GEOLOGY OF THE RUDDYGORE AND ZILLMANTON COPPER MINE AREAS, NEAR CHILLAGOE, NORTH QUEENSLAND

by

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SUMMARY

Detailed surface mapping at the Ruddygore and Zillmanton Copper Mines was carried out in conjunction with a geophysical survey by the Bureau of Mineral Resources in July and August, 1959.

At the Ruddygore Mine, 29,293 tons of hand-picked ore with a grade of 3.9% copper were mined (1903 to 1909) from two open cuts. The copper is in a metasomatized monzonite body in the Almaden Monzonite of Carboniferous age. Hornblende, biotite and quartz were found to be variable components of the monzonite and, based on this, five varieties of monzonite have been mapped. Stocks of leucocratic microgranodiorite have been intruded into the monzonite: the various types of monzonite are mantled round these stocks with the more acid (biotite-rich) types nearest the microgranites. This zoning, together with flow banding in the monzonite, suggests that acid differentiates from the original magma streamed into centres of low pressure and then intruded the zoned, and probably crystalline, mantle surrounding the centre. The force of the intrusion caused shattering of the monzonite above the intrusive. Copper-bearing solutions, accumulated with the acid differentiate, rose into the shattered rock, metasomatized it and deposited copper minerals in the open spaces. A number of areas of metasomatized monzonite are known around the Ruddygore Mine: others may be indicated by the geophysical anomalies found during 1959. A comparison is made between the Ruddygore area and some American porphyry copper areas.

The Zillmanton Mine is located along a shear in Silurian sediments near a contact with the Almaden Monzonite. When, in 1913, the mine collapsed and was flooded, the manager's figures showed that 30,000 tons of 4% copper had been developed. The sediments in the area - marble, banded calc-silicate marble, and silicified siltstone - have been intruded by a monzonite similar to that at Ruddygore. A mineralized shear, in marble, is parallel to the contact. The lode which is capped with a siliceous haematite gossan, has a width of about 30 feet and can be traced for a length of . The geophysical work may indicate extensions of the lode to the east and south-east.

INTRODUCTION

The Ruddygore and Zillmanton Copper Mine areas were mapped in conjunction with a geophysical survey by the Bureau of Mineral Resources, during July and August, 1959, to aid the interpretation of geophysical results. The geophysical data for the Ruddygore Mine has been published (Horvath, 1959).

The Ruddygore Mine is situated one and a half miles north-east of Chillagoe, and the Zillmanton Mine two and a half miles north-west of Chillagoe, the town nearest the two mines. Chillagoe lies 139 miles by rail west of the seaport of Cairns. A 3'6" gauge railway and a fair to good dirt and bitumen road connect the two towns. Chillagoe is served by a nearby air-field which is suitable for light aircraft.

The Chillagoe area has a mature topography, with an average relief of 200 feet. Chillagoe Creek, which is spring fed, drains the area and flows into the Walsh River eight miles north of Chillagoe.

Mapping at the two mines was controlled by a surveyed grid with stations every 50 feet on co-ordinate lines 200 feet apart. The grid was drawn at a scale of 200 feet to one inch and the geology plotted on this grid. At the Ruddygore Mine days were spent mapping an area 5400 feet by 3800 feet, and at the Zillmanton Mine one day to map an area 4000 feet by 2000 feet. Underground workings were inaccessible and reliance has been placed on the observations of others for such details.

GEOLOGY OF THE RUDDYGORE MINE AREA

PREVIOUS MINING AND MAPPING

Mining at the Ruddygore Mine commenced as a small open cut in 1896. Between 1899 and 1901, three shafts were put down to 100 feet and cross-cuts developed to connect with winzes from the open cuts. From 1903 to 1909, the No. 1 open cut was developed to measure 450 feet by 80 feet and 80 feet deep; a second open cut, 250 feet to the north-east, is 70 feet in diameter and 80 feet deep.

Three diamond drill holes were drilled in 1907; one, 304 feet deep from the bottom of the No. 1 open cut, assayed 13.6% copper and 1.6 oz/ton silver for a three foot length of core. (The location of this sample is not known, but is probably from the zone of secondary enrichment about the 100-foot level.). A second hole was drilled horizontally for 514 feet from the south end of the 100-foot tunnel level, and the third was located north of the workings and was 300 feet deep. No results for these holes are available.

In 1908 a shaft was sunk near the No. 1 open cut, and levels developed at 125 feet, 225 feet and 325 feet; ore came from only the 125-foot level. Work ceased in October 1909.

Ore from the mine averaged 1.5% copper; total production was 29,293 tons of handpicked ore, with the grade depending on the degree of handpicking, as follows:

Year	Tons	Copper%	Silver oz/ton
1903	394	5	1.4
1904	4225	5.3	2
1905			
1906	5277	4.2	2.1
1907	4753	4.8	3.3
1908	4139	3.6	2.5
1909	10505	2.9	1.1

Broken Hill South Ltd. held the mine under an Authority to Prospect from 1947 to 1949. They put down eight churn drill holes into various parts of the main metasomatized ore body, and three holes into a supposed extension. The depth of the holes ranged from eight feet to 60 feet, and in all the copper values were low, generally in the range 0% to 0.15%, with the highest assay of 1.33% copper for a five foot section. Although some of the holes passed the water table at about 48 feet, none of the holes penetrated as far as the zone of secondary enrichment shown by previous mining to be about 110 feet below the surface. No development was carried out after this initial investigation.

At the time of the present survey, Mount Isa Mines held an Authority to Prospect over the area.

Mention of the development at the Ruddygore Mine is made in the Mining Warden's reports for the years 1903 to 1909; other reports are by Jensen (1941); Stillwell (1947); Broadhurst (1949); and de Keyser et al (1958).

GENERAL GEOLOGICAL SETTING

The copper is found in a metasomatized monzonite body in the Almaden Monzonite of Middle - Upper Carboniferous age. The monzonite, intrusive into Silurian limestones and calcareous sediments of the Chillagoe Formation, crops out in a belt 20 miles long, averaging three miles wide, and trending north-north-west between Almaden and the Walsh River (figure 2). On the western side the monzonite is in contact with metamorphosed Chillagoe Formation; to the east the percentage of quartz increases, and hornblende decreases in the monzonite, until about three to five miles from the contact the rock is an adamellite. This adamellite - the Herbert River Granite - crops out over an area of 1200 square miles south of Almaden. It is possible that the Almaden Monzonite is a variant of the Herbert River Granite, produced by assimilation of limestone of the Chillagoe Formation. Rhyolite dykes intrude the monzonite in the mine area, and five miles to the east the Herbert River Granite is overlain by Permian acid volcanics.

DETAILED SURFACE GEOLOGY OF THE MINE AREA

Monzonite.

In the mine area, five varieties of the Almaden Monzonite have been recognised as follows:

Monzonite containing,
a) hornblende.
b) hornblende and quartz.
c) hornblende and biotite.
d) hornblende, biotite and quartz.
e) biotite and quartz.

Boundaries between all types are gradational, but by far the most abundant are types 'a' and 'b'. The following general petrographical description is taken from a report by Stillwell, 1947:

'... grain size about 1.0 to 2.0 mm ...the rock consists essentially of quartz, orthoclase, plagioclase, hornblende and biotite, the hornblende and biotite showing partial alteration to chlorite and epidote. The proportion of quartz is rather greater than is required for a quartz diorite, and the proportion of plagioclase equals or exceeds the amount of orthoclase.

The hornblende was originally a brown variety, and some is preserved as such in the cores of the hornblende crystals. Much of it, however, is green from partial or complete alteration to chlorite. Where it is completely altered to chlorite, grains of pale yellow epidote have developed in association with the chlorite. The hornblende tends to occur associated in clusters with somewhat ragged flakes of chloritized biotite.

The feldspars are clear to cloudy, the orthoclase being the more altered. The alteration, however, is not severe.'

Distribution of the monzonite varieties is shown in figure 3. South and west of the mine, hornblende monzonites are common: for example, between 1000E and 1000W, quartz hornblende patches are distributed through hornblende monzonite. Between 1000W and 3000W there are small areas where a low percentage of biotite is found in the (quartz) hornblende monzonite. Similarly, east and north-east of the mine, hornblende and quartz hornblende monzonites crop out and there are a few patches where biotite is a major constituent. Some xenoliths of dolerite and hornfelsed sediments are found in the monzonite.

North and north-west of the mine there is a major change in the type of monzonite. Here biotite is the diagnostic mineral: it is occasionally combined with hornblende, and always with quartz. This biotite-rich area is probably associated with stocks of leucocratic microgranite (the relationship is discussed later).

Two structures are found in the monzonite: jointing and flow banding. Two directions of steep-dipping jointing are present, but some areas are recognised where only one of the two is well developed. One set of joints strike about 35 degrees, and the other 065 degrees; both dip between 60 and 90 degrees, either side of the vertical. A third set is an undulating shallow-dipping joint, with an average dip of 15 degrees.

Flow banding is most pronounced in the mine area. The banding is regular, though wispy, and seems to be due to bands of leucocratic quartz monzonite in the normal rock type. The bands average two inches wide and may be traced across a single outcrop. It appears that the bands are segregations from the monzonite; the boundary between the two rock types is diffuse, but the transition is restricted to a zone one eighth of an inch wide.

Leucocratic Microgranodiorite.

In the area mapped (figure 3) there are two areas of outcrop of a leucocratic microgranodiorite; one, about 800 feet by 400 feet, is north-west of the mine; the second, 1400 feet by 700 feet, is north to north-east of the mine. The rock was called an aplite by Broadhurst (1949).

Stillwell (1947) has described the rock as being similar to the monzonite, but containing,

'less and small ferromagnesian minerals and perhaps more quartz. In the hand specimen it appears...rather finer-grained than the other rocks' (monzonite).

Compared with the monzonite,

'the ferromagnesians...are finer grained...and are completely altered to chlorite, iron ore and epidote. Some of the chlorite is bleached almost colourless. The original mineral appears to have been largely biotite, but some hornblende may have been present. The orthoclase crystals are so cloudy as to be almost opaque. The plagioclase is rather less altered.'

Jointing in the microgranodiorite generally trends 335 degrees and dips between 60 degrees and 90 degrees either side of the vertical. Both the 065 degree joints and the flat joints are found in the microgranodiorite as in the monzonite.

The relationship between the monzonite and leucocratic microgranodiorite is not known because all contact zones are covered by talus or soil. Flow banding has not been found in the microgranodiorite: the banding (in the monzonite) generally is parallel to the contact. One noteable feature is the absence of monzonite xenoliths in the microgranodiorite, or vice versa, but xenoliths of dolerite and hornfels are found in both.

Metasomatised rocks.

Alteration products of monzonite and microgranodiorite make up the third group of rocks which crop out in the area. Metasomatized monzonite has attracted attention because copper mineralization at the Ruddygore Mine is associated with this rock.

The mine is located towards the north-western end of a metasomatized monzonite body which trends 335 degrees and crops out over a length of 1800 feet and a width of 400 feet. Three narrow dykes of metasomatized monzonite, represented by a few outcrops trending 065 degrees away from the north-western edge of the main body, follow approximately the lines 100S, 700S and 1300S. The southern dyke is the longest with a length of 1300 feet and a width of 30 feet.

Three areas of metasomatized monzonite are known. The most important is that in which the mine is located. The second area is exposed in three small pits at about 1800S, 2600W; and the third, with an area equivalent to that of the main body, is outside the area mapped, about 700 to 1000 feet north-east of 500N, 2400E.

Various degrees of metasomatism have been noted. As the ore body is approached the hornblende and biotite in the monzonite are altered firstly to epidote and chlorite and finally to an aggregation of bleached chlorite in fibrous clusters. Similarly, the feldspars become cloudy and where metasomatism is intense, the orthoclase, and some of the plagioclase, is replaced by massive sericite.

'The impression is thus gained that the area originally consisted of a uniform igneous rock type '(monzonite)' and that it has undergone locally an intense metasomatism, with conversion of the ferromagnesians to chlorite and the feldspars to sericite, thus darkening the colour of the rock, and blurring the outlines of the ferromagnesian minerals in the hand specimen. The transition from slightly altered to intensely altered rock is gradational.' (Stillwell, 1947).

The outer boundary of the metasomatized rock shown on figure 3 indicates where the alteration first becomes noticeable.

Other small bodies of metasomatised rock are generally restricted to the microgranodiorite. The metasomatized microgranodiorite bodies average 700 feet in length, 50 feet in width, and trend 065 degrees. They crop out in a swarm north of the main metasomatized monzonite.

The trends of the various metasomatized zones follow the main vertical joint directions common to the monzonite and microgranodiorite, that is 335 degrees and 065 degrees. Best development of the near horizontal joint, rarely found in the unaltered rocks, is in the main metasomatized monzonite body and this joint has been claimed by Broadhurst (1949) to be one of the main controls of ore deposition.

Another type of alteration of the monzonite is found in outcrops about 255S, 2600W. Here the rock is made up of a mosaic of fine calcite crystals surrounding rare phenocrysts of quartz and biotite (some altered to chlorite). Apparently all feldspars in the rock have been replaced by calcite. Weathering of the rock has given rise to the calcareous crust in this area.

Mineralization

The Ruddygore Mine is situated at the northern end of the largest mass of metasomatized monzonite in the area mapped. Size and shape of the ore body can be gauged from the dimensions of the two open cuts; No. 1 is 450 feet by 80 feet by 80 feet deep and the No. 2 is 70 feet in diameter and 80 feet deep, although some of the upper parts of the open cuts, particularly in No. 2, must have been overburden. As shown in the cross-section of the mine (figure 4), low grade mineralization surrounded the areas of better grade ore. Assay results were given in the section 'Previous Mining and Mapping'.

At the surface the ore is generally leached, although in some places carbonates occur at the surface. The most conspicuous occurrence of carbonate was apparently the original gossan, which Dr. Logan Jack reported as a mass of 'porphyry' rich in carbonate and several feet high.

Carbonates predominate to a depth of 40 feet, below which is chalcopyrite ore; sulphides can occasionally be found at the surface when they are associated with calcite veins. About the 100-foot level the chalcopyrite is reported to be accompanied by 'black ore', and Broadhurst (1949) suggested this was bornite. The primary ore is associated with euhedral quartz in anastomosing veins, two to six inches wide, in the metasomatised monzonite.

There is evidence of sulphide enrichment at the water table because the best ore in the mine came from an underhand stope below the 100-foot level. Here the ore was reported to bulk 5% copper in some places. However, the enriched mineralization was found to end on a flat floor just above the 125-foot level.

At the south-eastern end of the main metasomatized body (about 1000S, 1200E), away from the main workings of the Ruddygore Mine, there are numerous small shafts and pits. Other small areas of metasomatized rock, are: along 125°S from 500E to 100W; about 1800S, 2600W; at 1300N, 500E. There is also the large body north-east of the area, mentioned earlier; and Broadhurst suggests another area, about 900N, 400E, covered by soil, but shown to be metasomatized monzonite by the drilling of B.H.P. (1948).

The finding of small pits, sunk probably on copper stained rock, associated with the widespread occurrence of metasomatized monzonite indicates the relationship between copper mineralization and metasomatized rock. To see if there was any copper in the unaltered rock, samples were tested chemically in the Bureau of Mineral Resources. The results are:-

Specimen.	Copper in ppm.	Rock type	Grid Ref.
A346	14	Quartz trachyte	1250N, 2100W
A347	24	Hornblende biotite Monzonite	600S, 2250W
A348	32	Calcified Monzonite	255S, 2575W
A349	18	Hornblende Monzonite	050N, 600E
A350	28	Quartz Monzonite	150S, 1600E
A351	24	Microgranodiorite	900N, 1675E
A352	760	Metasomatized Monzonite	050N, 1100E
A353	22	Metasomatized Microgranodiorite	650N, 1850E

All the copper values are low, even that of A352 which came from near the Number 1 open cut, but it is not known whether these low values indicate a lack of copper in the monzonite, or are due to surface leaching.

Hypothesis on relationships between the igneous rocks.

The proposed geological history of the area is:

1. In the Carboniferous, the Herbert River Granite intruded Silurian limestone and calcareous sediments. Assimilation of these sediments left an excess of lime in the magma: some was taken into the feldspar molecule to produce a more calcic plagioclase than in the surrounding granite, and the rest combined with some of the silica to produce a calcic hornblende. Some of the silica silicified contact rocks. The final product was a monzonitic magma.

2. However, mixing in the magma chamber was not complete, and during crystallisation acid fractions moved through the crystal mesh into regions of low pressure. Evidence for this differentation is seen in:

a) The zoning found in the monzonite. The leucocratic microgranodiorite is certainly the most acid phase and the more acidic types of monzonite are mantled around this. Also, the stocks of microgranodiorite are minor bodies in the main monzonite intrusion.

b) The flow banding in the monzonite. This represents blebs of the differentiate moving towards one of the centres of accumulation, but trapped in the crystal mesh of the monzonite. Later forces, described below, have drawn out the blebs and orientated some of them normal to the original direction in which they were streaming.

3. While the lower levels of the monzonite intrusion were still in a plastic condition and the upper levels were crystallized, some of the accumulations of mafic poor, quartz-rich, magma differentiate commenced to rise through the zoned mantles surrounding them and into the crystalline hornblende monzonite. Here they crystallised as small stocks of leucocratic microgranodiorite. The force of intrusion caused shattering of the monzonite above the rising cupolas of acid magma. It was this intrusion which orientated the blebs of differentiate in the monzonite normal to the outward pressure of the intrusive force: the flow banding now generally conforms to the outline of the microgranite stocks, and in places is contorted near them.

4. Copper-bearing solutions accumulated with the differentiate and rose into the shattered rock above the stocks of microgranodiorite. These solutions metasomatized the rock, and deposited copper and silica in the open spaces. Possibly there was a decrease in volume of the monzonite accompanying the metasomatic reactions (Locke, 1926); this would allow the collapse of the metasomatised rock and the formation of flat tension joints. As Broadhurst (1949) suggested, the upper limit of the flat jointing would limit the collapsed body and the mineralization. (The finding of 'aplite' - my microgranodiorite - in the 325 foot level under the Number 1 open cut tends to confirm this hypothesis: figure 4. The swarm of metasomatized microgranodiorite dykes may represent the lower levels of a major altered body, now eroded.)

Rhyolite dykes.

A number of glassy rhyolite dykes, often flow banded, was found in the area. Most of them are only a few feet in length, but one was traced for a length of 4700 feet and had an average width of 20 feet. This dyke trends 065 degrees along 1200S, and over this distance it grades from a grey glass, through a porphyritic rhyolite, to a porphyritic quartz trachyte. The dykes are probably Upper Permian.

GEOLOGICAL SIGNIFICANCE OF GEOPHYSICAL ANOMALIES.

The electromagnetic (Turam) anomalies shown in figure 3 are taken from a report by Horvath (1959).

Between 000 and 2400E there are a number of weak to medium anomalies, all trending about 065 degrees, parallel to the long axis of the main metasomatized body: those anomalies near this body are probably related to it. The anomaly from 1500N, 1250E to 700N, 1250E may represent a northern extension of the main body.

The four anomalies along 2000E are approximately at right angles to the swarm of metasomatised microgranodiorite dykes. They may indicate a metasomatised body beneath, or in, the microgranodiorite intrusion. However, it is more probable that the dyke swarm represents the remnants of a major altered body, now eroded.

The other area with geophysical anomalies is between 1000W and 3000W. The anomalies - some are strong - trend 340 degrees and are mainly in soil covered areas. They may be related to calcified mo[illegible]ite which is either mineralized or else is a good aquifer.

RECOMMENDATIONS

1. The area between 1500W and 2000W, and 400N and 1500S should be costeaned and drilled to determine the cause of the strong anomalies in this area.

2. Exploratory drilling should be carried out in the area from 800E to the eastern limit of the second major metasomatized body, about 1500 feet north-east of the area mapped. A number of the holes should be about 500 feet deep.

Firstly the grade of copper throughout the metasomatized bodies should be found; for example, Jensen (1941) reported that the early management of the mine proved the existence of chalcopyrite-bearing 'porphyry' (metasomatized monzonite) for 360 feet between the two open cuts, on the 100 foot level. The possibility of low grade copper ore beneath about 2000E should be explored.

GEOLOGY OF THE ZILLMANTON MINE AREA

PREVIOUS MINING AND MAPPING

This data was taken mainly from a report by Jensen (1941, p.34). About 1902 the Chillagoe Company sank three shafts on the Zillmanton Lode: two were at least 350 feet deep and connected by a level at that depth, and the third, Reid's Shaft, which was further to the west, was sunk to 375 feet. Earlier shallow workings were west of Reid's Shaft. No total production figures are given, but in 1910, the Zillmanton Mines produced 2,252.96 tons of ore containing 96.96 tons of copper (4.3%) and 3.200 oz. of silver (1.4 oz. silver per ton). In 1913, the Zillmanton Shafts twisted and the lower workings collapsed through an inrush of water: the mine was abandoned. The manager's report for 1913 indicated 30,000 tons of 4 to 5% copper ore developed and proved in the mine.

Since 1913 a number of mining companies have held authorities to prospect the area, but no development has been attempted. In 1941 Jensen made a brief survey of the mine; in 1957 Langron published the results of a geophysical survey of the western part of the lode.

GENERAL GEOLOGICAL SETTING.

The mine is located along a shear in Silurian sediments near a contact with the Almaden Monzonite (figure 2). The gossan outcrop of the lode ranges in width from 20 to 60 feet, and can be traced for about one mile. The lode strikes 270 degrees and, on the evidence of underground workings, dips south at about 55 degrees (Jensen, 1941).

DETAILED SURFACE GEOLOGY OF THE MINE AREA

Sediments

The sedimentary succession in the area mapped (figure 5), is:

Marble: A white, saccharoidal marble, generally massive, with occasional evidence of bedding. The bedding generally strikes 290 degrees, and dips south at 75 degrees. Estimated thickness of the marble is 500 feet.

Banded calc-silicate marble: This rock interfingers with, and overlies, the marble; its prominent outcrops appear iron stained and well banded. In the hand specimen the rock consists of saccharoidal marble, siderite, quartz, and calc-silicates. Thickness is about 400 feet.

Silicified siltstone: Occasional lenses of siltstone are found in the banded calc-silicate marble. The rock is generally mottled purple (weathered) and grey (fresh), and contains scattered crystals of calcite and pyrite.

Marble: The saccharoidal marble reappears at the top of the section.

The sediments are Silurian and are part of the Chillagoe Formation; the beds strike about 270^{o}, and dips south at 75^{o}. They have been metamorphosed by the Carboniferous Almaden Monzonite.

Monzonite

Intruding the sediments is a monzonite - the Almaden Monzonite - petrologically similar to that at Ruddygore. The monzonite has been described earlier in this paper under 'Detailed Surface Geology of the Mine Area' for the Ruddygore Mine, and only the main characteristics will be mentioned.

Of the five varieties of monzonite at Ruddygore, four crop out here; all contain hornblende; quartz and biotite are sometimes present; and the biotite/quartz variety of the Ruddygore area is absent. Three directions of jointing are 360 degrees, 335 degrees, and 270 degrees; and dips range from 60 degrees to 80 degrees. A fourth joint dips between 10 degrees and 30 degrees and has an irregular strike. The monzonite is not flow banded.

Siliceous haematite lode.

Scattered outcrops of siliceous haematite cap the Zillmanton Lode and parallel the edge of outcrop of the monzonite; the outcrops are separated from the monzonite by 50 feet of either soil or marble. Hand specimens of the haematite consist of vesicular silicified haematite, with goethite lining the larger vugs, and limonite on exposed surfaces.

A continuous haematite lode extends from 000 to 2000E along about 650S; the width of the lode is uncertain because of the wide spread of haematite rubble, but it does not exceed 200 feet, and is probably about 60 feet. Other small areas of haematite outcrop are at 1100S, 2400E; 1500S, 2400E; and at 1850S, 2500E, a large volume of haematite rubble has been shed from north of 000S, 3400E, on to the area mapped.

In many places, a surface crust of travertine is associated with the haematite rubble. Possibly this crust is a residual from the weathering of a calcite-garnet-magnetite rock similar to that found in small pits west of the area mapped. The source for the iron along this line is unknown: it might have been introduced into a shear from the granite, or it may have come from a metamorphosed, impure sediment. Where pure limestone was in contact with the monzonite it was recrystallized, but no new minerals were added.

Mineralization.

The Zillmanton lode has been described as,

'ranging up to 60 feet in width. It has a dangerous clay hanging wall, and a running mud zone between the iron-garnet lode and limestone. This clay carries secondary copper minerals through it. It is understood that the most consistent and richest zone of the lode was adjacent to the footwall, where chalcopyrite occured in the kaolin and kaolinized granite.' (Jensen, 1941).

The average grade was 4% copper and 1.35 oz. silver per ton. A sample of monzonite from 450S, 1200E was tested chemically and gave 22 ppm copper.

GEOLOGICAL SIGNIFICANCE OF GEOPHYSICAL ANOMALIES

Electromagnetic anomalies trend across the area from west to east, and are continuations of anomalies found by Langron (1957) along the western extension of the Shannon - Zillmanton lode. A weak to medium anomaly follows the line of siliceous haematite from 650S, 000E to 800S, 2100E. Here the intensity increases to strong and the anomaly trends south-east across haematite rubble, marble, and banded calc-silicate marble to 1300S, 3000E; and then mainly over soil to 1600S, 4000E. At 1200S, 2800E a medium anomaly branches from the main anomaly and trends east, mainly over soil and marble rubble, to 1600S, 4000E. A third, medium to weak, anomaly trends from 1900S, 700E, east to 1850S, 3400E. For the most part, the anomaly trends over, or near, a marble - soil boundary (at 1850S, 2500E a marble - haematite boundary), but from 2650E to 3400E it trends over marble outcrop.

All three anomalies lie mainly over soil or rubble areas. Lack of outcrop may indicate shearing along these lines, with a possibility of mineralization in the shears, as at the Zillmanton Mine.

RECOMMENDATIONS

1. Costeaning along the geophysical anomalies and drilling to intersect possible lodes at depths of 150 feet and 300 feet is warranted. Possible shearing would parallel the bedding and dip south at 50 to 70 degrees. The point of branching of the main lode at 1200S, 2800E should be investigated first.

2. If sufficient ore is proved in these investigations, then it may be economical to re-open the Zillmanton Mine.

CONCLUSIONS

Individually, the mines of the Mungana - Chillagoe - Almaden district are small. However, when considered as a mineral province in relation to the low grade copper deposit at the Ruddygore Mine, a parallel with American Porphyry Copper areas is seen.

The characteristics of the American deposits can be summarised as follows:

1. Chalcopyrite or bornite is usually the principal mineral. Secondary enrichment acts to concentrate the copper.

2. Metasomatic alteration is generally caused by the introduction of sulphur and potassium. The list of hypogene minerals includes quartz, sericite, alunite, kaolin, chlorite, feldspars, hydromuscovite, and tourmaline. The highly altered rock grades into unaltered rock.

3. There is intense shattering of the host rock, and breccia pipes are present in most, but not all, areas.

4. Oxidation of the ore leads to the development of 'live limonite' at the surface.

5. Many porphyry districts contain commercial deposits of lead, zinc, gold, and silver outside the porphyry zone proper.

6. Porphyry coppers are found in Mesozoic rocks.

For comparison, the characteristics of the RUDDYGORE Mine and area are:

1. From the small deposits mined, there is evidence of widespread chalcopyrite/pyrite mineralization, particularly in the metasomatized monzonite of the Ruddygore Mine. Ore from the mine averaged 1.5% copper. Small areas, probably in the zone of secondary enrichment, assayed as high as 13.8% copper. The grade of copper in development headings is not known.

2. The intensely metasom[illegible]ed rock at the Ruddygore Mine consists of fibrous bleached chlorite, massive sericite and some plagioclase. This rock grades into unaltered monzonite.

3. Possibly the rectangular and irregularly shaped areas of intensely metasomatized monzonite represent breccia pipes.

4. 'Live limonite' is possibly present in small vugs in the outcrop of the metasomatized monzonite.

5. Small, commercial deposits of lead, zinc, gold, and silver have been worked to the west and south of the Ruddygore area--(see figure 2, and the Zillmanton report).

6. The Almaden Monzonite is Carboniferous. The granites and monzonite of this area are Carboniferous and Permian, and are among the youngest granites in Queensland. The tectonic history of the area has allowed these granites to only now be exposed at the same level of intrusion as Mesozoic granites in America.

Because of the similarities in this generalised comparison with American Porphyry coppers, some consideration should be given to the possibility of discovering a low grade disseminated copper ore in the Ruddygore Area.

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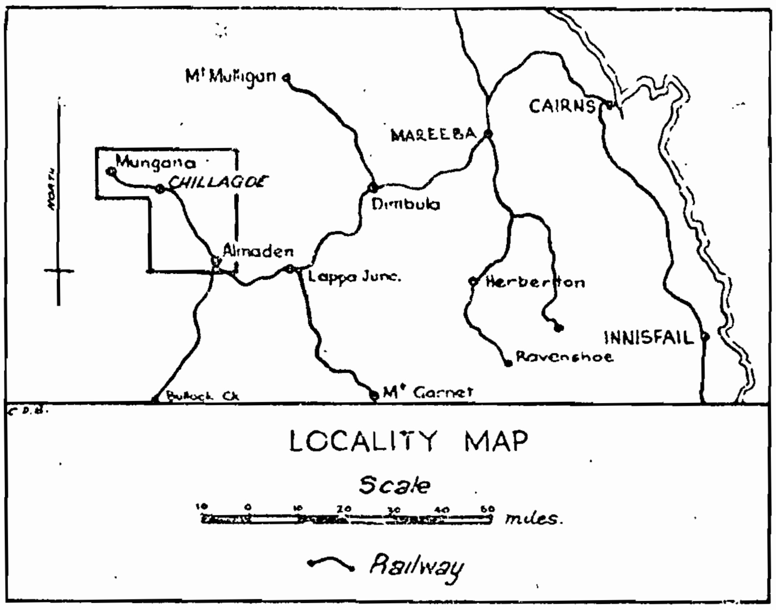


FIGURE 1

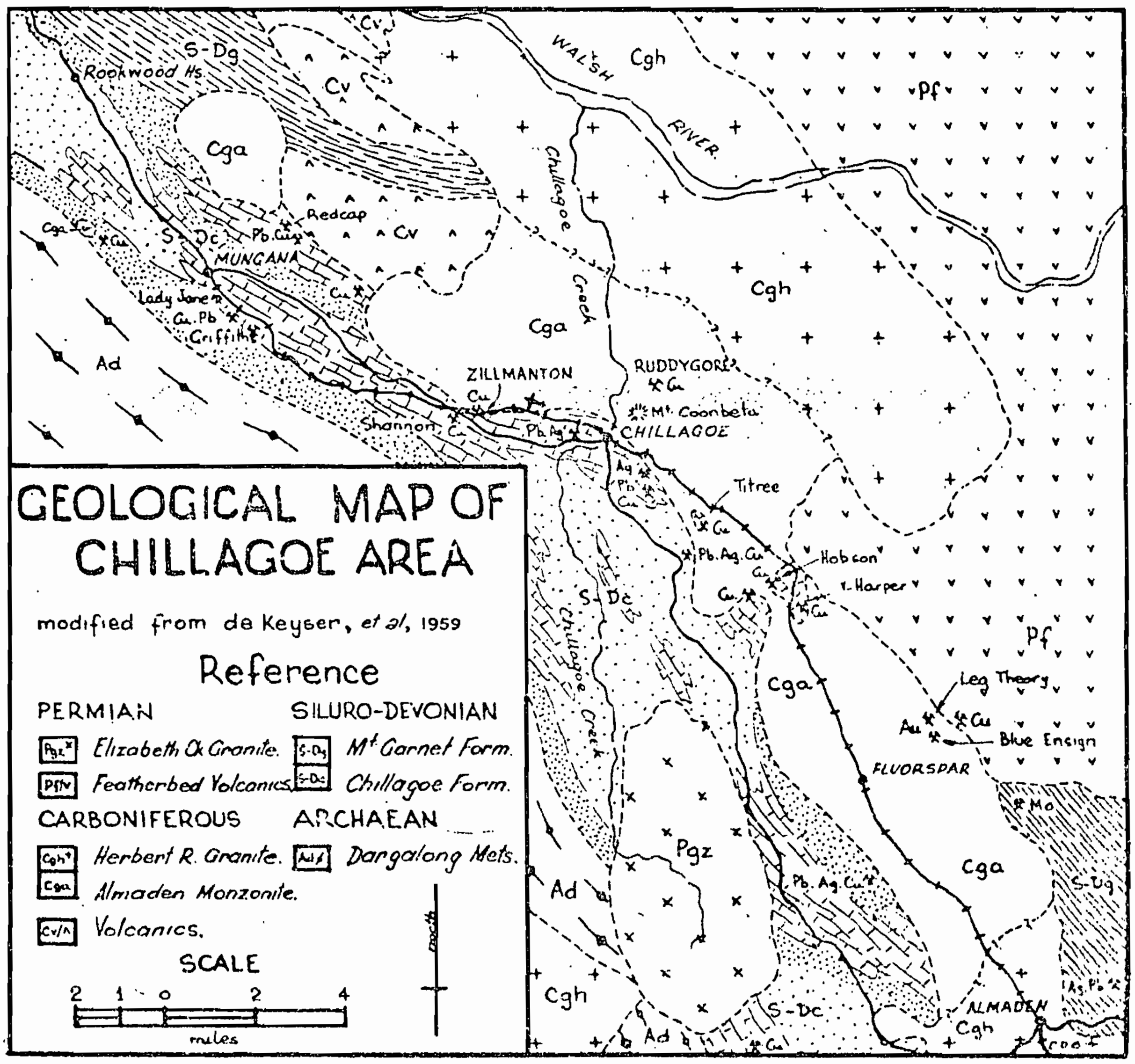
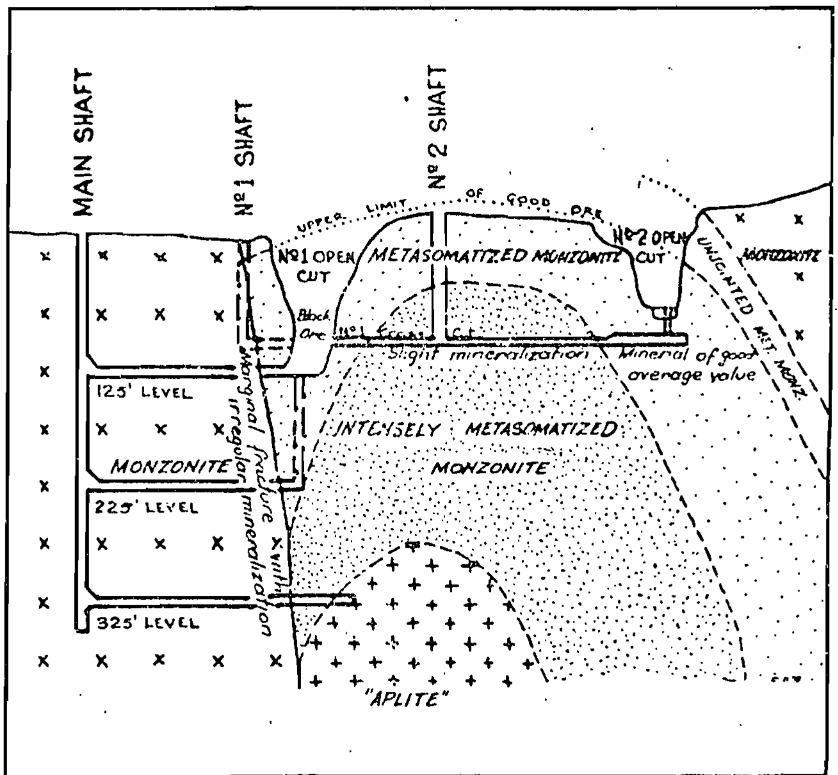


FIGURE 2

GEOLOGICAL MAP
RUDDYGORE MINE NEAR CHILLAGOE
NORTH QUEENSLAND



CROSS-SECTION OF RUDDYGORE COPPER MINE

from Broadhurst, 1949.

Scale

100 50 0 100 200 300

feet

FIGURE 4


GEOLOGICAL MAP OF
ZILLMANTON MINE AREA
NEAR CHILLAGOE NORTH QUEENSLAND
Reference
CARBONIFEROUS
Monzonite, with hornblende
" " ,quartz & hornblende
" " ,hornblende & biotite
" " ,quartz, hornblende, biotite
Siliceous hæmatite
Hæmatite rubble
SILURIAN
Marble
Banded calc-silicate marble
Silicified quartz siltstone with disseminated pyrite
Travertine
Strong
Medium
Weak
Electromagnetic Indication
Scale
FEET
Geology & Drawn by C.D. Branch
Bureau of Mineral Resources
CANBERRA. Nov 1959
No 1 SHAFT
No 2
AIR SHAFT
Soil
Rubble
Soil and Rubble
Disseminated Pyrite
Aplite
Chert
Chert Nodules
Siliceous hæmatite
MAGNETIC NORTH
TO MUNGANA