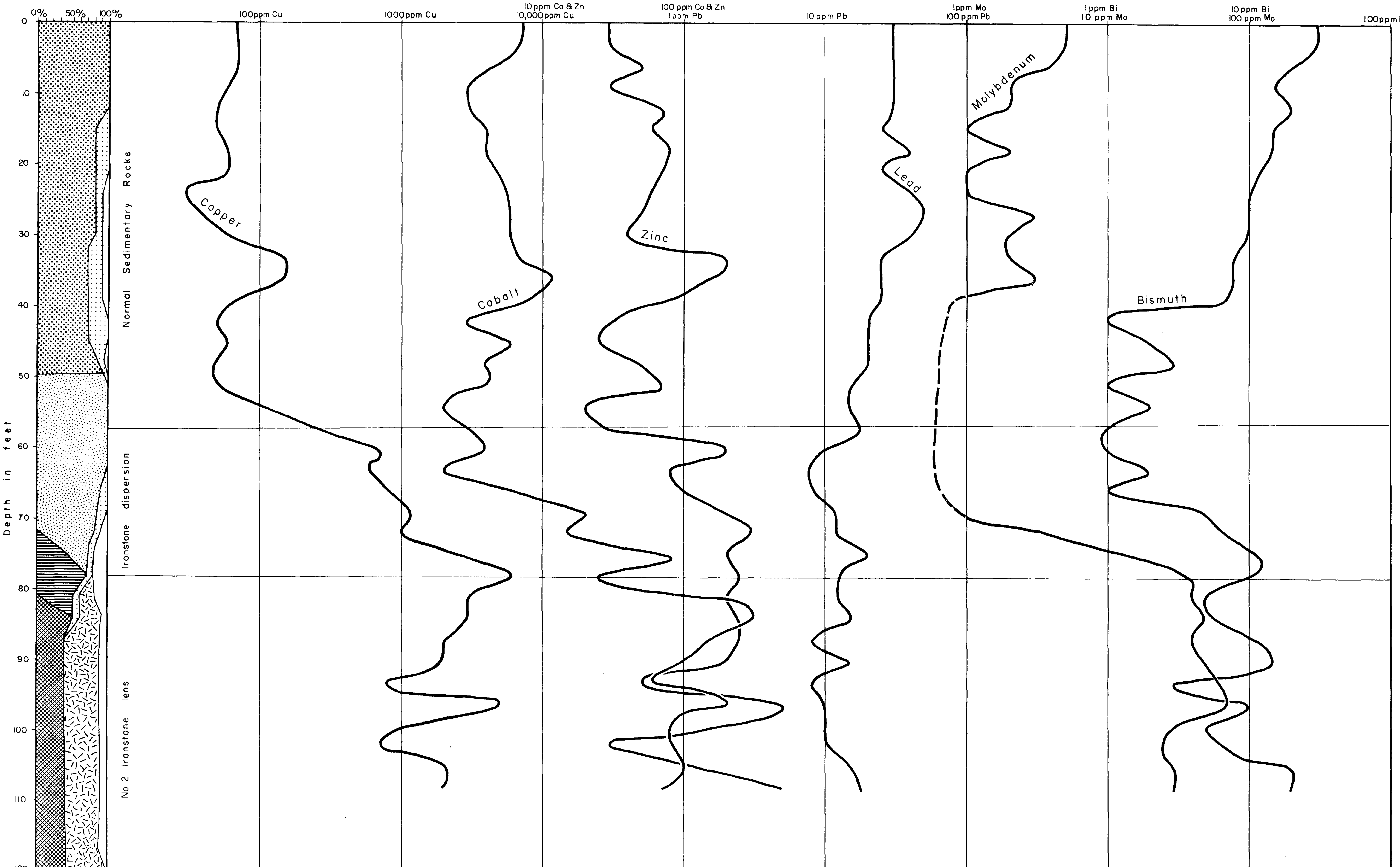
Hole logged from waggon drill chips sampled at 3 feet intervals, by visual % estimation using binocular microscope
Gold assays by the Tennant Creek Government Battery. Trace is less than 0·3 dwt/ton Other elements by spectrographic analysis at A.M.D.L.

Bureau of Mineral Resources, Geology and Geophysics. *February 1965* *To accompany Record 1965/48* E53/A14/80 JK

010674 Plate 12

NORTHERN STAR - HOLE No 9 500S 300E - GEOCHEMISTRY

Comparison of lithology and geochemical Distribution



Quartz

Jasper and silicified pink siltstone

Pink to red micaceous siltstone and shale

Yellow to white leached shale and siltstone

Red to purple-brown hematite shale

Micaceous (specular) and metallic hematite

Massive, non-metallic magniferous hematite

Hole logged from waggon drill chips sampled at 3 feet intervals, by visual % estimation using binocular microscope. Gold assays by the Tennant Creek Government Battery. Trace is less than 0·3 dwt/ton. Other elements by spectrographic analysis at A.M.D.L.

Bureau of Mineral Resources, Geology and Geophysics   February 1965   To accompany Record 1965/48

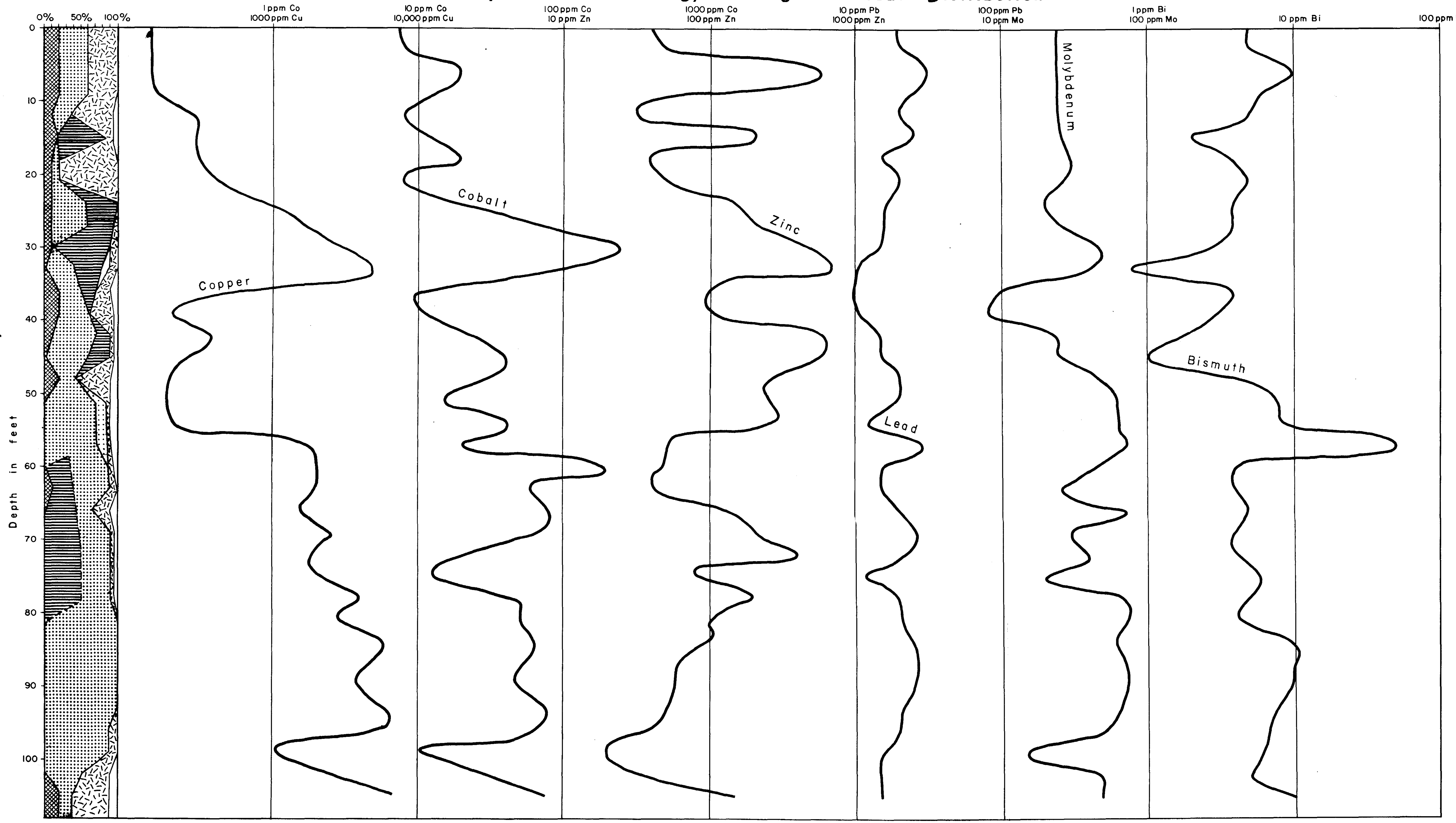
E53/A14/81

JK

NORTHERN STAR - HOLE No 14 300S 220E - GEOCHEMISTRY

010674 Plate 13

Comparison of lithology and geochemical Distribution



[Quartz symbol]	*Quartz*	[symbol]	*Micaceous (specular) hematite and metallic hematite.*	[symbol]	*Massive, non-metallic, manganiferous hematite*
[symbol]	*Jasper and silicified siltstone*	[symbol]	*Cellular hematite-replaced hematite shale and veinlets of non-metallic hematite, in part limonitic*	[symbol]	*Leached siltstones and shale*

Hole logged from waggon drill chips sampled at 3 feet intervals, by visual % estimation using binocular microscope.
Gold assays by the Tennant Creek Government Battery. Trace is less than 0·3 dwt/ton. Other elements by spectrographic analysis at A.M.D.L.

Bureau of Mineral Resources, Geology and Geophysics. *February 1965* *To accompany Record 1965/48*

E53/A14/82 JK

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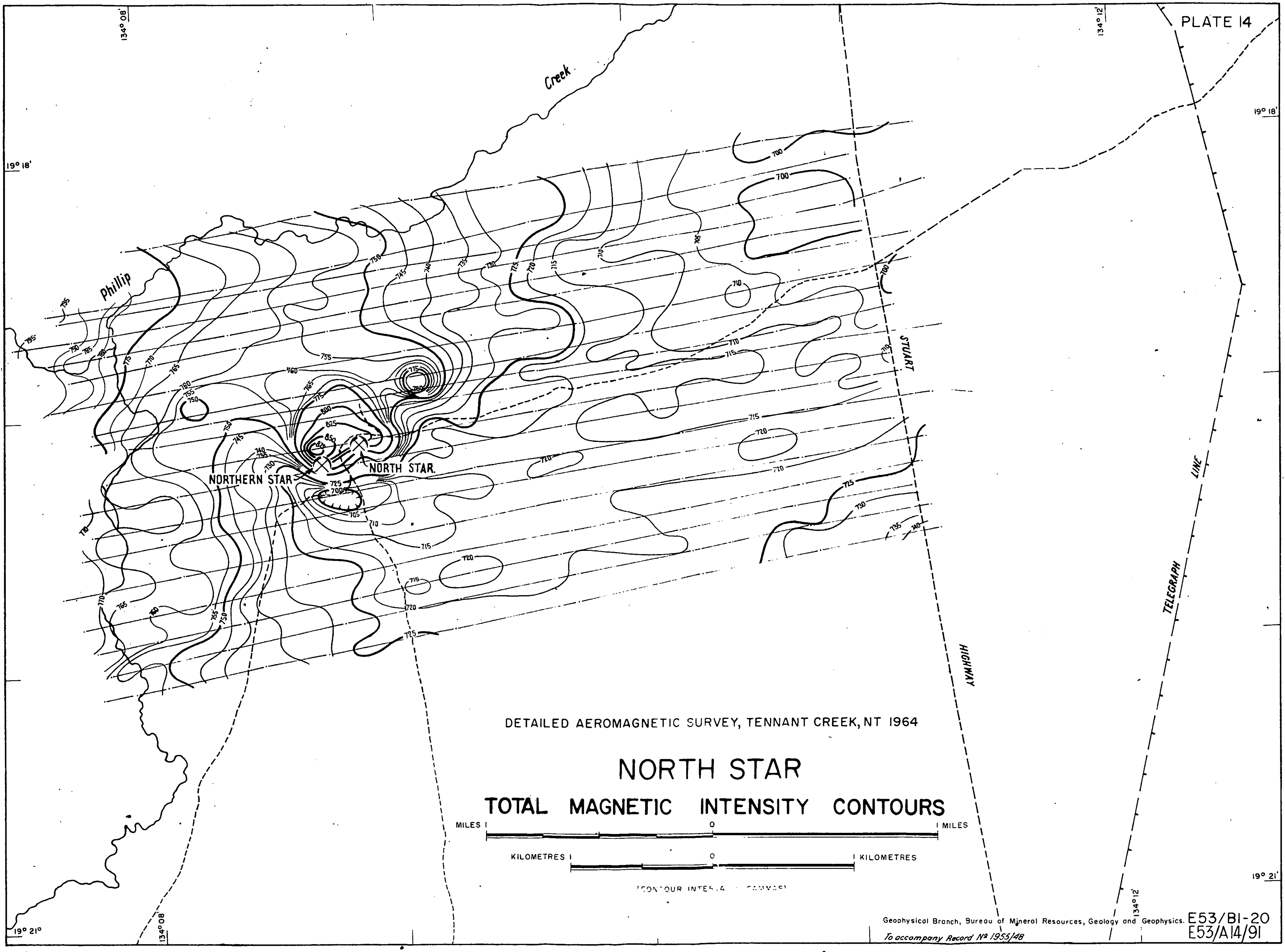
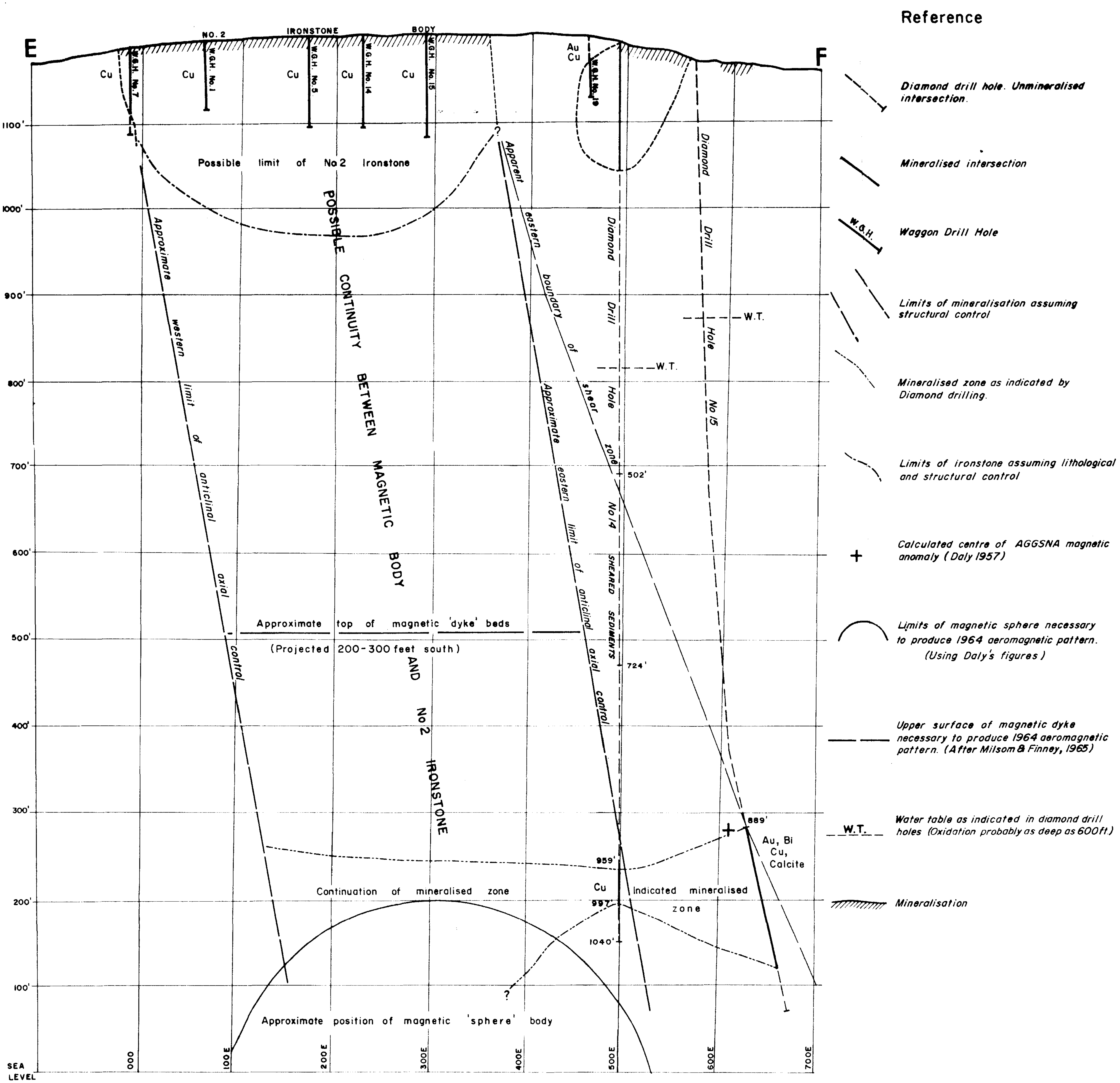


PLATE 14
134° 08'
134° 12'
19° 18'
19° 21'
Creek
Phillip
STUART
HIGHWAY
TELEGRAPH
LINE
NORTHERN STAR
NORTH STAR
DETAILED AEROMAGNETIC SURVEY, TENNANT CREEK, NT 1964
NORTH STAR
TOTAL MAGNETIC INTENSITY CONTOURS
MILES 1 0 1 MILES
KILOMETRES 1 0 1 KILOMETRES
Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics.
To accompany Record Nº 1955/48
E53/B1-20
E53/A14/91

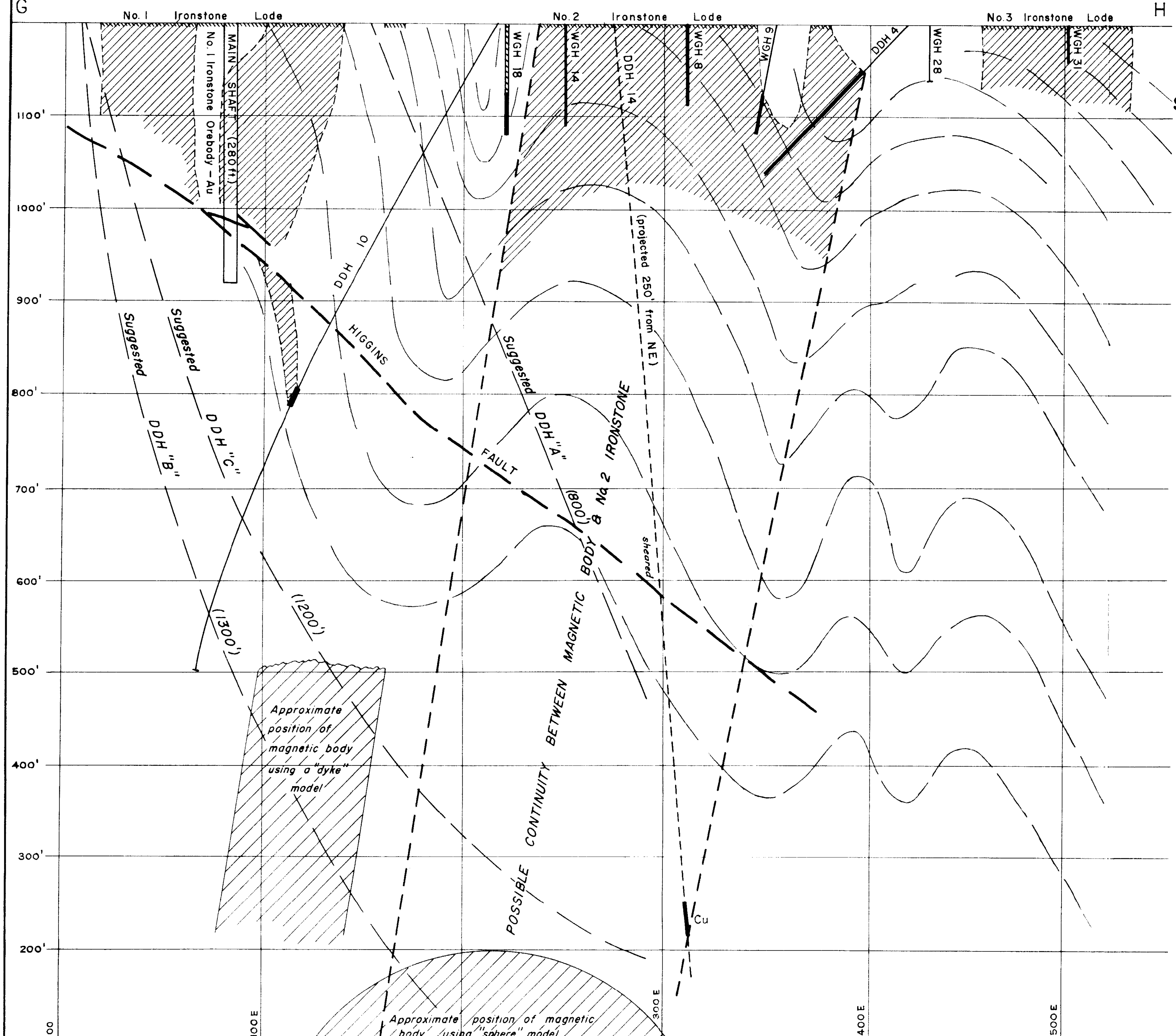
LONG SECTION E-F STRUCTURE, MAGNETICS AND MINERALISATION

NORTHERN STAR, TENNANT CREEK



010674

Plate 16



CROSS SECTION G-H

Structure, Magnetics and Mineralisation

NORTHERN STAR

TENNANT CREEK

Showing suggested position of three Diamond Drill Holes

Reference

WGH Wagon Drill Hole — *Unmineralised* / Cu *Mineralised*

DDH Diamond Drill Hole — *Unmineralised* / Cu *Mineralised*

Inferred bedding trend

Ironstone body

Suggested Diamond Drill Hole to test No 2 Ironstone and magnetic bodies for mineralisation at depth

100 0 100 200 FEET

Bureau of Mineral Resources Geology and Geophysics June 1965 To accompany Record 1965/48

E 53/A14/93