Chief Geologist

COMMONWEALTH OF AUSTRALIA

MINISTRY OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

Report No. 6

GEOLOGY OF NEW OCCIDENTAL, NEW COBAR AND CHESNEY MINES, COBAR, NEW SOUTH WALES

By

C. J. SULLIVAN

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Issued Under The Authority Of Senator the Hon. W. H. Spooner,
Minister For National Development
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LIST OF REPORTS

1. Preliminary Report on the Geophysical Survey of the Collie Coal Basin - N.G Chamberlain, 1948.

2. Observations on the Stratigraphy and Palaeontology of Devonian, Western Portion of Kimberley Division, Western Australia - Curt Teichert, 1949.

3. Preliminary Report on Geology and Coal Resources of Oaklands - Coorabin Coalfield New South Wales - E. K. Sturmfels, 1950.

4. Geology of the Nerrima Dome, Kimberley Division, Western Australia - D. J. Guppy J. O. Cuthbert and A. W. Lindner, 1950.

5. Observations of Terrestrial Magnetism at Heard, Kergeulen and Macquarie Islands 1947-1948. (Carried out in co-operation with the Australian National Researcl Expedition, 1947-48) — N. G. Chamberlain, 1952.

6. Geology of New Occidental, New Cobar and Chesney Mines, Cobar, New Soutl Wales - C. J. Sullivan, 1951.

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Ministry Of National Development

Minister - Senator the Hon. W. H. Spooner

Secretary - H. G. Raggatt

Bureau Of Mineral Resources, Geology And Geophysics

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C O N T E N T S

C O N T E N T S (Cont'd)

A P P E N D I C E S

1. Plans prepared and available for examination but not published in Report
2. Petrology of rocks in the neighbourhood of New Cobar Mine. W.B. Dallwitz.
3. Mineragraphic investigations of ore-specimens from New Cobar Mine. C.S.I.R.O. Report 328, by F.L. Stillwell.
4. Tables showing production of mines in Cobar district, not described in text.

(Appendices 2–4:) At back of Report

I L L U S T R A T I O N S

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* In addition to the plans published with this Report, a number of other plans accompanied the original typescript report. These plans may be examined at the Bureau of Mineral Resources in Canberra and Melbourne, at the New South Wales Mines Department in Sydney, and at the offices of the New Occidental Gold Mines Limited, Cobar. The unpublished plans are listed in Appendix 1.

TABLES

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

The Cobar mining field was examined by geologists of the Bureau in collaboration with geologists of the Department of Mines, New South Wales, between August 1946 and June 1947.

Attention was concentrated on the operating mines - New Occidental, New Cobar and Chesney - all of which are owned and operated by New Occidental Gold Mines N.L.

At the conclusion of this work a typewritten report (No.1947/74) accompanied by 68 plans was issued to the operating company and to other interested parties. Since then the Bureau has carried out some additional studies of the Cobar mining field, and has also extended its work to include the Cobar-Nymagee metalliferous province as a whole. As the Cobar-Nymagee investigation is still in progress the present report is confined mainly to a description of the Cobar mines.

It had previously been realized that the New Occidental, New Cobar, and Chesney orebodies lay close to a sharp contact between fine-grained and coarse-grained sediments. The contact had been interpreted (i) as a fault, and (ii) as a sheared limb of an overturned fold. The writer considers that the feature is a discordant contact of regional character - probably a fault, or a series of faults, occurring a little to the west of the axis of an anticlinal fold. The contact has been folded, probably during the formation of the lode shears; the contact is itself an ore-channel, and has localized later shear-zones of small displacement in which the present orebodies have been deposited.

The folded portions of the contact are of particular interest because most of the orebodies occur in the vicinity of these folds. This is believed to result from the development by fracturing of openings favourable for ore-localization concurrently with the folding of the contact. The regional examination indicates also that these minor anticlinal cross-folds have a basic genetic significance in that they may overlie small, cupola-like projections in an underlying, more or less concordant, granitic mass.

The discordant, ore-bearing contact has been traced to 25 miles south of Cobar and part of it has been investigated with a magnetometer. To date one interesting magnetic anomaly associated with an anticlinal pitch-change has been found, and the site is to be drilled. Much work along these lines remains to be done, but the Bureau, in conjunction with Enterprise Exploration Limited, is pushing ahead rapidly with the investigation. In this work the relationship between ore occurrence, the discordant contact, and the folds in that contact are being given special attention. The results of geophysical work and diamond drilling have been described in

Geophysical Progress Reports of which the latest are No.1948/43 and 1948/72.

It is believed that there are only moderate chances of finding complete repetitions of either the New Cobar or Chesney deposits, although the existence of additional shoots related to the known orebodies is a distinct possibility. At the New Occidental mine the chances of making a major discovery are somewhat greater; perhaps the most promising locality is that within 600 feet of the present most northerly workings where an extension of the main lode may occur. This could be cheaply tested at No. 6 level and No. 11 level.

Prospecting for lateral extensions of known deposits has been neglected at Cobar, although such possibilities would have been eagerly tested elsewhere in Australia.

In Report No.1947/74 the following exploration was outlined for the three deposits examined:-

Mine	No. of d.d.h.	Total length (feet)	Remarks
New Occidental	8	1845 (910 ft. of drilling could be replaced by 300-400 ft. driving plus lateral drilling in No.11 level).	Horizontal drilling to test, at Nos. 6 and 11 levels, possibility of ore occurrence north of present lode, and to test carbonate-lead-zinc lode at Nos. 6 and 7 levels.
New Cobar	10	1760	Horizontal drilling to test for ore south of Western orebody, for possible occurrences related to contact north-east of deposit and for ore in walls of main lode. Structural information would also be obtained.
Chesney	Normal development programme recommended but no special drilling envisaged. Localities are suggested in which it is thought additional small shoots may be discovered.		

Owing partly to shortage of manpower, mining of the New Cobar deposit ceased in March 1948. Prior to this some drilling, as recommended, was carried out to test the ground south of the Western orebody; mineralized ground was intersected, but no payable ore was revealed.

At the New Occidental mine, No. 13 level main drive was extended 175 feet north of the northern end of the main orebody. The first 50 feet of the drive cut across the lode-channel at a slight angle and revealed material assaying 0.2 dwt. to 4.5 dwt. of gold per ton. The remaining 125 feet of the drive was in country east of the lode-channel. When this was noted, a hole was drilled west of the drive at 872N which intersected sulphide mineralization over a width of 20 feet, of which one 5-foot section contained 4.4 dwt. of gold per ton. The possibility thus remains that easily accessible payable ore exists north of the lode that is being exploited, and above the present developed levels. This possibility should be tested.

The Peaks area was not examined in detail during the 1946-47 investigation upon which the present report is largely based. Since that time it has been found that the Peaks lode-system is associated with folds in the contact and that, structurally, the area is one of great interest. Geophysical work was recommended, and marked anomalies were found by magnetic, self-potential and gravimetric methods. Initial drilling of the magnetic anomaly at shallow depths revealed unpayable but interesting pyrite-pyrrhotite-gold mineralization over a width exceeding 200 feet. Further testing by drilling is necessary and is now proceeding. It has been suggested, however (Sullivan, 1949), that the Peaks area is essentially one of low-temperature mineralization, and that large-scale copper-pyrrhotite deposits may not occur within depths from the surface that would permit economic mining. The geophysical work is described in Geophysical Progress Report No. 1948/43.

As a result of the 1946-47 examination of the field, a close relationship between ore occurrence and geological structure was noted, and extensive prospecting by geological, geophysical and diamond-drilling methods was recommended. The Bureau, in conjunction with Enterprise Exploration Limited, is now carrying out this work. To date several promising geophysical anomalies have been located. Drilling of the Dapville anomaly outlined a shoot of payable ore, and other drilling is now being vigorously prosecuted.

A joint bulletin on recent investigations in the Cobar-Nymagee district will be published by the New South Wales Mines Department, Enterprise Exploration Limited, North Broken Hill Limited and the Bureau of Mineral Resources.

INTRODUCTION

Many aspects of the Cobar mineral field have been described with considerable accuracy and detail by E.C. Andrews (1911). This report contains a penetrating study of the field, and the conclusions reached have, in general, survived a good deal of searching criticism and re-examination. The reader requiring details of the history, climate and general geology of the field is referred to Andrews' report.

The geological examination dealt with in this report was carried out in collaboration with the Geological Survey, Mines Department, New South Wales. Most of the surface mapping, together with some underground mapping, was performed by C. St.J. Mulholland and E.O. Rayner of the Mines Department, who were on the field from mid-August 1946 to early October 1946. Officers of the Bureau of Mineral Resources carried out the more detailed underground mapping. The following periods were spent at Cobar by members of the geological staff of the Bureau:-

C.J. Sullivan,	14th August 1946 to 12th December 1946;
K.R. Fleischman,	October 1946 to December 1946, and March 1947 to June 1947;
J.F. Ivanac,	April 1947 to June 1947;
W.B. Dallwitz,	24th March to 14th April 1947.

Further local and regional mapping was carried out by the Bureau during 1947 and 1948.

Mulholland and Rayner (1947) have described the area in an unpublished report.

A preliminary magnetic survey of part of the field was carried out by the Geophysical Section of the Bureau during the first half of 1947 and, since then, the Bureau and Enterprise Exploration Limited have made extensive geophysical studies.

Messrs. Dallwitz, Fleischman and Ivanac made a special study of the New Cobar mine and the plans of that deposit and the report on it are largely their work. Mr. Dallwitz contributed very considerably to the report in general. Mr. A.E. Crisp has been most helpful as photographer.

The ready co-operation of the Department of Mines, New South Wales, and the assistance of the staff of New Occidental Gold Mines N.L. are greatly appreciated.

SITUATION

Cobar is situated 464 miles by rail west-north-west of Sydney, at the end of a branch line from Nyngan on the Sydney-Bourke railway, and is connected with Broken Hill by a formed gravel motor road, 260 miles long (Plate 1).

Nearly all stores and equipment are brought from Sydney, and flotation concentrates are sent by rail for treatment at Port Kembla.

CLIMATE - TOPOGRAPHY

Cobar is situated in semi-arid sheep-grazing country. Summer temperatures are high. The average rainfall is approximately 15 inches per year, a considerable proportion of which is derived from summer storms. Dust storms are frequent.

Water supply is a major problem. Water for domestic purposes is obtained from earth tanks or dams, and it frequently contains a high percentage of suspended clay. Mine water is used for treatment purposes.

The area is one of very low relief. It is broadly a plain - at Cobar only 800 feet above sea level - with some low ridges composed of the more resistant rocks.

HISTORY

The history of the Cobar mining field until 1911 is given in considerable detail by Andrews (1911), and the details of production are best seen in the tables accompanying his report.

The Great Cobar deposit was discovered in 1869, the Occidental and C.S.A. in 1871, and the New Cobar and Peaks in 1887. Mining was begun in 1871. Until 1875 ore was shipped to South Australia where several copper mines were operating, but in that year the first smelters were erected in Cobar. The Great Cobar Copper-Mining Company Limited, with a capital of £80,000, was formed in 1876.

Mining was suspended in 1889 because of the low price of copper and the high cost of transport. However, the railway to Cobar was completed in 1891 and this affected mining costs very favourably.

In 1906 the Great Cobar property was purchased by an English company - The Great Cobar Limited - for £804,000 cash. At this time there were 1,350 miners employed in the field, including those employed at the Occidental, Chesney and Fort Bourke (New Cobar) mines.

Until the end of 1911, total production from the field was reported to have been:

Copper	95,000 tons
Gold	460,000 ounces
Silver	1,180,300 ounces

A steady production was maintained until 1914, when the Great Cobar group (Great Cobar, Chesney, Fort Bourke and Peaks) closed down, partly on account of war conditions. Government finance was made available for the re-organization of the smelters on the Great Cobar mine which re-commenced operations early in 1916 and continued throughout the remainder of the war. In 1919, however, the price of copper fell, and the mines operated by Great Cobar group again closed down. The C.S.A. mine closed in 1920 and since then no copper-smelting has been done at Cobar.

The Occidental mine produced intermittently until 1920 and then closed down. From 1921 to 1930, inclusive, mining at Cobar virtually ceased. The population of Cobar, previously several thousand, dwindled to approximately 700.

Mulholland and Rayner describe the subsequent history as follows:

"In 1930 the price of gold rose rapidly, and New Occidental Limited was formed to test the Occidental Mine. In 1931 this company went into liquidation and a new company with more capital - New Occidental Gold Mines N.L. - was formed to operate the mine.

"Production commenced in 1935. In the previous year New Cobar Gold Mines N.L. had been formed to work the Cobar Gold Mine, but in 1935 this company was absorbed in New Occidental Gold Mines N.L., and the mill at New Occidental was re-organized with a flotation section to take the cupriferous sulphides of the New Cobar Mine. In 1937 the Chesney Mine was acquired by the New Occidental Company. In this year G. Wright commenced mining the oxidized cap of the middle lens of the Great Cobar Lode and produced some very rich gold ore. In 1940 operations on this area were carried out by Great Western Mines Pty. Ltd.

"Despite the outbreak of World War II in 1939, production and development continued at a normal rate until 1942. After this year, owing to shortages of manpower and to restrictions of gold-mining, development at the Occidental Mine was curtailed, and attention was paid to production from New Cobar and Chesney Mines. Production from the Chesney Mines commenced in 1943 and continued until 1945, and the mine was opened again in 1946. Development work and production have been resumed at the Occidental Mine, but shortage of manpower has been an obstacle to carrying out full-scale operations.

"Since 1911, the Cobar Mines have produced more than 33,000 tons of copper, 570,000 ounces of gold, and 780,000 ounces of silver, valued at more than £7,000,000 of which over £4,000,000 is the value of products from New Occidental Gold Mines."

In March 1948, the New Cobar mine was closed because of shortage of labour. Late in 1948 the company was experiencing difficulties because costs rose whereas the price of gold remained fixed.

From 1935 to May 1946 the company paid £738,110 in dividends on a capital of £303,750.

Table 1 shows the total recorded value of production from the Cobar field from 1871 to 30th May 1948.

TABLE 1.

Value of Recorded Production from Cobar Field, 1871-30th May 1948.

Year	£	Year	£
1871-1896	917,180 +	1922	---
1897	108,306	1923	---
1898	178,900	1924	---
1899	265,580	1925	1,692
1900	292,070	1926	493
1901	343,249	1927	240
1902	224,699	1928	59
1903	492,686	1929	---
1904	503,756	1930	215
1905	688,642	1931	157
1906	767,822	1932	140
1907	718,199	1933	42
1908	628,976	1934	29
1909	505,936	1935	101,242 ≠
1910	552,049	1936	229,065 ≠
1911	647,353	1937	284,807
1912	746,083	1938	415,926
1913	694,864	1939	473,828
1914	326,367	1940	548,905
1915	301,810	1941	543,978
1916	629,148	1942	532,010
1917	608,084	1943	541,254
1918	648,470	1944	561,950
1919	161,889	1945	288,802
1920	138,270	1946	353,004
1921	---	1947/48 (to 30th May)	247,055
		Total	£17,215,281

+ Incomplete.

≠ Estimated Australian Value.

Available records show that the field has probably produced, to the end of 1946, 130,000 tons of copper, 1,000,000 oz. of gold, and 1,900,000 oz. of silver. At current Australian prices this production would be valued at approximately £A31,000,000.

MAPPING METHODS - CO-ORDINATE SYSTEM

The mineralized belt extending from Spains Tank to the New Occidental mine, a distance of 1,500 feet, was mapped on a scale of 100 feet to one inch. Accessible parts of each level of the New Cobar, Chesney and New Occidental mines were mapped on a scale of 40 feet to one inch, and all available assay and diamond-drilling information was assembled and studied.

The surface was mapped by establishing a pegged grid, the area between the pegs being mapped by plane table or by chain and compass.

The underground mapping was based on mine survey plans, geological features being plotted as mapped. The marking of boundaries between the finer-grained rocks was found to be difficult, particularly at New Cobar where numerous specimens were collected and studied under the microscope for the purpose of checking the mapping. Bedding in the finer-grained rocks is in general totally obscured by cleavage, and this adds to the difficulty in distinguishing between rock-types.

The origin of the co-ordinate system used in the surface mapping by Mulholland and Rayner is situated 350 feet south-east of the New Occidental shaft, and the meridians are true north and south.

STRUCTURAL GEOLOGY

The general geological setting of the deposits is illustrated in Plate 2, Sheets 1-4, by Mulholland and Rayner (included in this report), by the surface plan of the New Cobar deposit (Plate 6), and by the geological maps of the Cobar Mining Field by E.C. Andrews.

The orebodies occur in a series of shear zones, which normally strike north-north-west and are vertical or dip east at angles of 80 to 85 degrees. The Occidental-Chesney shear is situated at a contact between coarse and fine rocks, and the New Cobar shear is very close to this contact. Mapping by the Bureau indicates that the association of ore with the contact continues at least as far south as Nurri Trig Station, a distance of 20 miles, and that the contact lies a little to the west of an anticlinal axis.

The contact is thus an important feature and warrants careful consideration. Much attention has been devoted to this problem and, during the course of the examination, several hypotheses have been considered.

Changes in emphasis and points of view may be detected on some of the plans, particularly those of New Occidental. The features that control ore-deposition on any field are often obscure, and perhaps this is more so at Cobar than normally. It is believed that only by detailed and continuous study can an accurate knowledge of these features be obtained. As shown on the surface plans, the strike of the bedding of the coarse rock is rarely parallel to the contact, and the mapping of the New Occidental and Chesney mines indicates that, in section also, the hangingwall (coarse) rock dips consistently west into the easterly-dipping contact for depths measured in thousands of feet.

It has generally been concluded by previous workers that the Occidental-Chesney line of lode fills one fault which has caused the discordance noted, and that the New Occidental line of lode fills a second fault,occurring en echelon, north and west of the New Occidental-Chesney fault. There are, however, serious objections to this interpretation. The Occidental-Chesney shear dies out quite rapidly at about 8,700N (Plate 2, Sheet 2) although, at the Chesney mine, the vertical displacement on the contact is known to exceed 1,000 feet and is probably much greater. Detailed mapping by W.B. Dallwitz suggests that from 8,300N to 8,500N (see surface plan of Cobar mine, Plate 6) the silicified zone marking the Occidental-Chesney shear remains only approximately at the contact and that, in some places, sandy tuff is found west of the lode-channel. The main Chesney lode is not at the contact, and the New Cobar lode shear is also some distance west of it. Also, the character of the north-westerly trending contact extending from 8,500N to 9,000N (Plate 6) is of critical importance. If the Occidental-Chesney and New Cobar shears are en echelon faults, and the observed discordance along the contacts near which they occur is due to them, then the portion of the contact between them (8,500N to 9,000N) should be a normal bedding contact, dipping south with the dip of the bedding in the sandy tuffs. Exploration at Nos. 7, 8 and 9 levels (including d.d.h. 81A) indicates, however, that this contact dips north-east and that the nose of the fold in the contact at 9,000N, 2,860W pitches north. In fact, this portion of the contact is strictly comparable to that marked by the folded surface whereas the latter approximates to a plane surface, e.g., both are markedly discordant with the coarse tuff in the hangingwall.

Attempts have been made to explain the apparent displacement at the contact by assuming that in the vicinity of the contact there has been a local overturning of the folding to the east and that, in effect, the shear-zones at and near the contact are elongated folds accompanied by great thinning of the beds along the limbs. The bedding in both hangingwall and footwall is assumed to be parallel, or nearly parallel, to the contact. In this way the conception of a large displacement is avoided. In the vicinity of orebodies, folds in bedding in both hangingwall and footwall rocks are assumed to pitch north with the orebodies. However, in mapping the mines from level to level it is not possible to avoid the conclusion that the hangingwall sandy tuff, (in which bedding planes are clearly apparent) consistently dips and strikes at a considerable angle to the contact. Although it shows the effect of drag, especially where a lode exists along the contact, in no place does it become parallel in dip and strike to the contact. Workings and diamond-drilling results at New Occidental show clearly that the lode cuts across the direction of the dip of the hangingwall tuff for a distance of 3,000 feet vertically, representing a true thickness of perhaps 2,000 feet of sandy tuff.

In discussing this folding hypothesis, there has been a tendency to speak of the pitch of orebodies, bedding planes, folds in the contact, and mineral-grain elongation or lineation as though they were synonymous. The lineation in the shear zones at Cobar pitches north at approximately 80 degrees, that is, parallel to the striae on the walls of the lodes and, presumably, parallel to the direction of movement within the shear zones. The lineation is not related to the pitch of bedding although, in folded rocks as distinct from shear zones, it does normally lie parallel to the pitch of the folds.

This is illustrated by Figure 1 which is a photograph of a specimen from the New Occidental open-cut showing a fine-grained tuff with an interbedded coarser band. The observer is looking south. The bedding dips west and pitches south across the cleavage plane shown in the lower right of

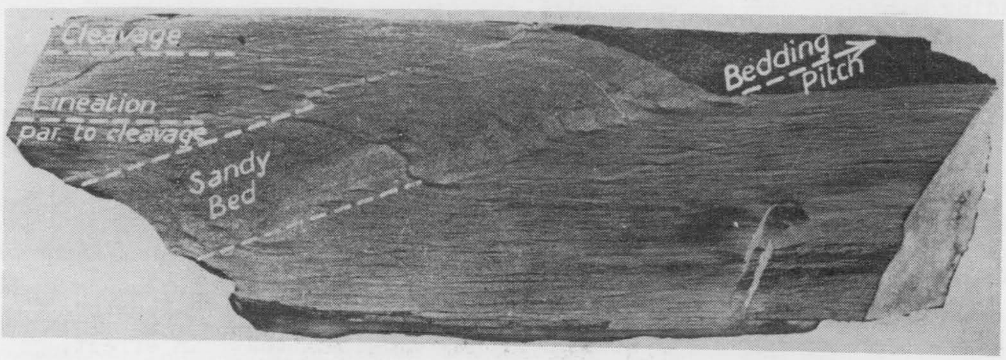

Figure 1. Photograph showing relation of cleavage, mineral-grain elongation and bedding.

the photograph. The cleavage dips at 85 degrees east. The mineral-grain elongation is in the plane of the cleavage and pitches steeply towards the observer. The cleavage is strongly developed in the fine-grained rock and is much less pronounced in the coarser-grained rock.

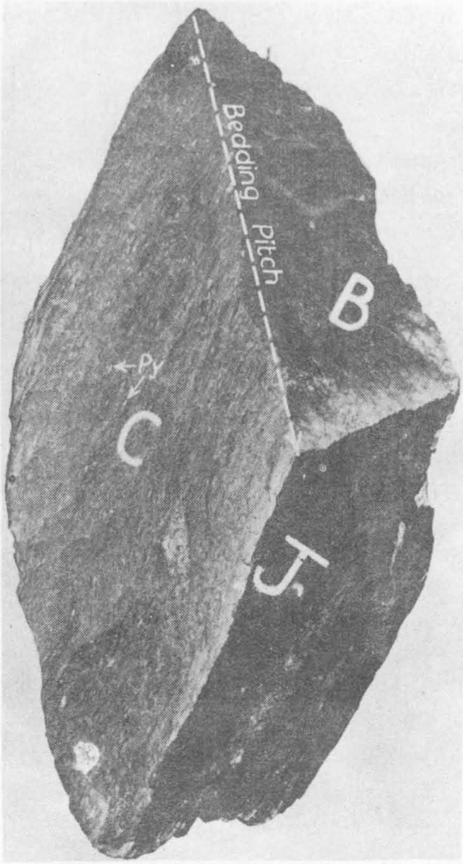

Figure 2. Photograph showing relation of cleavage, jointing and mineral-grain elongation.

As shown in Figure 2, (in which C indicates the cleavage face - trending north-south - B the bedding plane, and J a joint plane) the lineation, as well as being in the plane of the cleavage, has a pitch parallel to the joint plane, which is sometimes known as the grain plane. The white elongated grains that can be seen on the cleavage face are grains of pyrite which have the same orientation. As in Fig. 1 the bedding pitches south across the cleavage.

However, bedding-readings in the fine-grained rocks west of the contact are most difficult to obtain, and most geological maps of the district give very few authentic readings. Beds of sandy tuff near the New Cobar shaft have an almost vertical northerly dip and are sub-parallel to the contact. Similar conditions were mapped west of the Albion-Bowman lodes at the New Occidental mine, in which these lodes follow the discordant contact. Where these conditions apply, the pitch of folding in the footwall (fine-grained) rocks is northerly, parallel to the pitch of folds in the contact. In other places the fine-grained beds are not parallel to the contact and may pitch south. It is clear, however, that the minor folds associated with the orebodies are anticlinal cross-folds, and that they thus involve a change of pitch which may be quite significant.

It is considered that neither the en echelon faulting nor the folding hypothesis given above accounts satisfactorily for the conditions found at Cobar, and that the junction between the fine and coarse rocks must be regarded as a discordant contact that has been folded. It existed prior to the formation of the lode-shears, but this shearing has been localized and guided by the contact. The degree of displacement on the lode-shears may be quite small (see Plate 8). The contact itself may be regarded as a major channel along which ore-bearing solutions have circulated and, near the Queen Bee Mine, the emplacement of small bodies of quartz porphyry appears to have been partly controlled by the contact.

It seems likely that the discordant contact is due to faulting and shearing associated with the epi-Silurian orogeny that gave rise to the major north-south folding of the region. The cross-folding of the contact and the development of the lode-shears appear to be connected with a later period of folding, probably with the period during which the Amphitheatre Dome (Andrews, 1911) was formed. Though evidence of the age of the rocks is meagre, this folding may have occurred at the close of the Middle Devonian.

Although the discordant contact may be regarded as an ore-bearing channel, payable concentrations have so far been found only at certain points along it. In the three mines examined the deposits have essentially the same relationship to the contact, and an attempt is made to explain this in Figure 3.

In plan view, forces acting in the directions shown would buckle the contact as observed at New Cobar and elsewhere. Another consequence of the application of these forces is the development of two systems of fractures, one striking parallel to the north-trending contact, the other striking north-west. The fractures that strike north-west are

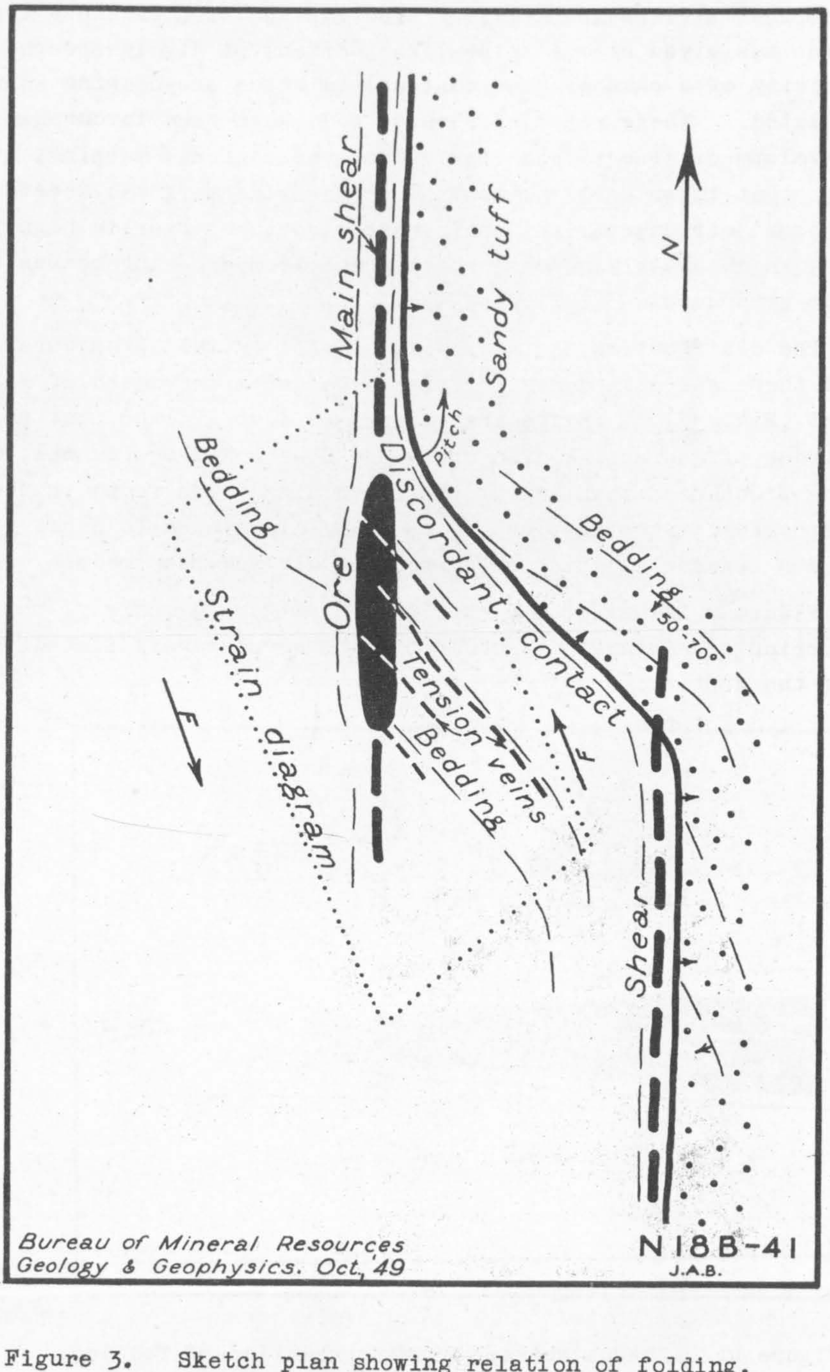

Figure 3. Sketch plan showing relation of folding, fracture pattern and ore occurrence.

gash-fractures and are sub-parallel to the bedding and to that portion of the contact that strikes north-west. The intersection of these two sets of fractures has given rise to pipe-like portions of highly-sheared rock in the vicinity of a channel (the contact) in which ore-bearing solutions have circulated. These pipes of sheared rock have been favourable loci for the development of ore-deposits. From the regional mapping, it seems likely also that these small anticlinal cross-folds mark the crests of elongated domal structures, and that these structures overlie high points, or cupolas, in an underlying concordant granitic mass. Orebodies tend to occur above such cupolas (Sullivan, 1949).

The distribution of the small, as well as the large, orebodies shows that there was a tendency for ore to be deposited south of folds in the contact (Plate 2). In the area mapped in 1946-47, the most pronounced folds in order of decreasing size are - New Cobar, New Occidental, Chesney. A fold more pronounced than any of these has since been found in the Peaks Area; geophysical investigation of the newly-discovered fold has yielded the promising results to which reference has already been made.

Figure 4 illustrates a corollary of Figure 3, namely, that a non-outcropping ore deposit may occur beneath a relatively flat-dipping portion of the contact.

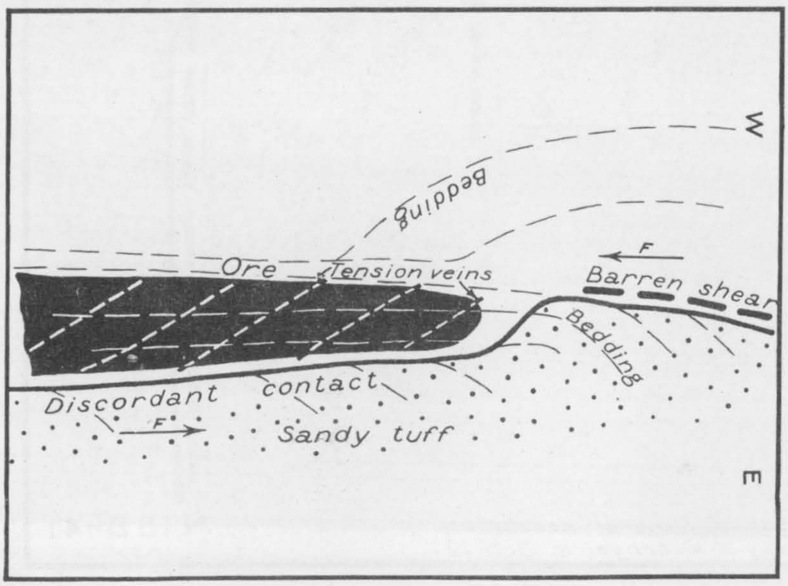

Figure 4. Sketch section showing relation of folding, fracture pattern , and ore occurrence.

Within the orebodies there are several features that illustrate the strain pattern of the area. As already mentioned, the mineral-grain elongation pitches north at a steep angle parallel to the axis of maximum stretching and to the pitch of the orebodies. In a plane approximately at right angles to the maximum stretching there are many tension joints which normally dip south-east at a low angle; many of the joints are filled with alternating layers of fine-grained quartz and sulphides coated with botryoidal calcite accompanied by pyrite. The joints may be responsible for local enrichments within orebodies, and it is not unlikely that the presence of a large number of these joints within a mass of rock has contributed to the development of the orebodies as a whole.

The shear zones in which the ore occurs are considered to have relatively small reverse displacements. The eastern walls appear to have moved upward relative to the western walls. This is suggested by the direction and type of the striae on the walls, the arrangement of complementary fractures, the direction of dragging of the beds and the occurrence of ore on the relatively flat-dipping portions of the shears and in fractures concave to the east.

Perhaps the most important point arising from the conception of the existence of a discordant contact, or contacts, of regional character and pre-dating the lode-shearing is its application to regional prospecting. Mapping now proceeding shows that this feature can be traced south of Mount Nurri and will probably be of great assistance in localizing prospecting (Sullivan, 1949).

However, the present report is devoted mainly to the description of three mines at Cobar, and it would be premature at this stage to attempt to describe the regional geology.

The structural setting is different for each of the three deposits examined, and details will be given with the description of each deposit.

GENERAL GEOLOGY

During the 1946-47 investigation it was not possible to determine the stratigraphic succession and map the regional structure; as stated above, the regional mapping now in progress is not yet sufficiently advanced to enable the results to be described here.

The following description of the area is taken from the report by Mulholland and Rayner:-

"The rocks in the vicinity of Cobar are of probable Silurian age, overlain on the west by a thick series of Devonian sediments. The area described in this report, however, lies entirely within the region occupied by Silurian rocks. Andrews has divided the Silurian at Cobar into Cobar Beds and C.S.A. Beds.

"Lithologically, both groups are very similar, being made up of slates, cherts, sandy slates, sandy mudstones, fine-grained sandstones, and quartzites. The Cobar Beds are generally more altered by regional metamorphism than the C.S.A. Beds, and the latter contain more sandy members. The Cobar Beds proper have a well developed cleavage, but cleavage is not always so prominent in the C.S.A. Beds.

"The main mass of sandstones of the Cobar Beds is stronger than the neighbouring finer-grained rocks and, as they form the hangingwall rocks of the lode systems, they have suffered a certain amount of silicification. These two factors tend to make the sandstone more resistant to weathering than the neighbouring members of the series, and consequently they outcrop as a well-marked ridge extending from the Nyngan road to the Peaks. They are underlain by sandy slates and fine-grained cleaved, micaceous sandstones. They are overlain by red and yellow sandy slates, slates, and fine-grained sandstones. The latter overlying group are the host rocks for the main lodes of the district.

"There appears to be a variation in any one horizon from sandy to slaty types. The main sandstones of the Cobar Beds become finer grained and appear to merge into sandy slates when followed north. North of the Nyngan-Cobar road the sandstones are not nearly so prominent as south therefrom.

"Areas of mineralization are indicated on the surface by red slates frequently traversed by quartz veins, outcrops of silicified breccia, and siliceous manganese-stained gossans. The red slates appear as grey slates and cherts below the zones of oxidation.

"The C.S.A. Beds overlie the Cobar Beds to the west and outcrop strongly between the Public School and the Hospital. They contain a number of sandstone beds and yellow sandy slates.

"There are no igneous rocks[ø] within the area under review, but porphyries occur in a number of areas within 30 miles of Cobar,

ø Since the above was written, granite has been discovered 6 miles east of Cobar (Sullivan, 1949).

the closest being near the Queen Bee Mine about 7 miles south-east of the Occidental Mine. Granites have been recorded from the vicinity of Mount Drysdale (24 miles north of Cobar) and near Wirlong (about 50 miles south of Cobar). Both granites and porphyries intrude the Silurian sediments. At Wirlong the granite is overlain by Upper Devonian sandstones, and its probable age is Middle Devonian or late Silurian.

"Recent deposits mask most of the less elevated areas, particularly in the vicinity of Young Australia Dam and Spains Tank."

The distribution of the various formations within the area surveyed is illustrated in Plate 2.

The petrological work of W.B. Dallwitz (Appendix 2) shows that the sediments of the Cobar Series, at least, were deposited in a volcanic environment, and are tuffaceous. In the present report they are referred to as sandy tuffs, slaty tuffs, and fine tuffs. The fine tuffs are uniformly fine-grained; the slaty tuffs have scattered, coarse grains set in a fine-grained groundmass.

INDIVIDUAL MINES

1. NEW OCCIDENTAL MINE

History: The early history of the New Occidental mine is given by E.C. Andrews (1911), to whose report the reader is referred. The deposit is said to have been discovered in 1871, and was taken up for copper mining in 1872. However, it was found to be mainly a gold-bearing lode, and a trial crushing of 2 tons sent to Ballarat assayed 2 ounces of gold per ton. Mining operations were short-lived, as were those initiated about 1878. During this period the mine was known as the United.

In 1889 the mine was renamed the Occidental, mining was re-commenced and was continued, with minor interruptions, until 1921 when production ceased on almost the whole of the Cobar field.

No steps were taken to re-open the mine until 1930, when the price of gold was increased. The history of the property since that date is given in the section dealing with the general history of the field.

TABLE 2.

PRODUCTION - NEW OCCIDENTAL MINE

Year	Ore treated tons	Tailings treated tons	Slimes treated tons	Yield Gold oz.	Average Gold dwt/ton	Value £
1889	690			718	20.8	
1890	140			118.5	16.9	474
1891	2,534			1,555	12.3	6,207
1892	2,800			841	6.0	3,488
1893	4,400			1,090	4.9	
1894			no record			
1895	8,647			1,492	3.5	
1896	9,900			1,651	3.3	
1897-8			no record			
1899				3,703		
1900			no record			
1901	28,076			(3,353	(2.4	(14,990
		22,215		(3,079	(2.8	(9,887
1902	6,654			1,144	3.4	3,700
1903	(45,567			(8,800	(3.9	(34,200
	(47,066			(5,005	(2.1	(18,450
1904	(	34,000		(3,870	(2.3	(15,250
	(44,089			(4,150	(1.9	(16,164
1905	(	34,300		(4,544	(2.6	(14,924
	(		7,500	(1,015	(2.7	(2,658
1906	(46,258			(4,821	(2.1	(17,765
	(	63,037		(7,030	(2.2	(25,878
1907	(45,719			(3,959	(1.7	(14,662
	(		27,600	(8,449	(6.1	(28,500
1908	(51,103			(4,480	(1.8	(15,338
	(	36,000		(5,606	(3.1	(19,390
	(		40,771	(3,599	(1.8	(22,909
1909	(49,557			(5,428	(2.2	(18,911
	(	33,000		(5,926	(3.6	(20,243
1910	(49,784			(4,356	(1.7	(14,421
	(	33,000		(5,878	(3.6	(16,775
	(		22,930	(4,581	(4.0	(13,825
1911	(33,164			(1,755	(1.0	(5,077
	(201(cons.)			(1,302	(135.4	(5,209
	(	33,800		(6,424	(3.8	(21,186
	(		12,145	(3,783	(6.2	(12,083
1912	36,827			11,893	6.4	48,231
1913	26,783			12,562	9.4	53,263
1914	28,739			11,768	8.2	49,897
1915	25,714			9,997	7.8	44,078
1916	13,297			6,600	9.9	27,602
1917	18,661			8,100	8.7	33,223
1918	10,176			4,334	8.5	18,370
1919			no record			
1920	42			420	200.0	1,780
1921	2,069			671	6.5	3,455
1922-34			no record			
1935	34,297			11,502	6.7	48,883
1936	72,373			24,276	6.7	103,173
1937	82,984			27,504	6.6	240,657
1937	2,585	(floated)		802	6.2	7,016
1938	96,213			32,063	6.7	282,851
1939	97,524			34,386	7.1	335,607 /
1940	97,158			31,787	6.5	346,706
1941	87,458			27,888	6.3	365,731
1942	107,266			37,783	7.0	395,901
1943	85,125			30,479	7.1	318,875
1944	72,800			28,517	7.8	299,440
1945	16,780			6,114	7.3	64,947
1946	35,925		48,418	11,410	4.9	121,390 ø
Total:	1,527,145	289,352	159,364	494,361	5.0	3,623,640

/ Approximate; values for New Occidental and New Cobar not published separately.

ø Approximate.

Table 2 gives the production statistics available for the years 1889 to 1946. It will be noted that, after the secondarily-enriched ore had been mined from 1889 to 1891, the grade dropped to 4-6 dwt. of gold per ton. However, in 1908, according to Andrews, the total mining and milling cost was only 7/7.37d. per ton. At that time ore assaying 4.5 dwt. was being worked at a profit, and up to the end of 1908 a total of £51,450 had been paid in dividends on capital amounting to only £4,320.

To the end of May 1948, the present company treated 1,013,838 tons of ore from this mine, averaging 6.7 dwt. of gold per ton.

Workings, Ventilation. The deposit has been opened on fourteen levels to a depth of approximately 2,000 feet. The present company has worked the deposit from No. 7 level at 740 feet. Access is through a vertical three-compartment shaft, 12 feet by 4 feet 6 inches in the clear. Difficulty is being experienced with haulage from a depth of 2,000 feet in such a small shaft; the shaft may have to be extended in size to cope with mining at deeper levels, or a new shaft may have to be sunk.

Ventilation is a considerable problem on Nos. 13 and 14 levels. The pipe-like form of the orebody and the fact that there is only one shaft contribute to these difficulties.

Working of the deposit at deeper levels will thus involve problems of haulage, servicing and ventilation.

Type of Ore. The Occidental gold-bearing lodes consist primarily of quartz, pyrite, pyrrhotite, chalcopyrite and gold; minor quantities of galena, sphalerite and magnetite are found in some places.

The quartz is usually fine-grained and, in the hand specimen, some of it has the appearance of chert.

Numerous fragments of chloritized slate occur in the ore, which has been formed by replacement rather than by filling.

Up to the present, the copper-content of the ore has been sufficiently low to allow straight cyanidation after fine grinding. In the north drive, at No. 13 level, there appeared to be an increase in chalcopyrite, but this increase may be quite local. Diamond drilling below No. 14 level has revealed ore of a type similar to that mined to date.

The bullion recovered by cyanidation has a fineness ranging from 810 to 860 and contains from 21 to 36 parts of silver per thousand.

Shape and Dimensions of Lode. The normal horizontal section of the Occidental lode is shown in Figure 5 and on the various level plans (e.g., Plate 3).

On the property there are five lodes that have been worked; they are known as the Eastern lode, the Western lode, the Gossan lode, the Bowman lode and the Albion lode.

The Eastern lode lies immediately west of the discordant contact between the coarse and the fine rocks. It has been worked over a maximum length of about 480 feet and a width of 10 to 25 feet. The Western lode is sub-parallel to the Eastern lode and, at the southern end, may coalesce with it - as on Nos. 9 and 10 levels - to form a continuous orebody up to 60 feet wide The northern portion of the Western lode is normally distinct from the Eastern lode and has been mined over widths of 15 to 40 feet. The two lodes together are known as the Main orebody which, in plan, is shaped like a tuning fork with the prongs pointing north.

The Gossan lode lies west of the Western lode to which it is parallel; it is intersected in each of the crosscuts from the Main shaft. It has been mined appreciably only on Nos. 1 and 2 levels, but recent diamond drilling (T25B) intersected payable ore in this lode 675 feet below No.14 level.

The Bowman lode lies immediately north-east of the Eastern lode and has been exposed by driving on Nos. 1 to 10 levels over widths to 10 feet and lengths to 100 feet. The Albion lode, which lies north of the Bowman lode, has been stoped from the surface to No. 2 level over a width of approximately 10 feet and a length of 110 feet. Andrews (1911) reports that 870 tons of ore obtained from the Albion lode, in 1895 yielded over an ounce of gold to the ton; subsequent records of production are not available.

The Bowman lode is reported to have yielded some high-grade ore. Andrews (1911, p. 142) quotes assays of an "indicator" found on No. 5 level, 200 to 260 feet north of the crosscut from the Main shaft and in the position of what is now called the Bowman lode. The indicator consisted of bands of magnetite and slate occurring over a maximum width of 2 feet 6 inches to 3 feet. Along its western wall, the magnetite-bearing slate was rich in bismuth and also contained galena and pyrite. Three specimens assayed, respectively, 1 oz. 6 dwt., 27 oz., and 33 oz. 17 dwt. of gold per ton.

Ore Reserves - Costs. Assay plans of Nos. 12, 13 and 14 levels, and the results of drilling at No. 15 level are shown in Plate O-15.

Ore reserves as at 30th May 1948 were estimated as follows:

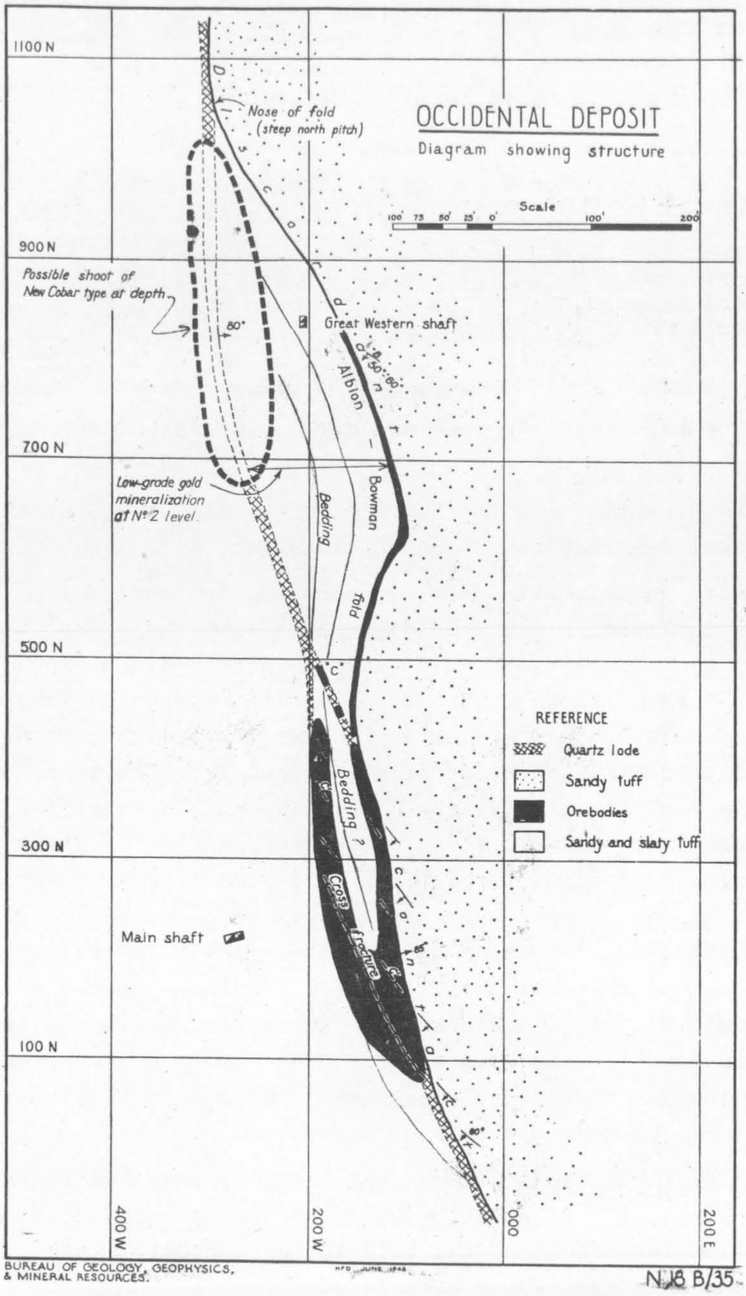

Figure 5. Occidental deposit - diagram showing structure.

	Tons	Estimated Grade
Positive ore above No. 14 level	343,150	6.8 dwt.
Ore broken in stopes	14,055	6.5 dwt.
Total positive ore	357,205	
Probable ore to No.15 level	162,000	

Operating costs per ton of ore were:

	For year ended 25/11/45	For year ended 1/12/46	For 18 months ended 30/5/48
Tons milled	16,780	35,925	125,350
Mining cost	£1.10. 5.	£1. 3. 2.	£1. 2. 7.
Development expense	4. 0.	4. 0.	7. 2.
Milling cost	£1. 5.11.	17. 3.	18. 8.
	£3. 0. 4.	£2. 4. 5.	£2. 8. 5.

This compares with the average cost of £1.15. 0. per ton for the years 1939-41.

Structure. The essentials of the New Occidental structure, as deduced during the present examination, are shown in Figure 5.

The major addition to previous knowledge resulting from this work is probably the realization that the discordant contact, after following the eastern side of the main ore-shoot, bounds the Bowman-Albion lode on its eastern side. This is shown most clearly by the mapping on Nos. 2, 3, 7, 8, and 9 levels. The tough sandy rock in the hangingwall strikes north-west, and generally dips south-west at 45 to 65 degrees into the lode, the lode-channel having a vertical to easterly dip. The beds west of the Bowman-Albion lode range from sandy to fine tuff and are almost parallel to the lode in strike and dip. On some of the plans of levels these beds are shown in the same colour as the coarser hangingwall rock because, during the earlier part of the examination, it was thought that the north-westerly prolongation of the eastern leg of the Occidental lode (C, Figure 5) marked the position of the "main fault." It is now considered, however, that this prolongation is along a major cross-fracture parallel to the northern leg of the Albion fold in the discordant contact and marks the northern limit of the cross-fracturing that has helped to localize the orebody.

The amount of crushing along the contact, revealed in the Albion-Bowman lode workings, is not extensive and the unusual enrichment may be related to the damming effect of the fold in the contact, along which ore-bearing solutions have apparently circulated.

The fold in the contact and the folds in the footwall beds pitch north steeply; those in the coarse-grained hangingwall beds pitch south at a small angle across the lode-channel.

As explained in the general description of the structure of the field, the cross-fractures C,C' (Figure 5) have tended to develop in their observed positions for the same reason as the fold developed in the contact. They probably do not occur between 500N and 700N because, in this area, they would have to break across the bedding at too high an angle. In the position of the Main orebody, the bedding has probably had a north-westerly trend which has predisposed it to fracturing in this direction. These conditions could recur between 700N and 1,100N (Figure 5), where also the bedding probably turns north-west, but crosscutting in this vicinity at No. 2 level revealed that, although slight mineralization occurred over a width of 170 feet, the grade was only 1 to 2 dwt. per ton.

The effect in plan of the cross-fracturing on the distribution of gold-mineralization is shown on Plate O-18 (after Mulholland and Rayner). The accompanying photograph of a thin section shows the detail of the controlling structure. Plate 4 gives a cross-sectional view of this feature.

As illustrated in Figure 4, changes of dip in the contact are likely to affect ore-deposition in the same way as do changes of strike. Plate O-21, section 700N, suggests that, for this reason, ore could occur below No. 8 level. As noted in the description of the New Cobar mine, the relatively low-dipping parts of the shears are generally more favourable for deposition than the steep-dipping parts because of the reverse nature of the shearing. For this reason an increase in gold-mineralization could occur below No. 2 level, where a change in dip takes place.

These features, combined with the favourable attitude of the bedding, might have been sufficient to cause the localization of an orebody north of the known orebody and below No. 2 level. Changes might also be expected to occur at No. 8 level; the favourable position would be south of the northern (north-west) limb of the Albion fold.

In addition to the structural reasons outlined above, there are direct indications that the area immediately north of the Occidental lode may contain ore. Some of these are:-

(1) The cross-cutting at No. 2 level revealed values ranging from 0.8 to 2.4 dwt. over a width of 170 feet. The dip here is unfavourable, as explained above. The ground has not been explored below this level. Gold-bearing solutions must have been present to cause such widespread mineralization.

(2) At No. 6 level, diamond drill hole No. 2 revealed a zone of gold-mineralization more than 100 feet wide west of the Albion lode; three of the samples assayed 4.4, 4.6 and 6.8 dwt., respectively. The north drive on the main lode was stopped only 20 feet north of the ore, two samples of which assayed 26.8 and 28.4 dwt. (Plate O-6).

(3) At No. 12 level, ore almost at the face of the north drive assays 5.9 dwt. per ton.

General considerations also point to the desirability of prospecting along the strike of the lode as distinct from the search for repetitions (not extensions) by very deep drill holes:-

(a) An ore deposit above the present bottom level is of much greater value than one at a great depth below it.

(b) The pipe-like form of the Cobar orebodies, with their remarkable persistence in depth, favours lateral prospecting.

One diamond drill intersection at an arbitrary point has a poor chance of striking ore as compared with a drive along the known ore-channel. Some deep holes can be drilled only if long crosscuts are available or are cut and, in addition, it is extremely difficult to ensure that they intersect a given target.

It is rather remarkable that at no point below No. 2 level has the northern extension of the Occidental lode-channel been explored for more than 100 feet - notwithstanding the facts that quartz-mineralization extends to the northern limits of exploration and that encouraging, though sporadic, gold assays have been obtained.

Plate O-11 suggests that a new orebody may exist at places where the strike of bedding is favourable below a change in dip of the contact. Structurally, such a deposit would resemble that in the New Cobar mine. The area could be tested initially by drilling, as shown, from the eastern crosscut on No. 11 level. This drilling would amount to a total of 910 feet. An alternative would be to continue the north drive at No. 12 level for another 300 to 400 feet, depending on the results being obtained. From this drive lateral drill holes would be extended at regular intervals to the contact marked by the Albion-Bowman lode-channel, and some lateral drilling to the west would also be desirable. It would be necessary to carry the exploration as far north as the nose of the Albion-Bowman fold - shown in Figure 5 at approximately 1,000N.

The apparent change in the dip of the discordant contact at about No. 2 level (Plate O-21, section 700N) could also have a favourable effect on ore-deposition, as this has happened in the New Cobar mine (Plate 8). It is therefore recommended that from the end of the eastern drive on No. 6 level at approximately 700N, three holes should be drilled horizontally in a north-westerly direction to intersect the probable northward extension of the Western lode system which has been worked to 650N (Plate 0-6). The drill holes should be directed so as to cut this extension at approximately 720N, 800N and 900N. They would be known as diamond drill holes Nos. 4, 5 and 6, and their combined lengths would be 650 feet. The existence of payable ore on the Western lode system from 570N to 650N, north of the normal position of the northern termination of workings in the Western lode, is regarded as evidence that there is a possibility of intersecting ore in these drill holes. The details of the proposed testing could best be decided in consultation with the mine staff.

The chances of finding another shoot similar in size to that worked in the New Occidental mine are not particularly good because, although Cobar orebodies have a considerable vertical range, only three important deposits crop out over a distance of 1.5 miles. However, the size of the possible prize is large, and the cost of testing should not exceed £5,000.(1)

Another prospect at New Occidental well worth testing is the shear zone replaced by calcite and dolomite and occurring near the shaft at Nos. 4 and 5 levels. At No. 4 level this zone is exposed over a width of 35 feet, and may continue over a greater width west of the platt. The slate has been almost completely replaced by calcite and dolomite, and a sample of selected high-grade material assayed 11.74 per cent lead and 14.04 per cent zinc. The average lead-zinc content of the lode at Nos. 4 and 5 levels is low, but it is not impossible that the calcite-dolomite mass represents the upper, relatively barren, portion of the lead-zinc lode. The fact that it is not found in the crosscuts from the shaft at lower levels may be explained if it is assumed that the lode has a northerly pitch similar to that of the main shoots of the district. To test this possibility, it is suggested that diamond drill hole No. 7 (135 feet) be drilled from No. 6 level and that diamond drill hole No. 8 (150 feet) be drilled from No. 7 level. No.8 hole will test ground that could be interesting even from the point of view of gold-mineralization. Any orebody that might be intersected by these holes could be outlined readily and cheaply by lateral drilling from existing levels.

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(1) Since the above was written some testing, as outlined in the summary, has been carried out. Further prospecting of this ground is well warranted.

Effects of Structural Pattern on Depth-Extension of Occidental Orebody. The changes in shape and dimensions of the Occidental orebody with depth are shown in Plate 0-17. At all levels the ore occurs within an ellipse bounded on the west by the Gossan lode, on the east by the discordant contact, and on the north-east by a cross-shear (C, Figure 5) which strikes off in a north-westerly direction from the point at which the Bowman lode (at the discordant contact) branches from the Main lode. The shape and size of the ellipse determine, to a large extent, the shape and size of the lode.

At Nos. 13 and 14 levels, there is a marked diminution in the area of the ellipse and of payable ore as compared with the levels above. This is accompanied by an increased degree of crenulation in the hangingwall (noted at No. 13 level) and by a sharp westerly swing of the northern extension of the East lode shear (C, Figure 5). The hangingwall of the East lode, which above this level is composed of hard sandy tuff, consists here of alternating sandy and fine tuff.

The evidence suggests that, perhaps because the hangingwall rock is less competent at this level, the northern limb of the Bowman-Albion fold has developed a more westerly trend than is common in the upper levels, i.e., the change in strike of the contact from north to north-west has become more pronounced. As the cross-shear marking the north-eastern boundary of the Occidental lode is believed to be parallel to the north-westerly trending limb of this fold (Figures 3 and 5), the observed effect could easily result from this condition. At the same time, any such increase in the amplitude of the fold would increase the similarity between the position of the possible new shoot illustrated on Plate 0-11 and the position of the New Cobar orebody.

Another factor that may have influenced the variations in grade and width of the Occidental orebody with depth is the change of dip at No.5 level which has already been mentioned (Plate 0-21, section 200N). This would tend to cause an increase in cross-fracturing as illustrated in Figure 4 which would, in turn, tend to shatter the area between the eastern and western shears so giving rise to a wide orebody.

It can therefore be said that the size and value of the Occidental orebody depend to a large extent on the shape of the Bowman-Albion fold in the discordant contact - and the form of this fold at depth is rather unpredictable. Diamond drill hole T25B indicates that east of the Main lode the contact may extend in an almost straight line for a distance of 1,250 feet below No. 14 level. This, together with the encouraging assay results, is taken as a hopeful indication that the orebody continues downwards. There is little direct knowledge, however, of the form and relationships of the fold in the discordant contact at depth, mainly because there has been little exploration north of the Occidental orebody.

2. NEW COBAR (COBAR OR FORT BOURKE) MINE

History. The history and past production of the New Cobar mine are epitomized in Table 3.

The orebody, though forming a bold siliceous outcrop only one and a half miles from the Great Cobar, was not discovered until 1887 - 17 years after the finding of the Great Cobar. The mine was first known as the Fort Bourke, and was worked successfully to a depth of approximately 325 feet where free-milling ore gave place to the mixed gold-copper ore of the sulphide zone; the latter ore was difficult to treat by standard methods available in the years 1890 to 1910.

The Great Cobar Company acquired the property in 1910 and, from that year until 1919, ore from this mine was treated in the Great Cobar smelting plant, but no separate records of gold and copper production were kept.

The mine was idle during the period 1920-33 but, in 1934, New Cobar Gold Mines N.L. was formed to work the property. In 1935 this company was absorbed into New Occidental Gold Mines N.L. Production began in 1937 and continued until March 1948 when operations ceased because of lack of manpower and a fall in grade at the bottom level. Maximum output of approximately 5,000 tons per month was attained in 1946. The total recorded output for 1890-1948 was 1,001,672 tons, and the average recovery during 1937-1948 was 5.1 dwt. of gold per ton and 1.0 per cent copper.

Workings, Ventilation. The deposit was worked from a three-compartment vertical shaft and ten levels, the lowest of which was 1,277 feet below the collar of the shaft. The workings are in good condition and the shaft is adequate for haulage and servicing requirements. No filling is required to support the stopes, though it was used in the upper levels. At the time of writing (February 1949) the mine is being kept unwatered.

When the mine was being worked, an adequate fan system provided good ventilation.

Type of Ore. The ore is silicified chloritic fine tuff impregnated with sulphides and containing veins and segregations of white quartz. Small quantities of ferriferous dolomite are present. Pyrrhotite and chalcopyrite are the two principal sulphides, but the ore commonly contains a little pyrite,

TABLE 3.

PRODUCTION

NEW COBAR MINE (COBAR OR FORT BOURKE)

Year	Ore raised tons	Ore treated: Crude ore tons	Ore treated: Tailings etc. tons	Yield: Gold oz.	Yield: Copper tons	Average: Gold dwt/ton	Average: Copper per cent	Value £
1890			no	record				no record
1891		600		150		5		" "
1892-5			no	record				" "
1896		1,474		509		6.9		" "
1897-9			no	record				
		72,607		7,971.24		2.2		27,818
1900			42,294	10,382.38		4.9		32,321
1901		74,349		18,153		4.9		54,767
1902		17,621		9,915		1.1		30,539
1903		76,307		32,840		8.6		100,916
1904		64,700		27,666		8.5		94,943
1905		15,176		10,503		13.8		32,750
1906		3,034		(413		(2.7		(1,193
			5,179	(2,235		(8.6		(7,026
1907	1,679			177.93		7.1		712
1908		500			2.65		.5	160
				75				321
1909	1,450	6,558		2,596		7.9		(9,733
					98.0			(1,254
1910	18,360	24,603						
1911	48,804	43,209						
1912		50,906						
1913		44,192		Included in Great Cobar Returns				
1914	11,829	11,829						
1915	-	-						
1916	19,115	21,548						
1917	19,823	15,235						
1918	6,421	9,132						
1919	179	637						
1920-36			no	record				
1937		2,694		835	28	6.2	1.0	8,845
1938		48,004		14,474	648	6.0	1.3	130,245
1939		39,775		14,028	515	7.0	1.3	169,520⌿
1940		51,908		15,372	579	5.9	1.1	201,891
1941		40,822		13,006	582	6.3	1.4	171,134
1942		35,029		8,935	491	5.1	1.4	135,159
1943		43,100		9,708	xxx	4.4		153,887
1944		25,528		6,691	405	5.2	1.6	107,725
1945		54,183		12,623	744	4.6	1.4	216,387
1946		61,446		12,414	693	4.0	1.1	202,108
1947/48 (to 30th May)		44,966		6,229	334	2.8	0.7	110,460
Total 1890-1946:		1,001,672	47,473	237,901				-
Total 1937-1946:		447,455		114,315	5,019	5.1	1.1	2,001,814

⌿ Approximate: New Occidental and New Cobar not published separately.

xxx New Cobar not recorded separately.

sphalerite, galena and bismuthinite. Native bismuth and gold are also present. A mineragraphic report on the ore by F.L. Stillwell is included as Appendix 3.

The ore from New Cobar was transported two miles by diesel motor truck to the New Occidental plant where it was bulked with ore from the Chesney mine. A copper-gold flotation concentrate was produced, and this was sent to the Electrolytic Refining and Smelting Company at Port Kembla, New South Wales, for extraction of gold and copper.

Lode Dimensions. The Main lode extends in a north-westerly direction for a distance of approximately 650 feet. On most levels the lode has been mined in two sections known as the northern and southern shoots. The payable width ranges from 20 to 40 feet.

Approximately 280 feet north of the northern end of the Main orebody and along the same lode-channel, a second deposit - known as the Jubilee lode - occurs. This has been partly proved at Nos. 2, 3, 4 and 7 levels to extend over a length of 150 to 180 feet, and to have a width of 10 to 18 feet. The ore appears to contain 1 to 2 per cent copper and probably 1 dwt. of gold per ton.

At Nos. 8, 9 and 10 levels a third lode, known as the Western orebody, occurs south and west of the Main orebody. It has been mined over a length of 120 to 150 feet and has averaged 6 to 8 dwt. of gold per ton.

Ore Reserves. Ore reserves at 30th May 1948 were estimated as follows:-

	Tons	Estimated grade
Positive ore above No. 10 level	92,190	2.6 dwt. gold 0.9% copper
Broken ore reserves	4,497	

This estimate - made by the company - includes 43,500 tons of 2 per cent copper ore in the Jubilee lode.

Costs. Operating costs per ton of ore were:-

Year ended	25.11.45.	1.12.46.	30.5.48.
Tons milled	54,138	61,448	44,966
Mining cost	£1. 2. 1.	£1. 2. 8.	£1. 5. 3.
Development expense	10. 0.	7. 3.	2. 2.
Milling cost	18. 1.	16. 5.	1. 0. 4.
Total cost	£2.10. 2.	£2. 6. 4.	£2. 7. 9.

Structure. The structure of the New Cobar deposits, as worked out during the present examination, is illustrated diagrammatically in Figure 3 - referred to previously in the discussion of the Cobar structure as a whole.

The ore lies south of a sharp fold in the discordant contact between fine- and coarse-grained rocks. The fold is the most marked of those associated with the three main deposits discussed here. The development of tension fractures south of that portion of the contact that trends north-west is shown clearly on the surface plan of the New Cobar area (Plate 6). It is considered that the intersection of these fractures with the New Cobar shear is partly responsible for the localization of the orebody.

The position of the New Cobar orebody has caused some geologists to consider that the southern ends of the north-south shears are, for some reason, favourable for ore-localization. Figure 3 shows clearly how the north-south shears die out quickly with distance from the discordant contact which has enabled them to develop. The termination of the shear and the position of the orebody have a common cause, namely, the folding of the contact.

One of the most interesting features of the New Cobar deposit is the shape of the contact between fine and coarse rocks from 8,500N to 9,000N (Plate 6). This contact is not easily mapped because the overlying finer-grained rocks contain numerous coarse bands. However, close mapping indicates that the contact is not straight but is folded as shown. As with the straight north-south portions of the contact, the bedding in the coarse rocks is discordant to the contact. The information about the structure of the finer beds is much more limited, although some readings show a southerly dip. Other beds, for example those near the Main shaft on the upper levels (Plate 7), dip steeply northward. The change of pitch associated with the cross-folding is probably of considerable importance in ore-localization.

As previously explained, it was at first expected that the contact exposed at the surface between 8,500N and 9,000N (Plate 6) would pitch south with the bedding in the sandy tuffs. Underground exploration indicates that this does not occur, and it is evident that it is a folded discordant contact dipping north-east, and that the nose of the fold at 9,000N pitches north as shown in Plate 7. The position of the nose has been interpolated from only a few exposures and intersections which are enumerated below:-

The contact is exposed in the crosscut at 9,130N, No. 7 level. The position of the nose at this level was interpolated from this intersection, taking into account the position of the nose relative to that of the orebody at the surface. Diamond drill holes 64A and 156 gave further information at No. 8 level (Plate N.C.-8). The crosscut at 8,770N on No. 9 level did not reveal any coarse rocks although, on the previously postulated southerly pitch of the nose at 9,000N (surface), their presence would have been expected. Finally, diamond drill hole No. 81A (Plates 6, N.C.-9) remained in fine tuff for almost the whole of its length, but entered coarse-grained rocks near the end. The hole terminated approximately 2,400 feet below the surface, and the position of the contact at this depth as shown in Plate 6 has been interpolated from this result and from what appears to be the line of pitch of the nose as inferred from the evidence mentioned above. It is evident that the north-easterly dip of the contact between 8,500N and 9,000N is flatter than the easterly dip of the contact from 9,000N north.

If the longitudinal projection (Plate 7) is a correct interpretation of the structure, the New Cobar orebody remains, at all levels, a short distance south of the nose and, presumably, will continue in depth as far as the fold continues. The fold is a most pronounced feature and is not likely to die out rapidly. The results obtained in diamond drill hole 81A, which intersected the Main orebody and not the Western orebody at which it was aimed, suggest that the Main orebody probably continues for 1,200 feet below No. 9 level as substantially as it has to that level.

It is, however, realized that the grade and width of the Main orebody decreased substantially from above No. 7 level to No. 9 level (Plate 6). To investigate the reasons for the decrease, cross-sections were drawn at intervals of 100 feet along the strike of the orebody, using stope assay plans as well as level plans. It was found that there is a general steepening of dip immediately below No. 6 level (Plate 8); this was noted on sections from 8,500N to 8,800N but is less marked from 8,900N north. As the shear is considered to be of a reverse type, the steeply-dipping portions are relatively compressed and are unfavourable for ore-deposition.

The change in dip of the lode is accompanied by a change in strike of the lode-channel with depth. From No. 7 level down the strike swings north-westerly as compared with the upper levels. The variation in the detail of ore-arrangement pointed out by Mulholland and Rayner (1947) is also marked.

It is considered that these changes may reflect changes in dip and strike of the contact from 9,000N north, and they also appear to be related to changes in dip of the contact from 8,500N south (Plates 6 and 8). These changes are certain to exist and they have no doubt affected the attitude of the shear, which has been localized by the contact. Conversely, it is likely that a repetition of the orebody - with normal dimensions - occurs where the north-south portion of the contact resumes its former attitude (always provided that the fold itself continues). Too little is known about the attitude of the fold at depth to predict where the orebody will reform, but it is considered that the case for development downward is a strong one.

New Orebodies - Prospecting. Although considerable thought has been given to the possibility of discovering additional orebodies at New Cobar, present knowledge of the deposit indicates that the chances of finding a repetition-body of the size of the deposit already exploited are probably slender. There is little evidence that the structural conditions under which the ore-body was formed are repeated within the vicinity of the mine. Most of the ore to be won from the area will probably be obtained from the downward extension of the known deposit. This is limited on the south by the sandy tuffs in the vicinity of the Main shaft (Plates 6, 7 and 8), and on the north by the nose of the fold in the discordant contact.

There is always a chance that smaller orebodies, subsidiary to the main deposit, will be discovered. The Western orebody occupies a gash-fracture and was not payable beyond 40 feet above No. 8 level. Plate 8 illustrates this point, and shows that this orebody flattened in dip and gained in gold-content when it emerged into slates from the sandy tuffs that occur in the vicinity of the Main shaft. Plate 8 also shows how the Western orebody dips towards the Main orebody in vertical cross-section. The intersection of the two lodes pitches north steeply, the pitch being parallel to that of the Main orebody.

From the position of the Western orebody underground and from its known dip and pitch, it appears likely that the area of silicified, brecciated rock occurring immediately south-east of the Main shaft in sandy tuff corresponds to the position on the surface of the Western orebody (Plate 6). A second siliceous formation commences 85 feet south of the one mentioned above, and extends 170 feet south; it is expected that this also will emerge from the sandy tuff and it may become payable. The emergence will occur at a deeper level than in the case of the Western orebody and diamond drill hole P4, No. 10 level, is designed to test this possibility.

Diamond drill hole P4 will also test the further possibility that the main ore-shoot is becoming payable at depth south of the downward prolongation of the line shown in Plate 7 as limiting the southern end of the orebody on the upper levels. The southerly extension of the Main orebody, as seen between 8,560N and 8,670N, No. 9 level, is probably due to the migration with depth of the unfavourable sandy tuff to the southward relative to the normal pitch-line of the orebody (Plate 7). As already mentioned, the orebody is limited on the south by the sandy rocks (Plate 6) and, if the sandy beds dip south whereas the nose of the fold in the discordant contact at 9,000N (Plate 6) pitches north, the main shear occurs for a greater distance in favourable rocks with increasing depth. Diamond drill hole P4 will test this possibility as well as prospecting for ore south of the Western orebody as described above. This prospect is considered to be one of the most promising at New Cobar. During drilling, the position of the boundary of the sandy tuff occurring around the Main shaft should be noted.

Between Nos. 5 and 6 levels, small lenses of ore have been intersected in the southern wall of the Main lode between 8,500N and 8,600N. A comparison between Plates N.C.-6 and 6 shows that, at the surface, the sandy tuff is in immediate contact with the south-western portion of the Main orebody; at No. 6 level, it is 150 feet south-west of the orebody. The lenses between Nos. 5 and 6 levels probably correspond at the surface to the patch of silicified, brecciated rock that occurs in sandy tuff 80 feet north-north-east of the shaft. The brecciated zones have passed, at No. 6 level, into fine-grained rocks favourable for ore-deposition and payable ore is found there.

Around the Main shaft, the trend of the unfavourable sandy tuffs is away from the north-pitching zones of fracturing in which the orebodies are localized so that, at the southern end of the New Cobar deposit as a whole, the conditions were favourable for ore-deposition.

It is considered that the best chances of a larger-scale discovery lie south of the contact that occurs at the surface between 8,500N and 9,000N (Plate 6). The reasons are that this is believed to be the main ore-bearing channel, that a magnetic anomaly* tends to enclose this contact and that, if the fold X, for example, were accentuated at depth into a fold such as X', favourable structural conditions for the occurrence of a new deposit could exist. The limited diamond-drilling programme outlined for this deposit has been designed on these assumptions, and also to supply information on the shape of the discordant contact, which is likely to have an important influence on the occurrence of ore.

The diamond drilling recommended is shown on the level plans and is as follows:-

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* See Geophysical Report No. 1947/60.

Level	Diamond drill hole	Length (feet)	Purpose
No. 3	S1	250	To test ground between main lode and folded contact and to locate contact.
No. 3	S2	130	
No. 3	S3	150	
No. 3	S4	60	
No. 3	P1	100	To test mineralized ground intersected in crosscut, 9,400N.
No. 3	P2	85	To test northern extension of promising mineralization in crosscuts, 8,900N.
No. 4	P3	280	To test possible mineralized ground. Drill to contact.
No. 7	S5	260	To test possible ore-bearing position and to locate contact.
No. 7	S6	50	To locate nose.
No. 7	S7	100 (?)	To find contact and, hence, its dip and strike.
No. 9	S8	60	To locate nose.
No. 10	P4	260	To test for new orebody south of Western orebody, and to test southern extension of Main lode.
	Total:	1,785	Estimated cost: £1,000.

The drilling should be under geological supervision, and the programme might have to be modified as results become known.

(Since the above recommendations were made, two holes - 230 feet and 305 feet in length, respectively - were drilled from No. 10 level to test the possibility of ore-occurrence to the south-west of the Western orebody. The company reports that "both holes intersected lode formation in the position estimated by Mr. Sullivan, but values of both gold and copper were very low." Further drilling, as outlined, should be undertaken).

3. CHESNEY MINE.

History and Production. The following table summarises production from the Chesney mine from 1887 to May 1948.

TABLE 4.

PRODUCTION - CHESNEY MINE

Year	Ore Raised	Ore Treated	Yield		Average		Value
			Gold	Copper	Gold	Copper	
	tons	tons	oz.	tons	dwt/ton	per cent	£A
1887	-	2	9	-	90	-	-
1888	-	59.5	127.3	-	43.7	-	-
1889	-	2,436	796.6	-	6.5	-	3,099
1890	-	880	586	-	13.3	-	-
1891	-	⌿	885.42	-	-	-	-
1892	-	-	-	-	-	-	-
1893	-	328	222.45	-	13.4	-	-
1894	-	1,985	1,019	-	10.3	-	-
1895	-	1,781	288	-	3.2	-	-
1896	-	2,440	436	-	2.5	-	-
1897	-	-	-	-	-	-	-
1898	-	-	-	-	-	-	-
1899	-	-	-	-	-	-	-
1900	-	-	-	-	-	-	-
1901	-	4,500	225	135	7.0	3.0	⌿
1902	-	420	9.5	-	0.4	-	⌿
1903	-	1,140	53.5	27.5	0.9	2.4	⌿
1904	16,885.11	16,885					⌿
1905	45,310.73	45,310					⌿
1906	26,613.73	26,613					⌿
1907	-	-					⌿
1908	51,579	51,473					⌿
1909	41,272	40,679					⌿
1910	34,236	32,076					⌿
1911	22,431	22,919					⌿
1912	67,000	45,995					⌿
1913	-	67,035					⌿
1914	-	45					⌿
1915	-	-					⌿
1916	5,684	5,481					⌿
1917	-	251					⌿
1918	-	-					⌿
1919	41	-		3.5			267
1920	925	925		55			5,438
1921-42	-	-		-			-
1943	-	20,985	1,322	466	1.3	2.2	68,492
1944	-	38,888	5,733	881	2.9	2.3	154,785
1945	-	1,421	301	36	4.2	2.5	7,076
1946	-	5,605	832	141	3.0	2.5	23,001
1947/48	(to 30th May)	37,429	3,433	747	1.8	2.0	134,058
Total:	311,976 ++	475,987					

⌿ Not available. ++ Incomplete

From 1904 until 1920 the Chesney mine was worked by Great Cobar Limited, and no separate records of the production of gold and copper during that period are now available. The ore is reported to have been mined partly because of its siliceous nature which facilitated smelting of the basic Great Cobar ore. The mine was re-opened in 1942 at the request of the Commonwealth Government in order to help supply Australia's copper requirements. During 1948 production was increased from 1,100 tons to 4,500 tons per month; this result was achieved partly by transfer of manpower from the New Cobar mine.

Workings, Ventilation, Nature of Ground. The mine has been opened up by means of a three-compartment vertical shaft and eight levels, the lowest of which is 925 feet below the collar of the shaft (Plate 10).

Ventilation is adequate. The ground, as elsewhere at Cobar, stands very well and requires a minimum of timbering. Stope-filling is not required.

Nature of Ore. The orebody is a siliceous gold-copper deposit, the ore consisting of chlorite schist with fine-grained quartz, some calcite, chalcopyrite, pyrrhotite, pyrite, sphalerite, galena and gold.

Lode Dimensions. The lode has been mined over a length of 600 feet and over widths to 60 feet, the average width being approximately 20 feet. Below No. 5 level the orebody consists of two gold-copper shoots - each approximately 100 feet long - connected by a low-grade copper-bearing lode.

The northern gold-copper pipe extends from near the surface to No. 8 level. The southern pipe was first encountered at No. 6 level; it appears to extend for 100 feet above this level and has been mined to No. 8 level.

Ore Reserves. Sampling in the Chesney mine has been sporadic and has not been well recorded. It is therefore probable that the best guides to grade are the records of recent production given in Table 4. During the years 1943 to 1948, 104,328 tons of ore yielded an average of 2.2 dwt. of gold per ton and 2.1 per cent copper. From stope measurements it is estimated that approximately 14,000 tons of this ore came from the central section of the mine and the remainder from the northern and southern gold-pipes.

It was estimated by the writer, in November 1946, that between Nos. 8 and 5 levels (363 feet vertically) the northern gold-pipe possibly contained 50,000 tons of ore assaying 3.0 dwt. of gold per ton and 2.0 per cent copper. Between 5th August 1946 and 27th October 1946, 3,690 tons of ore - obtained mainly from this section - had a head value of 3.69 dwt. of gold per ton and 3.0 per cent copper. The recovery was 80.47 per cent of gold and 95.5 per cent of copper. However, judging from the overall operating results, this grade was unusually high.

At the time of the examination, the Southern orebody appeared to be continuing strongly underfoot at No. 8 level, but very small quantities of ore remained in it above this level. A drill hole below No. 8 level revealed ore assaying 2.8 per cent copper over a width of 20 feet. It is believed that the proposed No. 9 level, 150 feet below No. 8 level, would develop about 25,000 tons of ore in this shoot which should average 2.5 per cent copper and perhaps 2.0 dwt. of gold per ton. In the past this ore has yielded as much as 3 dwt. of gold per ton but the management considers that the gold-content decreases with depth.

The Central orebody in the Chesney mine is approximately 350 feet long and has been mined over widths to 30 feet; it would probably average 16 feet in width. The body is largely intact between Nos. 8 and 6 levels (vertical interval 212 feet), and therefore this block may contain approximately 100,000 tons of mineralized lode material. A further 50,000 tons probably remains between Nos. 6 and 5 levels, making a total of 150,000 tons.

The grade of this material is most problematical as it has not been adequately tested by stoping or by thorough sampling. The available assay plans indicate that, as shown in the longitudinal projection (Plate 10), the strike-length of 350 feet contains a core of higher-grade ore - about 150 feet long - which probably contains 2.5 to 3.0 per cent copper, but that the remaining 200 feet contain only 1.0 to 1.5 per cent copper. The recoverable gold-content in both parts of the orebody is less than 1 dwt. per ton. Sampling on No. 8 level suggests that the high-grade ore cuts out about 50 feet above this level, but this may be quite a local phenomenon.

On the available evidence it is believed that the 150,000 tons of possible ore remaining in the central section could be expected to yield 1.75 to 2.0 per cent copper and less than 1 dwt. of gold per ton.

An indication of the overall grade of the mine is provided by the results obtained during the eighteen months ended 30th May 1948. Over this period the mine yielded 37,429 tons of ore averaging 2.35 dwt. of gold per ton and 2.16 per cent copper (head value).

However, the company's estimate of the grade of the ore reserves at that date was considerably lower,* being as follows:-

Positive ore	121,800 tons	(1.2 dwt. of gold/ton (1.88 per cent copper
Ore broken in stopes	8,335	
	130,135 tons	
Probable ore above proposed No. 9 level	191,000 tons	

Costs. Operating costs per ton of ore were:-

	Year ended 1.12.46.	18 months ended 30.5.48.
Tons milled	5,605	37,429
Mining cost	£1. 7. 4.	£1.14. 8.
Development expense	3. 4.	9. 6.
Milling cost	16. 5.	1. 2. 0.
	£2. 7. 1.	£3. 6. 2.

Structure. The structure of the Chesney lode is illustrated on the plan of No. 6 level (Plate 9), on the longitudinal projection of the mine (Plate 10), and on the surface plan (Plate 2, Sheet 2). The central 350 feet of the lode strikes N.14 degrees W. and dips 85 degrees east. This is the strike and dip of the Chesney shear which has been traced for 800 feet on the surface, and also of the main Chesney-Young Australia-Occidental shear (discordant contact) about 80 feet east of the Chesney shear, which is referred to in this mine as the East-lode shear.

At both ends of the Chesney lode, shears striking approximately 330 degrees intersect the main lode system, and the strike of the orebody swings in sympathy with them. The northern and southern gold-pipes occur at the intersection of the cross-shears with the Chesney shear, the locus of intersection pitching steeply northward. The structures that strike 330 degrees are in the nature of gash-fractures joining the East lode to the Chesney lode, and it would appear that they have fed gold from the predominantly gold-bearing East lode into the predominantly copper-bearing Chesney shear.

* Since the above estimate was made, the north drive at No. 8 level has been extended and has continued to expose ore well to the north of the position at which the northern end of the known orebody would be expected to intersect this level. Taking into account the probable pitch, this development is most encouraging and improves the ore prospects considerably. The lodes now exposed in the Chesney mine contain about 3,000 tons per vertical foot of material, with perhaps 1.3 per cent copper and 1.2 dwt. of gold per ton.

The pipe-like bodies formed at the intersections of fracture systems are thus essentially similar to those found at New Occidental and New Cobar, and it is considered very likely that they are closely related in origin to folds in the contact similar to those at the mines mentioned. One such bend occurs between 7,000N and 7,200N (Plate 2, Sheet 2), and a second minor fold occurs in the vicinity of the Main shaft.

Plate 9 shows that the line joining the top of the gold-pipes is tilted southward at approximately 45 degrees to the horizontal, and it was at first thought that this may be related to the pitch of the sandy tuff (called quartzite on the plans) across the hangingwall of the East-lode shear. It is possible that certain types of beds, being more or less competent than average, have influenced the formation of folds in the contact, and thus of gash-fracture. However, there is not much information available about the shape of the contact at depth.

Prospecting. The copper-content of the Chesney main lode is of marginal value at present (1947) metal prices, and prospecting has resolved itself into the search for non-outcropping gold-copper shoots similar to those found previously. To date these shoots have yielded only 15,000 to 20,000 tons of ore per 100 feet vertically, and it is extremely doubtful if a pipe of this size and grade would be of value at, say, 1,000 feet below the present bottom level, unless it could be worked in conjunction with a number of other shoots of payable ore.

In addition, it must be pointed out that short shoots of limited vertical extent are poor targets for deep drilling and that, in view of the present ore position at Cobar, it is more important to find ore within reasonable range of present openings than to obtain one or two drilling intersections at extreme depth. Lateral prospecting by extension of existing drives is therefore more attractive.

The next logical step in exploration would be the normal one of driving No. 9 level, perhaps after some preliminary shallow drilling from selected positions in the western crosscut at 6,300N, No. 8 level. No. 9 level, if carefully sampled, would give most valuable information concerning the structure and grade of the known orebodies. The central body is poor at No. 8 level, and it is important to determine if this condition continues to No. 9 level. No diamond drilling could possibly give the complete picture of such ore-distribution.

Between 6,000N and 5,500N there are, in the discordant contact, a number of minor folds to which short occurrences of quartz and lode formation appear to be related (Plate 2, Sheets 2 and 3). These could be tested at moderate expense by driving southward along the Chesney shear from No. 9 level for a distance of 300 to 500 feet (depending on results) and drilling laterally to the contact. This drilling should be planned taking into account the southern pitch of the line joining the tops of the north and south shoots, as well as the occurrence of the features mentioned above.

4. PEAKS AREA.

Production Tables. The recorded production from the Peaks Area is shown in Tables 5 and 6.

TABLE 5.

PRODUCTION - PEAK SILVER MINE

Year	Ore raised tons	Ore treated tons	Yield			Average			Value £
			Gold oz.	Silver oz.	Lead tons	Gold dwt/ton	Silver oz./ton	Lead per cent	
1906		200	17	6,059	25	1.7	30.3	12.5	1,349
1907	600	167	15	5,600	29	1.8	33.5	17.4	1,280
1908	-	-	-	-	-	-	-	-	-
1909				No returns					
1910	1,076	751		No record					832
1911	200		20	3,400	1.5				523
1912	188		26	8,135	18				1,329
1913	483		42	12,652	35				2,275
1914	-	-	-	-	-	-	-	-	-
1915	656	656	657	1,838					2,811
Total	3,203		777	37,684	108				10,399

T A B L E 6.

PRODUCTION - PEAK MINES (BLUE, BROWN AND CONQUEROR LODES).

Year	Ore raised tons	Ore treated tons	Yield Gold oz.	Yield Silver oz.	Average Gold dwt/ton	Average Silver oz/ton	Value £
1896		1,500	3,205		42.6		
1897				121,251			11,762
1898-1900	-	-	-	-	-	-	-
1901		2,570	2,000		15.6		7,950
1902		832	657		15.8		2,499
1903		3,430	2,640		15.4		9,912
1904		3,272	1,829		11.2		7,118
1905		1,827	1,275		13.8		4,945
1906		862	1,117		25.8		4,327
1907 ++	2,681	2,681	Included with Great Cobar				
1908 ++	2,701	2,524					
1909 ++	2,209	2,013	1,249		12.4		
1910 ++	467	310	++				
1911		785	2,563	8,592	65.3	10.9	10,049
1912		1,432					
1913		307					
1914		427	145		6.8		580
1915	656	657	657		20		2,464
1916	209	175					
1917	127	127					4,373
1918	40						
1919	227	227	195	975	17.2	4.3	1,010
1920	204	204*	128	37,082	12.5	181.7	9,224
1921		(139*	(100	(9,713	(14.4	(69.9	(1,842
		(283‡	(331	(70,155	(23.4	(247.9	(6,473
1925		285	133	5,300	9.3	18.6	1,192
1926-27	-	-	-	-	-	-	-
1928	13	13	14	605	21.5	46.5	59
1931	12	12	19		31.6	-	87
1932	-	9ø	33		73.2	-	140
1933-35	-	-	-	-	-	-	-
1936	156	118	213.5	6,018	36.2	51.0	
1937		111.5	173.5	2,329	31.1	20.9	1,794
1938			123	1,196			
1939		5.5	10	124	36.2	22.54	
1940	250	200	32		3.2		308
1941	190	190⌿	57		6.0		514
1942	216	216≠	65		6.0		670
	35	27⫽	38		28.1		380
1943-44	-	-	-	-	-	-	-
1945	50	50	24		9.6		240
1946			80				716
Total:		27,821	19,106	263,340			90,628

++ Incomplete Return.
* Brown Lode.
‡ Conqueror Lode.
ø Battery Residues.
⌿ The Blue Lode.
≠ The Blue Peak.
⫽ The Peak.

General Description. During the 1946-47 Cobar examination only a short time was spent in the vicinity of these mines, but available information was assembled on Plates P-1 to P-15. These show that the workings on the Blue lode, Brown lode and Conqueror lode revealed only small, rich shoots of gold-silver ore, and that they are essentially deposits best suited to exploitation by small parties and syndicates.

At the time of the 1946-47 examination, the only substantial known deposit was the "Big lode" which lies in a marked shear zone. The southern extension of this zone has not been thoroughly prospected. The lode is exposed on the surface over a length of 500 feet, and ranges in width from 25 to 65 feet; it consists of brown, gossanous material with boxworks after sulphides. It has been thoroughly leached.

L.F. Harper (personal communication, 1929) states that, while the leases were held by the Great Cobar Company, the lode was tested by one crosscut at the 53-ft. level (Plates P-3, P-11) and by another at the 100-ft. level (Plates P-4, P-11). Gold-content was reported as "low". In 1927-28, the Peak Company received aid from the Prospecting Vote of the New South Wales Mines Department to drive a crosscut to the "Big lode" at the 160-ft. level (Plate P-5). The ore-channel was reached at 68 feet, and the crosscut was continued for 30 feet in channel material and ore. The gold-content was low, but it was stated that the copper-content was higher than that obtained in the levels above. At the time of Mr. Harper's visit, a crosscut at the 226-ft. level had not reached the lode.

Mulholland and Rayner (1947) state that the lode was cut at the 226-ft. level (Plate P-6) "and is stated to have assayed 7 dwt. gold and a trace of copper over a width of 9 feet". These authors also state that the lode was intersected in a crosscut from a winze 65 feet below the 100-ft. level. Samples taken from there are said to have ranged from a trace to 7 dwt. of gold per ton. Small quantities of native copper are present in the lode. One hundred tons of ore obtained from this section is said to have had an average gold-content of 5.5 dwt. per ton.

Diamond Drilling. The most interesting information about the lode was obtained from diamond drilling carried out during 1942-43 with the aid of money advanced by the Commonwealth Government. The results are shown on Plates P-10 to P-14.

No. 1 d.d.h. deflected from an inclination of 65 degrees at the collar to one of 83 degrees, and had to be abandoned at 290 feet.

No. 2 d.d.h. penetrated the lode at a vertical depth of 530 feet, and remained in it to a vertical depth of 600 feet. It revealed copper-lead-zinc mineralization which, over a length of 248 feet down the borehole (a true thickness of approximately 200 feet), had a weighted average value of £S2.3.5. per ton, or £A2.14.5. per ton at the London metal price ruling at 4/6/47. This is the value of the total metal content, not the recoverable value.

In sections the bore assayed as follows:-

Position	Width feet	Pb %	Zn %	Cu %	Ag dwt.	Au dwt.	Value per ton in sterling London (4/6/47)	Value per ton at Australian fixed price (4/6/47)
595-650	55	0.94	2.86	0.52	2.3	-	£3.11. 7.	£1.11. 0.
650-764	114	0.24	1.09	0.18	-	-	1. 4. 2.	10. 2.
764-819	55	0.50	1.19	1.58	9.7	0.5	3.10. 4.	2.10. 4.
819-843	24	0.20	0.35	0.06	0.2		10. 1.	4. 0.
Weighted Averages	248	0.45	1.43	0.55	2.68		£2. 3. 5. (£A2.14.5.)	16.11.

The details of the sampling are shown on Plate P-12. Although the values are low, the width of mineralization is very interesting.

No. 3 d.d.h. (Plates P-11, P-12) intersected the lode at an approximate vertical depth of 250 feet, and revealed 25 feet true width of low-grade copper-silver-gold mineralization. The detailed results are shown with the section of the hole on Plate P-12. The best result obtained was from 365 to 370 feet; this section assayed 1.39 per cent copper, 4.6 dwt. of silver and 1.6 dwt. of gold per ton. It is probable that leaching extends to this depth, and native copper was noted in the core. In these circumstances, some copper and zinc may have been removed by leaching, but it would be expected that a considerable proportion of the original lead-content of the lode would be present. No assays for lead were made.

No. 4 d.d.h. intersected the lode between vertical depths of 285 feet and 420 feet. The detailed results of this drill hole are shown on Plate P-13. Over a length of 169 feet along the hole, equal to a true lode-width of approximately 130 feet, the ore averaged 0.88 per cent lead, 0.52 per cent zinc, 1.24 per cent copper and 3.0 dwt. of silver per ton. At prices ruling on 4/6/47, the section from 314 feet to 433 feet, a drilling-width of 119 feet, had a gross value of £A1.19. 0. at the Australian fixed prices and a sterling value of £2.17. 7. per ton at London prices.

No. 5 d.d.h. (Plates P-1 and P-10) was apparently outside the limits of the ore-shoot and gave very low results.

No. 6 d.d.h. (Plates P-1, P-10, P-11, P-14) revealed mineralization assaying 1.8 per cent copper from 838 to 840 feet and 1.2 per cent copper from 990 to 995 feet, but the general result was disappointing. The drilling was carried out primarily as a search for copper needed in wartime, and no assays for lead-zinc content appear to have been made on the cores from No. 6 d.d.h.

The results of the drilling suggest that the "Big lode" has been leached to a depth of approximately 250 feet. The leaching has removed a considerable proportion of the copper-content of the primary ore and probably most of the zinc. There is an enrichment of gold in the oxidized zone. There is little evidence of a zone of secondary copper-enrichment, but it is possible that such enrichment exists. The drilling indicates that, below the leached zone, there is a mineralized lens from 350 to 400 feet long and from 100 to 150, or more, feet wide, containing copper-lead-zinc mineralization - at present of sub-marginal grade.

(Since the above was written the area has been mapped by E.O.Rayner of the Mines Department, New South Wales, and also in part by the writer. The existence of a large-scale cross-fold was determined and geophysical work was recommended. This work revealed the presence of a strong magnetic anomaly of large dimensions, which is not related to any known ore-bodies but shows a marked correlation with a broad shear zone developed in conjunction with the cross-folding. Self-potential and gravity anomalies have also been surveyed. The geophysical work has been described by L.A.Richardson in Geophysical Report No. 1948/43.

One diamond drill hole tested the magnetic anomaly and reached an inclined depth of 1,070 feet; it intersected a broad zone of pyrite-pyrrhotite mineralization carrying low gold values. A deeper test is now being made).

<u>Canberra</u>. 30th July, 1951.

REFERENCES.

Andrews, E.C., 1911 - Report on the Cobar Copper and Goldfield, Geol. Surv. N.S.W., Miner. Res. No. 17, p.1.

Mulholland, C. St.J., and Rayner, E.O., 1947 - The gold-copper deposits of Cobar, N.S.W., Part 1: Central section (Great Cobar-New Occidental), Rep. Geol. Surv. N.S.W., (Unpublished).

Sullivan, C.J., 1949 - Mineralization in the Cobar-Nymagee province and its significance, Proc. Aust. Inst. Min. & Metall. (In Press).

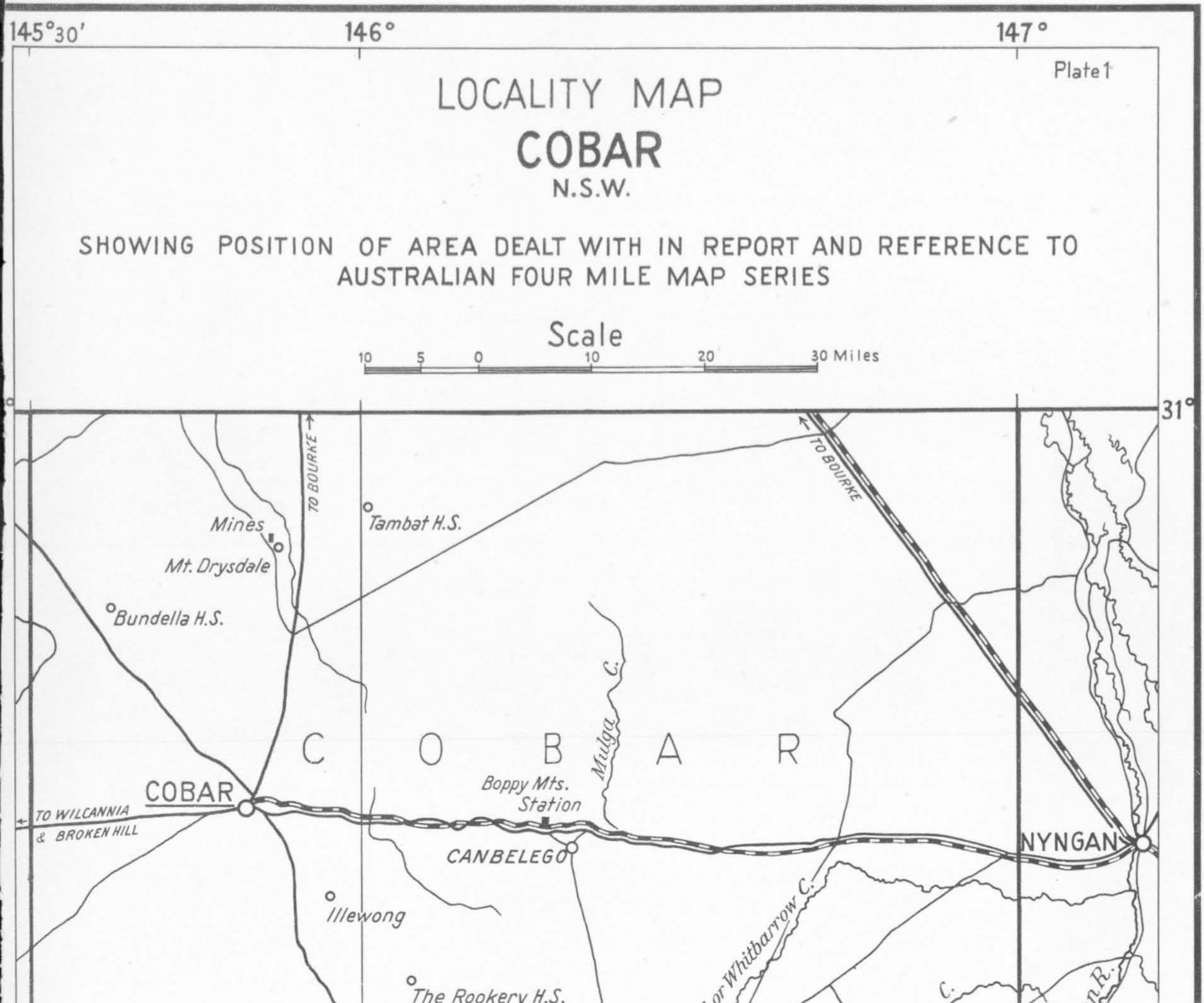
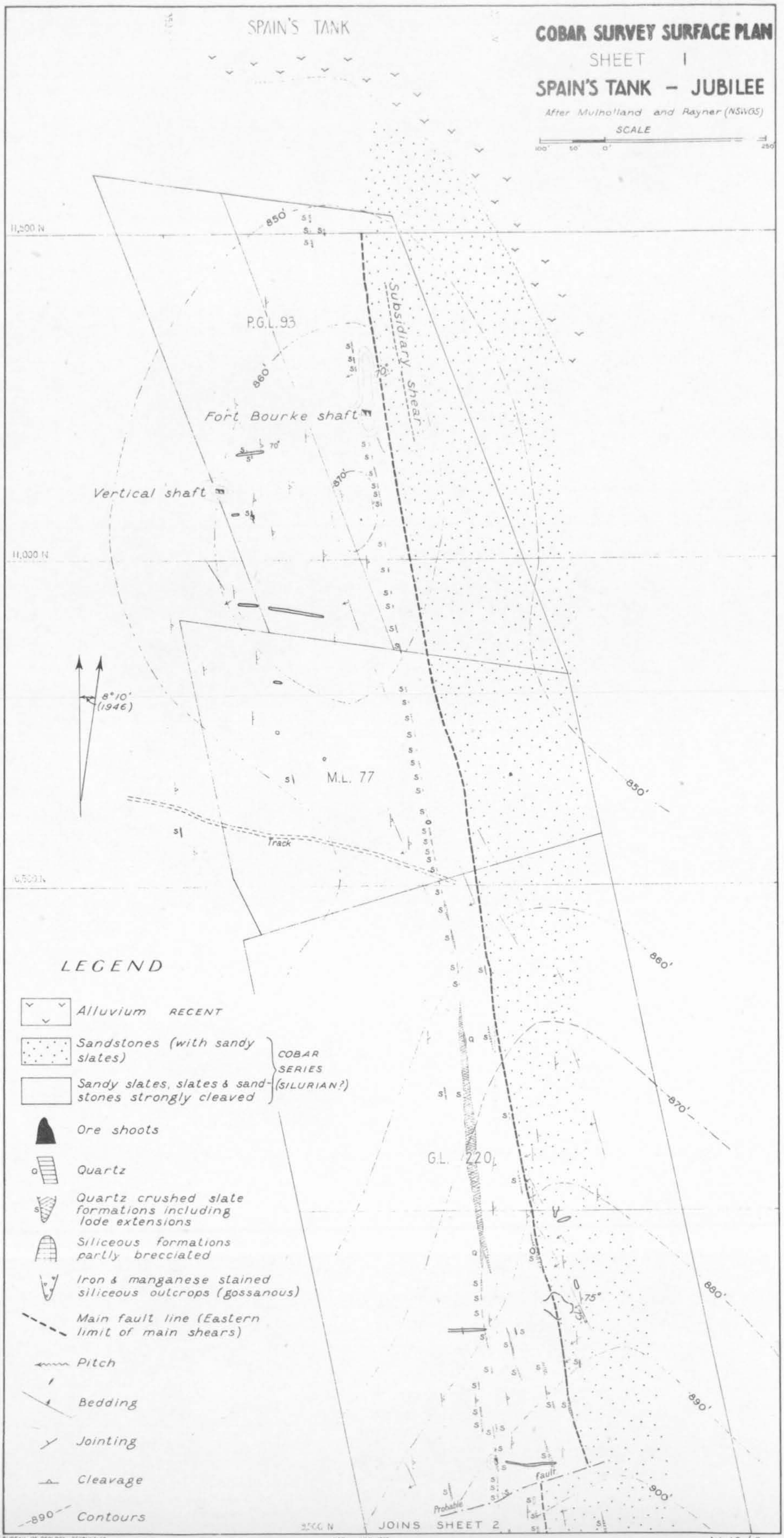

145°30′
146°
147°
Plate 1
LOCALITY MAP
COBAR
N.S.W.
SHOWING POSITION OF AREA DEALT WITH IN REPORT AND REFERENCE TO AUSTRALIAN FOUR MILE MAP SERIES
Scale
10 5 0 10 20 30 Miles
31°
32°
TO BOURKE
TO BOURKE
Tambat H.S.
Mines
Mt. Drysdale
Bundella H.S.
C O B A R
Mulga C.
COBAR
TO WILCANNIA & BROKEN HILL
Boppy Mts. Station
CANBELEGO
NYNGAN
Illewong
Crowal or Whitbarrow C.
The Rookery H.S.
Rest Downs H.S.
Pange C. or
Bogan R.
Nillera H.S.
Nymagee H.S.
Mines
NYMAGEE
Wirlong Prospect
Shuttleton Mines
Grahway
CARPINA
N Y M A G E E
COBAR
NEW SOUTH WALES
SYDNEY
VICTORIA
MELBOURNE
0 100 200 300 400M
Railway
Road
Boundaries of 4 mile Military Maps
N18-53
W.K.
UREAU OF MINERAL RESOURCES, GEOLOGY GEOPHYSICS, December 1950

PLATE 2



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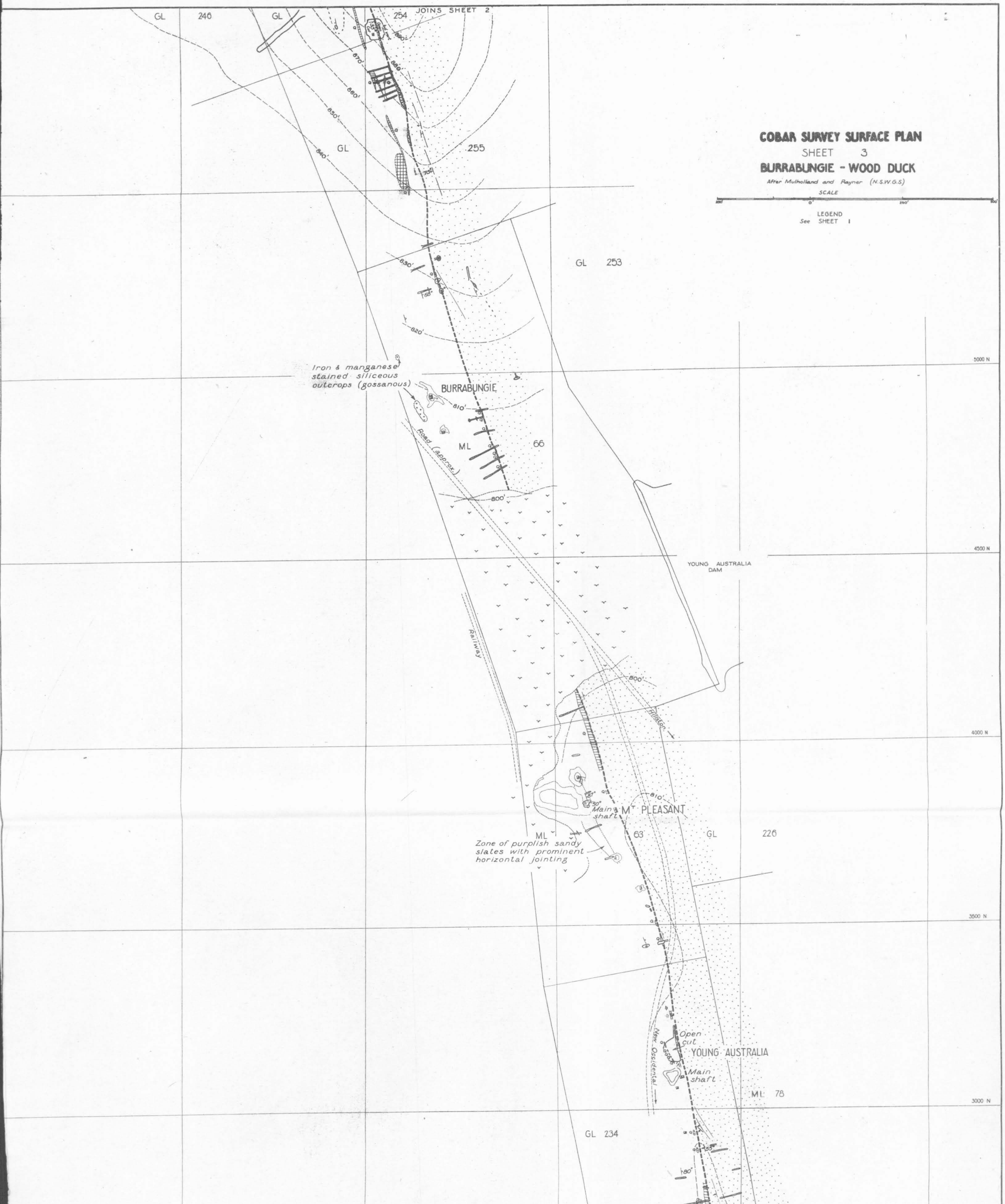
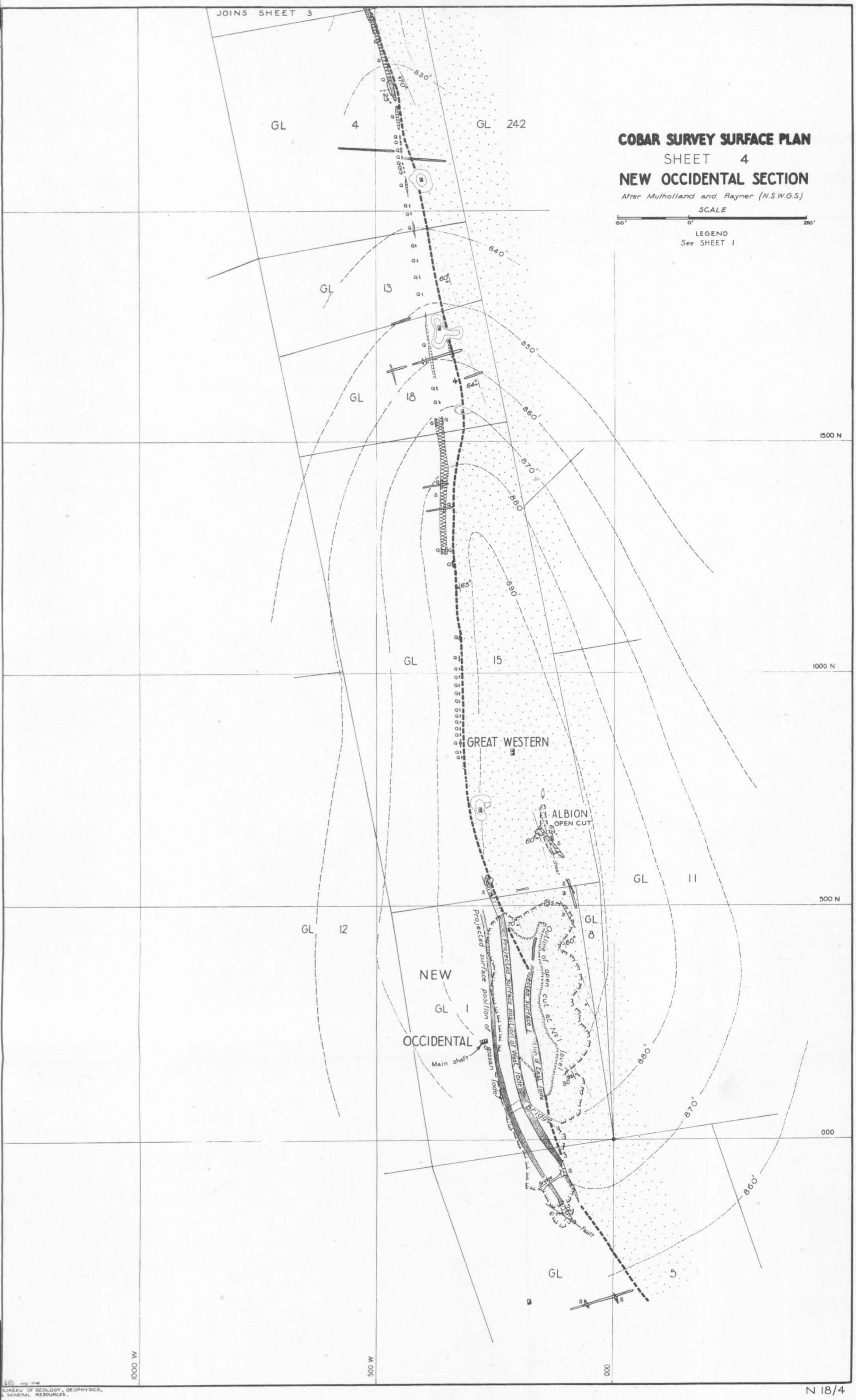
N 18/2

Bureau of Geology, Geophysics, & Mineral Resources.

N 18/1


COBAR SURVEY SURFACE PLAN
SHEET 3
BURRABUNGIE - WOOD DUCK
After Mulholland and Rayner (N.S.W.G.S.)
SCALE
250' 0' 250' 500'
LEGEND
See SHEET 1
JOINS SHEET 2
JOINS SHEET 4
GL 246
GL
254
GL
255
GL 253
Iron & manganese stained siliceous outcrops (gossanous)
BURRABUNGIE
ML
66
Road (approx.)
Railway
YOUNG AUSTRALIA DAM
Main shaft
Mt PLEASANT
ML
63
GL 226
Zone of purplish sandy slates with prominent horizontal jointing
Open cut
YOUNG AUSTRALIA
Main shaft
New Occidental
ML 78
GL 234
WOOD DUCK
5000 N
4500 N
4000 N
3500 N
3000 N
2500 N
2000 W
1500 W
1000 W
800'
810'
820'


JOINS SHEET 3
COBAR SURVEY SURFACE PLAN
SHEET 4
NEW OCCIDENTAL SECTION
After Mulholland and Rayner (N.S.W.G.S.)
SCALE
150'
0'
250'
LEGEND
See SHEET 1
GL 4
GL 242
GL 13
GL 18
GL 15
GL 11
GL 12
GL 8
GL 1
GL 5
830'
840'
850'
860'
870'
880'
890'
880'
870'
860'
1500 N
1000 N
500 N
000
1000 W
500 W
000
GREAT WESTERN
ALBION
OPEN CUT
NEW
OCCIDENTAL
Main shaft
Projected surface position of Gossan lode
Projected surface position of West lode
Projected surface position of East lode
Outline of open cut at No 1 level
Bridge
Fault

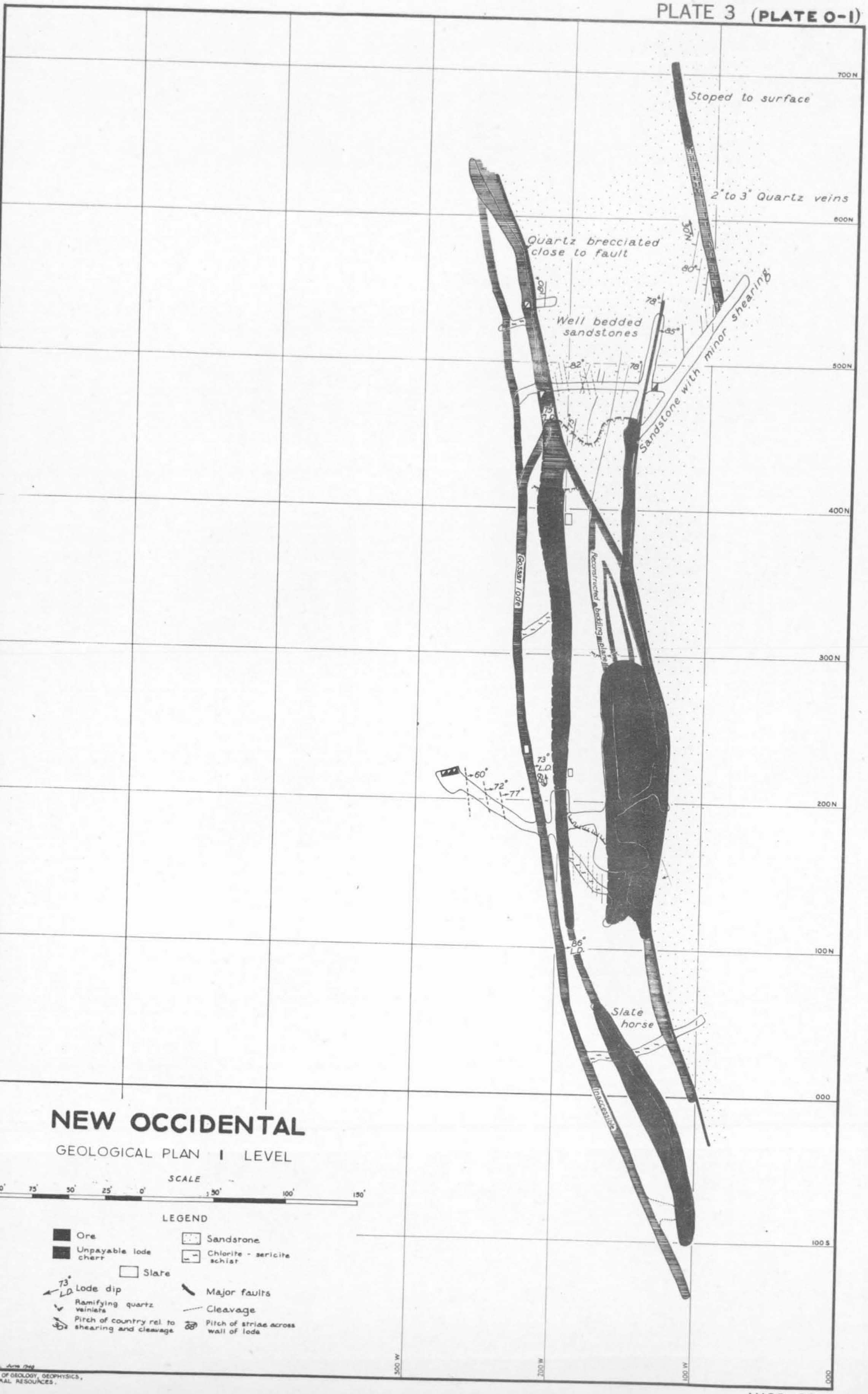


PLATE 3 (PLATE O-1)
Stoped to surface
2" to 3" Quartz veins
Quartz brecciated close to fault
Well bedded sandstones
Sandstone with minor shearing
Gossan lode
Reconstructed bedding plane
Slate horse
Inaccessible
700 N
600 N
500 N
400 N
300 N
200 N
100 N
000
100 S
300 W
200 W
100 W
000
NEW OCCIDENTAL
GEOLOGICAL PLAN I LEVEL
SCALE
100' 75' 50' 25' 0' 50' 100' 150'
LEGEND
Ore
Unpayable lode chert
Slate
Sandstone
Chlorite - sericite schist
Lode dip
Ramifying quartz veinlets
Pitch of country rel. to shearing and cleavage
Major faults
Cleavage
Pitch of striae across wall of lode
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N18B-36

NEW OCCIDENTAL

LONGITUDINAL PROJECTION
showing
ASSAY CONTOURS in DWT-FT

PLANE OF PROJECTION N(TRUE) 13°W VERTICAL THROUGH 350N-100W

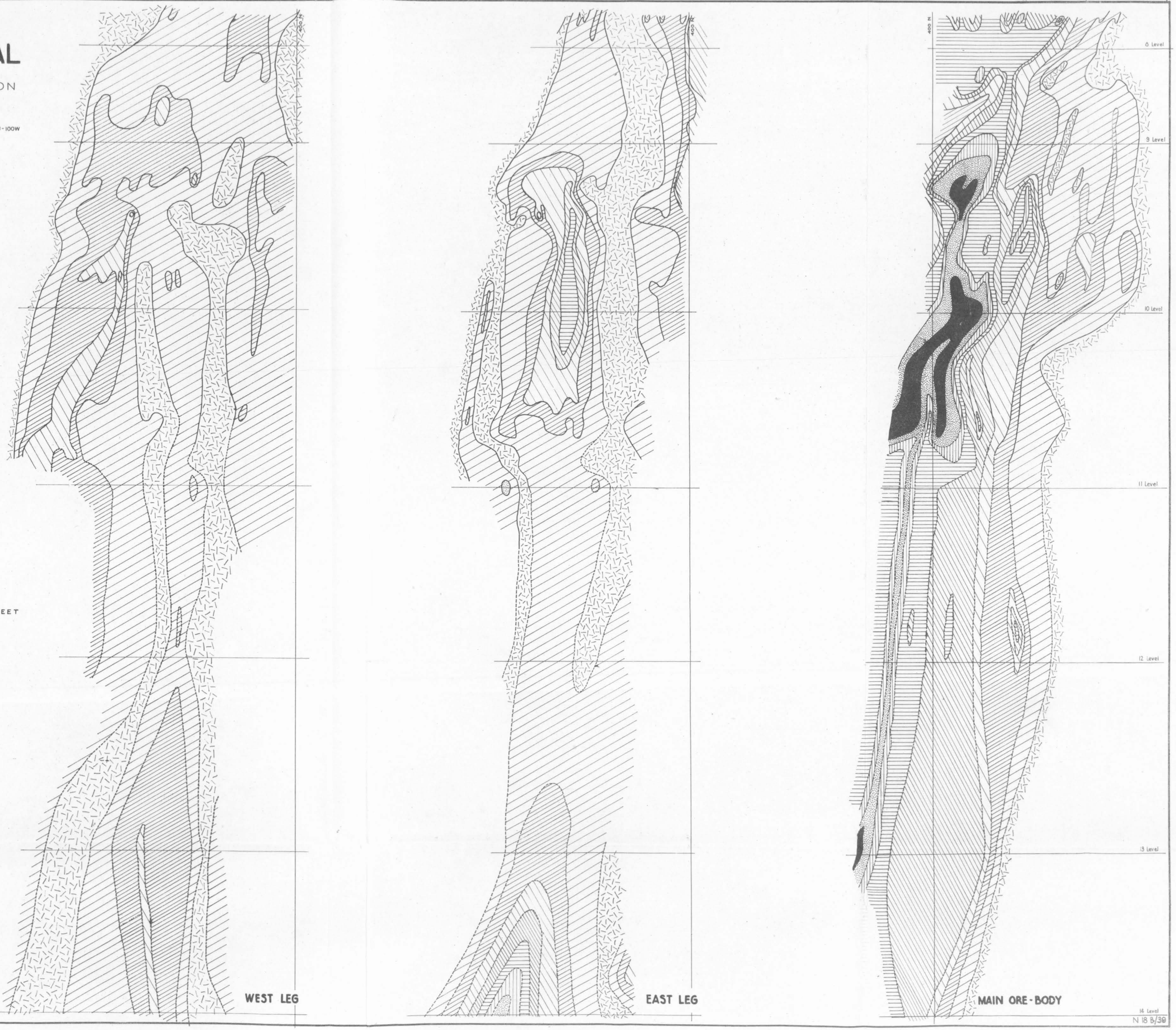
After Mulholland and Rayner (N.S.W.G.S.)

- +800 dwt-ft
- 700-800 dwt-ft
- 600-700 dwt-ft
- 500-600 dwt-ft
- 400-500 dwt-ft
- 300-400 dwt-ft
- 200-300 dwt-ft
- 100-200 dwt-ft
- 0-100 dwt-ft

Note: More assay data available above 11 level (solid lines) than below (broken lines)

SCALE

FEET 50 0 50 100 150 FEET



H.F.D. JUNE 1948
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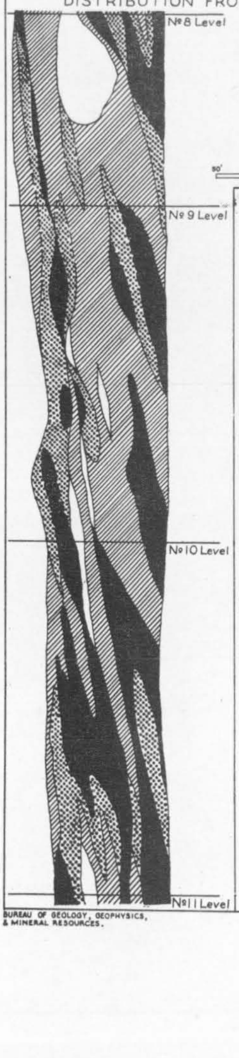
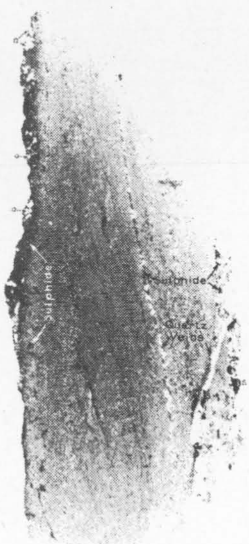
N 18 B/39

NEW OCCIDENTAL MINE

CROSS SECTION OF LODE SHOWING DETAIL OF ORE DISTRIBUTION FROM №8 TO №11 LEVELS

(After Mulholland & Rayner)





Photograph of thin section of ore oriented in plane of vertical cross section showing development of cleavage in direction of conjugate shearing

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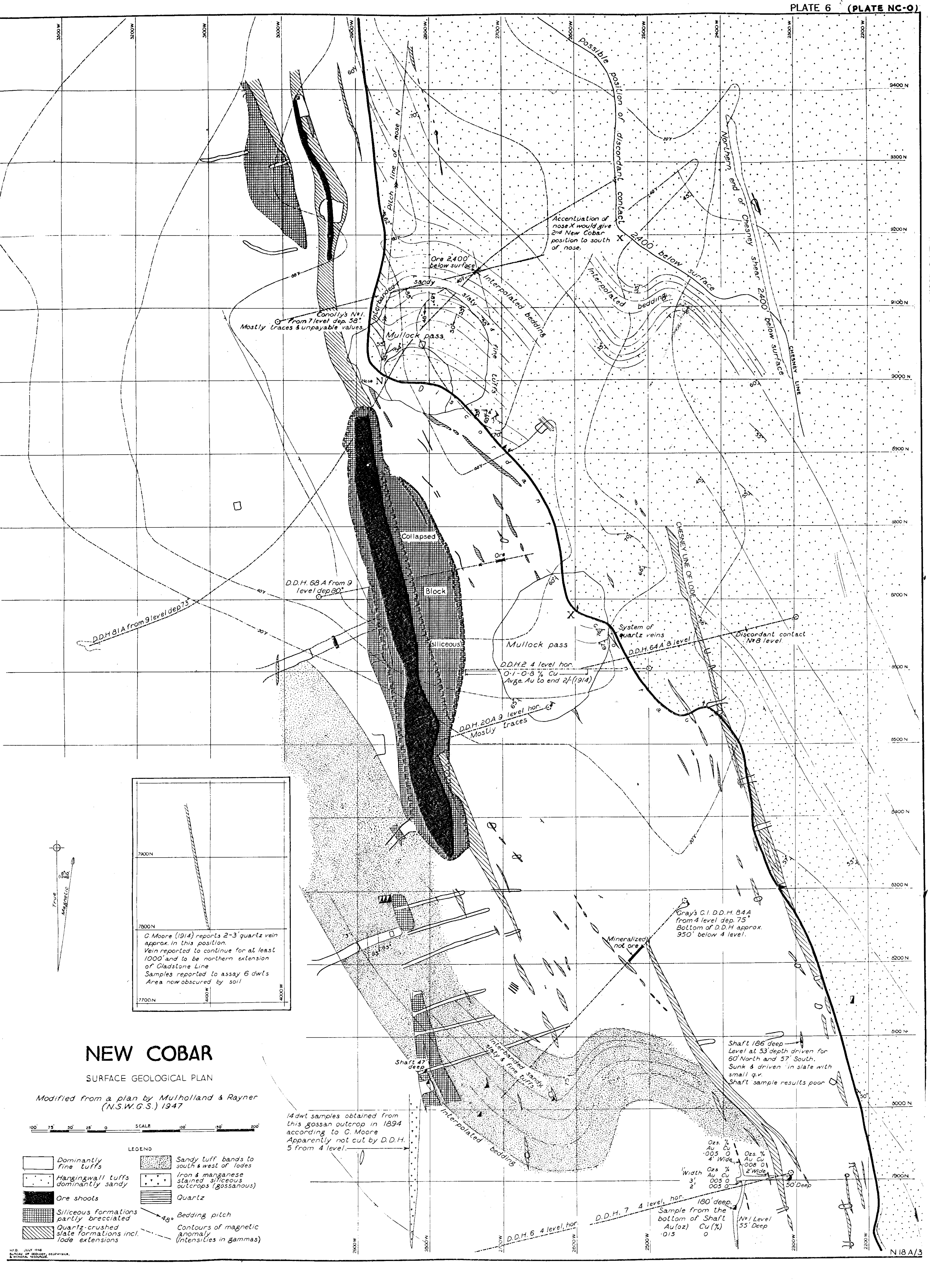
N 18 B/16


NEW COBAR
SURFACE GEOLOGICAL PLAN
Modified from a plan by Mulholland & Rayner (N.S.W.G.S.) 1947
SCALE
LEGEND
Dominantly fine tuffs
Hangingwall tuffs dominantly sandy
Ore shoots
Siliceous formations partly brecciated
Quartz-crushed slate formations incl. lode extensions
Sandy tuff bands to south & west of lodes
Iron & manganese stained siliceous outcrops (gossanous)
Quartz
Bedding pitch
Contours of magnetic anomaly (intensities in gammas)
Possible position of discordant contact
Northern end of Chesney shear 2400' below surface
2400' below surface
Accentuation of nose X would give 2nd New Cobar position to south of nose.
Ore 2,400' below surface
Pitch line of nose N
Interbanded sandy slaty & fine tuffs
Interpolated bedding
Conolly's Nº1. From 7 level dep. 58°. Mostly traces & unpayable values.
Mullock pass
Discordant
Collapsed
Block
Siliceous
D.D.H. 68 A from 9 level dep 80°
D.D.H. 81 A from 9 level dep 73°
Mullock pass
System of quartz veins
D.D.H. 64 A 8 level
Discordant contact Nº8 level.
D.D.H. 2 4 level hor. 0·1 - 0·8 % Cu. Avge. Au to end 2/- (1914)
D.D.H. 20 A 9 level hor. Mostly traces
CHESNEY LINE OF LODE
CHESNEY LINE
C. Moore (1914) reports 2-3' quartz vein approx. in this position. Vein reported to continue for at least 1000' and to be northern extension of Gladstone Line. Samples reported to assay 6 dwts. Area now obscured by soil
True
Magnetic
Gray's C.I. D.D.H. 84 A from 4 level dep. 75° Bottom of D.D.H approx. 950' below 4 level.
Mineralized not ore
Shaft 186' deep. Level at 53' depth driven for 60' North and 57' South. Sunk & driven in slate with small q.v. Shaft sample results poor
Shaft 47' deep
Interbanded sandy slaty & fine tuffs
Interpolated bedding
14 dwt samples obtained from this gossan outcrop in 1894 according to C. Moore. Apparently not cut by D.D.H. 5 from 4 level.
D.D.H. 6 4 level hor.
D.D.H. 7 4 level hor.
180' deep. Sample from the bottom of Shaft Au(oz) Cu(%) ·015 0
Nº1 Level 55' Deep
50' Deep
N 18 A/3
H.F.D. JULY 1948 BUREAU OF GEOLOGY, GEOPHYSICS, & MINERAL RESOURCES

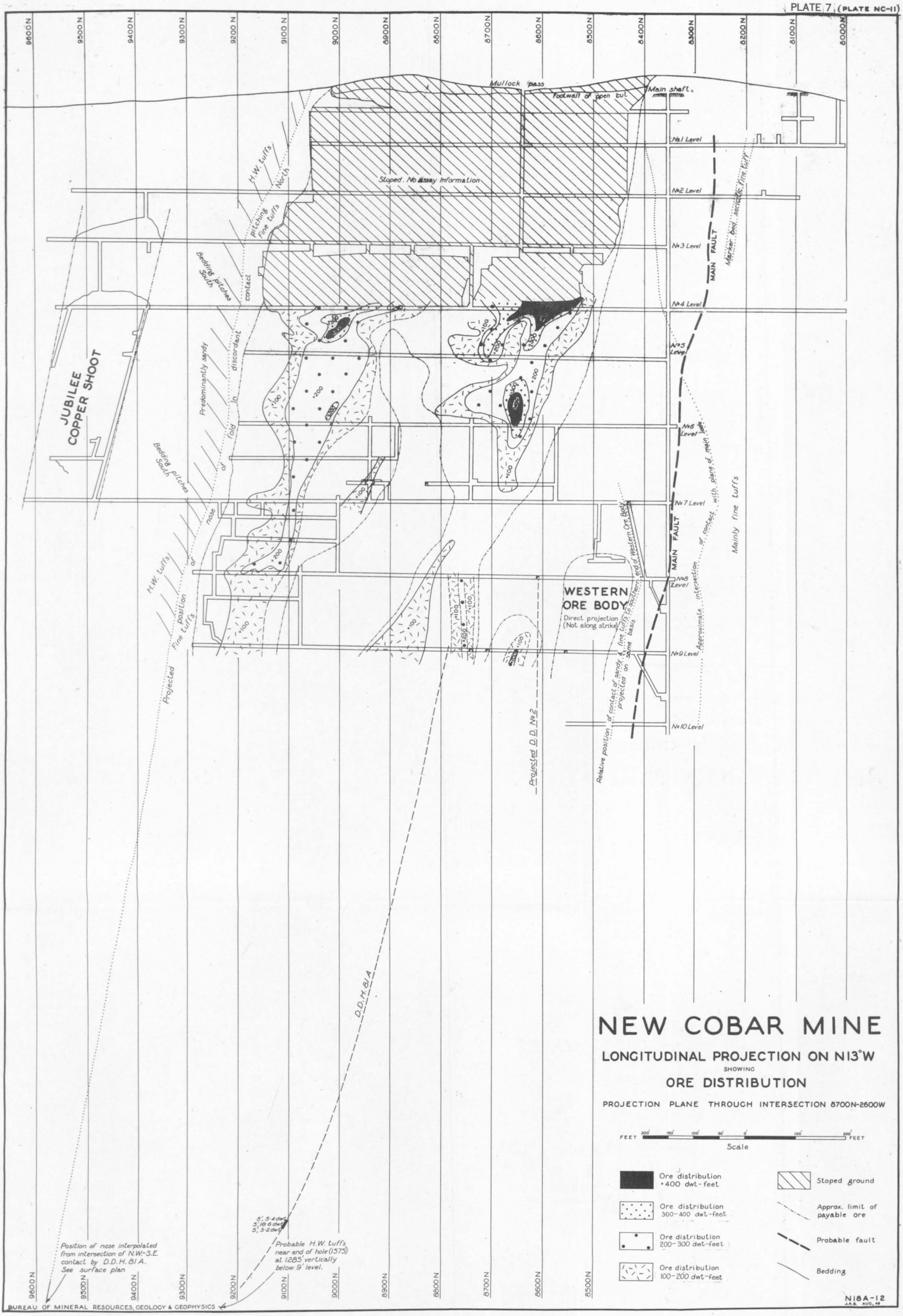
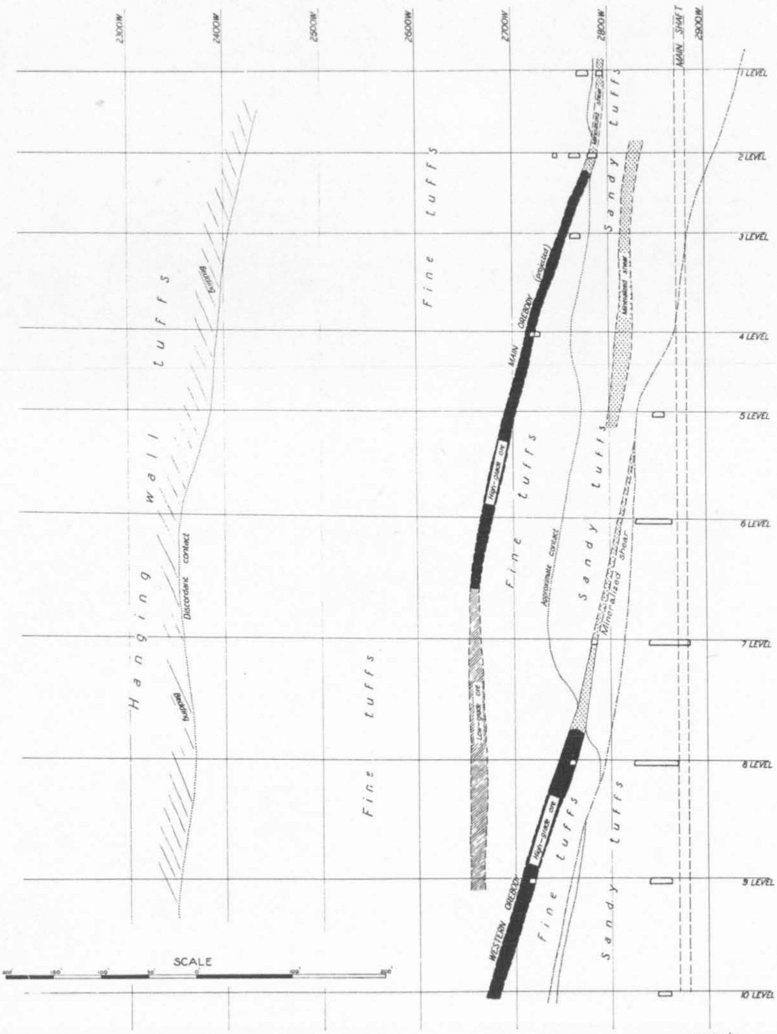


PLATE 7. (PLATE NC-11)
9600N
9500N
9400N
9300N
9200N
9100N
9000N
8900N
8800N
8700N
8600N
8500N
8400N
8300N
8200N
8100N
8000N
Mullock pass
Footwall of open cut
Main shaft
No.1 Level
No.2 Level
No.3 Level
No.4 Level
No.5 Level
No.6 Level
No.7 Level
No.8 Level
No.9 Level
No.10 Level
Stoped. No assay information
H.W. tuffs
North
pitching
Fine tuffs
Bedding pitches South
contact
discordant
in
fold
of
nose
or
position
Projected
Predominantly sandy
Bedding pitches South
H.W. tuffs
Fine tuffs
JUBILEE COPPER SHOOT
MAIN FAULT
Marker bed : sericitic fine tuff
Approximate intersection of contact with plane of main lode
Mainly fine tuffs
WESTERN ORE BODY
Direct projection (Not along strike)
Relative position of contact of sandy & fine tuffs to southern end of Western Ore Body projected on same basis
Projected D.D. No.2
D.D.H. 81A
5', 5·4 dwt
5', 18·6 dwt
5', 3·2 dwt
Position of nose interpolated from intersection of N.W.-S.E. contact by D.D.H. 81 A. See surface plan
Probable H.W. tuffs near end of hole (1575) at 1285' vertically below 9' level.
NEW COBAR MINE
LONGITUDINAL PROJECTION ON N13°W
SHOWING
ORE DISTRIBUTION
PROJECTION PLANE THROUGH INTERSECTION 8700N-2600W
FEET 200 150 100 50 0 100 200 FEET
Scale
Ore distribution +400 dwt-feet
Ore distribution 300-400 dwt-feet
Ore distribution 200-300 dwt-feet
Ore distribution 100-200 dwt-feet
Stoped ground
Approx. limit of payable ore
Probable fault
Bedding
BUREAU OF MINERAL RESOURCES, GEOLOGY & GEOPHYSICS
N18A-12

PLATE 8 (PLATE NC-12)

NEW COBAR MINE

Projection on vertical plane striking N55°E through 8300N, 2900W showing deflection and enrichment of orebodies on passing from sandy tuff to fine tuff, and change in dip of main orebody below No 6 Level accompanied by fall in grade.



N 18A/11

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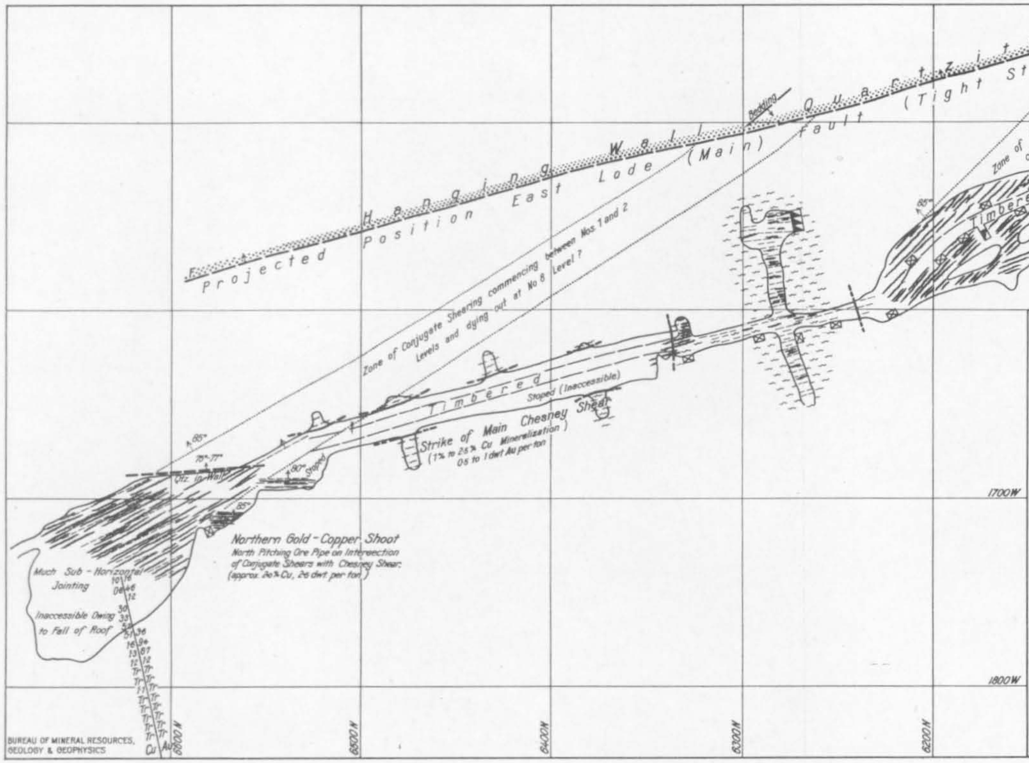
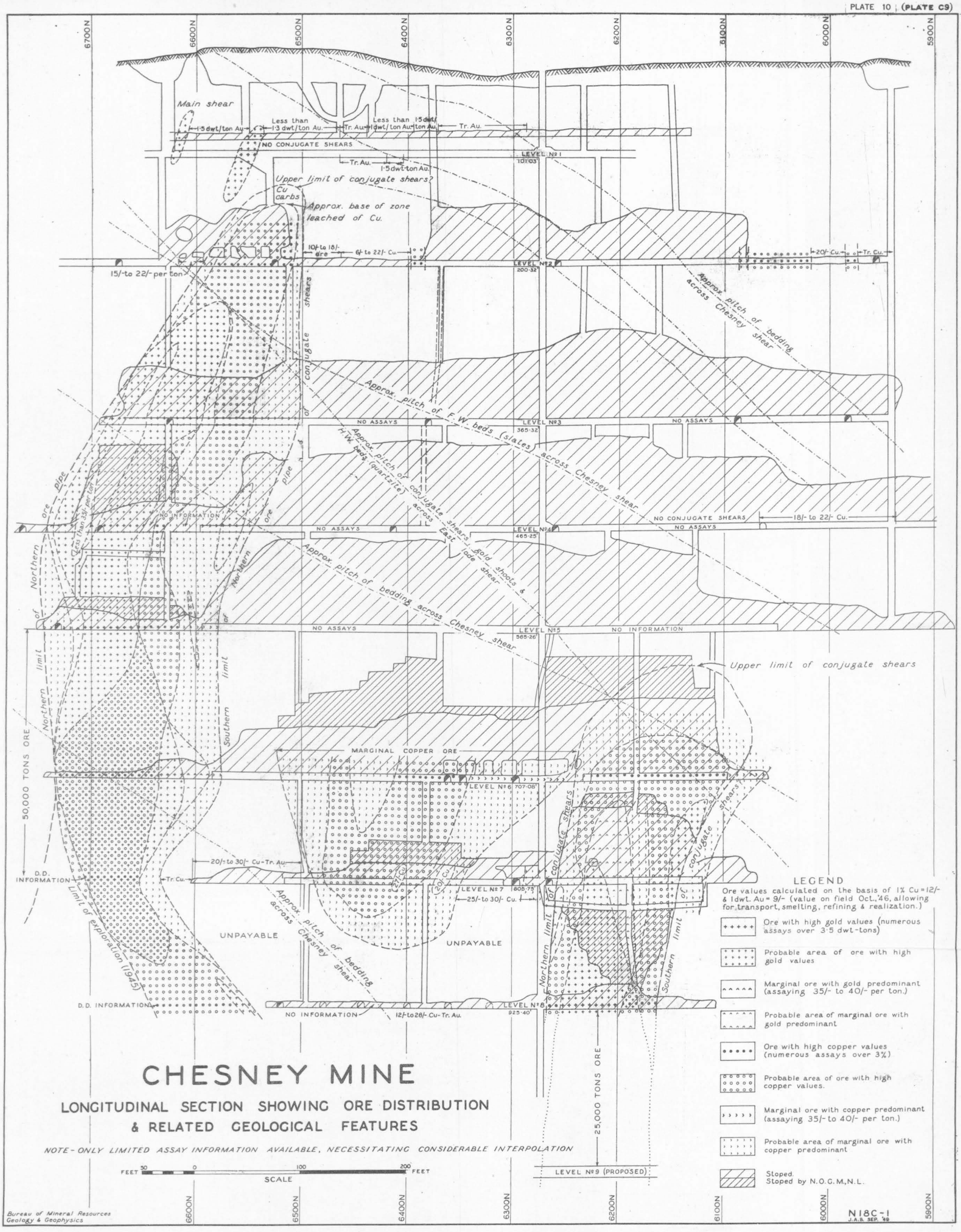
CHESNEY MINE

Plan of No 6 Level



Photograph of thin section of ore, oriented in horizontal plane, showing development of cleavage in direction of conjugate shearing and main shearing direction.

N18C-24


6700N
6600N
6500N
6400N
6300N
6200N
6100N
6000N
5900N
Main shear
1·5 dwt/ton Au
Less than 1·3 dwt/ton Au.
Tr. Au.
Less than 1·5 dwt/ton Au.
1 dwt/ton Au
Tr. Au.
NO CONJUGATE SHEARS
LEVEL Nº1 101·03'
Tr. Au.
1·5 dwt-ton Au.
Upper limit of conjugate shears?
Cu carbs
Approx. base of zone leached of Cu.
10/- to 18/- ore
6/- to 22/- Cu.
15/- to 22/- per ton
LEVEL Nº2 200·32'
20/- Cu.
Tr. Cu.
Approx. pitch of bedding across Chesney shear
Approx. pitch of F. W. beds (slates) across Chesney shear
limit of conjugate shears
NO ASSAYS
LEVEL Nº3 365·32'
NO ASSAYS
Approx. pitch of conjugate shears, gold shoots & H.W. beds (quartzite) across East lode shear
Northern limit of ore pipe
Southern limit of ore pipe
NO INFORMATION
Less than 33/- per ton
NO CONJUGATE SHEARS
18/- to 22/- Cu.
NO ASSAYS
LEVEL Nº4 465·25'
NO ASSAYS
Approx. pitch of bedding across Chesney shear
NO ASSAYS
LEVEL Nº5 565·26'
NO INFORMATION
Upper limit of conjugate shears
Northern limit
Southern limit
50,000 TONS ORE
MARGINAL COPPER ORE
LEVEL Nº6 707·08'
limit of conjugate shears
20/- to 30/- Cu-Tr. Au.
D.D. INFORMATION
Tr. Cu.
Limit of exploration (1945)
LEVEL Nº7 805·73'
25/- to 30/- Cu.
Approx. pitch of bedding across Chesney shear
UNPAYABLE
UNPAYABLE
Northern limit of conjugate shears
Southern limit
D.D. INFORMATION
LEVEL Nº8 925·40'
NO INFORMATION
12/- to 28/- Cu-Tr. Au.
25,000 TONS ORE
LEVEL Nº9 (PROPOSED)
CHESNEY MINE
LONGITUDINAL SECTION SHOWING ORE DISTRIBUTION & RELATED GEOLOGICAL FEATURES
NOTE - ONLY LIMITED ASSAY INFORMATION AVAILABLE, NECESSITATING CONSIDERABLE INTERPOLATION
FEET 50 0 100 200 FEET
SCALE
LEGEND
Ore values calculated on the basis of 1% Cu = 12/- & 1dwt. Au = 9/- (value on field Oct., '46, allowing for transport, smelting, refining & realization.)
Ore with high gold values (numerous assays over 3·5 dwt-tons)
Probable area of ore with high gold values
Marginal ore with gold predominant (assaying 35/- to 40/- per ton.)
Probable area of marginal ore with gold predominant
Ore with high copper values (numerous assays over 3%)
Probable area of ore with high copper values.
Marginal ore with copper predominant (assaying 35/- to 40/- per ton.)
Probable area of marginal ore with copper predominant
Stoped.
Stoped by N.O.G.M.,N.L.
Bureau of Mineral Resources Geology & Geophysics
N18C-1
J.A.B. SEP. '49

APPENDIX 1.*

Plans prepared and available for examination but not published in Report.

1. NEW OCCIDENTAL MINE

Plate O - 2 Geological Plan, No. 2 Level. Scale 1" = 40'
Plate O - 3 Geological Plan, No. 3 Level. Scale 1" = 40'
Plate O - 4 Geological Plan, No. 4 Level. Scale 1" = 40'
Plate O - 5 Geological Plan, No. 5 Level. Scale 1" = 40'
Plate O - 6 Geological Plan, No. 6 Level. Scale 1" = 40'
Plate O - 7 Geological Plan, No. 7 Level. Scale 1" = 40'
Plate O - 8 Geological Plan, No. 8 Level. Scale 1" = 40'
Plate O - 9 Geological Plan, No. 9 Level. Scale 1" = 40'
Plate O -10 Geological Plan, No.10 Level. Scale 1" = 40'
Plate O -11 Geological Plan, No.11 Level. Scale 1" = 40'
Plate O -12 Geological Plan, No.12 Level. Scale 1" = 40'
Plate O -13 Geological Plan, No.13 Level. Scale 1" = 40'
Plate O -14 Geological Plan, No.14 Level. Scale 1" = 40'
Plate O -15 Composite Assay Plan, Nos. 12, 13 and 14 Levels. Scale 1" = 20'
Plate O -17 Plans showing Outlines of Stopes Nos. 1-14 Levels. Scale 1" =100'
Plate O -18 Plan showing Distribution of Ore on Nos. 9-14 Levels. Scale 1" = 40'
Plate O -21 East-West Projections at 700N and 200N showing Possible new ore-body and existing Main Ore-body. Scale 1" =100'

2. NEW COBAR MINE

Plate N.C. - 5A. Assay Plan, No. 5 Level. Scale 1" = 40'
Plate N.C. - 6A. Assay Plan, No. 6 Level. Scale 1" = 40'
Plate N.C. - 7A. Assay Plan, No. 7 Level. Scale 1" = 40'
Plate N.C. - 8A. Assay Plan, No. 8 Level. Scale 1" = 40'
Plate N.C. - 9A. Assay Plan, No. 9 Level. Scale 1" = 40'
Plate N.C. - 1. Geological Plan, No. 1 Level. Scale 1" = 40'
Plate N.C. - 2. Geological Plan, No. 2 Level. Scale 1" = 40'

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* Plans listed hereunder may be examined at the office of the Bureau in Canberra and Melbourne, at the Mines Department, Sydney, and the office of New Occidental Gold Mines Ltd., Cobar.

3. CHESNEY MINE

4. PEAK MINE

APPENDIX 2.

PETROLOGY OF THE ROCKS IN THE NEIGHBOURHOOD OF THE NEW COBAR MINE

by

W.B. Dallwitz.

A. GENERAL STATEMENT

From the examination of between 130 and 140 thin sections of rocks from the New Cobar mine and the country in its immediate vicinity, it was concluded that all of them, and particularly the coarser-grained ones, are tuffaceous. The rocks have been divided, more or less arbitrarily, into three groups - tuffaceous sandstone, tuffaceous schist and argillaceous schist - according to grainsize. The tuffaceous sandstones show current-bedding in several places, and so it is clear that their component grains have been transported from their original resting-places by water or wind; that any transportation which took place was over a relatively short distance is shown by the angularity of most of the grains in these rocks.

Andrews (1911, 1913) and Mulholland and Rayner (1947) have referred to the rocks at and near the present working mines at Cobar as sandstones and slates, and several other geologists working privately have followed the same practice. In hand-specimens the tuffaceous nature of these rocks is not obvious, and the terms "sandstone" and "slate" are, in general, adequate for field usage. However, even some of the coarser rocks, particularly specimens from the underground workings, are macroscopically more like tuff than sandstone. Furthermore, in the vicinity of the ore-bodies, where shearing has been strongest, the fine-grained rocks have passed the stage of slate, and would more accurately be called low-grade schists, even in the hand-specimen.

It has been recognized previously that some of the rocks at Cobar and in the surrounding country are tuffaceous.

The following statements from Andrew's reports (1911 and 1913) are typical of his references to tuffs and lavas:-

(1911), p.48: In describing rock No. 8193 from M.L.5, Parish of Cobar, he says: "Under the microscope, the general appearance suggests a possibility of tuffaceous origin. ------- The particles (of quartz) are quite irregular in form."

(1911), p.49: Part of the description of rock No. 8106, from near the Queen Bee Trigonometrical Station, reads: "The quartz particles are very angular, and lie quite without orientation. The rock may, perhaps, be an altered tuff."

(1911), p.63: Relevant extracts from the description of rock No. 8175 from the Rabbit Hill mine are as follow:-
"Numerous fragments lie in a matrix. These consist principally of gray slate and granite; they are of varying shapes and dimensions, 10 m.m. being an approximation to a commonly occurring size. The rock seems to be a volcanic breccia."

(1911), p.69: In referring to the rocks of The Peak area he writes of "hard green sandstones or arenaceous tuffs".

(1913), p.16: "Conglomerates, quartzites, and tuffaceous sediments are fairly abundant in the younger members of the various series."

(1913), p.17: "Thirty-one miles (towards Nyngan) from Cobar the cherts and claystones give place to rhyolites, quartz-felspar porphyries, and tuffs, which stretch in unbroken manner for a distance of 12 or 13 miles" (towards Cobar).

(1913), p.31: In his account of the Mount Boppy Series, he says: "the tuffaceous material suggests the redistribution of volcanic matter by currents in a shallow sea."

(1913), p.33: The following is written of rocks outcropping near the 15-mile peg on the Nymagee-Hermidale road: "The abundant presence of tuffs, breccias (and agglomerates), the flow structures in the porphyries, and the lack of holocrystalline structure in the porphyries, coupled with their great width, namely from 1 to 3 miles, suggest a volcanic origin."

(1913), p.37: In describing a thin section of a rock from No. 3 Hill, Florida, he writes: "Angular fragments of quartz, of all shapes and sizes, comprise about one-half the rock, with finely clastic material making up the rest. A creamy quartz tuff". On p. 38 he continues: "Volcanic ash, angular fragments mainly quartz----". Referring to another rock he says: "Shattered phenocrysts of quartz and felspar, in a devitrified groundmass, which may perhaps be a pumice ash, in which case the whole rock will be tuffaceous".

From the above quotations it is clear that volcanic rocks are abundant in the neighbourhood of Cobar; it is probable that they are much more widespread than suggested by Andrews, because very little detailed work, particularly microscopic work, has been done on them. It is not surprising, therefore, that some of the Cobar rocks described in this report are tuffaceous.

Andrews' remark (1913, p.31) that the tuffaceous material has been redistributed "by currents in a shallow sea" accords with a conclusion that I reached independently before reading his reports; however, I would go further and must draw attention to the strong possibility that many, if not all, of the tuffaceous rocks, close to Cobar at any rate, have been transported short distances by streams from the site of their original deposition. This is suggested by the circumstancesthat many of the tuffaceous sandstones show regular bedding, a feature which, coupled with their general appearance in the hand-specimen, undoubtedly led past investigators to describe them simply as sandstones.

B. CLASSIFICATION AND DESCRIPTION OF ROCK TYPES AND THE SIGNIFICANCE OF THEIR DISTRIBUTION

Samples of country-rock, free from mineralization (particularly silicification) as far as possible, were collected at ten-foot intervals from the accessible parts of all levels in the mine; selected specimens were sectioned and studied microscopically.

Unweathered rocks were classified arbitrarily in a two-fold way, first, according to their colours in thin section and, secondly, according to grainsize as observed under the microscope. Weathered rocks, from the surface as well as from underground, could of course be classified only on the basis of grainsize. The depth of colour in the fresh rocks depends mainly upon the amount of chlorite they contain.

Following are the schemes of classification adopted:-

TABLE I - GRAINSIZE-CLASSIFICATION FOR ALL ROCK-TYPES

	Criteria	Description
A.	Very fine schistose base containing few or no grains circ. 0.035 m.m. in diameter (fig. 1)	Argillaceous schist
B.	Very fine schistose base containing fair number of grains circ. 0.035 m.m. in diameter	
C.	Very fine schistose base containing numerous grains circ. 0.035 m.m. in diameter	
D.	Rock consists almost entirely of grains circ. 0.035 m.m. in diameter (fig. 2)	Tuffaceous schist
E.	Scattered coarse grains (circ. 0.2 m.m. across) in a fine base which may correspond to either B, C, or D above (fig. 3)	
F.	Abundant coarse grains (circ. 0.2 m.m. across) in fine base (figs. 4 to 10)	Tuffaceous sandstone
G.	Cryptocrystalline	Chert

Rocks belonging to all types from A to E inclusive are found interbanded with tuffaceous sandstone to the west and south of the lodes.

TABLE II - COLOUR CLASSIFICATION FOR ARGILLACEOUS SCHIST, DIFFERENTIATED ACCORDING TO DEGREE OF CHLORITIZATION

	Colour of thin section	Description
1.	Dark green	Strongly chloritized argillaceous schist
2.	Medium green	
3.	Light green	
4.	Grey-green	Moderately chloritized argillaceous schist
5.	Greenish-grey	
6.	Light greenish-grey	Sericitized argillaceous schist
7.	Light grey	

(The colour-names listed in the first column of Table II have been allotted arbitrarily, though consistently, to the different rock-types, merely as a guide to the method used in differentiating them. These names are not to be taken literally as representing the true colours of the rocks in section, because the procedure that was followed was that the sections were graded on a colour-basis and then the names were allotted only for convenience in preparing the chart).

Nos. 8 and 9 levels were examined in considerable detail - more than 80 slides were made of rocks from these levels - to find whether there was any relationship between the grainsize of rocks and ore-distribution. This work merely confirmed what was already known, namely, that payable ore is confined to the argillaceous schist and is absent from the tuffaceous sandstone on the eastern side of the discordant contact and from the inter-banded tuffaceous sandstone, tuffaceous schists and argillaceous schists in the vicinity of the Main shaft (these latter rocks continue north and south-east of the shaft - Plate 6).

Some narrow bands of tuffaceous sandstone and tuffaceous schist were found within the ore-bearing zone (Plates N.C.7 and 9); the number of these is so small that their influence on ore-deposition seems to have been negligible. Differences in grainsize within the range A to D in Table I were noted in the argillaceous schist, but they appear to have had no influence in determining the positions of ore shoots. The only significant feature is that most of the rocks are fine-grained - a circumstance which apparently favoured deposition of ore.

In general it was found that chloritization was much greater in the ore-bearing shears themselves than in the areas outside of them. Furthermore, the intensity of chloritization is related to the length and intensity of the shears; thus, the gash-fracture system containing the Western orebody is less strongly chloritized than is the compression-shear in which the main lode-system occurs.

Some rocks on Nos. 8 and 9 levels did not fit strictly into the zones shown as being chloritized in different degrees. Thus, a few rocks in the strongly chloritized area belong strictly to the moderately chloritized section, whereas two or three of the rocks in the sericitic zone are actually moderately or strongly chloritized. However, the zones were defined on the evidence supplied by a majority of the specimens.

With one exception the rocks in the No. 9 level footwall crosscut were sericitic.

Although many of the geological boundaries on the plans are shown as being definite, they are seldom so in actual fact. Even the position of the discordant contact itself is difficult to mark, mainly because the rocks on either side of it may be interbanded (see Plate 6); bands in and near mullock cut at about 9,100N, 2,800W; Plate N.C.-7, bands in No. 7 level hangingwall crosscut).

The geological boundaries are generally, though not everywhere, gradational. Typical examples of the grading from one rock type to another are to be seen in the No. 9 level footwall crosscut and in the No. 1 level crosscut from the shaft towards the Western orebody. No doubt, if they were studied in detail, similar differences in rock type would be seen in the footwall tuffaceous sandstone on No. 9 level in the vicinity of the shaft and on all the other levels.

Even more indefinite than the boundaries between rock types in the footwall tuffaceous sandstone band are the boundaries between the footwall sandstone and the ore-bearing argillaceous schist, and also the boundaries between the zones of chloritization within the argillaceous schist. Because of this obscurity, in some places, such boundaries have not been marked definitely on the plans, but a space has been left uncoloured between the different horizons and zones, respectively. No amount of microscopic study would make it possible to mark in all geological boundaries and zones of chloritization with precision.

As a result of the close study of Nos. 8 and 9 levels and, to a lesser extent, of Nos. 7 and 10 levels, it was decided that detailed work on the other levels was not warranted. The only important distinctions were found to be the broad ones between the hangingwall tuffaceous sandstone, the ore-bearing argillaceous schist, and the interbanded, sandy and argillaceous rocks on the footwall side of the lodes.

However, it must be pointed out that careful noting of the degree of chloritization, especially in diamond-drill cores, could be of direct service in prospecting, as strong to moderate development of chlorite in the rocks over a width of some tens of feet, at any rate, has been shown to be significant in that it marks a zone of mineralization and, probably, of stronger shearing.

Following are generalized descriptions of the various rock types.

1. Argillaceous schist (figures 1, 2 and 12). In a very fine-grained base consisting of sericite, chlorite, quartz and microcrystalline (felsitic ?) material in various proportions are commonly set grains of quartz which are of the order of 0.03 to 0.4 m.m. across. The number of these quartz-grains is very variable; none at all may be present, or, at the other extreme, the rock may be made up almost entirely of them (Figure 2). Some of the grains have become elongated during shearing.

Chlorite, where present, in most instances is not evenly distributed throughout the rock. It is, therefore, probably not of metamorphic origin, because more or less uniform distribution would be expected in a fine-grained rock subjected to low-grade regional metamorphism. It is found in streaks, lenses and veinlets; the veinlets commonly branch and then re-unite farther along their course. In some places it wraps around isolated grains of introduced quartz. Several sections show that chlorite is more abundant close to quartz veinlets; others, again, contain streaks of chlorite arranged "en echelon". All this suggests that the chlorite is of metasomatic origin.

Variable amounts of one or more of the three minerals pyrrhotite, pyrite and magnetite are present in all unweathered argillaceous schist.

A brecciated structure is found in some specimens, dark fragments being embedded in a lighter groundmass (Figure 12). Many of these fragments are drawn out into lenses lying parallel to the cleavage; part of one of these lenses is seen on the left of Figure 12.

2. Tuffaceous schist (Figure 3), as suggested in Table 1, differs from argillaceous schist mainly in having larger grains of quartz (about 0.2 mm. across) embedded in a fine base, which was found to belong to one of the classes B, C or D of Table 1. The other difference is that the rocks belonging to this group are less chloritized than is the argillaceous schist, largely because they are generally interbanded with the more competent tuffaceous sandstones in the vicinity of the Main shaft and were, therefore, less amenable to shearing and the introduction of chlorite.

3. Tuffaceous sandstone. This rock-type is illustrated in Figures 4 to 10. Numerous sections show that these rocks are either entirely free from shearing or only slightly sheared.

In a fine-grained, partly felsitic groundmass containing some sericite and fine-grained chlorite are set angular to rounded grains and fragments of quartz, sericitized microcrystalline (felsitic) material and sericitized felspar, together with a few flakes of muscovite and chlorite. The accessory minerals are black iron ore (possibly ilmenite) changing to leucoxene, zircon and apatite. Pyrite and pyrrhotite have been introduced during the process of ore-deposition; pyrite is seen to have replaced black iron ore in some specimens.

Water-sorting of the constituent grains in the tuffaceous sandstones has been a very unimportant factor in their deposition. Grains of all sizes from the maximum to the minimum lie in juxtaposition, and any suggestion of bedding seen in thin section is usually a rough grading only. Relatively coarse sandstones grade into finer types; the comparatively sharp line of demarcation shown in Figure 11 is exceptional. In the long footwall cross-cut on No. 9 level, for example, no sharp dividing line can be drawn between the different rock-types shown; however, a more detailed study would undoubtedly make possible numerous other fine divisions within the footwall tuffaceous sandstones both there and on other levels. On most level plans the footwall sandstone belt has been left entirely undifferentiated.

Only one sample was found in which the tuffaceous character of these rocks could be seen megascopically without doubt, though it must be mentioned that most of them were not convincingly like ordinary sandstone even in the hand specimen. This undoubtedly tuffaceous rock is from No. 2 level at co-ordinate position 8,333N, 2,791W; it carries fragments of bleached argillaceous schist up to $\frac{1}{3}$ inch long in a base of tuffaceous sandstone.

As would be expected the number of quartz veinlets decreases markedly on passing from argillaceous schist to tuffaceous sandstone. In a few places the quartz in these veins shows comb-structure. The following minerals may accompany the quartz:- chlorite, pyrrhotite, pyrite, magnetite and calcite. The chlorite in some of the veins has a decussate or partly spherulitic structure, and it is pleochroic from medium green to greenish-yellow. Furthermore, it may contain numerous dark pleochroic "haloes", although no inclusions of radio-active minerals were seen in their centres.

In some sections of argillaceous schist, quartz veinlets occupy joint-planes making an angle of 70 to 80 degrees with the cleavage. Such veins have been seen on a larger scale in the mine-openings, and have been discussed in the general report. In other sections, highly tortuous quartz-veinlets were found; they can best be described as having been ptygmatically folded on a minute scale.

Grains of pyrrhotite and pyrite in the body of the rock (i.e., other than in quartz veins) may have "fingers" of quartz lying at right angles to their boundaries in the direction of cleavage.

Returning to a consideration of the tuffaceous sandstones, it is found that their general similarity of character on the eastern side of the discordant contact persists from the surface to the depth reached in d.d.h. 81A (see Figures 4 to 8). The tuffaceous sandstone on the footwall side of the lodes maintains its characteristics from the surface to No. 10 level (Figure 9) and shows a general likeness to the hangingwall tuffaceous sandstone. This similarity persists southwards to the New Occidental mine (see Figure 10, which is representative of tuffaceous sandstone from the eastern side of the discordant contact at No. 8 level). It is clear that there are considerable differences of grainsize between the various tuffaceous sandstones shown in the microphotographs; this is to be expected in a volcanic environment, but the fact remains that there is a broad textural similarity between all these rocks, sufficient to distinguish them as a group from tuffaceous schist and argillaceous schist.

A close examination of core from the last 10 feet of d.d.h. 81A makes it appear that it is by no means certain that the hole has penetrated east of the discordant contact. Undoubted tuffaceous sandstone (finer-grained than usual - see Figure 8) does occur there, but it has been found that a band of tuffaceous sandstone, also rather fine-grained, is found on No. 7 level (see Plate N.C. -7) at a place which is probably west of the true contact. D.d.h. 81A may have reached this or some similar band and may not have penetrated the ultimate contact; the dip of the contact may, therefore, be less steep than is shown in Plate 7. Diamond drill holes searching for the contact should be extended for approximately 50 feet beyond the first tuffaceous sandstone to make reasonably certain that the contact has been reached. In the cross-cut on No. 7 level, in d.d.h. 81A and in many places on the surface, it is impossible to define the contact within some feet because of interbanding of different rock-types. However, if a true thickness of about 50 feet of tuffaceous sandstone is observed in the approximate predicted position of the contact, it can reasonably be assumed that this feature has been intersected. There is generally no obvious disturbance or break in the rocks at the contact, and so it is seldom easy to be certain of its position. For example, in mapping the south-east-trending fold in the discordant contact on the surface at New Cobar, it was not possible to trace the contact as such, but instead it was found necessary to plot outcrops of tuffaceous sandstone and argillaceous schist on the plan and then interpolate a boundary that appeared to be reasonable between the two rock-types.

C. CONCLUSIONS

A detailed study of the rocks in the vicinity of the New Cobar mine has shown that some of them are partly tuffaceous. The recognition of this fact draws attention to at least one important point, namely, that it will probably not be possible to use any narrow bed as a marker in attempting to elucidate the detailed structure of the mines. In a volcanic environment beds are likely to lens out more rapidly than under normal subaqueous conditions of sedimentation. Thus, most of the narrow bands of tuffaceous schist and argillaceous schist in the tuffaceous sandstone horizon near the Main shaft cannot be traced as separate units, even from one level to the next. Tuffaceous and argillaceous schist components make up a much larger proportion of the total width of this horizon in the upper levels of the mine than in the lower. However, it will probably be possible to use relatively wide zones of mixed rocks, such as the tuffaceous sandstone belt to the west and south of the New Cobar Main shaft, as markers; Plate 6 shows that this belt follows reasonably closely the trend of the folded discordant contact.

As far as the orebodies at New Cobar are concerned, the work done confirms the previously accepted idea that the lodes are confined to the finer-grained rocks, namely, the argillaceous schists, and are absent from those rock groups which consist predominantly of tuffaceous sandstone and tuffaceous schist. Within the argillaceous schist belt the positions of the orebodies are controlled by shear zones, whose location can reasonably be explained as being connected with the folding of the discordant contact (see general report above). At the time of mineralization much chlorite was introduced into rocks within and around the lodes, and the intensity of chloritization decreases outwards from the orebodies.

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Mulholland, C. St. J. and Rayner, E.O., 1947:	The Gold-Copper Deposits of Cobar, N.S.W., Part 1., Central Section (Great Cobar-New Occidental). N.S.W. Dept. Mines, Geol. Surv. (unpublished).

DESCRIPTIONS OF FIGURES

Figure 1. Spec. 49: Argillaceous schist of Class A, Table 1. From No. 9 level, New Cobar mine.

Co-ordinate position: 8528N, 2748W. Base is largely sericite; clear grains are quartz, black grains are probably magnetite, together with a little pyrite. The elongated opaque grain on the right lies along the cleavage. Magnification: 72 diameters. Ordinary light.

Figure 2. Spec. 5: Argillaceous schist of Class D, Table 1. From No. 8 level, New Cobar mine.

Co-ordinate position: 8327N, 2848W. Consists largely of almost contiguous grains of quartz; a little sericite, calcite, and chlorite in the base. Black grains are mainly pyrrhotite.
Magnification: 72 diameters. Ordinary light.
Argillaceous schist Classes B & C, Table 1, are intermediate between A & D.

Figure 3. Spec. 72: Tuffaceous schist, No. 9 level, New Cobar mine.

Co-ordinate position: 8605N, 2991W. Grains of quartz (Q), more numerous than in average tuffaceous schist, in base of argillaceous schist of Class B (Table 1).
Black grains are probably magnetite.
Magnification: 72 diameters. Ordinary light.

Figure 4. Spec.191: Tuffaceous sandstone from surface outcrop of hanging-wall sandstone, New Cobar area.

Groundmass consists of quartz, sericite and felsitic or cryptocrystalline material. Q = quartz. Black areas represent haematite.
Magnification: 72 diameters. Ordinary light.

Figure 5. Spec.191: Same field as in Figure 4 between crossed nicols.

Figure 6. Spec.171: Tuffaceous sandstone from No. 7 level east cross-cut, New Cobar mine.

Co-ordinate position: 9168N, 2681W. Groundmass is quartz, sericite, chlorite and felsitic or cryptocrystalline material. Black grains are magnetite or ilmenite.
Q = quartz; Ft. = fragment of sericitized felspar or of altered, rhyolitic groundmass. Note concave boundaries of some quartz grains.
Magnification: 72 diameters. Ordinary light.

Figure 7. Spec.171: Same field as in Figure 6 between crossed nicols.

Figure 8. Spec.199: Tuffaceous sandstone from extreme end (1,575') of d.d.h. 81A, New Cobar mine.

Magnification: 72 diameters. Ordinary light.

Figure 9. Spec. 89: Tuffaceous sandstone from No. 10 level, cross-cut near Main shaft, New Cobar mine.

Co-ordinate position: 8390N, 2822W. Groundmass as for Figure 4. Q = quartz. F = sericitized felspar. Note concave boundaries of some quartz-grains, and also strong embayment, probably due to magmatic corrosion, in the large grain.
Magnification: 72 diameters. Ordinary light.

Figure 10: Spec. 189A: Tuffaceous sandstone from No. 8 level hangingwall cross-cut, New Occidental mine.

Co-ordinate position: 250N, 80W, approximately. Groundmass is quartz, sericite, chlorite and felsitic or cryptocrystalline material. Q = quartz; Ft. = fragment of altered felsitic material; Ft' = fragment of sericitized felspar or of rhyolitic groundmass ; S = original flake of coarse sericite (muscovite).
Magnification: 72 diameters. Ordinary light.

Figure 11: Spec. 62: Junction of bed of tuffaceous sandstone with bed of argillaceous schist of Class A (Table 1), No. 9 level, New Cobar mine.

Co-ordinate position: 8382N, 2834W, C = cleavage-direction, which is at an angle of approximately 17 degrees to the bedding (B). Black grains are pyrite and black iron ore.
Magnification: 72 diameters. Ordinary light.

Figure 12: Spec. 22: Brecciated argillaceous schist of Class B, Table 1. From No. 8 level, New Cobar mine.

Co-ordinate position: 8557N, 2750W. Fragments of darker schist in light-coloured base. Black grains probably magnetite.
Magnification: 72 diameters. Ordinary light.

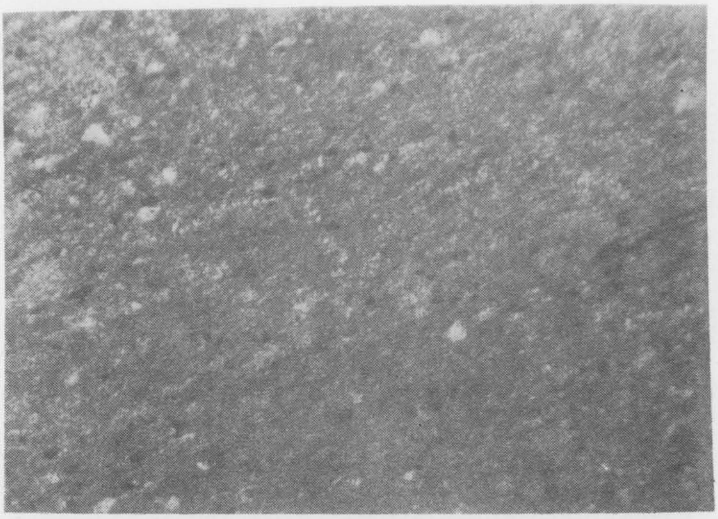

Fig. 1.

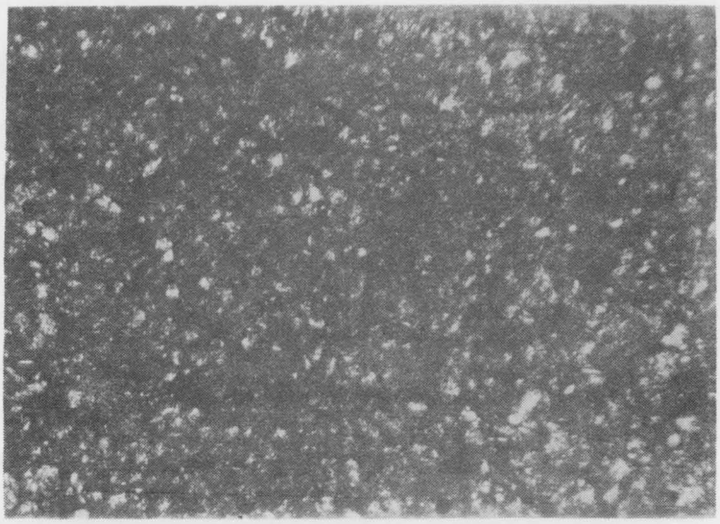

Fig. 2.

Fig. 3.

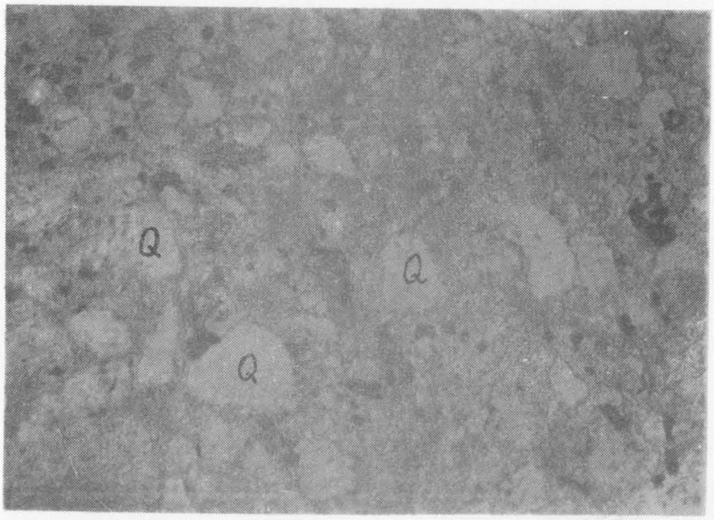

Fig. 4.

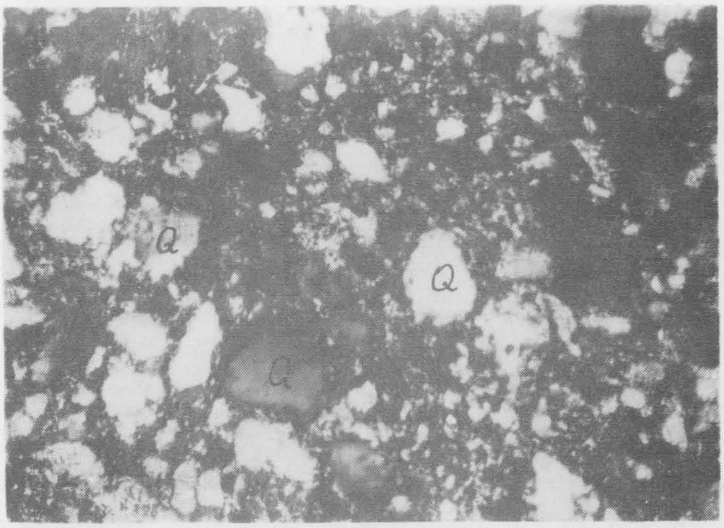

Fig. 5.

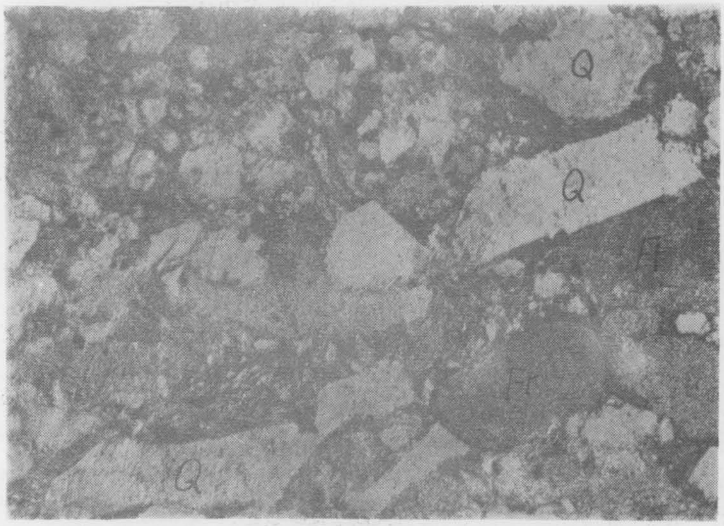

Fig. 6.

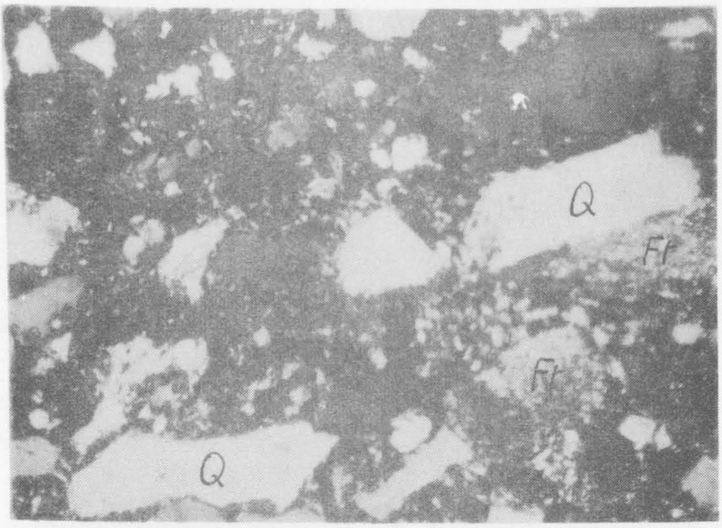

Fig. 7.

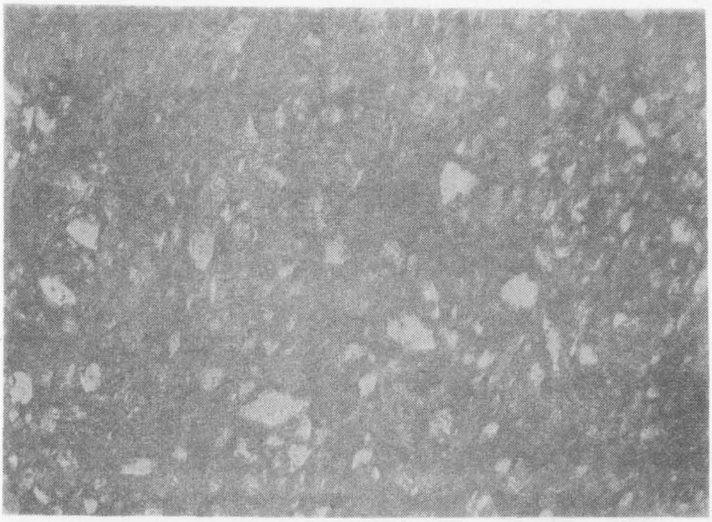

Fig. 8.

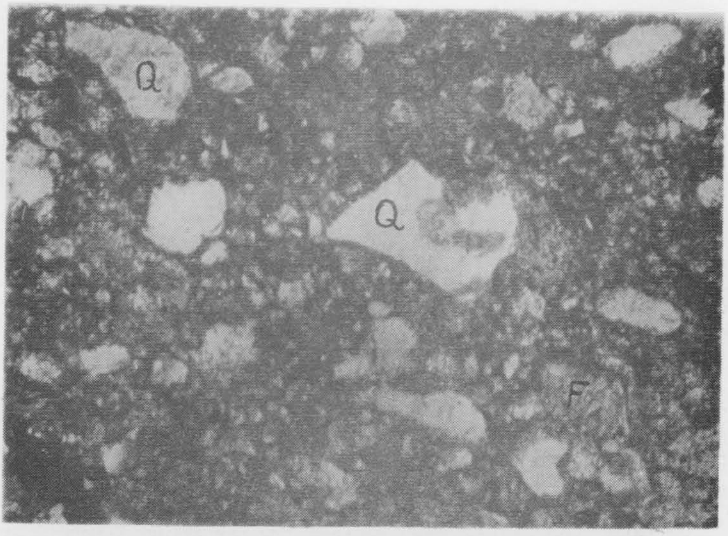

Fig. 9.

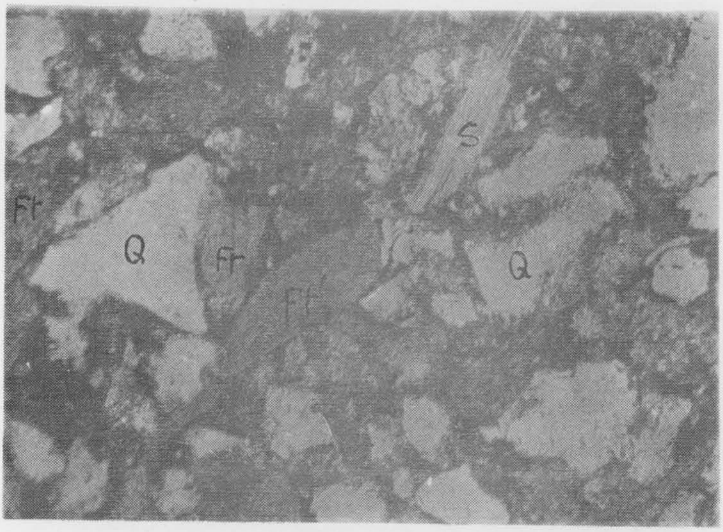

Fig. 10.

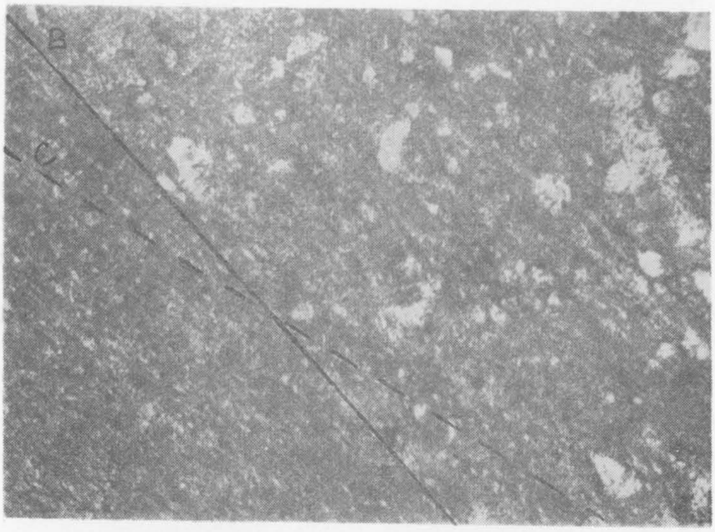

Fig. 11.

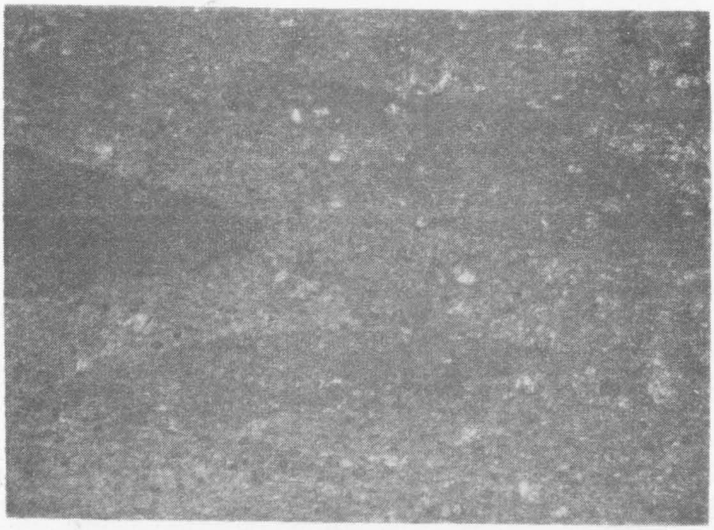

Fig. 12.

ORE SPECIMENS FROM NEW COBAR MINE*

by

Frank L. Stillwell

Specimens of ore from the Western ore-body, New Cobar mine, have been submitted for mineragraphic examination by the New Occidental Gold Mines.

The specimens consist of silicified chloritic slate impregnated with sulphides and containing veins and segregations of white quartz. Pyrrhotite and chalcopyrite are the two chief sulphides visible in the hand specimens. Pyrrhotite is prominent in the dark silicified slate in which there are occasional small segregations of galena. Chalcopyrite is more noticeable in irregular patches and seams in the white quartz.

A thin section of the ore shows that the dark areas consist essentially of dusty quartz in small crystals with interlocking crenulate boundaries. The white quartz consists of much larger clear crystals from which the dusty inclusions have been expelled. Other transparent minerals present are chlorite, biotite and calcite. Chlorite and the sulphides tend to occur around the margins of the larger quartz crystals. Laminae of chlorite and biotite are, in part, intimately intergrown with the sulphides. The carbonate contains iron, lime and magnesium, and is very sporadic and subordinate.

Polished sections have revealed the following minerals - magnetite, pyrite, pyrrhotite, chalcopyrite, sphalerite, galena, native bismuth, bismuthinite and gold.

Magnetite occurs as occasional grains throughout the sulphides and quartz. In places it occurs in parallel bands representing traces of original bedding planes and forms isolated clusters or rosettes in quartz. The individuals in the rosettes are prismatic and resemble the form of hematite rather than magnetite, and show no internal reflections.

Pyrite is much less abundant than pyrrhotite and appears to be confined to definite bands. In some fragments it occurs as clusters of coarse crystals in quartz. Many of these pyrite crystals are shattered and traversed by veins of quartz or sulphides. The latter consists mainly of

* Mineragraphic Investigations of C.S. & I.R., Report No. 328, University of Melbourne, 1st September, 1945.

pyrrhotite and chalcopyrite which are accompanied by small amounts of sphalerite and galena and gold. In areas of abundant chalcopyrite, a limited amount of replacement of pyrite by chalcopyrite is indicated by the presence of small residuals of pyrite in the chalcopyrite.

Pyrrhotite is the most abundant sulphide. Where its development is limited and quartz predominates, it occurs around the margins of quartz crystals. With more extensive development it forms large areas isolating particles of quartz. In places it has developed along the cleavage laminae of biotite and chlorite in such a way as to leave a tangle of micaceous laminae (often bent) in large areas of pyrrhotite. These areas of associated pyrrhotite and gangue are practically devoid of pyrite and tend to pass by transition into areas with abundant chalcopyrite.

Chalcopyrite, like pyrrhotite, occurs in wide areas and veins but is less often in intimate association with the gangue minerals. It ranges in size from areas in white quartz which are often visible to the naked eye down to particles only a few microns in width. In places, small areas of pyrrhotite are included in chalcopyrite, while in other places chalcopyrite is moulded on large areas of pyrrhotite, but the two minerals are not extensively intergrown. It appears as if chalcopyrite has crystallized a little later in the mineralization sequence than pyrrhotite.

Sphalerite, compared with pyrrhotite and chalcopyrite, is a very minor constituent. It is found as occasional small grains of the order of 0.03 mm. in width, chiefly in chalcopyrite, but also in pyrrhotite. It also occurs in veins traversing pyrite crystals. It is similar in colour and reflection to magnetite from which it is distinguished by its reddish internal reflections.

Galena occurs in segregations up to 1 cm. in width. Such areas appear to be bounded chiefly by the gangue minerals except for a little marginal chalcopyrite. Galena also occurs in segregation veinlets in quartz which are sometimes continuous with chalcopyrite. It also appears in veins traversing pyrite along with chalcopyrite and sphalerite and rarely gold.

Native bismuth has been observed in one section and is readily recognized by its pink colour and high reflection. It occurs in shapeless grains, usually surrounded by bismuthinite, in areas of chalcopyrite or pyrrhotite and gangue. Some grains are 0.06 mm. in width, but others are only two or three microns wide along the grain boundaries of bismuthinite.

Bismuthinite is recognized as a bismuth-bearing sulphide, but cannot be positively distinguished from bismuth-lead sulphides, which are known to occur in the New Occidental mine. It occurs in small composite areas of fine fibres and plates in either quartz, pyrrhotite or chalcopyrite. The largest of these areas is about 0.03 mm. wide and one of the fibres was 0.05 mm. x 0.004 mm. It is characterized by strong pleochroism and anisotropism, and it is negative to the standard etching agents other than HNO_3. A slow effervescence appears to occur with HNO_3, but it is difficult to be sure that this does not arise from native bismuth. Its very sporadic occurrence and its almost constant association with corroded particles of native bismuth suggest that it may have been derived from the earlier formed native bismuth during the development of pyrrhotite and chalcopyrite.

Gold has previously been reported to occur as small particles enclosed in pyrrhotite and chalcopyrite (see Mineragraphic Report No. 58) from other parts of the New Cobar mine. In the examination of the present series of sections, it has been observed as small particles along with sphalerite and galena in a vein traversing pyrite. Three particles of a pale-coloured gold were visible and the largest occupied the full width of the vein (0.024 mm.) for a length of 0.042 mm. The other gold particles in this vein were 0.012 mm. x 0.012 mm. and 0.004 mm. x 0.005 mm.

Order of Crystallization. No evidence appears from this examination of more than one period of mineralization. There is, however, a mineralization sequence within the single period.

Pyrite is the first sulphide to crystallize and is followed by pyrrhotite, sphalerite, chalcopyrite and galena. Pyrite is intersected by veins containing pyrrhotite, sphalerite, chalcopyrite and galena. In some cases it is clear that galena forms the continuation of a vein beyond chalcopyrite, indicating a sequence in which galena is slightly later than chalcopyrite.

The few observations of the gold particles indicate that it crystallized in the sphalerite-galena range. The small vein in chalcopyrite indicates it is later than chalcopyrite. Inclusions of gold in pyrrhotite, however, suggest that some of the gold has been deposited with or before the pyrrhotite. The observations of native bismuth and bismuthinite in relation to other sulphides are also limited. They suggest that native bismuth probably formed before the sulphides, and its alteration to bismuthinite may have accompanied the development of pyrrhotite and chalcopyrite.

APPENDIX 4.

Production from mines of Cobar district not described in text.

TABLE 7.

TINTO MINE

Year	Ore raised tons	Ore treated tons	Ore sold tons	Yield				Average				Value £
				Gold oz.	Silver oz.	Lead tons	Copper tons	Gold dwt/ ton	Silver oz/ ton	Lead per cent	Copper per cent	
1906	300	300			450	45			1.5	15		900
1907	80	47	47				5				10.6	350
1908	-	-	-	-	-	-	-	-	-	-	-	-
1909	2,385		1,485	-	-	-	113	-	-	-	7.6	6,831
1910	2,364		2,364	113	132	-	123	0.96	.06	-	5.2	7,586
1911	97		97	-	-	-	3.5	-	-	-	3.6	190
1912	60		-	-	-	-	-	-	-	-	-	-
1913	-	815	-	-	-	24	17	-	-	2.9	2.1	1,587
Total:	5,286	1,162	3,993									17,444

TABLE 8.

C.S.A. MINE

Year	Ore treated tons	Yield				Average				Value £
		Gold oz.	Silver oz.	Lead tons	Copper tons	Gold dwt/ ton	Silver oz./ ton	Lead per cent	Copper per cent	
1905	300	30	600	150	-	2.0	2	50	-	2,595
1906	3,800	235	3,800	912	-	1.2	1	24	-	17,941
1907	1,200	60	1,200	288	-	1.0	1	24	-	4,140
1908-10					no record					
1911	491	-	-	-	22.5	-	-	-	4.6	1,259
1912	2,519	250	10,076	806	-	2.0	4	32	-	14,185
1913	4,053	-	-	1,000	-	-	-	-	-	11,697
1914	1,499	-	-	-	79*	-	-	-	5.3	5,700
1915	4,350	-	-	-	455	-	-	-	10.5	34,139
1916	(2,530	-	-	-	380	-	-	-	(15.0	} 47,910
	(1,643	-	-	332	-	-	-	-	(20.2	
1917	12,646	75	-	-	443	0.11	-	-	3.5	35,364
1918	55,028	558	60,294	-	2,232†	0.2	1.1	-	4.1	237,290
1919	15,626	43	8,791	-	396	0.05	0.6	-	2.5	44,173
1920	7,874	84	10,194	-	232	0.2	1.3	-	2.9	26,144
1921-44	-	-	-	-	-	-	-	-	-	-
1945	9	-	13	-	3.8	-	1.4	-	42.2	392
1946	29	-	25	-	4.0	-	0.86	-	13.79	420
Total:	113,597	1,335	94,993	3,488	4,247					483,358

* Estimated from value.
† Included 79 tons copper from purchased ores.

T A B L E 9.

GREAT COBAR MINE

Year	Ore raised tons	Great Cobar ore treated tons	Total ≠ ore treated tons	Total Yield ≠ Gold oz.	Total Yield ≠ Copper tons	Total Yield ≠ Silver oz.	Average ≠ Gold dwt/ton	Average ≠ Copper per cent	Average ≠ Silver oz/ton	Value £
1871-6	-	3,000	3,000	-	900	-	-	30.0	-	-
1876(June-Dec.)	-	1,458	1,458	-	255	-	-	17.5	-	-
1877	-	4,880	4,880	-	523	-	-	10.7	-	-
1878	-	8,389	8,389	-	1,457	-	-	17.3	-	114,000
1879	-	12,615	12,615	-	1,891	-	-	15.0	-	-
1880	-	20,566	20,566	-	2,600	-	-	12.6	-	-
1881	21,109	21,552	21,552	-	2,568	-	-	11.9	-	-
1882	13,787	11,702	11,702	-	1,805	-	-	15.4	-	126,350
1883	19,000	18,096	18,096	-	2,401	-	-	13.3	-	158,464
1884	21,561	23,879	23,879	-	2,769	-	-	11.6	-	-
1885	23,300	23,300	23,300	-	2,135	-	-	9.1	-	106,750
1886	25,887	25,887	25,887	-	2,044	-	-	7.9	-	80,951
1887	19,163	19,163	19,163	-	1,521	-	-	7.9	-	68,445
1888	13,210	13,210	13,210	-	1,005	-	-	7.6	-	60,300
1889	8,177	8,177	8,177	-	668	-	-	8.2	-	-
1890-1893	-	-	-	-	-	-	-	-	-	-
1894	13,460	13,460	13,460	-	665	-	-	4.9	-	26,600
1895	-	38,278	38,278	-	1,694	-	-	4.4	-	68,120
1896	-	63,185	63,185	-	2,708	-	-	4.3	-	107,200
1897	-	64,262	64,262	-	2,492	-	-	3.9	-	-
1898	-	111,557	111,557	16,215	3,520	145,665	2.9	3.2	1.3	-
1899	-	123,834	123,834	13,698	3,746	59,586	2.2	3.0	0.5	-
1900	-	114,465	114,465	8,900	3,475	60,366	1.5	3.0	0.5	-
1901	-	110,767	110,767	7,253	3,206	52,336	1.3	2.9	0.5	-
1902	-	89,634	89,634	3,097	2,416	16,933	0.7	2.7	0.2	-
1903	-	141,781	141,781	11,078	3,333	40,403	1.6	2.4	0.3	-
1904	-	127,083	143,244	9,495	3,580	57,635	1.3	2.5	0.4	-
1905	-	135,248	180,538	9,160	4,061	53,207	1.0	2.2	0.3	-
1906	-	ø	198,168	11,758	4,030	78,522	1.2	2.0	0.4	-
1907	-	ø	167,605	12,569	4,359	64,934	1.5	2.6	0.4	-
1908	177,592	169,697	234,877	16,568	5,127	90,196	1.4	2.1	0.4	-
1909	160,265	203,746	203,746	13,069	4,855	79,887	1.3	2.4	0.4	-
1910	244,987	241,764	293,324	22,048	6,248	109,421	1.5	2.1	0.4	-
1911	278,049	279,589	352,149	29,332	6,548	122,559	1.7	1.9	0.3	485,875
1912	not recd.	255,993	361,298	39,072	6,650	202,330	2.2	1.8	0.6	575,521
1913	219,875	219,875	334,187	24,942	5,985	103,837	1.5	1.8	0.3	379,477
1914	56,032	57,371	69,690	6,014	1,410	24,305	1.7	2.0	0.3	111,164
1915	1,449	-	-	-	-	-	-	-	-	-
1916	134,596	134,421	170,833	11,436	2,642	47,819	1.3	1.5	0.3	314,726
1917	126,624	126,995	158,270	10,878	2,694	45,206	1.4	1.7	0.3	364,596
1918	114,270	113,540	122,672	10,298	2,415	38,009	1.7	2.0	0.3	266,146
1919	25,623	25,623	26,301	1,134	540	8,594	0.9	2.1	0.3	60,948
1920	240	240	-	-	45	-	-	18.8	-	4,546
1921	83	83	83	-	15	-	-	18.0	-	1,120
1922-35	-	-	-	-	-	-	-	-	-	-
1936	3,300	1,300	-	1,825	-	-	28.0	-	-	-
1937	2,934	2,934	-	2,834	15//	-	19.3	-	-	25,019
1938-40	-	-	-	-	-	-	-	-	-	-
1941	-	3,206	-	636	-	-	3.9	-	-	6,599
1942-45	-	-	-	-	-	-	-	-	-	-
1946	50	30	-	7	1.8	34	4.6	6.0	1.1	265
TOTAL:		3,182,629x 3,450,000/	4,104,082	293,316	113,018	1,501,784	1.4	2.8	0.4	

≠ Includes Chesney, Peak and production of other mines in Great Cobar Group, tested at Great Cobar.

ø Not published. x Incomplete / Estimated, approximate. // From 50 tons ore.

TABLE 10.

GLADSTONE MINE

Year	Ore raised tons	Ore sold or treated tons	Yield Copper tons	Yield Silver oz.	Average Copper per cent	Average Silver oz/ton	Value £
1908	8	8	2	-	25	-	126
1909	209	28.75	10.5	91	36.5	3.2	455
1910	300	210	28	-	13.3	-	1,204
1911	1,300	1,111	94	-	8.5	-	-
1912			no record				
1913	1,000	508	149	-	29.3	-	10,000
1914	-	3,297	231	-	7.0	-	15,009
1915	11,116	11,116	627	-	5.6	-	46,398
1916	6,513	6,513	245	-	3.8	-	24,480
1917	5,732	5,732	284	10,716	5.0	1.9	35,099
1918	6,607	1,987	222	-	11.2	-	22,698
1919	2,214	1,356	109	-	8.0	-	10,557
1920	1,976	1,976	127	-	6.4	-	12,600
Total:	36,975	33,843	2,129	10,807	6.3	-	178,726

TABLE 11.

MOUNT PLEASANT MINE

Year	Ore treated tons	Yield Gold oz.	Yield Copper tons	Average Gold dwt/ton	Average Copper per cent	Value £
1895	469	87	-	3.6	-	-
1896-7	-	-	-	-	-	-
1898	10	-	2.7	-	27	-
1899	-	-	-	-	-	-
1900	510	-	28.75	-	5.6	-
1901	-	-	-	-	-	-
1902	2,353	-	150	-	6.4	-
1903-14	-	-	-	-	-	-
1915	338	-	-	-	-	2,117
Total:	3,680		181.45			

TABLE 12.

YOUNG AUSTRALIA MINE

Year	Ore raised tons	Ore treated tons	Yield Gold oz.	Yield Copper tons	Average Gold dwt/ton	Average Copper per cent	Value £
1896	1,900	-	1,003	-	10.6	-	-
1897-1911	-	-	-	-	-	-	-
1912	730	-	-	61	-	8.4	2,390
1913	770	-	-	53	-	6.9	3,454
1914	950	600	37	59	1.2	9.8	3,835
1915	1,027	700	300	31	8.6	4.4	3,306
1916	900	-	-	28	-	3.1	2,900
Total:	6,277		1,340	232			15,885

TABLE 13.

QUEEN BEE MINE

Year	Ore raised tons	Ore treated tons	Ore sold tons	Yield Copper tons	Yield Silver oz.	Average Copper per cent	Value £
1902	383	-	83	-	-	-	497
1903	-	970	-	161	-	16.6	4,312
1904	1,469	1,150	319	136.5	-	11.9	(7,789 (2,565
1905	7,854	5,388	-	499.75	-	9.3	31,535
1906	11,556	7,158	-	573	-	8.0	47,525
1907	10,235	6,422	-	493.25	-	7.7	37,087
1908	10,467	9,978	-	663.5	-	6.6	35,378
1909	8,328	8,501	-	474	-	5.6	24,770
1910-11	-	-	-	-	-	-	-
1912	1,808	1,400	-	103	-	7.4	7,725
1913	-	300	-	4	-	1.3	457
1914	50	10	-	1.5	-	15.0	100
1915	700	178	-	45	-	25.3	3,150
1916	-	227	-	25	149	11.0	2,536
1917-18	-	-	-	-	-	-	-
1919	27	27	-	3.26	-	12.1	326
Total:	52,877	41,709	402	3,183	149	7.6	205,752