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GEOLOGICAL REPORT ON THE ATTUNGA COPPER MINE

by

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GEOLOGICAL REPORT ON THE ATTUNGA COPPER MINE.

(Report No.1943/1 - Plans 777-781)

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GEOLOGICAL REPORT ON THE ATTUNGA COPPER MINE.

INTRODUCTION.

LOCATION ETC.

The Attunga copper mine is 13 miles north of Tamworth in a direct line, in the parish of Attunga, County of Inglis. By road it is 22 miles, 13 to Attunga, than a further 9 miles up the valley of Attunga and Willowtree creek in a north-easterly to easterly direction. The last 3½ miles of road are through private property, but quite passable in most weather, the remainder of the road being very good. Haulage of ore to Attunga railway station is almost entirely flat or downhill and involves no steep adverse grades. The mine is situated on the northern slope of a moderately well timbered ridge, at the head of a small gully which runs into Willowtree Creek, a good source of permanent water, less than a mile from the mine. This gully more or less follows the outcrop of the lode beds for part of its length.

PREVIOUS REPORTS.

J. E. Carne describes the Attunga copper mine on pages 313-317 of Mineral Resources No. 6, New South Wales Department of Mines. A more detailed report was prepared by R. Logan Jack about the same period (1906?) and a copy of this was made available by Mr. N.Potter, Mine Manager and part owner of the property. Details of exposures on the lower levels, not now accessible, have been taken from this report. Other information available includes brief reports by C. St.J. Mulholland of the New South Wales Geological Survey, by Mr. J. W. Salter, Chief Inspector of Mines and by Mr. P. Warren, Senior Inspector of Mines, also a report by Mr. W. H. Edwards, a former manager of the mine.

MAPPING.

Excluding a preliminary visit on September 22nd, four days, November 20th023rd was spent on the property. In company with Mr. F. Hanlon of the New South Wales Geological Survey, the surface in the vicinity of the lode outcrops was mapped by plane table on a scale of 100 feet to an inch, and the accessible underground workings mapped in detail and sampled. Cleaning out of the lower "F" Adit had begun at the time of examination, but at the time of writing is no yet complete. This will be mapped at a later date and the results of the examination will be added as an appendix to this report.

In addition to the geological and contour map of the surface, plans submitted with this report include a longitudinal section on a scale of 100 feet to an inch, showing the generalised outline of the orebody and the relation between the various outcrops, a more detailed longitudinal section on a scale of 30 feet to an inch showing the distribution of ore values in the principal mineralised section; cross-sections through each of the two principal shafts, and plans of the A, B, and C levels (that of the F level to be prepared later) all on 30 feet to an inch.

HISTORY.

Carne notes that the outcrops were discovered and taken up by J. Brogan in 1902, but were probably known to the owner of the land (T. Bryan) prior to that date. From 1904 to 1906 considerable development work and a little stoping were done, during which at least 1450 tons of ore were despatched to smelters, of an average value of 6.2% Cu. The last work carried out by this Syndicate was the driving of the F adit to cut the lode some 215 feet below the outcrop, so as to facilitate mining and pumping water from lower levels. Plans to

develop the property further and produce ore on a larger scale did not mature, and floods closed the lower workings. Later shipments of ore recorded by the Mines Department include 5 tons in 1909, 100 tons of 5% Cu. in 1910 and 40 tons which produced 1½ tons of copper in 1916. From then on, the mine remained closed until 1940, when Messrs. Potter and Langford commenced shipping parcels of ore to Port Kembla. Present owners are Messrs. N. Potter and J.P.Kennaway of Newcastle. The mine is being prepared for the extraction of ore from the upper levels, ... above C level and the long F adit being cleaned out to determine the behaviour of the lode at that depth. Leases in force are P.M.L.1, P.M.L.2 and P.G.L.1, a total area of 29 acres (See Plate 1).

DEVELOPMENT.

Workings on the lode include an open cut, from which most of the ore sent away has been extracted, two shafts, at or near either end of the principal mineralised section, and a series of drives connecting the shafts at vertical intervals averaging about 45 feet. Several short drives have been put out along different streaks of mineralisation from the open cut and the No. 2 shaft is sunk from the floor of the cut. This shaft, which is offset at intervals, follows one section or another of the lode beds down to the level of the F adit, but now appears to be filled up to within 20 feet of the surface. The No. 1 shaft has been put down following the lode from just inside the mouth of B level, to a few feet below the bottom level "G", at 228 feet below B level. The C level adit hits the No. 1 shaft at 184 feet, 47 feet below "B" level and the No. 2 at 206 feet. F adit, 141-45 feet below C level is driven from a point lower down the gully obliquely to the lode, a distance of 740 feet to No. 1 shaft. Depths of the various levels referred to A level are B, 25 feet, C, 72 feet, D, 112 feet, E, 166 feet, F, 210 feet, G, 254 feet.

Some stoping has been done above C level, south of No. 1 shaft between B and C, and south of the No. 2 shaft about the horizon of B level. Other work on the leases includes a few surface costeans, a small open cut and exploratory shaft, ("O" shaft) on another mineralise section along the lode to the south, and another shallow shaft ("P"shaft on the southern side of the dividing ridge.

GENERAL GEOLOGY.

The country rock at the Attunga mine is a series of metamorphosed sedimentary rocks, originally laid down under shallow water conditions. The principal economic feature is a lenticular band of limestone in which the ore bodies are contained. This limestone lens has a total length of a little over 800 feet and a maximum width of 60 feet. Individual sections may be massive, but on the whole it is bedded, with bands of varying composition and intercalated beds and lenses of shale, sandstone and fine conglomerates. The dip as exposed on the surface and in the workings is very steep, usually to the west, and the strike varies from north-north-west to just east of north. On the hillslope west of the limestone, which is mostly covered with boulders, nothing but metamorphosed and silicified fine conglomerate was observed. Constituent pebbles in this rock are seldom more than an inch in any dimension and have often been elongated by differential pressure. Proportion of fine matrix to pebble content is high. Mr. Whitworth remarks evidence in thin section of tuffaceous character. The eastern slope of the valley is likewise covered by boulders in which the conglomerate predominates, but a band of shale appears to run along roughly parallel to the limestone, and shale seems to be also interbedded with the conglomerate right up to the andesite boundary (See Plate 1).

PLATE I.

SURFACE PLAN
ATTUNGA COPPER MINE
PARISH OF ATTUNGA
COUNTY OF INGLIS
NEW SOUTH WALES

100 0 100 200 FT.

LEGEND

- FINE CONGLOMERATE
- SHALE
- LIMESTONE
- ANDESITE

(METAMORPHOSED SEDIMENTARIES)

- ORE OUTCROP
- STRIKE & DIP
- FAULT
- TRAMLINE
- PLANE TABLE STATIONS

M.N. 9°30'

A.H. Fisher.
Chief Geologist
Mineral Resources Survey Branch.
31. 12. 42.

Gully
Arbitrary Datum 100 ft.
"F" Tunnel
Road
P.M.L. 2
Collapsed winze
Plane of Longitudinal Sections
Ore bin
Shed
"C" Tunnel
"B" Tunnel No 1 Shaft
No 2 Shaft
Open cut
Gully
P.G.L. 1
"O" Shaft
Open cut
Fence
"P" Shaft
P.M.L. 1
"O" Shaft.

SECTION Z – Z
SCALE 1" = 30 FT

Granite mass less than ½ mile to the south

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Away from the immediate vicinity of the mine, the sediments are mainly bedded shales and massive fine conglomerates, though fairly large bodies of limestone are not uncommon. Dip of the shales along Willowtree Creek is consistently to the southwest at low to moderate angles. Several hundred feet east of the limestone lens which carries the ore, and occupying the crest of a prominent hill, a hard andesitic rock outcrops. After running more or less parallel with the limestone for some distance, it swings around to the west and cuts right across the strike of the lode and it is obvious in the southeast corner of the mapped area (Plate 1) that the intrusive rock underlies the shales and conglomerates at shallow depths below the surface. From its distribution it is undoubtedly intrusive in habit and, in addition, the shales near the contact show a greater degree of induration than those farther away. In composition and texture it varies considerably, from a dacitic rock with quartz phenocrysts to an andesite breccia. Descriptions of three different phases are included in Mr. Whitworth's report on the rock specimens.

Both the sedimentary and the andesitic rocks have suffered contact as well as regional metamorphism, due to the intrusion of a large granite mass which outcrops less than ½ mile south of the most southerly workings and also a mile or so to the east. This granite is shown on the State Geological Map to be continuous with the very extensive New England granites, and the Attunga sediments are included in the Devonian. The greatest degree of contact metamorphism is shown by the limestone, massive beds being recrystallised to marble, while relatively impure beds, especially those originally laminated, or intercalated with shales, have been extensively altered, with abundant development of lime garnet and other contact metamorphic minerals. These latter constitute the host beds of the ore, which appears to have been developed principally where shearing of the altered limestone is most intense, some bands being more favoured than others. Following is a description in thin section of the fine conglomerate, the biotite granite to the south of the mine, and various phases of the andesitic rocks, prepared by Mr. H. F. Whitworth of the New South Wales Geological Survey.

PETROLOGICAL REPORT ON ROCKS FROM ATTUNGA.

No. 1. Silicified fine conglomerate from bottom ("F") adit mouth, Attunga Copper mine.

A hard dark grey clastic rock containing waterworn rock fragments up to ¼" in diameter. Under the microscope seen to be composed mainly of well rounded grains of quartz with some fragments of felspar, principally plagioclase, and waterworn grains and pebbles of hard rocks such as chert, quartzite and porphyry. The interstitial material was probably originally clayey, but now contains much chlorite and secondary quartz. The rock is well stratified, but the presence of the angular fragments of felspar which show little alteration, suggest that it is tuffaceous.

No. 2. Biotite granite from State Forest.

A normal type of coarse grained biotite granite composed of quartz, orthoclase, plagioclase and biotite with typical granitoid fabric. Except for a slight kaolinisation of the felspars, the rock is remarkably free from alteration.

No. 3. Andesite from near granite contact.

A grey coloured aphanitic rock, well weathered on the surface. It is composed of highly altered phenocrysts of felspar and augite in an almost opaque, stony ground mass.

Alteration of the felspar is so complete that all signs of the original twinning have been destroyed and many crystals are almost opaque owing to kaolinisation.

Many of the augite phenocrysts have been converted entirely to bright green, strongly pleochroic secondary amphibole, but some still have a core of recognisable augite.

Needles of actinolite have been developed abundantly by alteration of the ground mass, and many of these needles penetrate some of the phenocrysts. Signs of reaction between phenocrysts and ground mass are plentiful.

No. 4. Andesite breccia from "F" adit, Attunga.

In hand specimens this rock closely resembles No. 3, but under the microscope is seen to be composed of fragments of andesite, identical with No. 3, cemented together tightly, and with a little chlorite interstitial material. Alteration of the rock is similar to that seen in No. 2.

No. 5. Altered andesite, from "P" shaft, Attunga.

Somewhat similar to No. 3, but somewhat finer in grain size.

Alteration of the felspar phenocrysts has not proceeded to such a degree as to destroy all signs of twinning, but the alteration of the ferro-magnesian minerals is more complete, and they now consist entirely of aggregates of needles of actinolite.

Signs of reaction between ground mass and phenocrysts are common.

Relationship of the granite to the Andesite rocks.

The high degree of alteration of the andesites and andesite breccia and the freshness of the granite suggests that the andesites are the older rocks and have been intruded by the granite. The development of the actinolite needles in the andesites and breccia and its absence in the granite indicates that the former rocks have undergone alteration which has not been shared by the latter.

It is probable that the alteration of the andesite and breccia has been brought about by contact metamorphism due to the intrusion of the granite.

(Signed - H.F.Whitworth).

ECONOMIC GEOLOGY.

ORE DIMENSIONS.

Although the limestone lens has a width of 60 feet and is over 800 feet long, the principal mineralisation is limited to the section between the mouth of B tunnel and the south end of the open cut, a distance of 160 feet, and similarly, although in the open cut

mineralisation may be found extending over a width of 30 feet, less than half of this is ore and most of the individual lenses are not persistent. The habit of the ore is to occur in bunches and irregular lenses along the strike of the more susceptible lime-garnet beds in the limestone. The best of these lenses are seldom more than 5 or 6 feet wide, except very locally, and usually do not continue more than 50 feet without a break (see level plans, Plate 2). Individual streaks may be separated by barren bands, often shaly, or low-grade material which may make into ore along the strike. In general, exploration in the shape of crosscuts out into the limy beds on either side of the principal mineralised channel has not been successful

On account of its irregularity and the likelihood of ore playing out or making at short notice, it is difficult to forecast the behaviour of the ore lenses from one level to another. Calculation of ore reserves is rendered correspondingly difficult.

STRUCTURAL FEATURES.

Dip of the lode is very steeply to the west, though variations to both sides of the vertical occur. Strike of the principal mineralised section is from 10 to 20° west of north. Immediately south of the ore area, the enclosing limestone takes a bend to the west and it is likely that the shearing induced in the beds adjacent to this bend is largely responsible for the localisation of the ore values. North of the mineralised area, the limestone tends to widen out and becomes more massive and this also has doubtless had its influence in limiting ore formation in that direction. It is significant that cross faults occur near both ends of the ore-bearing section. These faults, which displace the country lefthandedly, are pre-ore and have acted as channels for the mineralising solutions, as copper carbonates are found along the faults themselves on both sides of the main lode beds. The fault near No. 1 shaft has a displacement of only a few feet, but that to the south of No.2 shaft in the open cut is more important, with a total displacement of twelve feet or so. On the southern side of the fault, good copper mineralisation follows the lime-garnet beds for a few feet and then plays out abruptly.

A conspicuous feature of the lode channel, remarked also by Dr. Jack on the lower levels, is consistent slickensiding in a more or less vertical direction on the walls of the ore lenses. The general pitch of the main ore body, as indicated by exposures in the open cut and A, B and C levels, is steeply to the North.

The smaller area of mineralisation near the top of the hill at O shaft may owe its presence partly to shearing in proximity to the andesitic mass which here abuts against the lode beds.

COMPOSITION.

The ore consists of green and blue copper carbonates replacing or permeating through the shattered, often granular, lime-garnet beds. Local enrichments of ore along faults and fractures are not uncommon. Molybdic ochre is plentiful and bismuth is also present. Sulphide minerals seen in ore on the dumps from the lower levels include chalcopyrite, pyrite and molybdenite. Account sales of 1452 tons 15 cwt. sent away in the period 1904-6 gave an average value of 6.2% Cu. Gold content is known for 1330 tons 9 cwts. of this amount and averaged 5.48 dwts. per ton. Silver values were fairly consistent between 5 and 6 ozs. per ton. A parcel of ore recently sent to Port Kembla assayed more than ½ per cent bismuth, but no bismuth values comparable with this were disclosed by sampling.

Following are the detailed results of samples taken during the course of the examination, which illustrate fairly well the metal content of the ore.

LOCATION	Width of sample	Copper %	Au. dwts per ton	Ag. ozs per ton	Molybdenum %	Bismut %
			dwts.	ozs.		
Face C tunnel, righthand drive, 45' south of No.1 shaft.	2'10"	2.00	0.4	0.18	0.03	-
C Tunnel, 24' south of No. 1 shaft.	8'8"	1.96	0.8	1.00	tr.	-
Face B tunnel, 70' south of No. 1 shaft.	4'3"	6.12	4.25	4.16	-	tr.
B Tunnel, N. side small X-cut, 56' south of shaft, W. half of lode.	4'3"	8.11	10.4	9.15	0.14	tr.
B tunnel, 56' south of shaft, E half of lode.	3'9"	5.27	1.2	3.11	0.03	tr.
B tunnel, 44' south of No. 1 shaft.	5'3"	5.34	0.6	5.8	0.35	tr.
B tunnel, 32' south of No. 1 shaft.	5'8"	4.60	0.4	2.10	0.03	tr.
Outcrop just outside mouth of B tunnel.	4'10"	4.66	0.6	6.4	tr.	tr.
S. face No. 2 shaft 12' below floor of open cut.	5'2"	7.80	2.4	3.19	tr.	0.1
Outcrop W. of N.W. corner of open cut.	11'6"	2.25	0.6	2.6	-	-
S. face open cut from east side.	3'9"	4.60	5.2	2.14	-	-
Continuing across open cut, separated from previous sample by 1'9" barren shale.	4'6"	2.55	3.2	2.0	0.1	-
Continuing across same face.	4'0"	5.53	2.4	5.12	0.05	tr.
Continuing across same face.	3'9"	5.88	20.4	6.14	tr.	tr.
Top open cut, 6-16' S. of "0" shaft.	8'0"	2.15	0.4	1.5	0.76	-

Without access to the lower levels, it is difficult to observe possible effects of secondary enrichment, but they are not believed to have been very important. Dr. Jack does mention the presence of chalcocite on the G level, but from specimens examined and the information available most of the sulphide copper exposed was chalcopyrite. From his description there seems to be a zone of poor values below D level and the ore above C level appears to be a primary shoot with perhaps a small amount of secondary enrichment from percolating solutions.

ORE GENESIS.

The obvious source of the mineralising solutions responsible for the Attunga lode formation is the granite which lies to the south and east. The presence of molybdenum and bismuth minerals confirms granitic origin in preference to genetic association with the older andesitic rocks close at hand.

In addition, the contact metamorphism of the limestone beds, consequent on the granitic intrusion, is earlier than the ore and the andesite itself carries mineralisation, notably at "P" shaft. It is likely that movements connected with the extrusion of the andesitic rocks were at least partly responsible for the steeper tilting of the sedimentaries in their neighbourhood and for the shearing of the impure limestones which later became the ore-bearing beds. Vertical slickensiding on the walls of the lode was developed during these movements. The close association of the andesitic rocks with the limestone suggests that part of the contact metamorphic effects so conspicuous in the limy beds may have been caused by heat emanating from these intrusives.

DESCRIPTION OF WORKINGS.

Open cut & A level. The open cut is approximately 20 feet wide by 45 feet long. Good ore is seen in No. 2 shaft, a sample on the south face at 12' deep returning 7.8% copper and 2.4 dwts. gold over 5 feet; 2 inches. This sample is the only one taken which returned any appreciable quantity of bismuth - 0.13%. Bands of medium values comprise the south face of the cut. An aggregate of four samples over a total of 16 feet, excluding 1'9" of barren shale, averaged 4.53 % Cu. and 7.55 dwts. Au. per ton. Gold value is high due to the most westerly sample, in which free gold was present, returning just over 1 oz. of gold per ton. Just north of this face, two steeply dipping faults cross the cut, displacing the beds left-handedly a distance of probably 12 feet horizontally. As elsewhere in the mine, mineralisation occurs along the faults themselves and to the south extends only a few feet beyond them except for one small streak of mineralisation which persists a short distance up the hill on the surface. A drive at A level on this streak ran out of ore into barren rock in a few feet and other exploratory drives from the cut also failed to find ore away from the faults. Just west of the north-west corner of the open cut an average sample across 11'6" of alternating barren shale and garnetiferous limestone carrying more or less copper, returned 2.25% Cu. This mineralisation is not persistent, though a few tons of ore might be picked from here, and the beds themselves are irregular, shale, silicified shale, limy beds and garnetiferous limestone interlensing and playing out with great rapidity.

Dr. Jack records that 424 tons sold from the open cut assayed Cu. 5.5 to 6.78%, Gold 3.1 to 9.14 dwt. per ton and Silver 4 ozs. 18 dwts. to 6 ozs. per ton.

B. Tunnel. Ore beds outcrop just near the mouth of B tunnel and a sample from 4'10" width, which included 1'6" of almost barren rock, returned 4.66% Cu. No. 1 shaft is sunk just inside the mouth of No. 1 tunnel and is now being used as an ore chute down to C level, where it is trucked to the ore bin at the beginning of the road out from the mine. Below C level the shaft has been filled up. On B level the ore becomes very low-grade near the shaft, but comes in again 20 feet or so along and the next 50 feet to the end of the drive at the time of mapping contained some of the best ore exposed in the mine. The ore is the usual garnet rock with copper carbonates disseminated through it. Width of ore is up to 8 feet and definite walls are not exposed except in one or two places where shaly beds have been broken into on the sides of the drive. Mineralisation is seen along a cross fault just past No. 1 shaft, and a crosscut has followed this streak out into low-grade hangingwall country. Similarly enrichment occurs on a small fault at the short crosscut near the end of the drive, and the high value of the sample taken there of the western half of the lode probably reflects this enrichment. Samples taken in the drive were:-

At 32' past No. 1 shaft					Width 5'8"	4.6% Cu.	0.4dwt. Au. per	
" 44'	"	"	"	"	"	5'3"	5.34%	0.6 "	"ton.
" 56'	"	"	"	"E half	"	3'9"	5.27%	1.2 "	" "
" "	"	"	"	"W "	"	4'3"	8.11%	10.4 "	" "
" 70'	"	"	"	""	"	4'3"	6.12%	4.25"	" "

Dr. Jack records that 160 tons were sold from B tunnel and from the open cut of an assay value varying from 5.2 to 6.7% Cu., 4 to 4.9 dwts. Au. per ton and 4 to 5 ozs 7 dwts. Ag. per ton.

C. Tunnel. This tunnel is driven more or less on the strike of the beds. It passes through a small body of intrusive andesite near the mouth, then through a fault in hard silicified shale and onto lode beds at about 50 feet. Narrow lenses of medium grade ore are exposed along the drive, but no orebody of any significance until just past No. 1 shaft, at 200' from the entrance. Irregular bunchy mineralisation is here developed and a sample across 8'8" returned 1.9% Cu. and 0.8 dwts. Au. per ton. A drive being put in on the right-hand lens had advanced about 20 feet and ore in the face assayed 2.0% Cu. and 0.4 dwts. Au. per ton. The old drive followed the left-hand streak of ore to No. 2 shaft, and this was stoped for some 14 feet above the level. According to Dr. Jack, 35 tons from this stope returned 5.6 to 8.3% Cu. and up to 3.6 dwts. Au. per ton. The drive was apparently continued 50 feet past No. 2 shaft, but Dr. Jack reports that it contained no ore beyond about 10 feet past the shaft. From a stope south of this shaft, 35 feet above this level, 76 tons assayed 6% Cu. and 3.8 dwts. Au. per ton and 14 tons assayed 8.78% Cu. (no allowance for gold).

Lower Levels. The following notes on the levels now inaccessible are taken from Dr. R. L. Jack's report

"Level D. 40 feet below Tunnel C, connects Nos. 1 and 2 shafts. Ten feet south of No. 1 shaft, 4 feet of good ore is seen on the roof and a cross-cut goes 63 feet to the west. The first 7 feet of the cross-cut is in lode matter, with a little carbonate ore in garnet rock. The next 4 feet is garnet rock with some bands of fair carbonate. Short of taking it all out, it would be impossible to sample this so as to average it, as there are good and poor veins. Sample 9 was taken as characteristic of about 2 feet, which if separable from the whole 4 feet would be very fine ore. It assayed Copper 5.2 per cent.

From this point onward, the crosscut traverses decomposed felspar slaty rocks.

There is ore at D level all the way (50 feet) between No. 1 and No. 2 shafts, but for part of the distance the level is driven on the eastern side of the ore. At No. 2 shaft the eastern or footwall is almost vertical, very soft and slickensiding vertically.

I took Sample 10 from the eastern side of the lode close to the barricade in the level (32 feet south of No. 1 shaft). This was an average of 4 feet 3 inches across the roof from the eastern side. It assayed Copper 4.3 per cent.

A 2½ feet band of slaty "mullock" lies to the west of Sample 10. Good ore is seen between this point and No. 2 shaft, but the roof is too much timbered to permit of sampling. Continuing the section of the lode from east to west at the nearest accessible point, viz. over No. 2 shaft, Sample 11 averages 3½ feet of ore. It assayed, Copper 3.2 per cent.

Sample 12 averages the remaining 4 feet of ore to the western side of the lode. It assayed Copper 2.2 per cent.

The ore in this level consists of carbonate of copper in a soft

kaolinic matrix.

Level E, is 50 feet above Tunnel F. Down No. 2 shaft the ore is seen to die out 18 feet below Level D, although the lode continues. It recommences 20 feet lower and the remaining distance down to E has very fair carbonate ore on the north side of the shaft, but at E it dwindles to a few inches. There are 5 feet of decomposing garnet rock on the west of it, and next a vertical band of (half-hundred-weight) lumps of carbonate ore. A cross-cut from the shaft after passing this band, cuts 10 feet of soft garnet rock, 10 feet of soft kaolinic rock, and 5 feet of limestone. No. 2 shaft is sunk 50 feet below E level. The lode is said to continue, but to carry no values until a depth of 44 feet is attained.

Level E connects shafts 1 and 2, but as it is driven in the country on the east side of the course of the lode, the latter cannot be satisfactorily seen. The level is barricaded for ventilation 6 feet south of No. 1 shaft. I was shown a fine specimen (several pounds in weight) of copper glance ore said to have come from this level.

Level G. Down No. 1 shaft from Level E, the lode is strong, but shows no values down to 80 feet at the top of Level G. This Level is 38 feet below that of Tunnel F. Limestone is seen in the level immediately west of the shaft, and for 18 feet in a cross-cut to the west. The following section is seen in the level on the north side of the shaft:-

(Eastern side)—	ft.	in.
Slate	1	0
Soft lode matter, no copper except stains in westmost 4 inches.	2	0
Hard blue quartzite.	3	0
Soft lode matter on roof of level, the western side showing molybdenite and pyrites.	5	0
Limestone	0	10
Garnet rock with copper carbonates.	0	10
Limestone, thickness unascertained.		

(Western side)—

At the southern face of the drive, 32 feet from No. 1 shaft, limestone on the western side is succeeded eastward by hard blue lode matter, consisting of quartz or quartzites with garnets. The eastern side of the level shows garnets and pyrites with a little carbonate of copper. In fact the ore is just on the point of transition from carbonate to sulphide. Water comes in from this face, and the bottom of Level E may be taken as the water level. Sample 18 was taken from the east side of the level 27 feet south of the shaft. It was a garnet rock containing a good deal of molybdenite, a little pyrites and some copper glance (chalcocite). It assayed, copper 2.2 per cent.

The level north of the shaft follows a very thin vein which has a steep underlie to the west, and is slickensided in a manner indicative of a vertical movement. This vein is a soft weathered garnet rock, accompanied by copper carbonate which sometimes becomes ore. There are also occasional crystals of pyrites. A short cross-cut has been driven to the west in similar lode matter, but no wall has been met with, nor has the limestone been touched.

A few feet north of the shaft a winze has been sunk 3 feet below the level. This, as it was the lowest portion of the workings, was baled out for my benefit and I made hasty notes and took samples.

The western 3 inches of the winze was composed of garnet rock, with a good deal of pyrites and a black sooty material which might have been black oxide of copper. Sample 17 assayed copper, 1.5 per cent.

silver 3 ozs. per ton and a trace of gold.

Next came 12 inches of soft garnet rock followed by 4 inches of slate, and lastly (on eastern side), 15 inches of slate, merging downwards into an ore in which carbonate of copper was mixed with pyrites. Sample 18 appeared to be composed of half iron glances and half pyrites half of the pyrites being copper pyrites; it assayed copper 11.9 per cent.

The dirt shovelled from the bottom of the winze gave a fair prospect of gold in the dish".

Other Outcrops. Near the top of the ridge is a shallow open cut and a shaft ("O") originally 38 feet deep, but now accessible for only 19 feet depth. The cut exposed garnet rocks with streaks and lenses of carbonate ore over a length of 40 feet and a width of up to 11 feet. An average sample just south of the shaft over 8 feet width returned 2.15% Cu., but much better grade ore could be selected. In the shaft (refer to Section, Plate 1) mineralisation plays out abruptly at 8 feet depth.

On the southern fall of the ridge, within the andesite, a shallow shaft known as "P" shaft has been put down on a narrow lode which strikes east-west, at right angles to the main lode direction. Although samples of bornite from this ore have returned up to 25% Cu. it is considered to be only a local splash of mineralisation, too small to be of much significance. The shaft was nearly full of water and no samples were obtained. The andesite here is finer grained than usual and more hornblendic - (see description of rock slides, No. 5).

ORE RESERVES.

Sampling during the present examination indicates that the ore on B level and in the open cut averages between 5 and 6 per cent. Study of the results obtained from shipments of ore in the productive years of the mine shows 1452 tons averaged 6.2% and this ore was subject to a certain amount of dressing before despatch. Recent shipments by Mr. Potter have been picked to better than 10% grade.

Owing to the manner in which the copper is distributed through the ore, it is not possible to obtain a clean product by picking and the discards are bound to contain some percentage of copper. Hence it would probably take at least three tons of five percent ore to yield by picking 1 ton of ten per cent.

The lenticular character of the ore shoots introduces further difficulties into the calculation of ore reserves. The following table shows approximately the amounts of ore and the values in the various sections of the mine. Dr. Jack's assays on D level have been used in calculating the grade of the block between C and D levels. (It should be mentioned that in various places, on B and C levels and in the main open cut, and in the cut near the "O" shaft, samples were taken in approximately the same location as samples taken by Dr. Jack and that in every case the values recorded by him are much higher than the recent sampling).

Section of Mine.	Tonnage	Average Width	Cu.%	Au.dwts.per ton.
South of main open cut.	200	16 feet.	4.5	7.5
Above B level	(250	5 feet	6.8	4.5
	(180	6 feet	5.0	0.6
Between B & C levels.				
South of No.1 shaft	750	5'9"	4.5	2.3
North of No.1 shaft	75	5 feet	4.6	0.6
Between C & D levels	495	5 feet	2.8	-
Open Cut at "O" shaft.	125	-	2.2	0.4
TOTAL TO D LEVEL.	2075		4.3%	

The total copper content of this 2075 tons amounts, on the above figures, to 88.8 tons, but owing to the necessity of picking the ore to shipping grade, considerably less than that amount would be obtained. Some estimate of the ore obtainable below D level may be possible when F adit is accessible. Mr. Jack's observations indicate poor values between C and E levels, but it is possible that at this depth the northward pitch of the ore body, if maintained from the surface down, may have carried the section containing the best lenses of ore out of the area between the shafts.

ACKNOWLEDGEMENT.

This opportunity is taken to acknowledge with thanks the ready co-operation of the New South Wales Department of Mines and in particular Mr. F.N.Hanlon's capable assistance in the field and Mr. H.F.Whitworth's microscopic examination of rock specimens and assays of samples.

SUMMARY.

The Attunga copper lodes are irregular lenses and bunches of ore in sheared garnetiferous limestone beds. Country rock is Devonian fine conglomerates, shales and limestones and intrusive andesite and andesite breccia. Acid biotite granite outcropping ½ mile distance has been responsible for the contact metamorphism and for the mineralisation. Although the limestone which carries the lode beds is more than 800 feet long and up to 60 feet wide, worthwhile mineralisation is limited to a length of 160 feet, near the open cut and Nos. 1 and 2 shafts and a maximum width of 16 feet, usually about 6 feet or less. A small development of ore occurs on the surface near the top of the hill at "O" shaft and a lens of ore in andesite on the southern fall contains bornite. Strike of the principal mineralised section is a little west of north, dip steep to the west and general pitch to the north, though individual lenses are not persistent.

Some 1600 tons of ore have been shipped from the mine altogether, mostly from the open cut, in the vicinity of a pre-ore cross fault. Faulting elsewhere in the mine is often accompanied by an increase in values. Average value of the ore shipped is 6.2% Cu. and a little over 5 dwts Au. per ton. Small amounts of molybdenum and bismuth are present.

Ore reserves down to D level, 112 feet below the surface are calculated at 2075 tons averaging 4.3% Cu. and 5-6 feet width. Owing to the necessity of picking this ore to at least 7% for shipment, the actual quantity worth sending away on present exposures will only be about 1000 tons. Best values are round about B level and gold values are confined to the open cut and the inner portion of B level. Levels below C are not now accessible, but Dr. R.L. Jack's report mentions little ore below D level.

F adit driven to cut the lode, 220 feet below the outcrop is being re-opened and will be examined when accessible.

RECOMMENDATION.

The leaseholders would probably be best advised to waste no time in getting out all the good ore possible from their operations around B level and the open cut and, unless very encouraging values are exposed in F adit, to avoid committing themselves to further heavy expenditure. The margin of profit is not high, and even if the mine below D level contained as much ore as the section above, which on Jack's report is unlikely, the tonnage after picking would still not be large, and the absence of gold values away from the open cut and the south end of B tunnel reduces the profit margin in such ore still more.

(N.H. Fisher)
Chief Geologist.

18th January, 1943.
CANBERRA. A.C.T.

GEOLOGICAL PLANS
A. B. & C. LEVELS
ATTUNGA COPPER MINE

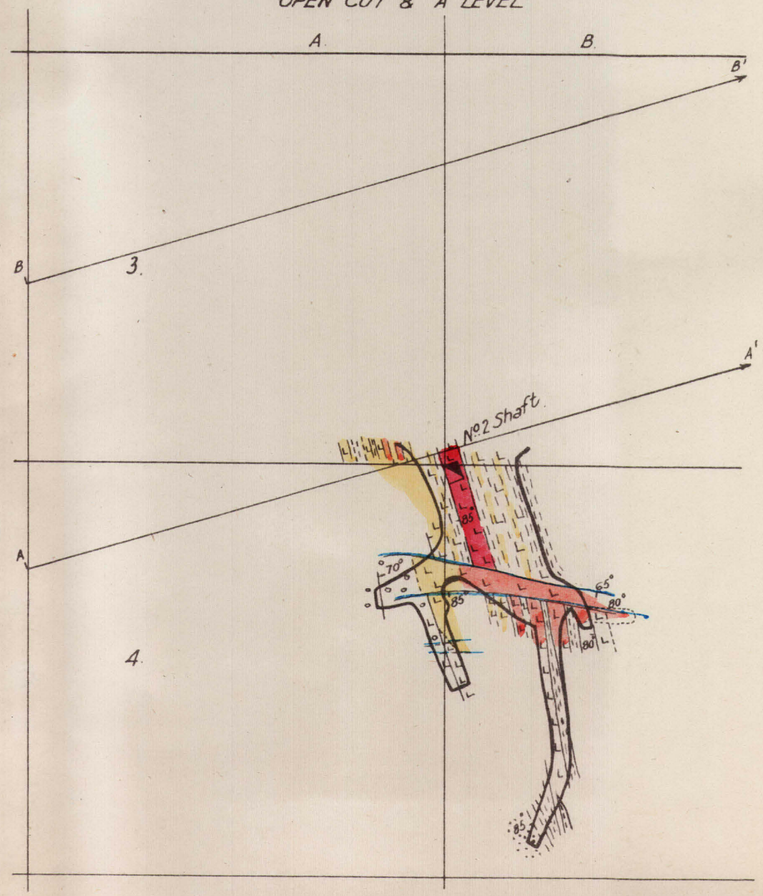
30′ 0 30′ 60′

M.N.

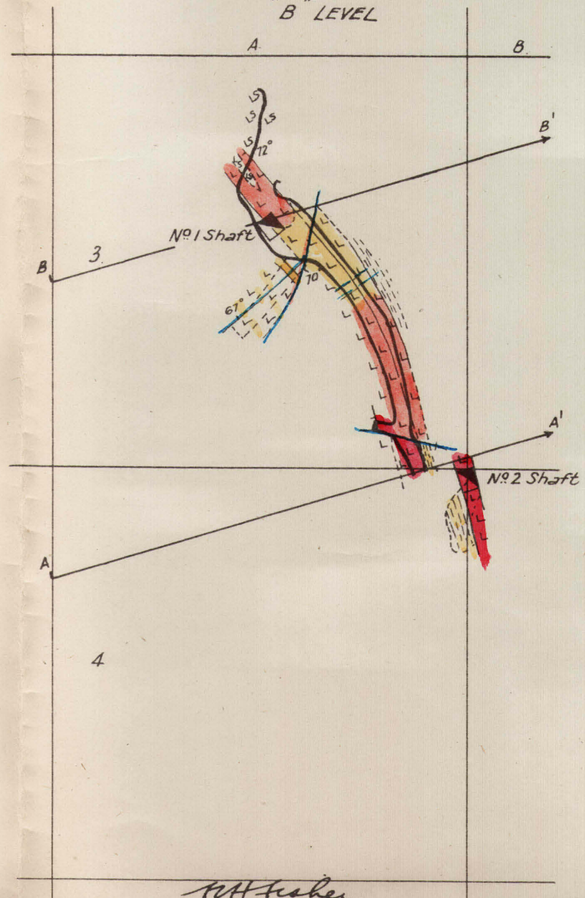
LEGEND

- > 6% Cu.
- 3% - 6% Cu.
- < 3% Cu.
- Fault
- Section line
- Shale
- Fine conglomerate.
- Sandstone
- Limestone
- Garnetiferous limestone } Lode beds.
- Andesite

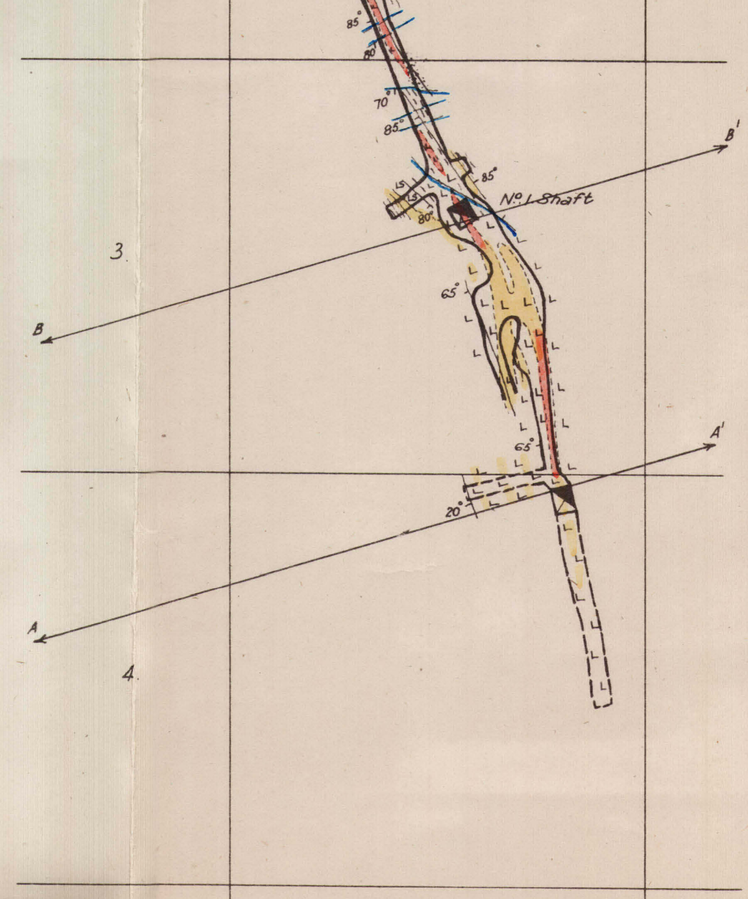
OPEN CUT & "A" LEVEL



"B" LEVEL



"C" LEVEL

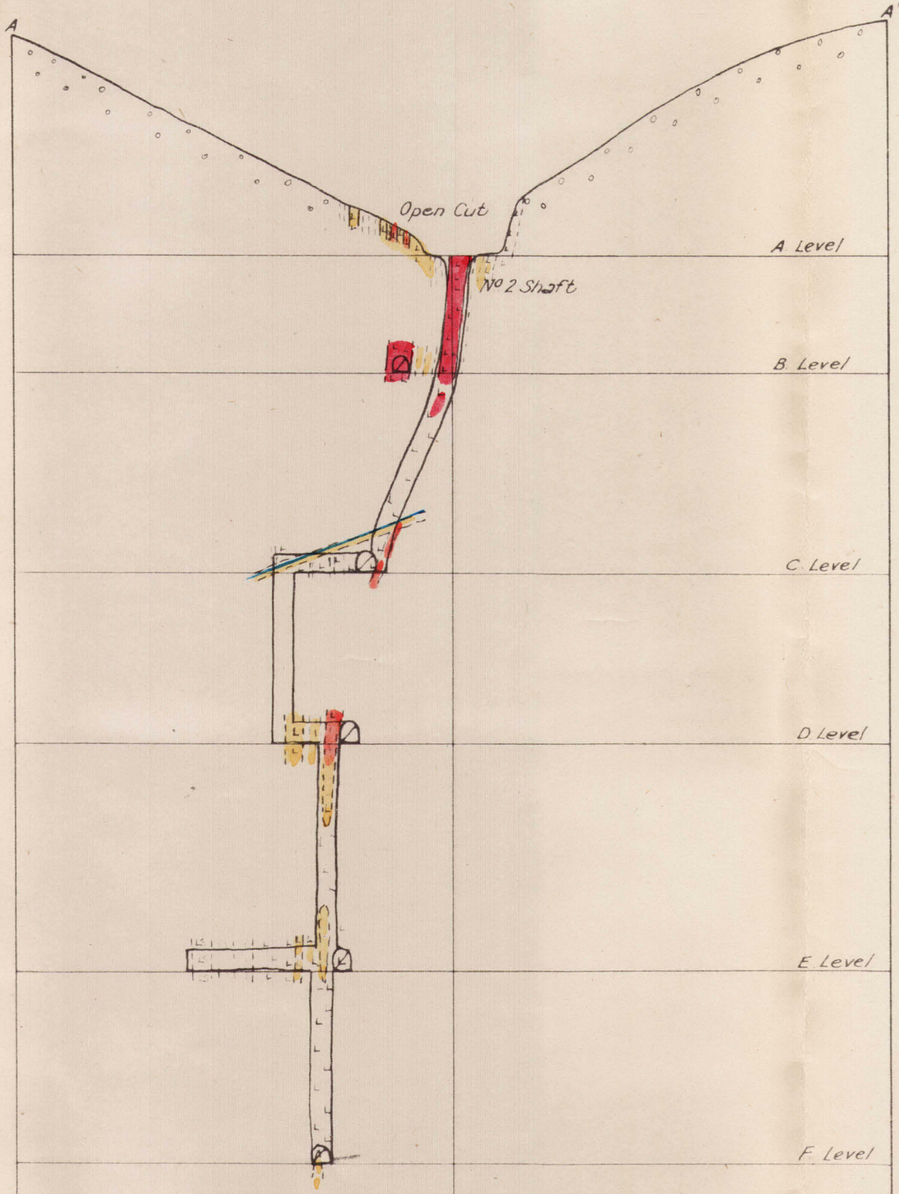


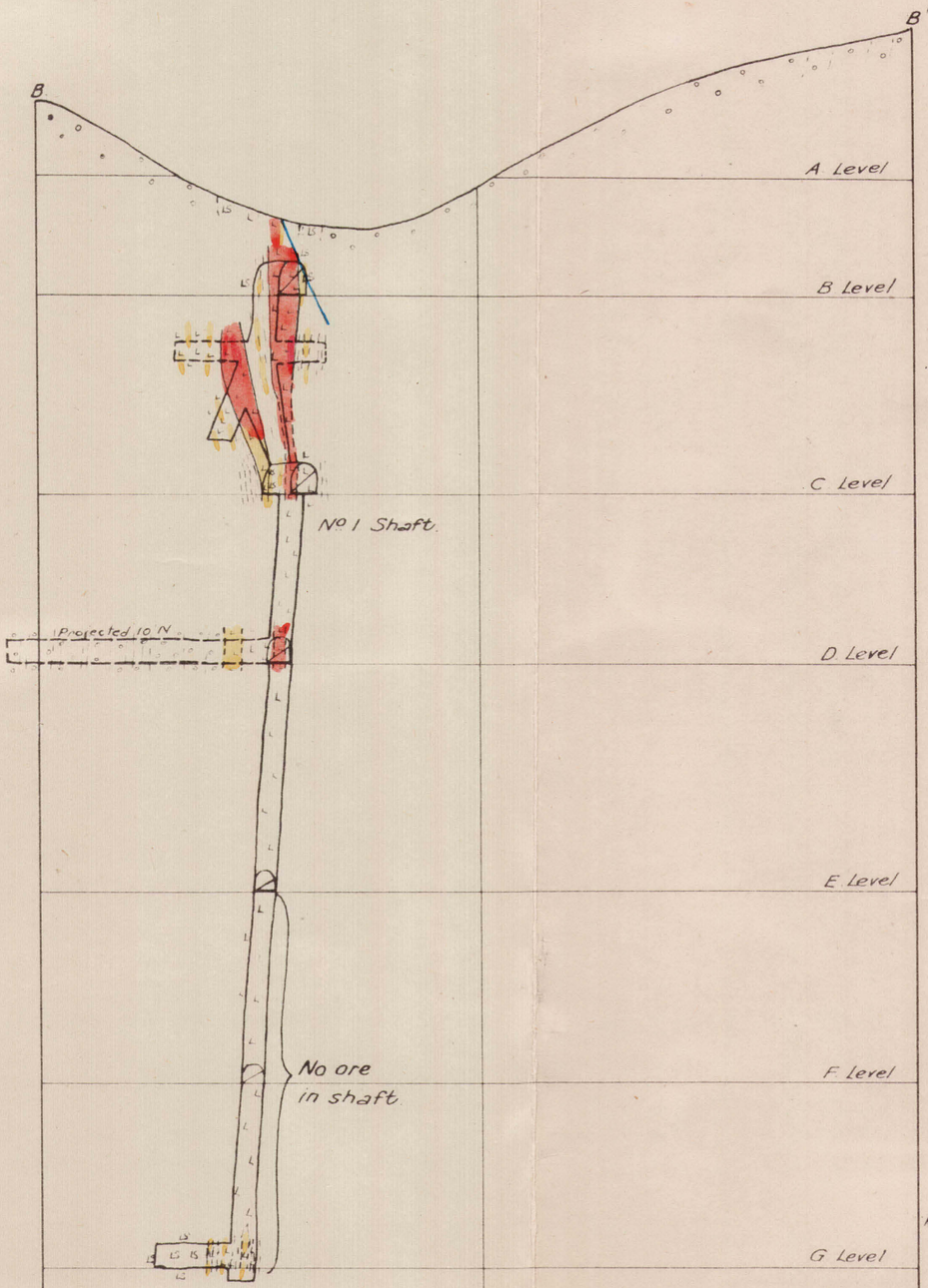
R.H. Fisher
Chief Geologist
Mineral Resources Survey Branch, 31-12-42.

CROSS SECTIONS A-A' & B-B'
ATTUNGA COPPER MINE
LOOKING NORTH

0 30 60 90'

Position of workings below C. Level not known exactly
For Legend see Plate 2



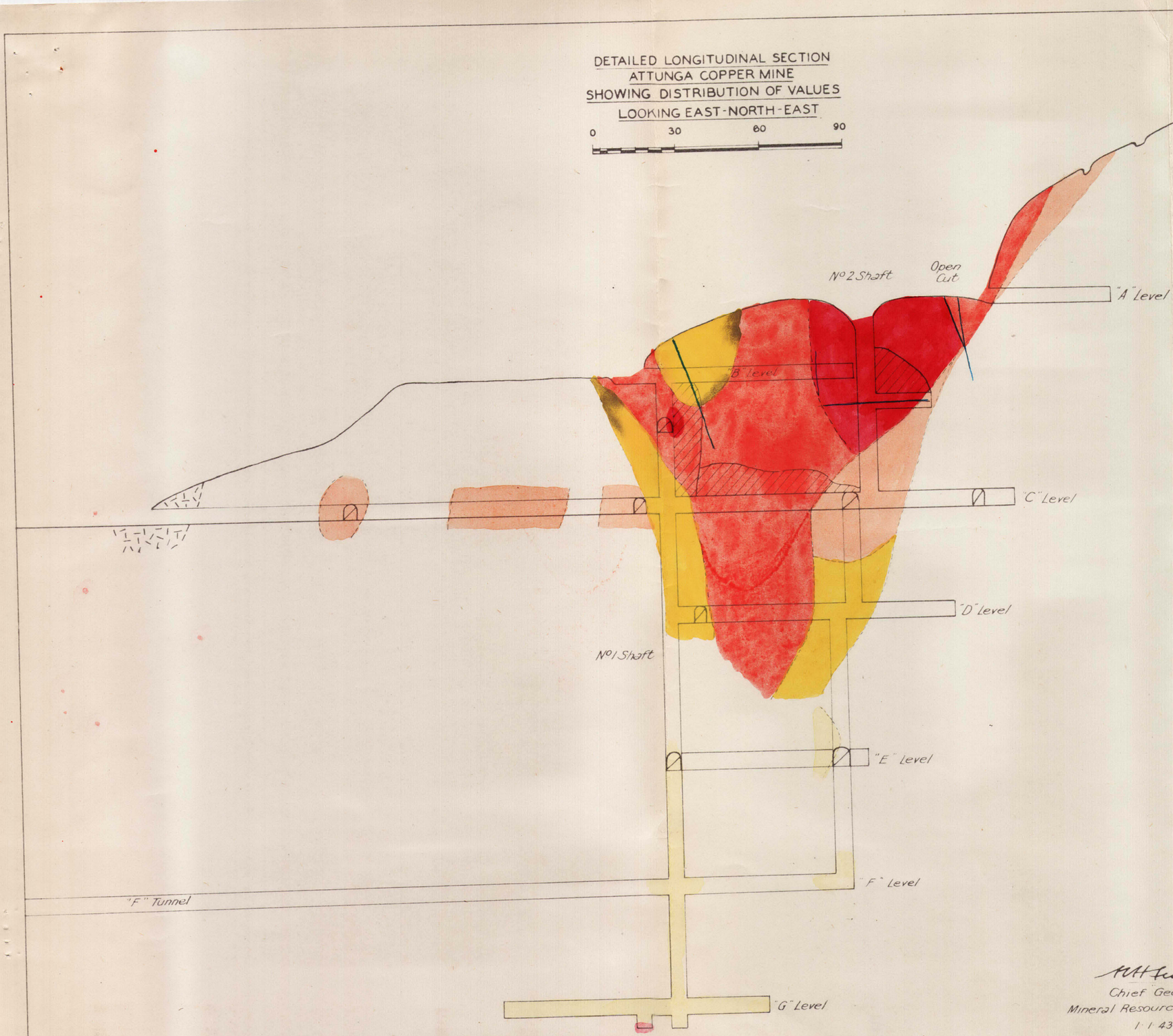


A H Baker
Chief Geologist
Mineral Resources Survey Branch
1-1-43

PLATE 5.

DETAILED LONGITUDINAL SECTION
ATTUNGA COPPER MINE
SHOWING DISTRIBUTION OF VALUES
LOOKING EAST-NORTH-EAST

0 30 60 90



LEGEND

- > 6% Cu > 3' thick.
- > 6% Cu < 3' thick
- 3%-6% Cu > 3' thick
- 3%-6% Cu < 3' thick
- < 3% Cu > 3' thick
- < 3% Cu < 3' thick
- Stoped
- Andesite
- Fault

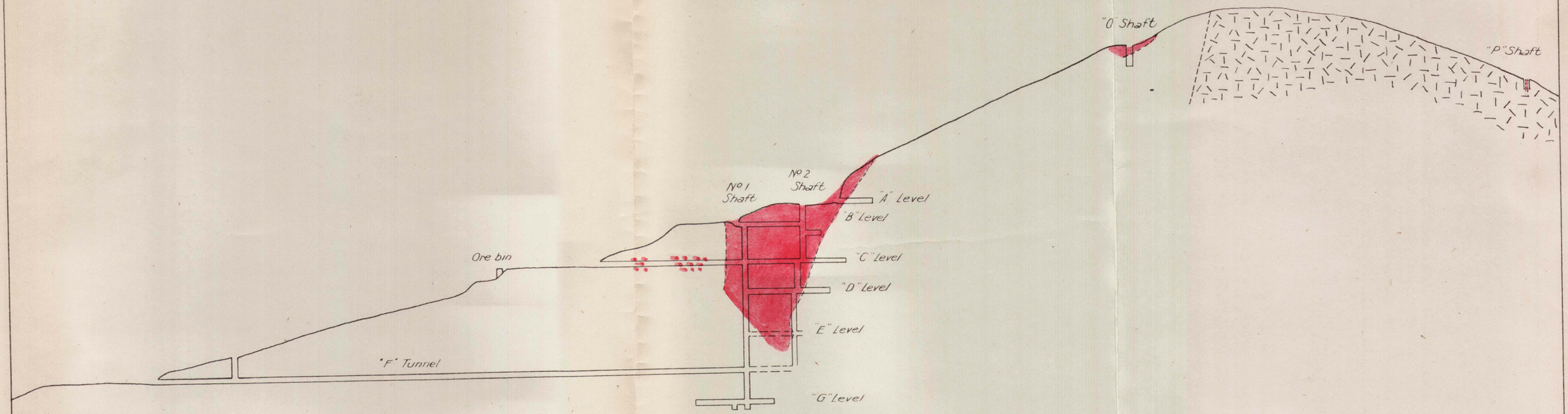
H.H. Fisher
Chief Geologist,
Mineral Resources Survey Branch
1.1.43

LONGITUDINAL SECTION
ATTUNGA COPPER MINE

SHOWING
GENERALISED OUTLINE OF ORE-BODIES
AND RELATION BETWEEN THE DIFFERENT MINERALISED
SECTIONS

100 0 100 200 FT.

LOOKING EAST & NORTHEAST
REFER TO PLATE I FOR DIRECTION
OF PLANE OF SECTION.



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31 12 42