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1958/76

A GEOLOGICAL EXAMINATION OF ELDORADO MINE, TENNANT CREEK, NORTHERN TERRITORY

by

G. R. Ryan

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INTRODUCTION

This report is the result of a brief examination of the Eldorado Mine, Tennant Creek. The examination arose from a request by the board of Eldorado Tennant Creek Ltd. to the Secretary, Department of Territories, for financial assistance in the form of a guarantee by the Commonwealth Government to the Company's bankers to cover a loan of £50,000.

The object of the investigation was to determine whether the chances of discovering further payable gold ore in the mine are such that the provision of the requested assistance is justified. As time was of the greatest importance a detailed investigation of the mine was not possible, but recent reports on the mine in 1953 and 1957 by Mr. F.A. Campbell, Consulting Geologist, have been consulted. The recommendations for development and the estimates of ore contained therein have been thoroughly examined.

Two weeks were spent at the mine in July, 1958, during which time critical areas in the mine were examined and some samples were taken for assay, mainly as a check against the results obtained by the Company.

GEOLOGY OF TENNANT CREEK GOLDFIELD

The geology of the Tennant Creek Goldfield is complex and as yet not fully understood. More comprehensive descriptions of the geology have been given by Ivanac (1954), Owen (1940), Conolly (1954), Woolnough (1936), and others. The gold and copper deposits which have been found at Tennant Creek are associated with bodies of "ironstone" which are composed of quartz, hematite, and magnetite. The mineral deposits and the ironstone have been formed by injection and replacement of sedimentary rocks of the Warramunga Group.

The Warramunga Group consists mainly of shale and greywacke with subordinate amounts of sandstone, mudstone, siltstone, and possibly some tuffaceous material. The sequence is indicative of deposition of ill-sorted sedimentary material in a shallow trough of a Precambrian sea - the Warramunga Geosyncline. The rocks have been folded, faulted, and sheared; and have been intruded by granite and porphyry, by the mineral-bearing hydrothermal solutions, and, at a later date, by basic igneous rocks.

The relationship between the mineral deposits, the igneous rocks, and the structure and bedding of the Warramunga Group has been investigated by many workers but is still not understood. Briefly, it may be said that the intrusion of the ironstone was controlled by structure because the ironstone bodies are always associated with structural features such as shears and folds; but the deposition of the ironstone was by replacement of favourable sedimentary beds, normally mudstone or shale. The mineralising fluids may have been contemporaneous with or later than the emplacement of the ironstone.

The most unusual geological feature of the Tennant Creek Goldfield is the depth of oxidation which is normally of the order of 300 feet but may be as deep as 800 feet. The ironstone bodies, which consist mainly of quartz and magnetite in the primary zone, have been converted to quartz and hematite in the oxidised zone. A little primary hematite is present, and secondary hematite is thought to have developed by the action of later hydrothermal fluids on the magnetite already emplaced. Some bodies of hematite are thought to be entirely primary.

As a result of the unusually deep oxidation the zones of primary and secondary sulphide minerals, notably those of copper, are found only well below the surface. Leaching at the surface has been so intense that only geochemical tests can detect the original presence of copper in many outcrops. The extent to which the gold has been redistributed and enriched in the oxidised zone is much in doubt.

ELDORADO MINE

GENERAL

The Eldorado Mine lies on a prominent ridge about four miles south of Tennant Creek township. Access is by a partly metalled road which leaves the Stuart Highway three miles south of the town. Eldorado Tennant Creek Ltd. owns the Eldorado Mine and a number of leases on either side of the mine. Included in these leases are five magnetic anomalies which were detected by the Aerial, Geological, and Geophysical Survey of Northern Australia in 1935 and 1936. Anomaly No. 5 on the Cat's Whiskers lease is associated with a strong copper anomaly detected by the Bureau of Mineral Resources geochemical survey in 1957.

The Eldorado orebody was discovered in 1932, and after some unsuccessful attempts to exploit it, Eldorado Pty. Ltd. began large scale operations in 1938. The mine was the only one at Tennant Creek which was permitted to continue operations throughout World War 11 and was exploited continuously until the suspension of operations on 25th July, 1958.

The recorded production of gold from the mine is given in Table 1. From this table it may be seen that the grade of ore won has decreased considerably in the last two years, and this has resulted in the closure of the mine. The loss of grade has been due to the lack of proved ore reserves which has made necessary the treatment of development ore as won. Much of this ore has not been payable.

BATTERY SANDS

The mine possesses its own battery plant and cyanidation plant, although the latter only came into operation in 1952. The plant was in effective operation at the time of the present inspection but it is subject to frequent breakdowns and is in need of overhaul. It is capable of a maximum throughput of about 500 tons a week but so far this maximum has rarely been attained. J.C. Coldham, Consulting Mining Engineer, has made several recommendations with regard to the more efficient operation of the plant.

Since the installation of the cyanidation plant a large tonnage of battery sands has been re-treated. It has been estimated by Coldham that about 24,600 tons of sands remain to be treated. He gives an average grade of 5.1 dwt. per ton but his sampling was superficial, and the sands dump will need to be more thoroughly sampled before a more exact assessment can be made. However, mine records for 1949, 1950, and 1951 indicate a loss of 5 dwt. to 7 dwt. in the tailings (Table 1).

The tailings loss from the re-treatment of the sands will be about 0.5 dwt. per ton. Costs are estimated at 28/- per ton; equivalent to about 1.75 dwt. per ton. Thus, for every dwt. in excess of 2.25 dwt. per ton contained in the dump, re-treatment should yield a profit of approximately £19,600. Installation of a new thickener will be necessary before full recovery can be attained. Construction of this thickener was in hand at the time of the closure of the mine.

DEVELOPMENT

The Eldorado orebody has been developed from four main levels at vertical intervals of 100 feet. The Main Shaft serves the upper three levels but was placed at the wrong end of the orebody (Plate 2). The 400-foot level is served by an internal inclined shaft. Two main ore shoots have been exploited from the East Stope and the Central Stope respectively (Plate 2). Some patches of high grade ore were won from a series of small ore shoots lying between the 200-foot level and the surface at the western end of the orebody and known as the Western Leases.

The stopes are described in detail by Ivanac (1954). The most continuous shoot of ore was encountered in the Eastern Stope and has been followed from the 400-foot level to the surface.

A coordinated system of development and exploration of the orebody has rarely been effected and has never been continued for very long with the result that there has never been a large tonnage of proved ore reserves. On many occasions, as at present, knowledge of the ore has been restricted to the working faces. The high grade ore has been exhausted leaving a shell of low grade ore which cannot now be exploited. The prime need at the moment is the discovery and proving of some high grade ore so that the considerable tonnage of low grade ore remaining in the mine can be extracted profitably.

The calculation of ore reserves, on the basis of assay values obtained on the faces of the present mine openings, is extremely unreliable owing to the very erratic occurrence of the gold. Either rock drilling or diamond drilling must be employed to test the orebody thoroughly to considerable depth.

The extent of the orebody to the east, north, and particularly to the north-east, is virtually unknown. Recommendations by F.A. Campbell in this respect have been for the most part ignored.

The method of sampling currently employed in the mine has been proved to be unreliable as the head grade of ore has been as much as 50% lower than that indicated in the assays. The checking of sampling in this type of orebody is difficult, and check samples cannot be expected to return similar assays. However, a few check samples were taken and were found to be in general agreement with those indicated by the mine sampling. Far too much attention was paid by the mining company to grab samples consisting mainly of fines and frequently taken from the foot of a rise, stope, or working face. As it is generally believed that most of the gold is contained in the fines, this method of sampling could prove very misleading. If the mine resumes operations sampling is one department which must be investigated thoroughly and which will require close supervision.

GEOLOGY

The geology of the Eldorado orebody has been described by Ivanac (1954) and by F.A. Campbell. It will be repeated here only where it bears directly on the present investigation.

The ironstone orebody is composed of quartz-hematite, is roughly rectangular in plan and strikes slightly south of east. It appears to be decreasing a little in width with depth and the true length has been obscured at the lower levels by faulting (Plate 2). However, the greatest horizontal development appears to be at the surface. The orebody plunges steeply to the north-east and lies on the north limb of an anticline which plunges to the west. The beds of the anticline are considerably contorted, and this may be attributed to disturbances caused during intrusion of the orebody and possibly also to drag folding.

The quartz-hematite body lies in sedimentary rocks which have formed the "crush" zone immediately adjacent to and enveloping the ironstone. This "crush" zone is typical of the Tennant Creek orebodies. It appears to have attained its maximum development in the footwall side of the orebody, i.e. to the south. Some gold has been won from the "crush" zone but most of the gold has been won from the brecciated ironstone itself. This brecciation becomes more extensive in depth but so far has only been encountered on the footwall side of the body and along the Pug Seam Fault (Plate 2). However,

as nothing is known of the north-eastern corner, and very little is known of the eastern and northern limits, of the orebody this restriction may be due only to lack of exploration. It is known that gold was won from the north-eastern portion at the surface. Further, Campbell considers that the north-eastern corner may be a locus of brecciation. However his theories have not been tested, and this remains a speculation.

At least three periods of faulting are represented in the orebody: (a) the Thomas Fault, (b) Fault "A" and the Pug Seam Fault, and (c) the Turner Fault (Plate 2). The Thomas Fault lies along the southern margin of the ironstone and dips to the north at about 70 degrees. In many places it represents the actual footwall of the orebody but in other places it lies within the ironstone. The Thomas Fault has been displaced by two faults which are parallel to each other. They are roughly vertical and strike east of north. Fault "A" is the westerly of the two and is of little importance but the easterly fault, the Pug Seam (Plates 2 and 3), is of major importance. Some very rich concentrations of gold have been found along this fault, which is up to 30 feet wide in places and may have acted either as a channel for the mineralising solutions or as a channel for descending ground water. It is not known whether the gold along the fault plane is primary or secondary. Movement along the Pug Seam Fault has been roughly horizontal and of the order of 70 feet. Both the Pug Seam Fault and Fault "A" terminate below on the Turner Fault which strikes approximately north and whose dip ranges from 12 degrees east to 40 degrees east. The Turner Fault has displaced the lower part of the Eldorado ironstone. The size of the lower part cannot be predicted but on Plate 3 a possible limit to the original body has been indicated.

It is generally held that the Turner Fault is a thrust, in which case the faulted extension of the orebody must be sought to the east, down the dip of the fault. However neither the direction nor the amount of displacement has been proved. Quartz-hematite has been found below the Turner Fault in only one place, at the western end of the 400-foot level. The eastern contact of this body with the sediments lying immediately in the footwall of the fault is indefinite and appears to be a normal contact and not faulted. The western limit of the body was met in diamond drill hole 400-6 and lies about 20 feet to the west of the face of the west drive (Plates 2 and 5). This body will have to be fully explored as it is the only source of potential ore proved below the Turner Fault, and it carries up to an ounce of gold per ton in the face of the west drive.

As the Turner Fault appears to be later than the mineralisation, there is no reason why the extension of the main orebody, when found, should not contain good grade ore, provided that the gold so far encountered is not secondary. Further detailed geological investigations will need to be directed towards two problems: the location of the ironstone below the fault, and the nature of the enrichment of the gold.

Any significant secondary enrichment of gold will have taken place towards the footwall of the orebody, and it is from the footwall that most of the gold has been won. As stated previously some gold has been won from the "crush" zone on the footwall side of the ironstone but most of the gold has come from the ironstone itself.

The richer concentrations of gold are found where the quartz-hematite is brecciated and accompanied by fractures filled with limonitic clay and bismuth carbonate. However, the gold is not confined to these fractures but is also present in the quartz-hematite. A sample from the west face of the main drive on the 400-foot level was split into coarse and fine sections, and each section was assayed. The coarse section, consisting almost entirely of quartz-hematite, assayed 14.3 dwt. per ton.

The fine section assayed 13.0 dwt. per ton. This sample is not conclusive, and further testing will be necessary. However, where less brecciated and blocky quartz-hematite is encountered without the accompanying clay seams in the fractures, the grade is low.

No significant enrichment has been found along the Turner Fault, but some very high assays have been returned from samples taken from the Pug Seam Fault and from the Thomas Fault. Neither of these faults has been properly tested over its known length and depth.

MAGNETIC ANOMALIES

There are five magnetic anomalies within the ground held by Eldorado Tennant Creek Ltd. and four of these have been tested by at least one diamond drill hole. The results have been inconclusive and in at least two cases further work appears to be warranted. At this stage the anomalies cannot be brought into consideration. It will be necessary to rehabilitate the main orebody before further exploration of the anomalies, with possible exception of the No. 2 anomaly, can be considered.

Anomaly No. 2 is thought to represent the faulted continuation of the Eldorado ironstone below the Turner Fault. The anomaly lies north-east of the mine at an estimated depth of 430 feet to 990 feet (Daly, 1957). Diamond drill holes S1 and S2 have been drilled by the company to test this anomaly (Plate 6) but the intersections were made some distance north of the expected position of the anomaly. Daly (1957) considers that the anomaly has not been tested. However diamond drill hole 6 drilled from the 400-foot level intersected an ironstone body north-east of the mine (Plate 6) and although no gold was encountered this body is worthy of further attention.

ORE PROSPECTS

It must be emphasised at the start of this evaluation of ore prospects that, owing to the complete lack of exploration and of penetrative assay data, no estimate of the reserves is justified. Proved and probable ore reserves do not exist, and even possible reserves are distinctly nebulous. The prospects of further ore may be considered under three headings:-

a) Immediate Ore Prospects

This section comprises ore immediately adjacent to the present mine openings. The ore might be blocked out with the minimum of exploration and could be readily available for exploitation. Both F.A. Campbell and J.C. Coldham have made pertinent recommendations in this respect. These recommendations have been examined briefly, and some have been discarded because the removal of ground concerned would be dangerous to surface or underground installations. However, there remains in the ironstone a large tonnage of completely untested material, of which part at least may be considered as potential ore. Four blocks in particular appear to be geologically and structurally favourable. These are:-

1) 100-foot level. At the north-east corner of the mine the Pug Seam Fault is 25 feet wide and has yielded more than the usual number of high assays (Plate 4). From Plate 2 it may be seen that the Pug Seam Fault could continue in ore for perhaps 100 feet to the north and possibly considerably further.

2) 300-foot level. Two diamond drill holes were put into the footwall of the orebody in the East Stope between the 300-foot level and the 400-foot level (Plate 5). Some very high assays were returned. Although the grade in this section

may possibly be very erratic, this footwall section of the lode appears favourable.

3) 400-foot level. No attempt has been made to locate the Pug Seam Fault west of the West Stope at this level (Plate 5). As good grade ore has been associated with this fault throughout the mine, this omission is difficult to understand. Some very good assays have been obtained in the West Stope, and the gold content may increase towards the Pug Seam Fault.

4) 400-foot level. Better than average assays have been obtained in the ironstone body underlying the Turner Fault in the west drive at this level. The extent of this body is unknown. (Plate 5.)

The four blocks listed above might contain up to 40,000 tons of ore about which sufficient is known to justify immediate exploration. In addition there is a large tonnage of material mainly at the eastern and north-eastern end of the ironstone about which nothing is known. Some of the places where testing may be warranted are listed below:-

1) North-east corner at 100-foot level - untested.

2) North-central sector at 100-foot level - untested, but probably poor grade.

3) The hangingwall and footwall of the Central Stope at the 200-foot level.

4) 200-foot level at western end below the Western Lenses. A steep mineralised shear in this vicinity may represent a continuation of the Western Lenses.

5) North and north-eastern sector at 200-foot level - untested.

6) Eastern end at 300-foot level. At the time of suspension of activities this block was being tested by an inclined rise from the East Stope at the 400-foot level but the rise had not then passed through a "horse" of mullock known to be present in this area.

7) Eastern and northern section of 400-foot level - untested.

8) Below 400-foot level and above Turner Fault. A winze to the Turner Fault from the level averaged 10 dwt. per ton for the first 10 feet below the level (Plate 5). The fault was struck at 16 feet in the winze.

Much, if not all, of this is probably low grade but it should be tested before it is discarded. Much of the material listed above can be sampled readily by rock drilling. Campbell has made several recommendations in this respect, and if his recommendations are followed and care is taken with the sampling of the sludge from the drill holes, it should be possible to block out any available ore fairly accurately.

b) Short-Term Ore Prospects

This involves a search for ore below the 400-foot level but sufficiently close to the present mine openings to enable them to be extended to the new ore. This exploration will have to be based on more detailed examination of the geology of the mine. Present evidence indicates two lines of search:-

i) for the limits and extension of the quartz-hematite body lying below the Turner Fault at the western end of the 400-foot level.

ii) for the continuation of the Eldorado ironstone.

c) Long-Term Ore Prospects

None of the magnetic anomalies on the company's holdings have been properly tested, but this work should await the consolidation of ore reserves in the mine. However it is understood that the company intend to explore the No. 5 anomaly by diamond drilling as soon as possible. The Bureau of Mineral Resources geochemical party obtained a strong copper anomaly at the surface in this vicinity in 1957, and this anomaly appears to be the most favourable one for testing.

CONCLUSIONS AND RECOMMENDATIONS

Owing to the lack of information the potential of the Eldorado orebody cannot be properly assessed. Over 200,000 tons of material remain untested in the ironstone of which at least 40,000 tons can be considered as offering an immediate prospect of ore. Much of this is so placed that exploration with rock drills, careful sampling, and correct interpretation of the results could lead to the discovery of a worth-while tonnage of ore of an economic grade.

The eastern, north-eastern, and northern limits of the ironstone are virtually unexplored and should be located. Diamond drilling should obviate the need for expensive and possibly unnecessary development while the examination of the core could give valuable information. The "crush" zone round the walls should not be overlooked; sampling of the drill core should be continued until signs of brecciation of the country rock have disappeared.

It is considered that the two areas most likely to yield payable ore are:-

1) The continuation of the Pug Seam Fault to the north at the 100-foot level and the block of material to the east of this. At this level in the mine the possibility of loss of grade due to the entering of the primary zone can be ignored. The area is readily accessible for exploration from both the 100-foot level and the 200-foot level. A rise from the 200-foot level encountered 22 feet of ore averaging 35 dwt. per ton east of the East Stope (Plate 4).

2) The footwall of the ironstone between the 300-foot level and the 400-foot level above the western end of the 400-foot level (Plate 5). Two diamond drill holes entered the footwall zone in this area and encountered very high but erratic values. This zone appears to be structurally favourable to the deposition of gold and may also be a locus for secondary enrichment.

The ore in the mine is known to be patchy but thorough testing should permit the selective mining of any ore of an economic grade. Testing of each block of the ironstone should be exhaustive, thus obviating unnecessary development and ensuring the proper planning of further openings.

In conclusion, if the mine is to be assisted, all development and exploration should be subjected to competent supervision. The present status of the mine may be summarised:

a) Such a large part of the Eldorado ironstone remains unexplored that it cannot be said that the mine has no potential.

b) Further development will be a waste of time without a fundamental change in the attitude of the company toward the exploitation of the orebody, particularly with regard to exploration.

ACKNOWLEDGMENTS

The very full cooperation received from Mr. H.C. Field, General Manager, and his staff during the investigation of the mine is gratefully acknowledged. Reports by F.A. Campbell, J.C. Coldham, and other consultants to the company were made available.

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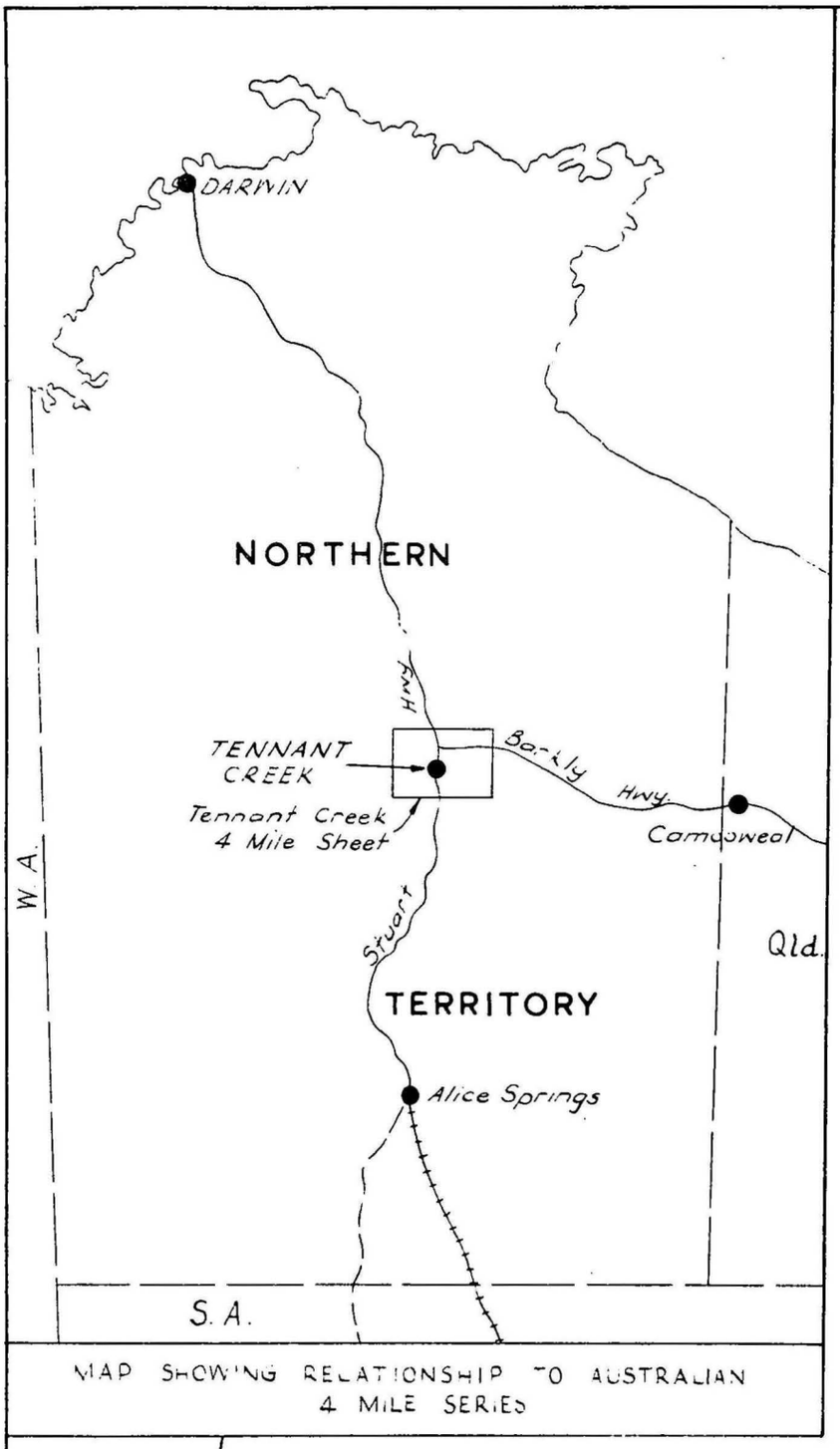
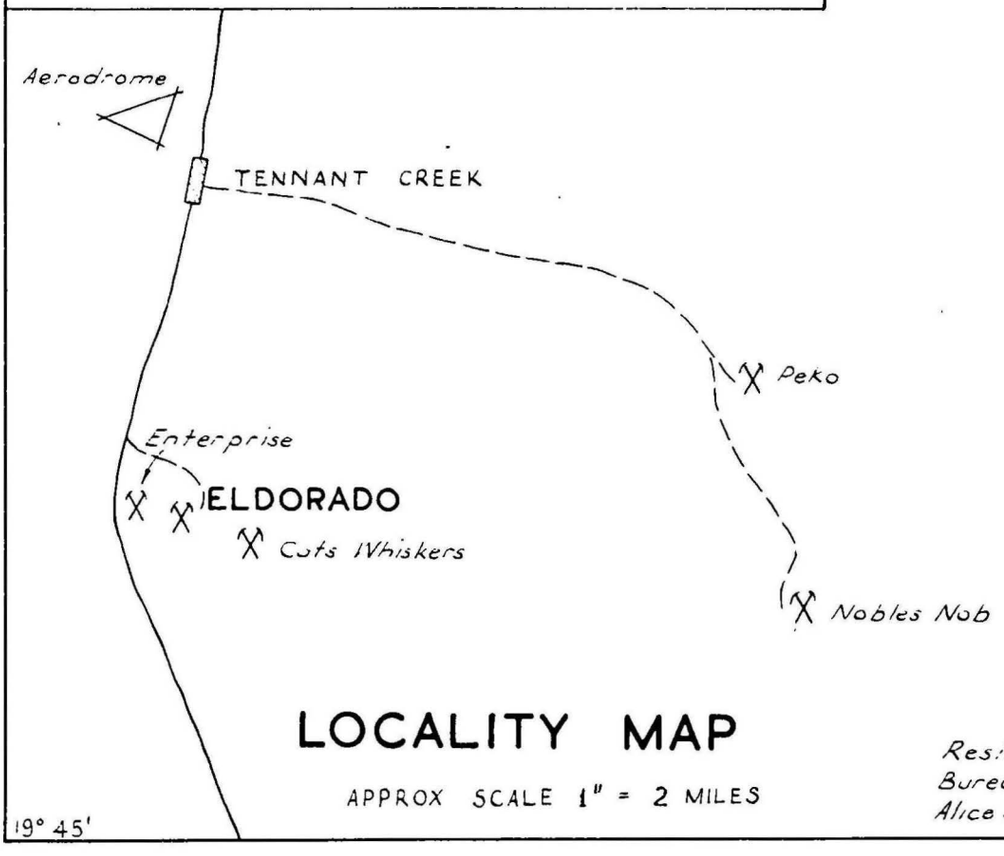
PLATE 1



MAP SHOWING RELATIONSHIP TO AUSTRALIAN 4 MILE SERIES

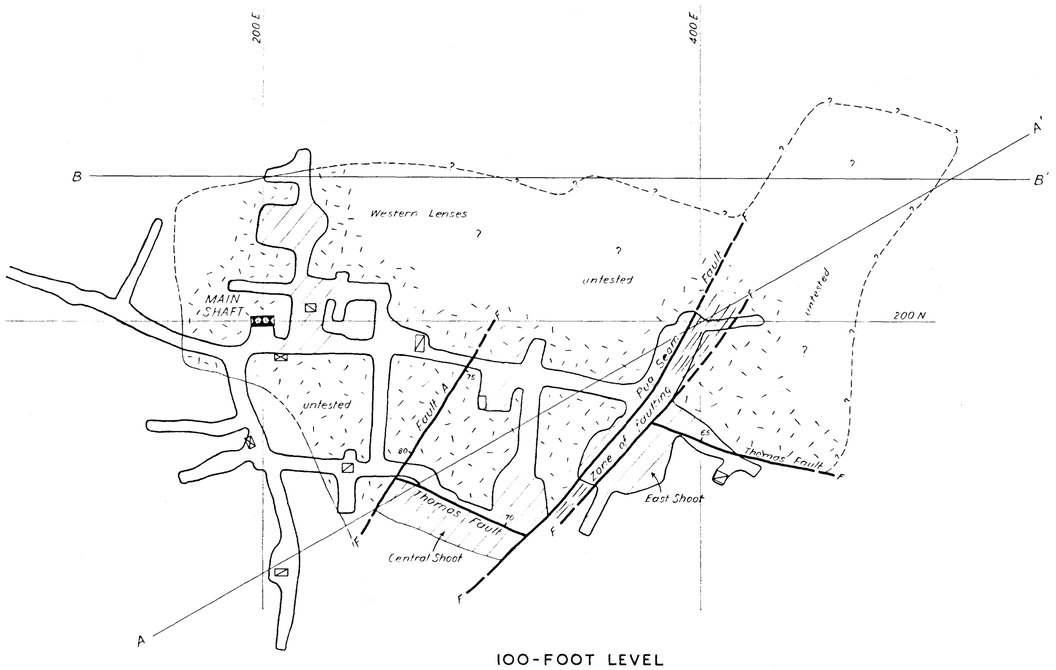


LOCALITY MAP

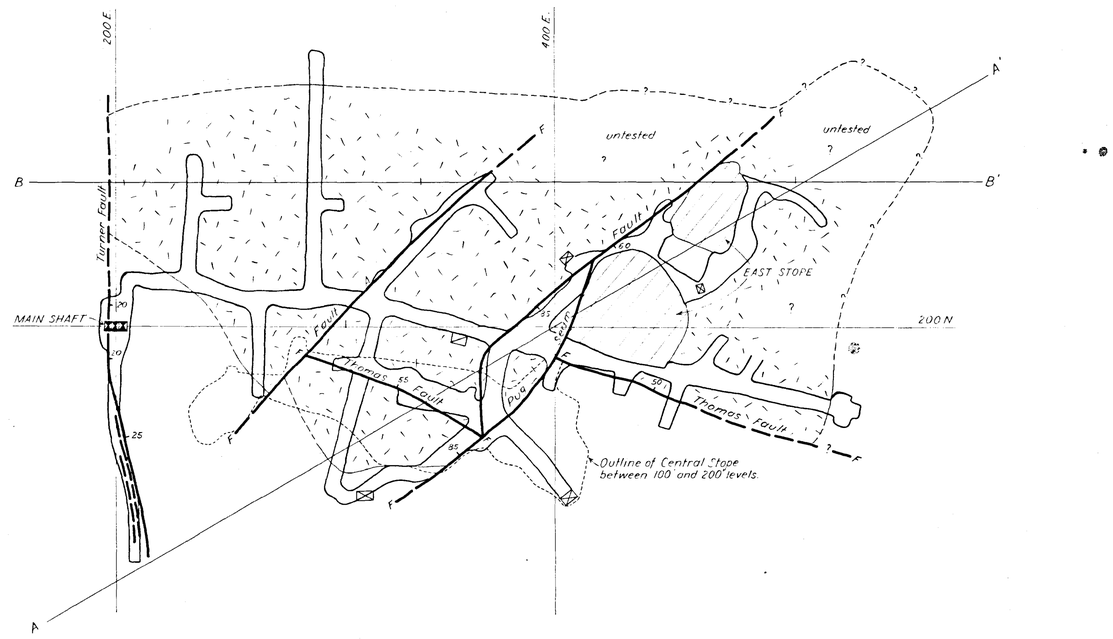
APPROX SCALE 1" = 2 MILES

Resident Geologists' Office
Bureau of Mineral Resources
Alice Springs N.T. July 1958

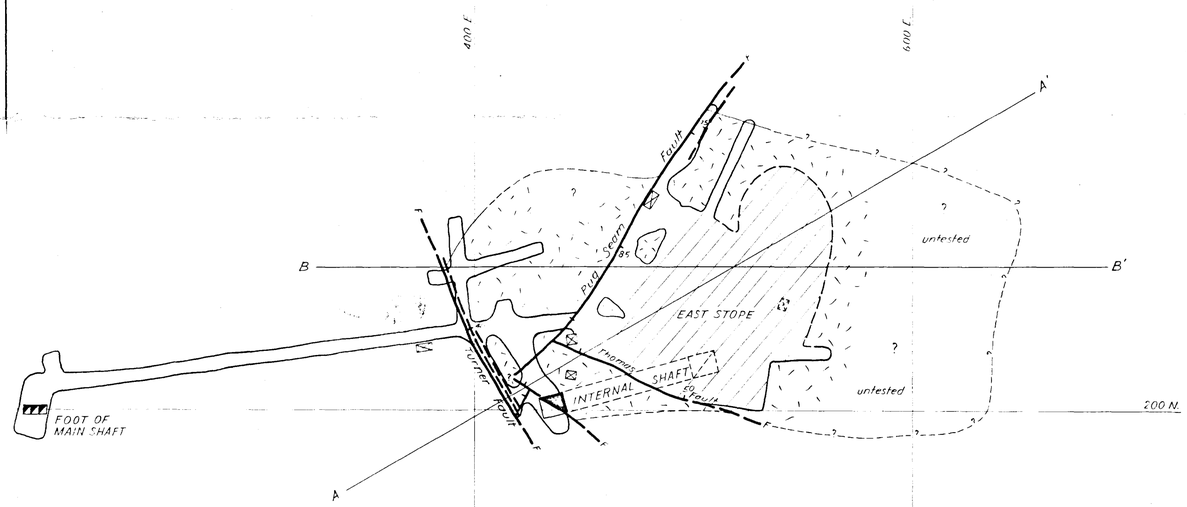
PLATE 2



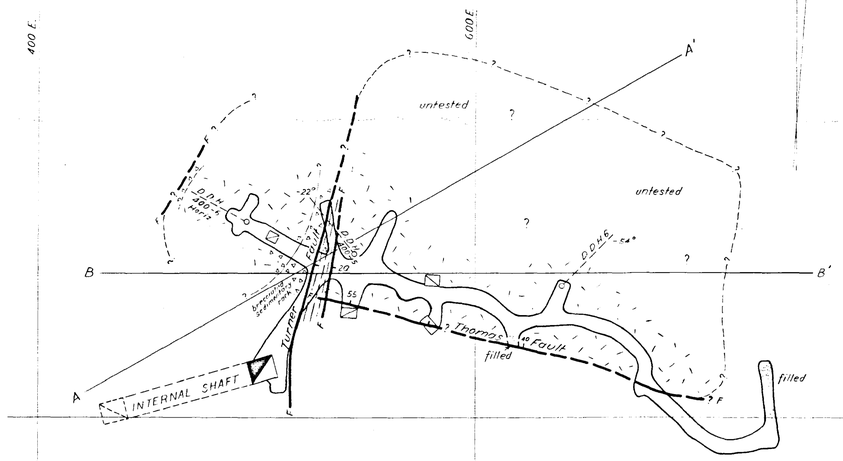
100-FOOT LEVEL



200-FOOT LEVEL



300-FOOT LEVEL



400-FOOT LEVEL

REFERENCE

- Fault - position accurate - with dip
- Fault - position inferred
- Limit of ironstone orebody - position accurate
- Limit of ironstone orebody - position approximate
- Limit of ironstone orebody - position inferred.
- Orebody - quartz hematite and "crush" zone at margins
- Stoped ore
- Underground workings - accurate.
- Underground workings - approximate
- D.D.H. 400'6" -22° Diamond Drill Hole showing collar bearing and angle of depression.
- Main Shaft
- Foot of Main Shaft
- Head of Internal Shaft
- Foot of Internal Shaft
- Head of Rise or Winze
- Foot of Rise or Winze
- Rise or Winze - extending through level
- A—A' Section Line

LEVEL PLANS

ELDORADO MINE

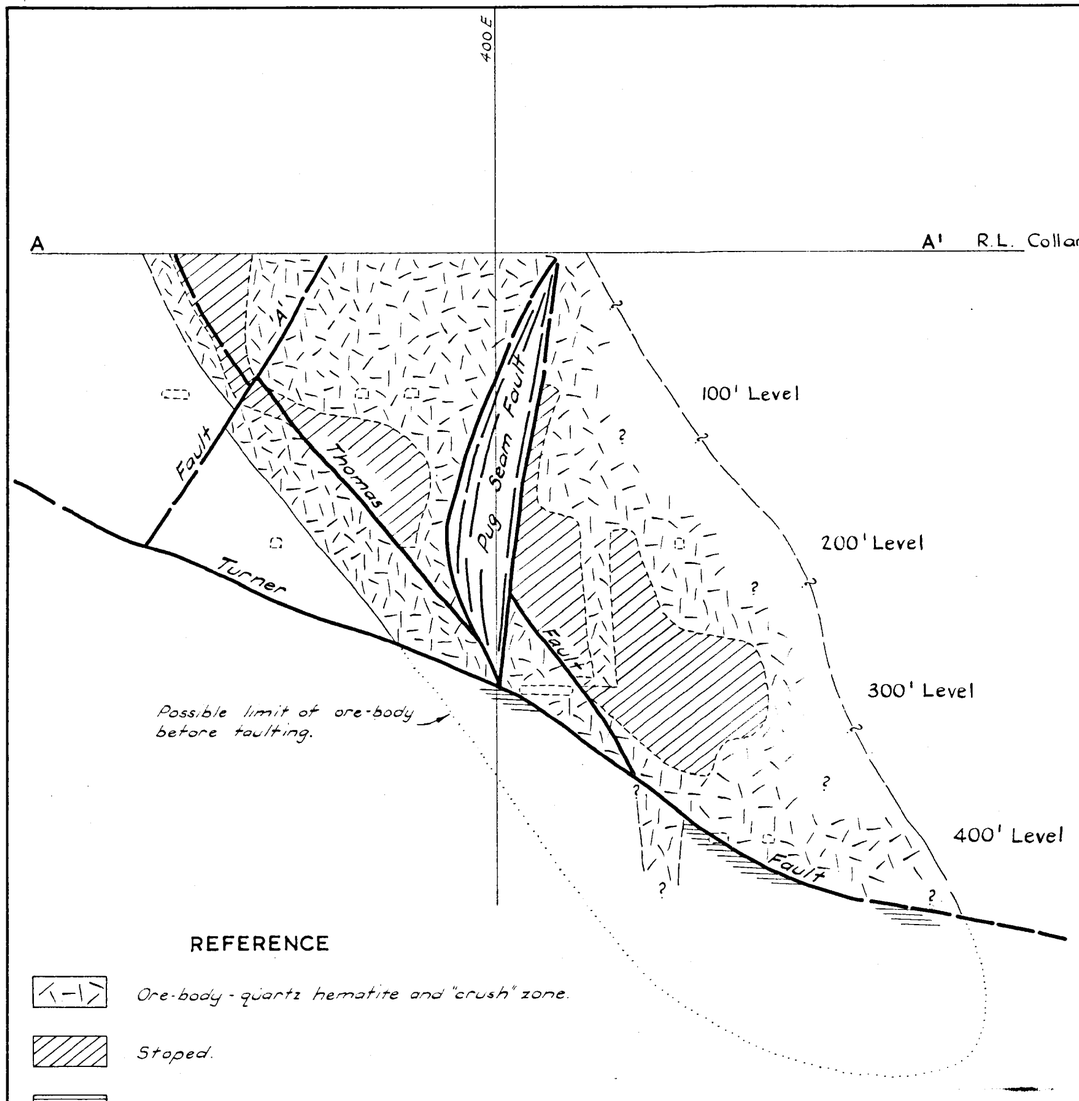
TENNANT CREEK, N.T.

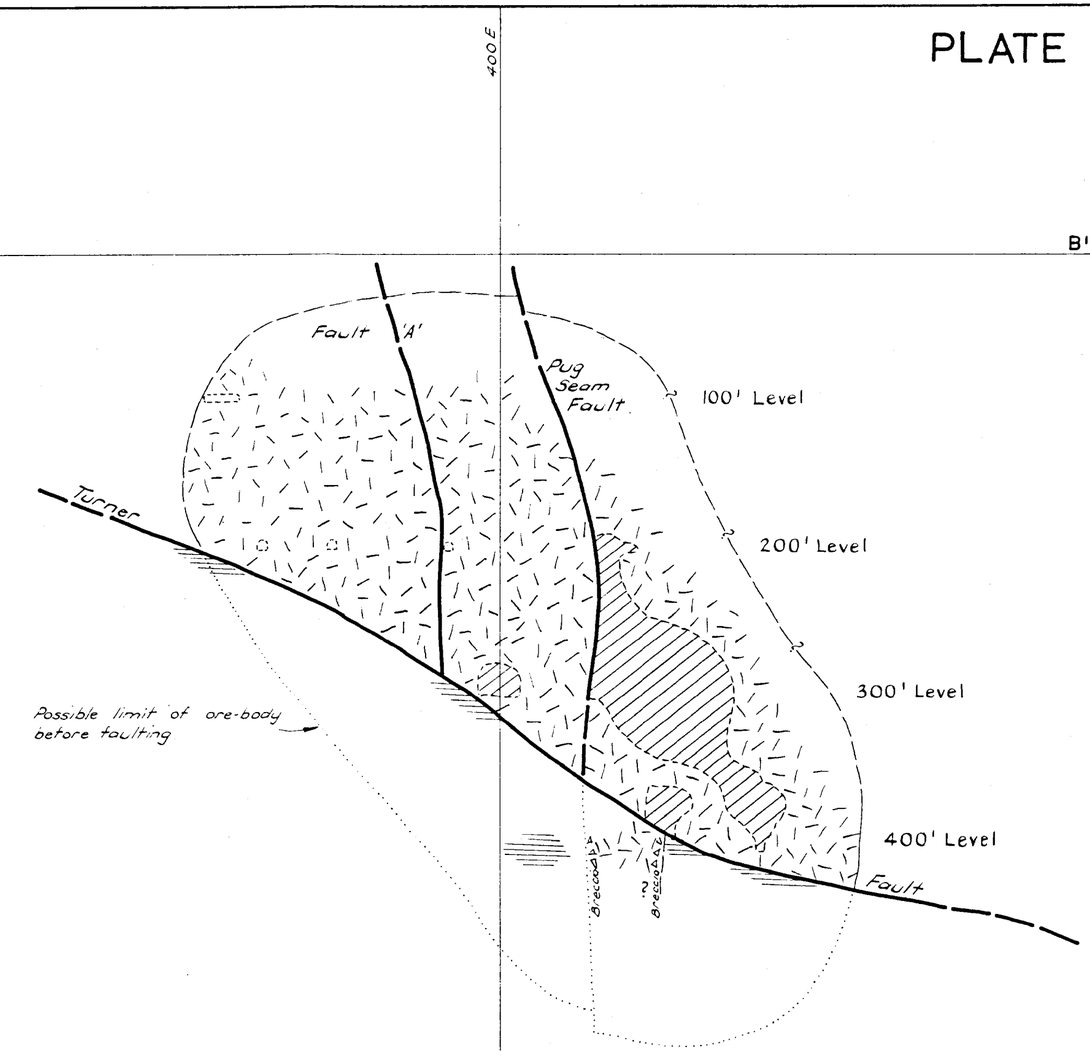
40 0 40 80 FEET

SCALE

Resident Geologist' Office
Bureau of Mineral Resources
Alice Springs, N.T., July 1958

PLATE 3





REFERENCE

- Ore-body - quartz hematite and "crush" zone.
- Stoped.
- Sedimentary rocks proved below Turner Fault.
- Fault
- Boundary of ore-body, position accurate.
- Boundary of ore-body, positions approximate.
- Boundary of ore-body, position inferred.
- Underground Workings

SECTIONS

ELDORADO MINE

TENNANT CREEK, N.T.

80 40 0 80 FEET

SCALE

Resident Geologists Office
Bureau of Mineral Resources
Alice Springs, N.T. July 1958.

PLATE 4

ASSAY PLAN
NORTH EAST CORNER 100 FOOT LEVEL

ELDORADO MINE - TENNANT CREEK, N.T.

0 0 10 20 FEET

SCALE

REFERENCE

- Fault position accurate.
- Fault position approximate.
- 6·6 Workings 100' level showing assay values (dwt/ton)
- Workings 200' level
- 1·0 Rock drill holes showing sludge assay values.
- (5·0) Grab sample from trucks showing assay values
- 1·2 Assay values in backs.

400 E

450 E

Continuation of Pug Seam Fault may be 120' - 150' long.

North-east corner of ore-body untested.

EAST STOPE
200 FT. LEVEL

200 N

22' @ 35 dwt/ton in this Rise

Present face

Previous face

Main East Drive

Limit of Stope 100' level

Pug Seam Fault

Thomas Fault

SOUTH EASTERN STOPE

Not accessible

150 N

50 N

350 E

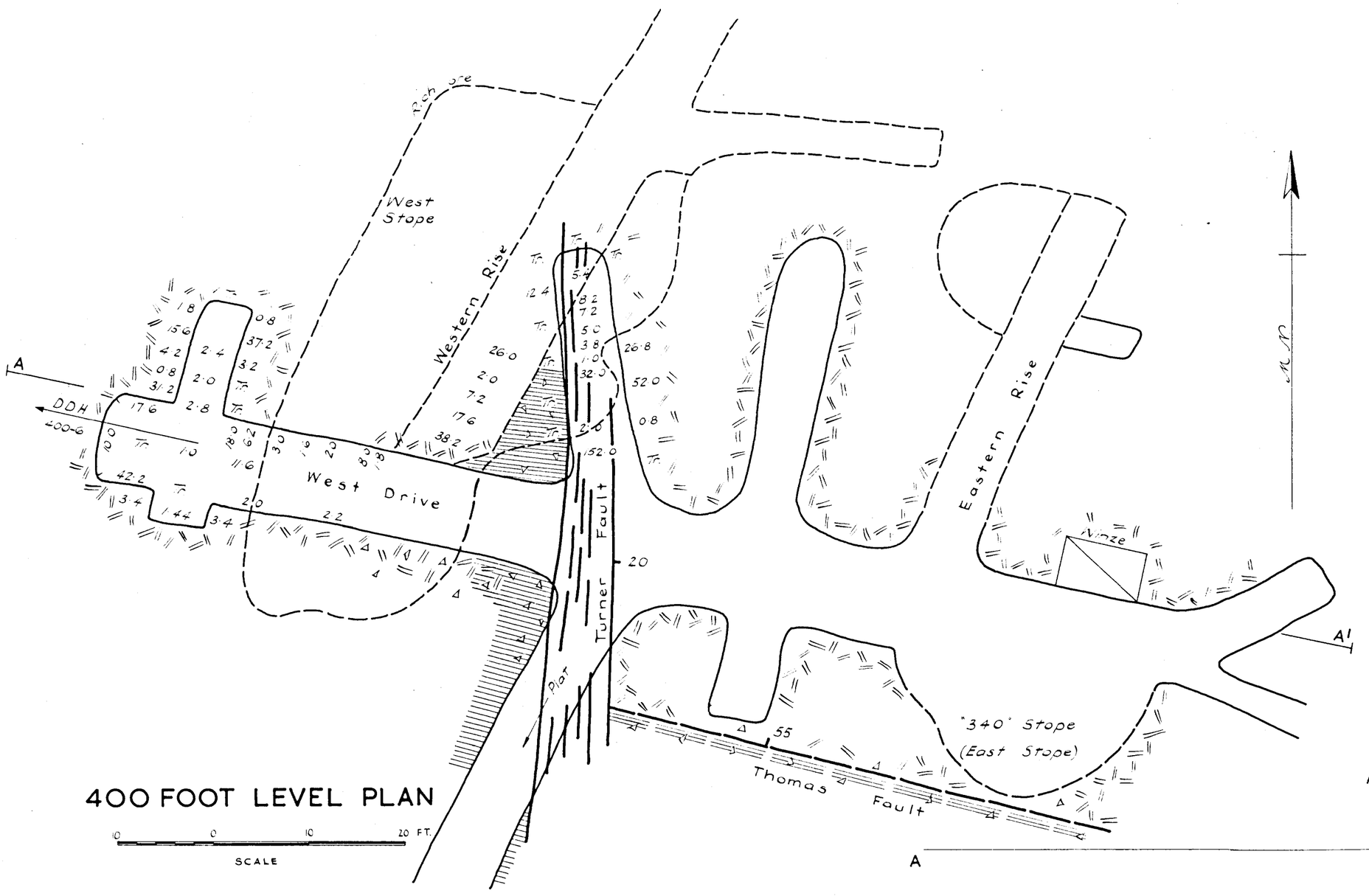
400 E

450 E

Resident Geologists' Office,
Bureau of Mineral Resources,
Alice Springs N.T. July, 1958.

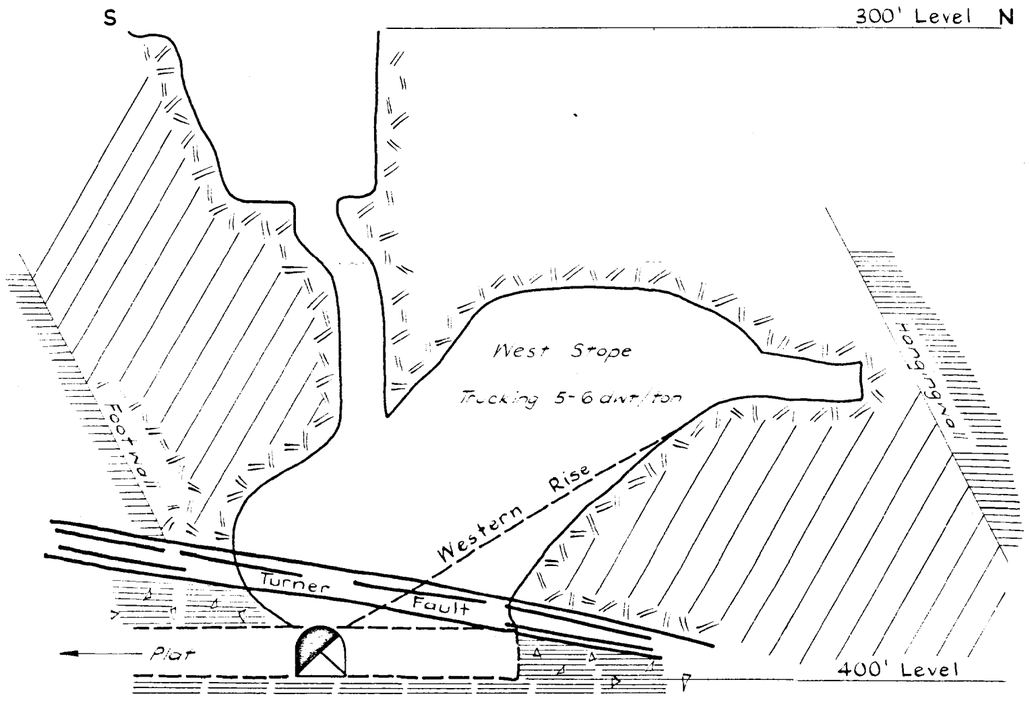
PLATE 5

PLAN AND SECTIONS
WESTERN PART
400 FOOT LEVEL
ELDORADO MINE
TENNANT CREEK, N.T.



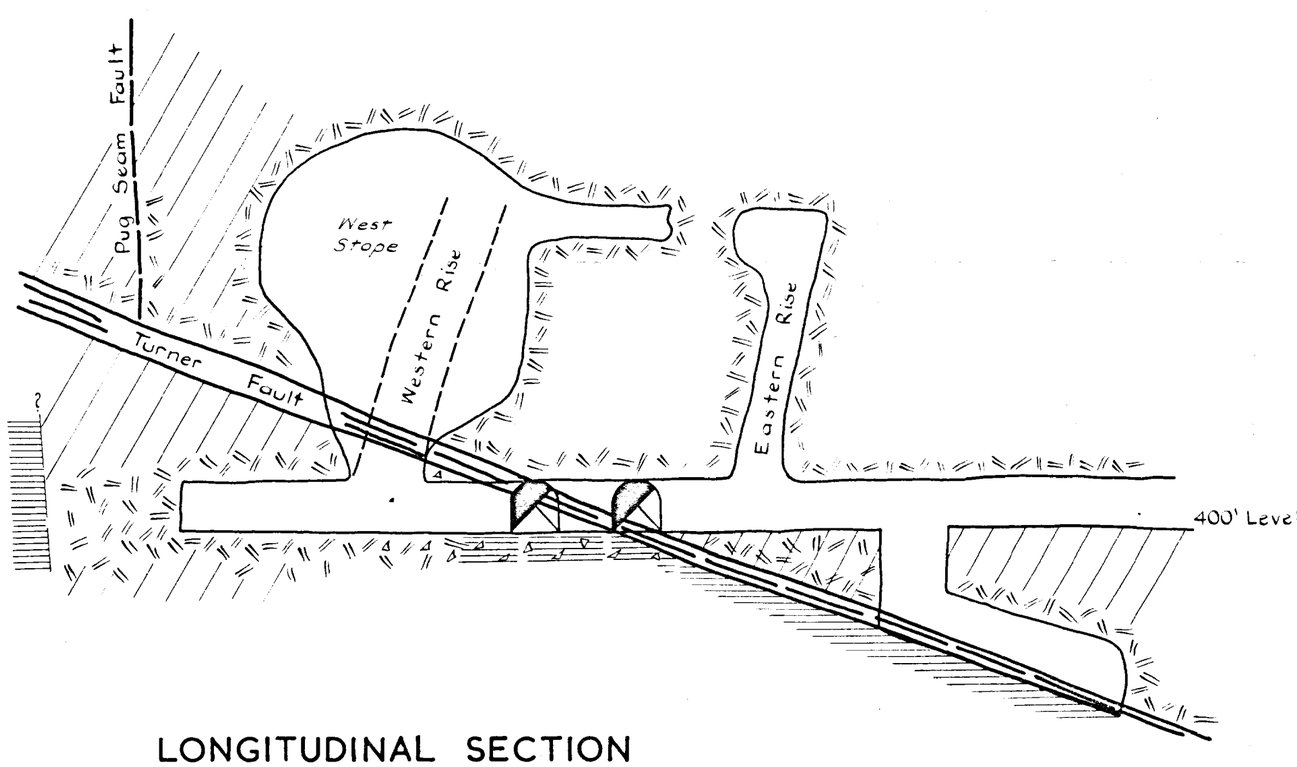
400 FOOT LEVEL PLAN

10 0 10 20 FT.
SCALE



DIAGRAMMATIC CROSS SECTION

20 10 0 20 40 FT.
SCALE



LONGITUDINAL SECTION

20 10 0 10 20 FT.
SCALE

REFERENCE

- Quartz - hematite
- Breccia
- Sedimentary rocks
- Fault - position accurate - with dip
- Fault - position inferred
- Areas of potential ore
- Workings
- Workings projected
- Cross-section of cross-cut or drive extending across plane of section
- 72 — Assay value (oz/ton)
- A — Section line

Resident Geologists' Office
Bureau of Mineral Resources,
Alice Springs, N.T. July, 1958.

PLATE 6

PLAN

RELATIONSHIP OF ELDORADO IRONSTONE TO IRONSTONE BODIES REVEALED BY DIAMOND DRILLING

ELDORADO MINE
TENNANT CREEK, N.T.

REFERENCE

- Hematite
- Magnetite
- Breccia
- Sedimentary rock (sometimes brecciated with hematite, magnetite and quartz veins)
- DDH6 −30° — Diamond drill hole showing collar bearing and depression. (RL-490)
- 400' — Magnetic intensity contour showing strength.

Plotted from surv by F.A. Campbell in report on Eldorado Mine, 30-4-57

40 20 0 40 80 FEET

SCALE

TURNER FAULT

Eldorado Ironstone at 400' Level.

Contact 400' Level

Contact 300' Level

Contact 200' Level

DDH 6 −54°

RL-550'

No values found

TURNER FAULT

RL-432'

RL-539'

Eldorado Ironstone at RL-550'

No values found

Contact 550'

DDH 4 −50°

RL-591

No values found

DDH 3 −30°

No values found

RL-534'

RL-597'

400 X

200 N

935 E

DDH S1

DDH S2

RL+17

RL-555

RL-564

RL-547'

hematite

RL-620'

hematite

Contact

+W. of RL-550'

RL-697'

hematite

RL-792'

RL-550'

400 X

Assays up to 4% tin from 500'-600', surface free

No 2 ANOMALY

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