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SUMMARY REPORT OF CROYDON SUB-PARTY, 1960 FIELD SEASON

by

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INTRODUCTION

The mapping, this field season, was a continuation of that started by the Bureau in 1956. Many of the areas of Upper Palaeozoic igneous rocks in the Croydon, Georgetown, Einasleigh, and Atherton 4-Mile Sheet areas were mapped in broad detail while examining them mainly for possible low-grade disseminated copper mineralization.

IGNEOUS GEOLOGY

Dumbano and Forsayth Granites

The age relationship between these two (?)Proterozoic granites was found in the Kidston area: at two localities large dykes of massive Dumbano Granite intrude foliated Forsayth Granite. The Dumbano Granite is grey with large euhedral phenocrysts of pink feldspar; it is similar to the Herbert River Granite (Carboniferous), but in the Dumbano Granite the feldspar phenocrysts are packed with small mica flakes.

Nanyetta Rhyolite

In the Silver Valley, and west of Mt. Garnet, there are a number of fault blocks of Nanyetta Rhyolite unconformably overlain by Glen Gordon Rhyolite. It was thought that the Nanyetta Rhyolite was Carboniferous, but it can now be shown to be an equivalent of the Silver Valley Conglomerate which is (?Middle) Carboniferous.

In the type area of the Silver Valley Conglomerate, the conglomerate contains many rhyolite pebbles, and, in part, is tuffaceous. There is a thin rhyolite flow at the top of the section. A section in a fault block of Nanyetta Rhyolite, a mile to the south, shows a much greater thickness of rhyolite (150 to 200 feet), underlain by a thin conglomerate bed identical to that in Silver Valley. Hence, it is concluded that the two formations are contemporaneous, and that the Nanyetta Rhyolite is (?Middle) Carboniferous. (The overlying Glen Gordon Rhyolite is thought to be Permo-Triassic).

Agate Creek Volcanics

The volcanics occupy a fault block, with an area of about 25 square miles, on the south-eastern edge of the Georgetown 4-Mile Sheet. Plant fossils found with the volcanics have been dated as Permian by M. White (1958).

A generalised section of the volcanics exposed, is (from the top) :

(a) Pink rhyolite and ignimbrite, intruded by rhyolite dykes. + 150 feet.

- - - - angular unconformity - - - -

(b) Viscous pink-purple rhyolite with platy flow banding. +40 feet.

(c) Basalt. There are two types of basalt: intrusive and extrusive. The intrusive basalt is massive, fine grained and has no amygdules. It crops out as an irregular pipe in the north-western corner of the volcanics, and as dykes nearby. In one case, an intrusive dyke grades into an extrusive basalt flow.

The extrusive basalts consist of alternating flows of massive basalt and anygdaloidal basalt (the amygdules are normally filled by agate and in a few cases by calcite).

Basalt flows average 20 feet in thickness on the north-western edge of the volcanics, but rapidly thicken to the south-east, where, through block faulting, they are repeated several times. The greatest thickness of basalt exceeds 200 feet.

(d) Extensive bed of cream mudstone and graded bedded shale (fifteen feet thick) crops out about half way up the basalt section. Glossopteris sp. is found in the shale. In many places the sediments have been silicified.

(e) As at (b), a viscous pink-purple rhyolite; 45 feet.

(f) Massive volcanic tuff and breccia, with rare flows of rhyolite glass up to three feet thick. The fragments in the upper breccias are all pink-purple rhyolite, but lower in the section there are many fragments of biotite schist. The base is not exposed. +200 feet.

The total thickness exceeds 700 feet.

The structure is that of a shallow basin, elongated north-west. A number of north-west faults cut the basin - they may also control the margins - and dips in the volcanics are steepened near the faults.

Two important points are brought out by these volcanics. The first is the striking similarity between the volcanics beneath the unconformity (units b to f), and the Nychum Volcanics on the Mossman 4-Mile Sheet. I think the structural environment is the same: the volcanics were poured out from fissures developed, in the Permian, at the intersection of Precambrian lines of weakness. (This is probably the setting for the Nanyetta Rhyolite (Carboniferous).)

The second point is that the volcanics above the unconformity can be correlated with the Newcastle Range Volcanics, thereby showing that there are definitely two ages of vulcanism in this area. The Newcastle Range Volcanics are now limited in age between the Permian and the Cretaceous, and are tentatively dated as Permo - Triassic.

Other areas of Permo-Triassic volcanics

Mapping of the Featherbed, Newcastle Range, and Scardons. Volcanics has given a clear picture of the geological history of acid extrusives in large cauldron subsidence areas.

1. Development of major faults bounding the future cauldron block. Slight local subsidence of the block formed shallow depressions on the peneplain land surface. Sediments in these depressions were mainly arkose.

2. Acid magma squeezed up the marginal faults was extruded as a viscous, pink rhyolite. Puys were built up, generally in groups, at various points along the faults.

3. Increase in the volatile content of the magma: at the surface the less viscous rhyolites flowed up to eight miles from the vents.

4. Explosive outpourings of volatile rich magma probably all the way around the cauldron block. Subsidence of the block accompanied the outpouring and the depression was filled by massive grey ignimbrite. This phase was repeated two, three, or more times, and up to 3000 feet of ignimbrite was accumulated.

5. Formation of ring complexas, generally beneath the large cauldrons.

6. Intrusion of the Elizabeth Creek Batholith.

7. Dyke swarms intruded into tension zones.

Interbedded with the ignimbrite in the Newcastle Range and Scardons Volcanics are huge piles of volcanic agglomerate: the piles appear to be conical, with a diameter of five to eight miles and a height of 300 to 500 feet. They may represent either explosive volcanoes or outwash fans.

The Barwidgi Volcanic Fissure was re-examined. A number of explosive vents filled with breccia are located at points of weakness along a rhyolite dyke, six miles long. (In this respect the structure is similar to that of the Tennyson Ring Dyke). Each of the vents is zoned: the walls of the vent are marked by flow rhyolite with vertical flow banding; inside this is a zone 20 to 50 feet across where irregular fragments of the wall are mixed with a tuffaceous matrix; the core, 10 to 60 feet in diameter, contains rounded boulders of Forsayth Granite, the country rock of the fissure. The zoning is best explained by convection movement with hot gasses and fluids rising up the centre of the pipe, and descending on the outside.

Permo-Triassic Granites

The Elizabeth Creek Granite was examined at many localities and will be discussed in the Economic Section.

Mapping of the Butlers Igneous Complex has changed the hypothesis put forward in 1958. The supposed rhyolite hood is now thought to be a succession of rhyolite, ignimbrite and volcanic breccia preserved in a small and irregular cauldron. The cauldron was intruded by a circular stock of micro-monzonite which, in turn, was intruded by pink granite stocks and dykes.

Some of the flow banded hood on the Lochaber Granite is now known to be a multiple injection zone of rhyolite dykes.

The Balcooma Rhyolite Porphyry seems to be the chilled roof of a granite injected into a fault zone. Later movements on the faults has sheared the granite.

The Croydon - Esmeralda - Foresthome Area

Two months were spent mapping the Permo-Triassic rocks of the Croydon-Esmeralda-Foresthome area. The rock units are (from the youngest):

Esmeralda Granite
.....intrusive contact .....
Inoruni Sandstone
..... structural discordance, but (?) no time break .....
Croydon Felsite

(a) Croydon Felsite

Structurally and mineralogically the Croydon Felsite is similar to the Featherbed Volcanics, Newcastle Range Volcanics, etc.- The cauldron block measures 75 miles by 43 miles, and the first subsidence must have been at the northern end because cream, silicified siltstones conformably underlie the felsite near Wallabadah W.H.

Puys of grey rhyolite were built up at various points along the boundary fault of the cauldron block, and on the eastern side a rift valley, eight miles wide, was filled by viscous rhyolite. Some of the later rhyolites were erupted from vents along faults in the centre of the cauldron.

The rhyolite phase was followed by contemporaneous subsidence of the cauldron and filling of the depression by ignimbrite. Two flows can be distinguished, each about 500 feet thick, and covering the whole cauldron.

(b) Inoruni Sandstone

Immediately following the effusion of the second ignimbrite, subsidence of the surface formed a basin 10 miles across above a developing ring complex. Into this basin was washed the unconsolidated material from the top of the ignimbrite flow. This quartz rich material is now the Inoruni Sandstone. The basin was formed by a number of (?) circular step-faults dipping steeply into the basin; the consolidated lower part of the ignimbrite flow was tilted against these faults and the Inoruni Sandstone was deposited unconformably on the ignimbrite.

(c) Esmeralda Granite

Intruding the Croydon Felsite and the Inoruni Sandstone is the Esmeralda Granite, which is the structural equivalent of the Elizabeth Creek Granite in this area. The granite crops out in an area 50 miles by eight miles between the Yappar River and Croydon, on the south-western side of the cauldron; and over a total area of 52 square miles made up of a number of small areas (largest 12 miles by four miles) between Snake Creek and Foresthome, on the eastern side of the cauldron.

Two types of granite are found; one is a microgranodiorite and the other a coarse grained granodiorite (almost a pegmatite in places). The two types must be virtually contemporaneous because each intrudes the other, and contacts are never sharp, indicating that the intruded rock was at least plastic at the time. A faint foliation of the large feldspar phenocrysts is present in some outcrops.

Quartz and greisen dykes are found in both types of granite, and at some localities the dykes are mineralized: Croydon (Au), Esmeralda (Au), Snake Creek (Ag-Pb-Cu), Mt. Little (Cu), and Stanhills (Sn). Some of the large areas of microgranodiorite show slight alteration.

Evidence for three types of intrusion has been found:

(1) forceful intrusion, with the tilting of blocks of country rock. This is generally restricted to the outer edge of the cauldron block.

(2) ring or block foundering, allowing a block of country rock to subside from under a flat roof, and granite fills the space.

(3) soaking of the country rock, so that the top of the granite intrusion is packed with xenoliths of the roof rock. The xenoliths are generally carbonaceous, and probably represent roof pendants that resisted assimilation.

ECONOMIC GEOLOGY

C.D. Branch

COPPER

Central Copper Mine (Precambrian mineralization)

The mine is 16 miles west of Einasleigh, in mica schist of the Einasleigh Metamorphics (?Archaean). Mining commenced in April 1960. The main lode, which parallels the foliation in the mica schist, has a length of 30 feet, width five feet, and has been worked to a depth of 12 feet. Bunches of malachite and azurite crystals, with some (?)chalcocite, are scattered throughout the lode and appear to be due to replacement in an epidote-magnetite rock. Two smaller epidote-iron-malachite lodes crop out nearby. About twenty tons of ore assaying 15% copper have been sent away.

Ruddygore Copper Mine (Permo-Carboniferous mineralization)

Following the mapping of the mine area last year (Branch, 1960: Bur. Min. Resour. Aust. Rec. 1960/51) it was concluded that there was a good possibility of discovering a low grade disseminated copper ore body in the Ruddygore area. Mt. Isa Mines Ltd. have drilled nine diamond drill holes in the mine area since then: seven holes, with an average depth of 200 feet, into the Ruddygore ore body; and two holes, each 150 feet deep, into a supposed second ore body 2000 feet to the north-east. All holes have been cored and show the same general section:

0' - 30' : iron rich and leached metasomatized monzonite.

30' - 80' : metasomatized monzonite; epidote-rich areas with bunches of coarse chalcopyrite crystals, also some zinc and galena (assay about 0.6% - 1.0% Copper). In one hole in the second ore body (?)tetrahedrite was found.

+80' : metasomatized monzonite with decreasing percentage of chalcopyrite.

The main differences between the main ore body and the second ore body are:

(1) Shattering and alteration in the second body has been more severe.

(2) Chalcopyrite in the second body is finer.

(3) (?)Tetrahedrite was found only in the second body.

Because of the more intense shatterings, the second ore body seems a better prospect for a low grade copper deposit.

The Ruddygore area was revisited three times with visitors from Canberra, and I now think that the number of rock types that are significant in prospecting for a copper ore body can be reduced from seven to four. The rock types are:

(1) hornblende monzonite (quartz and biotite as accessories); the "background" rock.

(2) quartz (often porphyritic) monzonite, sometimes rich in biotite and flow banded; the "ore-indicator" rock.

(3) metasomatized monzonite; the "ore body".

(4) leucocratic microgranodiorite; the no-mineralization indicator.

Newcastle Range (Permo-Triassic mineralization).

Five miles south of Eveleigh Homestead, the Newcastle Range Volcanics are intruded by a stock of Elizabeth Creek Granite. As well as tin mineralization, there are two small copper lodes associated with the granite. At Furbers Copper Mine a shaft 50 feet deep was sunk on a small greisenised granite lode. It was abandoned in 1939 when, at 50 feet, the ore changed from malachite to arsenical pyrite. Low's Mine is a chloritised shear in rhyolite containing malachite in the top eight feet and chalcopyrite below this.

There is no sign of widespread alteration of the granite stock, and I think that the area is unfavourable for finding a low grade copper deposit.

Esmeralda Granite (Permo-Triassic mineralization)

(a) Mt. Little copper field. On the southern edge of the basin containing the Inoruni Sandstone, two of the step-faults which formed the basin are mineralized. Two rows of shallow pits have been sunk on malachite staining in fault breccia. The southern line is in an area of metasomatized ignimbrite; the pits extend over a length of half a mile, and the deepest is 50 feet.

Half a mile to the north there are three pits, five feet deep, on a second fault line. Here metasomatised ignimbrite is adjacent to Inoruni Sandstone and the fault zone, 15 feet wide, is zoned. There is a preponderance of ignimbrite fragments in the southern half of the fault zone, and sandstone fragments in the northern half. Both types of breccia fragments are set in a rock flour and coated with a film of malachite.

Many of the rock fragments in the fault zone are well rounded. It is thought that the present level of exposure was near the original land surface and that at this level there was a lot of rolling and grinding of the rocks in the fault zone. Other boulders which look water worn may have been washed in from the surface at times when the fault zone was opened under tension.

(b) Snake Creek Mine. Traces of malachite were found with galena in a mineralized shear in metasomatized rhyolite, on Snake Creek. The shear is 150 yards long and four pits have been sunk along this line, the deepest to 25 feet. The rhyolite has been metasomatized, probably by an underlying granite; the feldspars are epidotised and the grey glass changes to green. On weathered surfaces the rock resembles the metasomatized monzonite in the Ruddygore Area.

TIN (all Permo-Triassic mineralization).

Gilmore Mine.

Since October 1960, Clutha Development Ltd. have deepened the main shaft from 350 feet to 450 feet. They have commenced mining good ore on the 450 foot level in what is thought to be a continuation of the Midas lode. This work is partly exploratory

in order to try and prove enough reserves to warrant setting up a battery at the mine.

Many tin lodes in country rock in the Emuford - Stannary Hills - Brownville area could probably be reopened and developed in a way comparable with the Gilmore Mine. The area between Mt. Misery and Brownville deserves more prospecting.

Tate Tin Field

The granite carrying cassiterite in this field is restricted to a small part of the total area of Elizabeth Creek Granite. Two differences between the mineralized and barren granite were noticed:

(1) The orthoclase in the mineralized granite was a much deeper shade of pink than elsewhere - a deep salmon pink compared with a light yellow-orange.

(2) Greisen dykes are restricted to the mineralized area. Taken together - for in some unmineralized areas there is one but not the other - these two points may be useful for prospecting, especially for sources of alluvial tin.

Newcastle Range

(a) Alluvial. In 1914, Deaf Creek, a branch of Eva Creek, was worked for alluvial tin over a length of 1½ miles, with an average width of 10 feet, and depth of four feet. Other small gullies nearby were worked at the same time. There is a possibility that similar alluvial deposits would be found in the area, but there is no ground suitable for dredging.

(b) Lodes. A small lode, 75 feet long, two feet six inches wide, and 25 feet deep was worked in the headwaters of Deaf Creek in 1946. The cassiterite was disseminated in greisenised Elizabeth Creek Granite and the walls of the lode were marked by granite with deep pink feldspars. At a depth of 25 feet the lode changed to fluorite-lead and was abandoned. More lodes could probably be found in the area, but they would probably be small (cf. Stanhills).

Stanhills

Mineralized greisen lodes are found in the Esmeralda Granite, and, above a flat roof to the granite, in the ignimbrite country rock. The lodes in the granite are small, and those in the ignimbrite would have little depth because they would pass down into granite and probably cut out. Alluvial tin has been won from both Cretaceous sandstones and recent alluvium, but there are no suitable dredging prospects.

There is one tin mine in ignimbrite north-east of the Croydon Gold Field: the Carron Tin Mine. There is a good possibility of other lodes in this area.

GOLD. (all Permo-Triassic mineralization)

Croydon Gold Field.

Gold lodes in the "Croydon Felsite" are quartz reefs in zones of greisenised or sheared rhyolite or ignimbrite. The lodes are in torsion and tension fractures associated with major north-trending faults indicated in the field by the repitition of various

marker units in the extrusives.

The gold-pyrite-quartz lodes in the Esmeralda Granite are in a major north-west fault zone which marks the edge of the granite in this area. Some lodes are in graphitic granite, but the graphite seems to have had no control in localising the gold.

Esmeralda Gold Field

Two groups of lodes, a quarter of a mile apart and both trending north, have been mined for gold. The lodes are quartz-gold-reefs in greisenised Esmeralda Granite; the main lode in each group was worked over a length of 500 feet, to a depth exceeding 100 feet with an average width of four feet.

Four water bores in the Esmeralda area passed through quartz reefs carrying some gold values at depths between 100 and 150 feet. Hoever, in each case there was a cover of about 100 feet of sand, and unless there was sufficient sulphide in the lodes to allow electro-magnetic prospecting to be used, exploration would be chancy and costly.

CONCLUSIONS AND RECOMMENDATIONS.

Ruddygore Area (Copper)

With the additional data from the drilling done by Mt. Isa Mines Ltd., this area is now more promising, than when considered last year, for the finding of a low grade disseminated copper deposit. More extensive detailed mapping of the Almaden Monzonite between Almaden and the Walsh River is needed to search for areas of metasomatized monzonite or quartz monzonite.

So far, no rich zone of secondary enrichment (chalcocite) has been found in the drill cores, but there was a zone of enrichment 20 feet thick, and bulking 5% copper, in the original Ruddygore workings (between the 100 and 120 foot levels). Any ore bodies cropping out on the Walsh River plain would have the best chance of building up an enriched zone because ground water circulation would not be as rapid as in the hillside areas already drilled.

Croydon - Esmeralda - Foresthome Area

Copper. Structurally, the Esmeralda Granite is similar to the Almaden Monzonite. Copper mineralization associated with the Esmeralda Granite has been found on the eastern side of the Gregory Range, and the small stocks of granite in this area deserve further mapping.

On the western side of the range, there has been no copper reported with either the tin or gold mineralization. However, the granites on both sides of the range are comagmatic, and areas of slight alteration in the granite between Croydon and the YarraRiver should be investigated in more detail, especially in the gold field areas. There is also a stock of granite twenty miles north-west of Inorunie Homestead that needs more mapping.

Now that the structure of the cauldron area is known the areas which warrant detailed mapping can be delineated. The mapping this field season has shown that the central part of the cauldron - that occupied by the ignimbrite - is not suitable for mineralization. In this area of about 1000 square miles there are only occasional major fault lines that have been hydrothermally altered. I think the granite would be too far below the surface to warrant prospecting for cupolas carrying mineralization.

However, the edge of the cauldron is highly favourable. In this area the granite has risen close to the present surface as a number of narrow (average seven miles wide) and elongated (two to 50 miles) stocks. Where granite does not crop out, the distribution of centres of rhyolite extrusion has shown that the granite belt is probably nearly continuous around the edge of the cauldron. The extent of the possible mineralized zone in sand covered areas can be accurately estimated because the mechanism of intrusion is known. This approach is useful on the western side of the area where Cretaceous sandstone of the artesian basin laps onto the granite, and also suggests that there may be prospecting areas on the northern and southern sides of the cauldron where little prospecting has been done.

Tin. Tin prospects are poor in this area: lodes in the granite are invariably small and lodes in the ignimbrite cut out in the granite at shallow depths; only the area on the Carron River deserves any consideration.

Gold. Re-opening existing workings does not seem to be worth while; geophysical prospecting in the Esmeralda area may be successful.

Other Areas

To complete the 1960 programme of regional mapping, of areas where possibly low grade disseminated copper deposits might be found, the following areas need investigation.

1. Prestwood Microgranite-Cumberland Range Volcanics.

The Esmeralda Granite and Prestwood Microgranite are in my opinion comagmatic. Gold and silver-lead mineralization is associated with high-level stocks of microgranite, and, as seen in the Snake Creek and Mt. Little areas, copper accompanies this ore mineral assemblage.

2. Balcooma Rhyolite Porphyry. Very little is known of this area, except that there is gold mineralization in the rhyolite porphyry, and the porphyry represents the top of a granite stock.

3. Kangaroo Hills - Ewan Field. Mapping in the western extension of this field on the Clarke River 4-mile area has shown that structurally and magmatically this field is similar to the areas already mentioned. Tin, silver-lead, and copper have been mined in the field, and I consider that, apart from the Ruddygore area, this is the next promising district for "porphyry copper" type mineralization.