TRS_136_161

TIN MINERALISATION NEAR MT. RAZORBACK, DUNDAS

by A. H. Blissett and A. B. Gulline.

INTRODUCTION

Fine cassiterite is intimately associated with sulphides in orebodies east and north of Mt. Razorback near Dundas on the West Coast. It has been worked intermittently since about 1909 in the Razorback Mine, sited on the east flank of Mt. Razorback; and from about 1940 in the Grand Prize Mine on Nevada Creek, approximately one mile to the north-west. Although records are incomplete the district has yielded concentrates representing at least 63 tons of metallic tin; of which about 46½ tons came from the Razorback Mine.

In 1958-59, three diamond-drilled boreholes were put down by the Department of Mines at the Razorback Mine, while between January and March, 1960, a detailed geophysical survey was carried out by the Bureau of Mineral Resources, Geology and Geophysics over the dense country between the two mines.

This report is based on detailed mapping over a period totalling some three months in 1959 and 1960, and includes an account of development and exploration which has taken place since the report by B. L. Taylor in 1951. It does not include a detailed account of the geophysical survey nor of recommendations made by the geophysical party, which will be embodied in their independent report.

LOCATION AND ACCESS

The Razorback Mine lies on Lewis Hill which forms a spur on the east slope of Mt. Razorback, three quarters of a mile north-east of the former township of Dundas, about nine miles by road east of Zeehan. The Rosebery road bears north from the Zeehan-Queenstown road about four miles east of Zeehan. One mile north of the junction, a secondary gravel road runs east through Dundas to Maestries mine. Half a mile east of Dundas, a rough track leads north to the Razorback Mine, half a mile away. The track crosses the Dundas Rivulet over a short bridge recently constructed by Mr. W. J. Hodge and then rises about 300 feet in a little over a quarter of a mile.

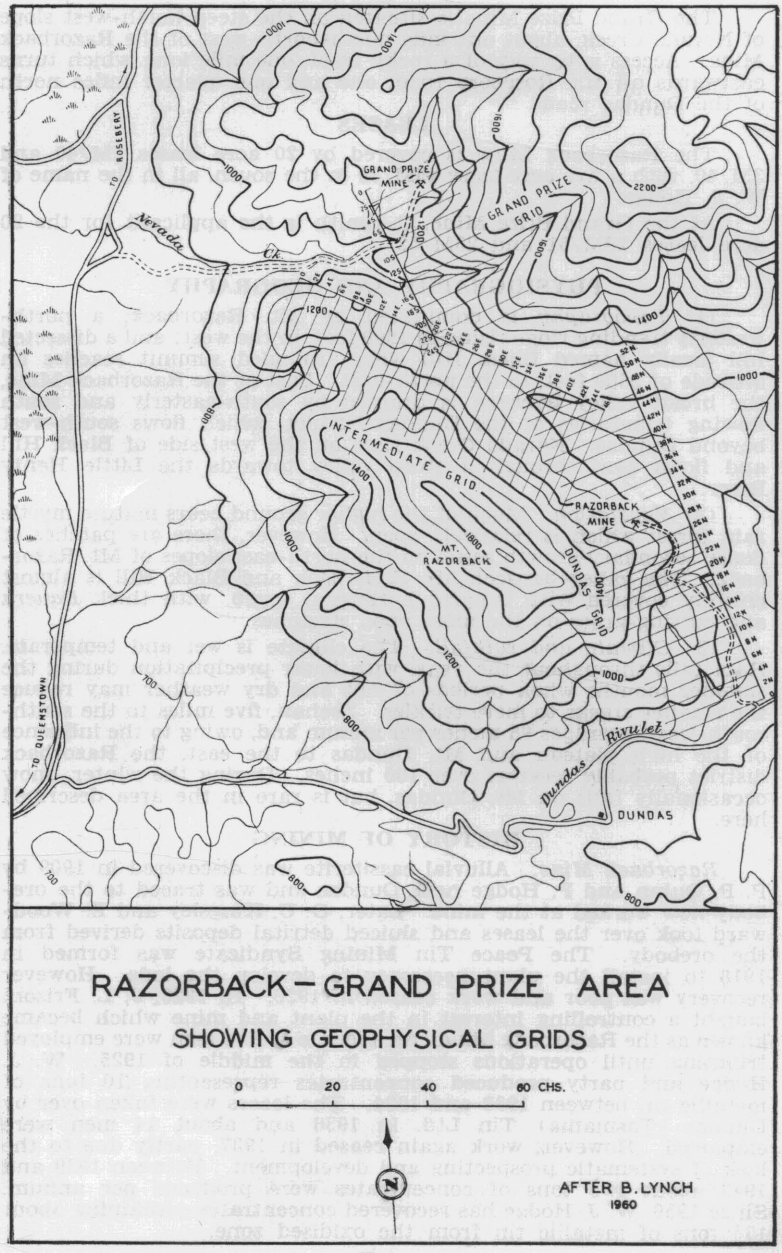


FIGURE 33.

5 cm

The Grand Prize Mine is situated on the steep north-west slope of Nevada Creek, about one mile north-north-west of the Razorback Mine. Access is by way of a rocky track one mile long which turns eastwards off the Rosebery road, one and one quarter miles north of the Dundas road.

LEASES

The Razorback Mine is covered by 20 acre leases 2M/40 and 3M/40, with a five acre lease 45M/39 to the south, all in the name of W. J. Hodge.

At the Grand Prize Mine, C. Smith is the applicant for the 20 acre leases 29M/51 and 23M/52.

PHYSIOGRAPHY AND GEOGRAPHY

(1) *Topography* is dominated by Mt. Razorback, a north-westerly trending ridge rising to 1900 feet, in the west; and a dissected hill locally named Black Hill whose rounded summit reaches an altitude of 2300 feet, to the north-east. East of the Razorback Mine, the broad valley between is drained by south-easterly and south flowing tributaries of the Dundas Rivulet, which flows south-west beyond Dundas. Nevada Creek rises on the west side of Black Hill and flows west through a steep valley towards the Little Henty River.

(2) *Vegetation.* Much of the higher ground bears mature myrtle rain forest which is relatively open. However, there are patches of dense secondary growth scrub on the north-east slopes of Mt. Razorback. The valley between Mt. Razorback and Black Hill is almost entirely covered with tangled horizontal scrub, with thick *Bauera* and cutting-grass on the more open stretches.

(3) *Climate and rainfall.* The climate is wet and temperate. Rain falls throughout the year, with lower precipitation during the summer months when periods of hot and dry weather may reduce the smaller creeks to mere trickles. Zeehan, five miles to the south-south-west, averages 98 inches per annum and, owing to the influence of the high plateau and Mt. Dundas to the east, the Razorback district probably receives over 100 inches. During the winter, snow occasionally falls on Mt. Dundas, but is rare in the area described here.

HISTORY OF MINING

Razorback Mine. Alluvial cassiterite was discovered in 1909 by P. P. Quinn and P. Hodge near Dundas and was traced to the orebody now worked at the mine. Later, O. C. Kingsley and E. Woodward took over the leases and sluiced detrital deposits derived from the orebody. The Peace Tin Mining Syndicate was formed in 1918 to install the plant necessary to develop the lode. However recovery was poor and work ceased in 1920. In 1923, J. L. Frizoni bought a controlling interest in the plant and mine which became known as the Razorback Mine. An average of five men were employed tributing until operations stopped in the middle of 1925. W. J. Hodge and party produced concentrates representing 10 tons of metallic tin between 1933 and 1934. The leases were taken over by Dundas (Tasmania) Tin Ltd. in 1936 and about 14 men were employed. However, work again ceased in 1937, partly due to the lack of systematic prospecting and development. Between 1939 and 1943 about two tons of concentrates were produced per annum. Since 1950, W. J. Hodge has recovered concentrates containing about 17½ tons of metallic tin from the oxidised zone.

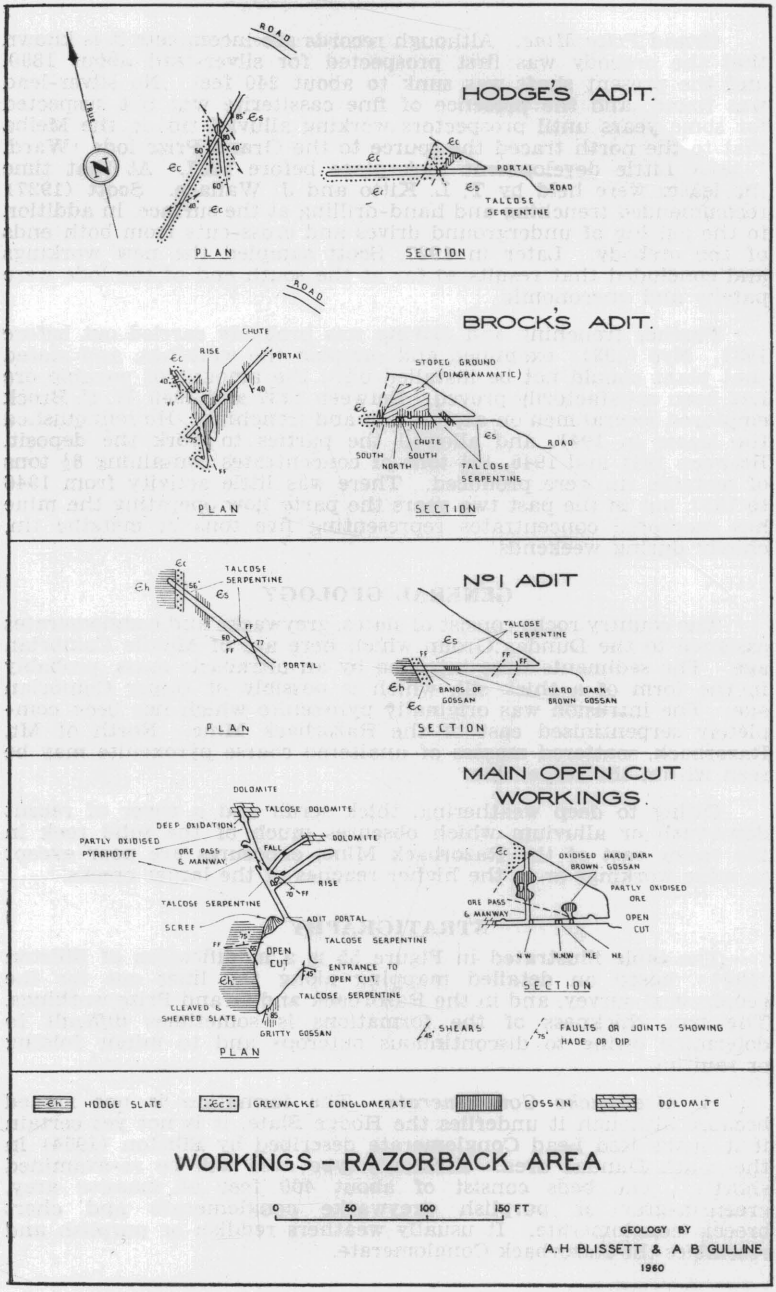


FIGURE 34.

Grand Prize Mine. Although records are incomplete it is known that the orebody was first prospected for silver-lead about 1890, and the present shaft was sunk to about 240 feet. No silver-lead was found, and the presence of fine cassiterite was not suspected for some years until prospectors working alluvial tin on the Melba Flat to the north traced the source to the Grand Prize lode (Ward, 1909). Little development took place before 1927. At that time the leases were held by T. L. Kitto and J. Wallace. Scott (1927) recommended trenching and hand-drilling at the surface, in addition to the cutting of underground drives and cross-cuts from both ends of the orebody. Later in 1927, Scott sampled the new workings and concluded that results so far at the south end of the lode were patchy and uneconomic.

Further trenching and driving was probably carried out before 1931. Nye (1931) examined and sampled the workings, and stated that plant should not be installed until the amount of payable ore had been satisfactorily proved. Between 1937 and 1940, H. E. Brock employed several men on exploration and trenching. He relinquished the leases in 1941, and allowed the parties to work the deposit. Between 1941 and 1945, 15½ tons of concentrates containing 8½ tons of metallic tin were produced. There was little activity from 1946 to 1957, but in the past two years the party now operating the mine has recovered concentrates representing five tons of metallic tin, chiefly during weekends.

GENERAL GEOLOGY

The country rocks consist of slates, greywacke and conglomerates assigned to the Dundas Group which here are of Middle Cambrian age. The sediments were intruded by an ultrabasic mass, probably in the form of a thick sill, which is possibly of Upper Cambrian age. The intrusion was originally pyroxenite which has been completely serpentinised east of the Razorback Mine. North of Mt. Razorback, scattered masses of unaltered coarse pyroxenite may be seen within the serpentine.

Owing to deep weathering, thick scrub and a cover of recent downwash or alluvium which obscures much of the solid rock in the valley east of the Razorback Mine, exposures are poor except in mine workings or in the higher reaches of the larger creeks.

STRATIGRAPHY

The table illustrated in Figure 55 is a modification of Elliston (1954), based on detailed mapping along the lines cut for the geophysical survey, and in the Razorback and Grand Prize workings. The true thickness of the formations is sometimes difficult to determine owing to discontinuous outcrops and to minor folding or faulting.

(1) *Greywacke Conglomerate.* The formation is not named because although it underlies the Hodge Slate, it is not yet certain if it is the Red Lead Conglomerate described by Elliston (1954) in the south Dundas area. Elliston's type area will be re-examined shortly. The beds consist of about 400 feet of massive grey, greenish-grey or purplish greywacke conglomerate and chert breccia-conglomerate. It usually weathers reddish or purplish and resembles the Razorback Conglomerate.

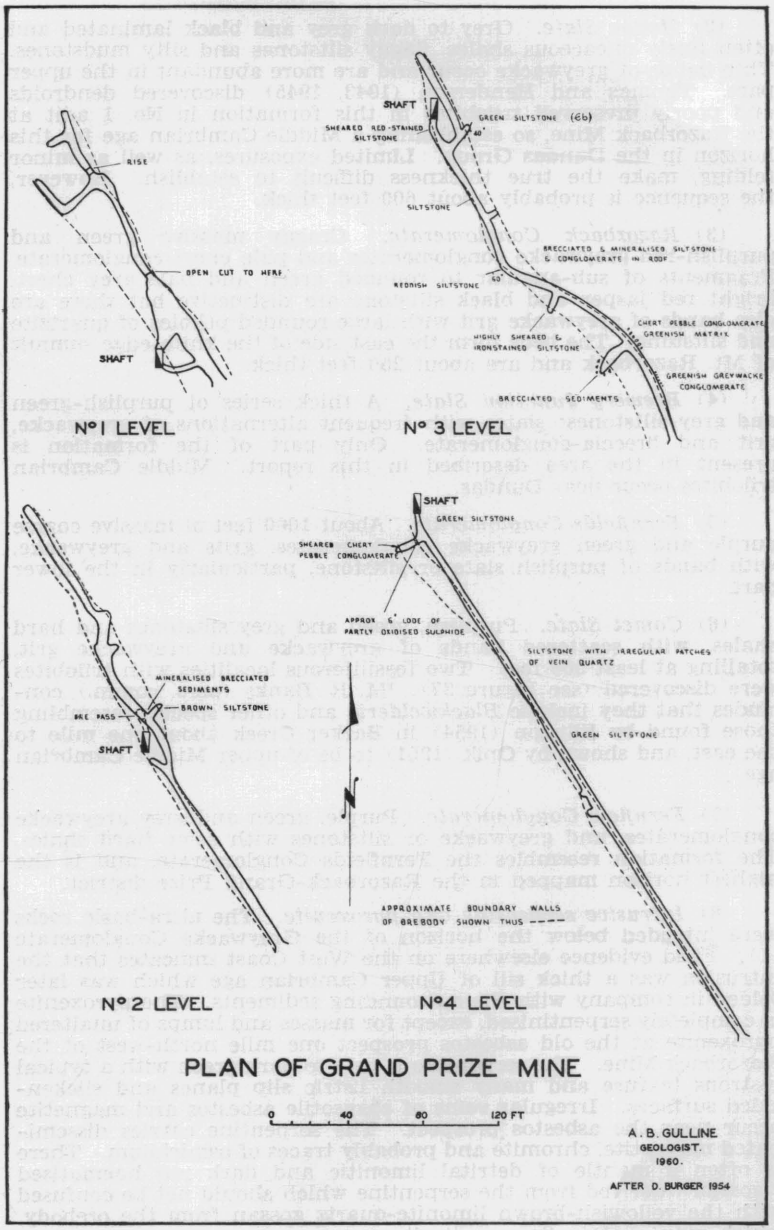
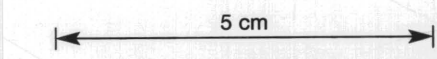

SHAFT
GREEN SILTSTONE (Eb)
SHEARED RED-STAINED SILTSTONE
40°
RISE
SILTSTONE
BRECCIATED & MINERALISED SILTSTONE & CONGLOMERATE IN ROOF
OPEN CUT TO HEAP
REDDISH SILTSTONE
40°
CHERT PEBBLE CONGLOMERATE GREENISH MATRIX
HIGHLY SHEARED & IRONSTAINED SILTSTONE
GREENISH GREYWACKE CONGLOMERATE
SHAFT
BRECCIATED SEDIMENTS
N°1 LEVEL
N° 3 LEVEL
SHAFT
GREEN SILTSTONE
SHEARED CHERT PEBBLE CONGLOMERATE
APPROX 6' LODE OF PARTLY OXIDISED SULPHIDE
SILTSTONE WITH IRREGULAR PATCHES OF VEIN QUARTZ
MINERALISED BRECCIATED SEDIMENTS
BRECCIATED BROWN SILTSTONE
ORE PASS
SHAFT
GREEN SILTSTONE
N
APPROXIMATE BOUNDARY WALLS OF ORE BODY SHOWN THUS ----
N°2 LEVEL
N°4 LEVEL
PLAN OF GRAND PRIZE MINE
0 40 80 120 FT
A. B. GULLINE GEOLOGIST. 1960.
AFTER D. BURGER 1954

FIGURE 35.


5 cm

(2) *Hodge Slate.* Grey to dark grey and black laminated and often finely micaceous shales, flaggy siltstones and silty mudstones. Thin bands of greywacke occur and are more abundant in the upper part. Thomas and Henderson (1943, 1945) discovered dendroids and poorly preserved trilobites in this formation in No. 1 adit at the Razorback Mine, so establishing a Middle Cambrian age for this horizon in the Dundas Group. Limited exposures, as well as minor folding, make the true thickness difficult to establish. However, the sequence is probably about 600 feet thick.

(3) *Razorback Conglomerate.* Craggy massive green and purplish-red greywacke conglomerates and pale chert conglomerate. Fragments of sub-angular to rounded green and pale grey chert, bright red jasper and black siltstone are distinctive but there are also bands of greywacke grit with large rounded pebbles of quartzite and siltstone. The beds form the east side of the knife-edge summit of Mt. Razorback and are about 250 feet thick.

(4) *Brewery Junction Slate.* A thick series of purplish-green and grey siltstones; slates with frequent alternations of greywacke, grit and breccia-conglomerate. Only part of the formation is present in the area described in this report. Middle Cambrian trilobites occur near Dundas.

(5) *Fernfields Conglomerate.* About 1000 feet of massive coarse purple and green greywacke conglomerates, grits and greywacke, with bands of purplish slate or siltstone, particularly in the lower part.

(6) *Comet Slate.* Purplish, green and grey siltstones and hard shales, with scattered bands of greywacke and greywacke grit, totalling at least 500 feet. Two fossiliferous localities with trilobites were discovered (see Figure 37). M. R. Banks (pers. comm.) concludes that they include *Blackwelderia* and other species resembling those found by Elliston (1954) in Barker Creek about one mile to the east, and shown by Opik (1951) to be of upper Middle Cambrian age.

(7) *Fernflow Conglomerate.* Purple, green and grey greywacke conglomerates, and greywacke or siltstones with some hard shales. The formation resembles the Fernfields Conglomerate, and is the highest horizon mapped in the Razorback-Grand Prize district.

(8) *Intrusive serpentine and pyroxenite.* The ultra-basic rocks were intruded below the horizon of the Greywacke Conglomerate (1). Field evidence elsewhere on the West Coast indicates that the intrusion was a thick sill of Upper Cambrian age which was later folded in company with the surrounding sediments. The pyroxenite is completely serpentinised, except for masses and lumps of unaltered pyroxenite at the old asbestos prospect one mile north-west of the Razorback Mine. The serpentine is pale to dark green with a typical lustrous texture and many smooth listric slip planes and slickensided surfaces. Irregular veins of chrysotile asbestos and magnetite occur near the asbestos prospect. The serpentine carries disseminated magnetite, chromite and probably traces of osmiridium. There is often a mantle of detrital limonitic and dark red haematised "gossan" derived from the serpentine which should not be confused with the yellowish-brown limonite-quartz gossan from the orebody, which may contain fine cassiterite.

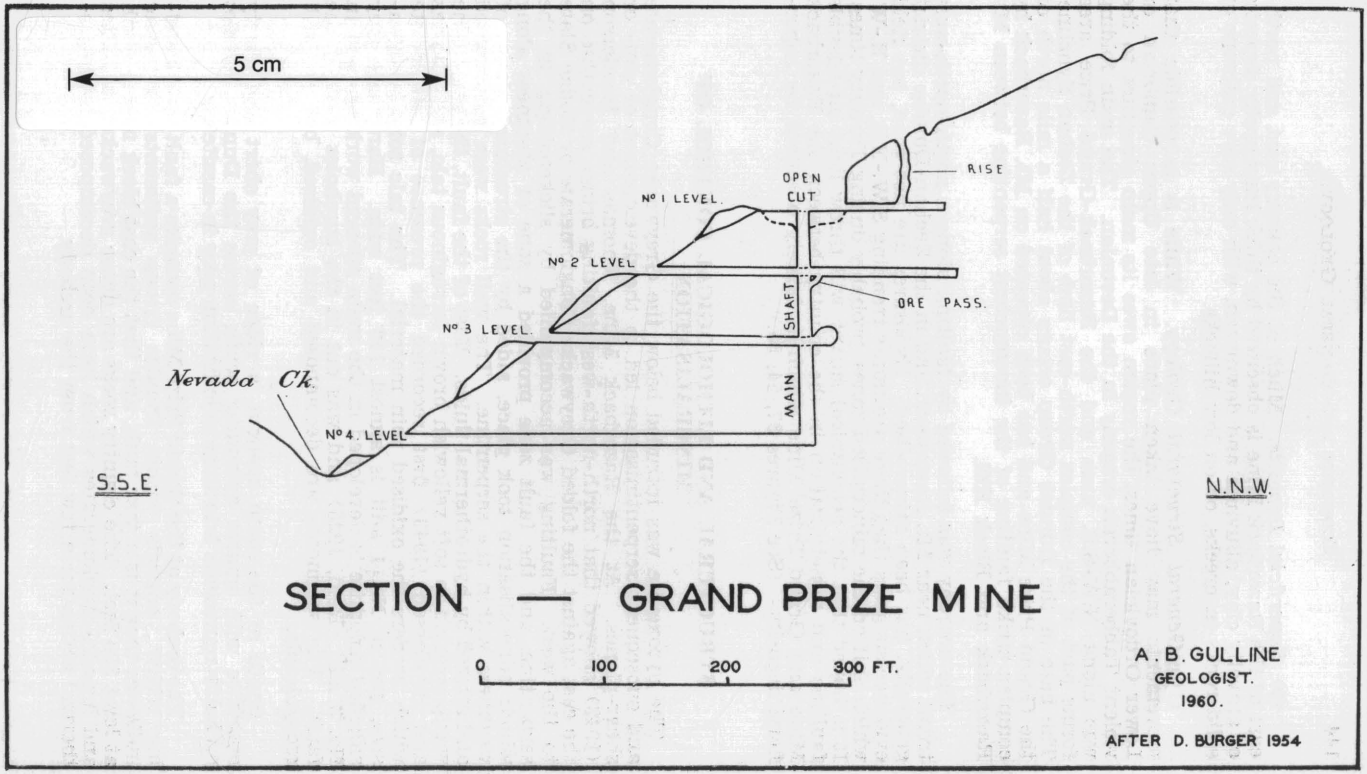

5 cm
OPEN CUT
RISE
Nº 1 LEVEL.
Nº 2 LEVEL
SHAFT
ORE PASS.
Nº 3 LEVEL.
MAIN
Nevada Ck.
Nº 4. LEVEL
S.S.E.
N.N.W.
SECTION — GRAND PRIZE MINE
0 100 200 300 FT.
A. B. GULLINE
GEOLOGIST.
1960.
AFTER D. BURGER 1954

FIGURE 36.

(9) *Superficial Deposits.* Much of the country east and north-east of the Razorback Mine is obscured by thick hummocky deposits of gravelly clay, alluvium and downwash, with only rare outcrops of solid rocks in creeks, or on low hillocks.

(10) *General Structural Geology.* While it is possible that movements may have taken place in late Upper Cambrian or Lower Ordovician times, the region owes its main structure to the violent Tabberabberan orogeny in the Devonian. The main folding was along N.W-S.E. axes and the Razorback-Grand Prize area forms part of the complex north-east limb of the Zeehan Syncline. The base of the Dundas Group occurs about half a mile north of the Grand Prize Mine and has been repeated on Mt. Razorback by complex strike faulting of the incompetent serpentine between Mt. Razorback and Black Hill.

The orogeny was followed by faulting along a north-north-west trend which near Mt. Razorback, and in the Zeehan-Dundas district generally, has been mineralised. Exposures are not good, but field evidence suggests that there are faults trending S.W.-N.E. and E.-W. which shifted the mineralised zones, probably during Tertiary times. It is hoped that the geophysical survey will throw light on possible faulting and mineralisation in the country between the Razorback Mine and Grand Prize Mine which is largely obscured by superficial deposits. (See Figures 37, 54, 55.)

STRUCTURAL AND LITHOLOGICAL CONTROL OF MINERALISATION

The pyroxenite was intruded below the Greywacke Conglomerate and subsequent serpentinisation led to the development of slip- or shear-planes. At the Razorback Mine, Thomas and Henderson (1943) showed that north-north-west faulting brings serpentine on the east against the folded Greywacke Conglomerate or Hodge Slate to the west. Faulting was accompanied by slickensiding in the serpentine, and the fault zone provided a zone of weakness along which mineralisation took place, aided by the structural planes of weakness within the serpentine. The wall rocks were decomposed and altered by hydrothermal fluids. East of the fault, the serpentine was converted to soft yellowish brown ferruginous talc, and Thomas and Henderson (1943) first recorded the presence of pistomesite which borders the oxidised vein material. The talc zone is extensive, and in No. 1 adit is almost 150 feet wide. Hard pale grey silicified dolomite is developed in the main opencut workings and in No. 3 adit (Reid, 1925) and was cut in the boreholes west of the fault. The sediments are decomposed and oxidised, but are still recognisable.

South of the main opencut, a ridge of grey chert and cherty quartzite with quartz extending south across the Dundas Rivulet probably represents late stage silicification poor in cassiterite.

The orebody at the Grand Prize Mine occupies a fault zone trending N.N.W., entirely within Dundas Group sediments. Mapping indicates that it is a tear fault, and that the east block moved south at least 300 feet. The country rocks are dense greywackes, argillites and breccia-conglomerates which have been decomposed by hydrothermal action for a few feet from the orebody.

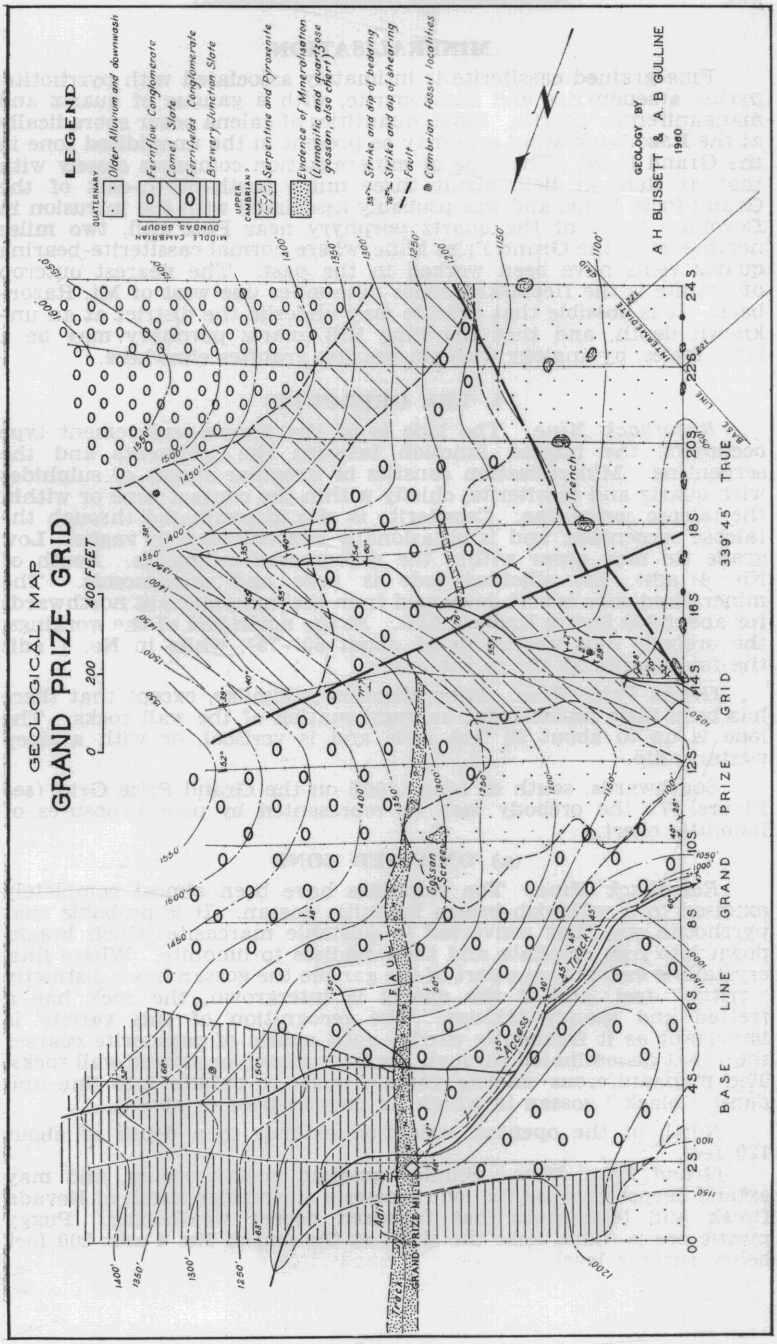

GEOLOGICAL MAP
GRAND PRIZE GRID
0 200 400 FEET
LEGEND
QUATERNARY
Older Alluvium and downwash
MIDDLE CAMBRIAN
DUNDAS GROUP
Fernflow Conglomerate
Comet Slate
Fernfields Conglomerate
Brewery Junction Slate
UPPER CAMBRIAN?
Serpentine and Pyroxenite
Evidence of Mineralisation (Limonitic and quartzose gossan, also chert)
Strike and dip of bedding
Strike and dip of shearing
Fault
Cambrian fossil localities
GEOLOGY BY
A H BLISSETT & A B GULLINE
1960
BASE LINE GRAND PRIZE GRID 339° 45' TRUE
Trench
Gossan Screen
Track
Access
FAULT
GRAND PRIZE No 1
Adit

FIGURE 37.

MINERALISATION

Fine-grained cassiterite is intimately associated with pyrrhotite, pyrite, arsenopyrite and chalcopyrite, with a gangue of quartz and manganiferous siderite. Small quantities of galena occur sporadically at the Razorback Mine, and may be present in the unoxidised zone in the Grand Prize. The type of mineralisation compares closely with that at Renison Bell, about three miles north-north-east of the Grand Prize Mine, and was probably associated with the intrusion in Devonian times of the quartz porphyry near Pine Hill, two miles north-east of the Grand Prize Mine, where normal cassiterite-bearing quartz veins have been worked in the past. The nearest outcrop of granite is the Heemskirk mass nine miles due west of Mt. Razorback. It is possible that granite may underlie the district at an unknown depth, and that the Pine Hill quartz porphyry may be a later facies, by analogy with tin bearing granites elsewhere.

1. THE OREBODIES

Razorback Mine. The lode is of the fissure-replacement type occupying the faulted junction between the sediments and the serpentine. Mineralisation consists of irregular shoots of sulphides with quartz and cassiterite, chiefly within the contact zone or within the talcose serpentine. Cassiterite is also disseminated through the talcose serpentine, and is occasionally concentrated in vughs. Low grade tin may occur within the decomposed sediments. South of No. 4 adit, the silicified lode is poor and uneconomic. The mineralised zone is best developed from the main opencut northwards for about 800 feet to Hodge's Adit. At the north end of the workings, the orebody dips westwards at about 60°-75°, while in No. 1 adit the fault hades at 60° to the east.

Grand Prize Mine. Mineralisation is similar, except that there has been little replacement or impregnation of the wall rocks. The lode is up to about 25 feet wide and is vertical, or with a steep westerly dip.

Southwards, south of Line 1200S on the Grand Prize Grid (see Figure 37) the orebody may be represented by poor exposures of limonitic chert.

(a) OXIDISED ZONE

Razorback Mine. The sulphides have been almost completely oxidised to a yellowish-brown limonitic gossan. It is probable that pyrrhotite was first converted to unstable marcasite which breaks down into iron sulphate and then oxidises to limonite. Where fine, crystalline quartz forms part of the gangue the gossan has a distinctly "gritty" feel, and if the quartz is intergrown, the rock has a fretted and spongy texture. The recognition of this variety is important as it frequently carries good values of cassiterite coarser than that disseminated through the finer gossan or altered wall rocks. The manganiferous siderite gangue tends to oxidise into fine and dense "black" gossan in which tin may be poor or absent.

North of the opencut, oxidation extends to a depth of about 120 feet.

Grand Prize Mine. Similar oxidised gossan occurs, and may extend deeper because the lode crosses a steep ridge north of Nevada Creek and topography has favoured deeper weathering. Puggy pyritic ore is found near the shaft at the end of No. 4 adit 200 feet below surface level.

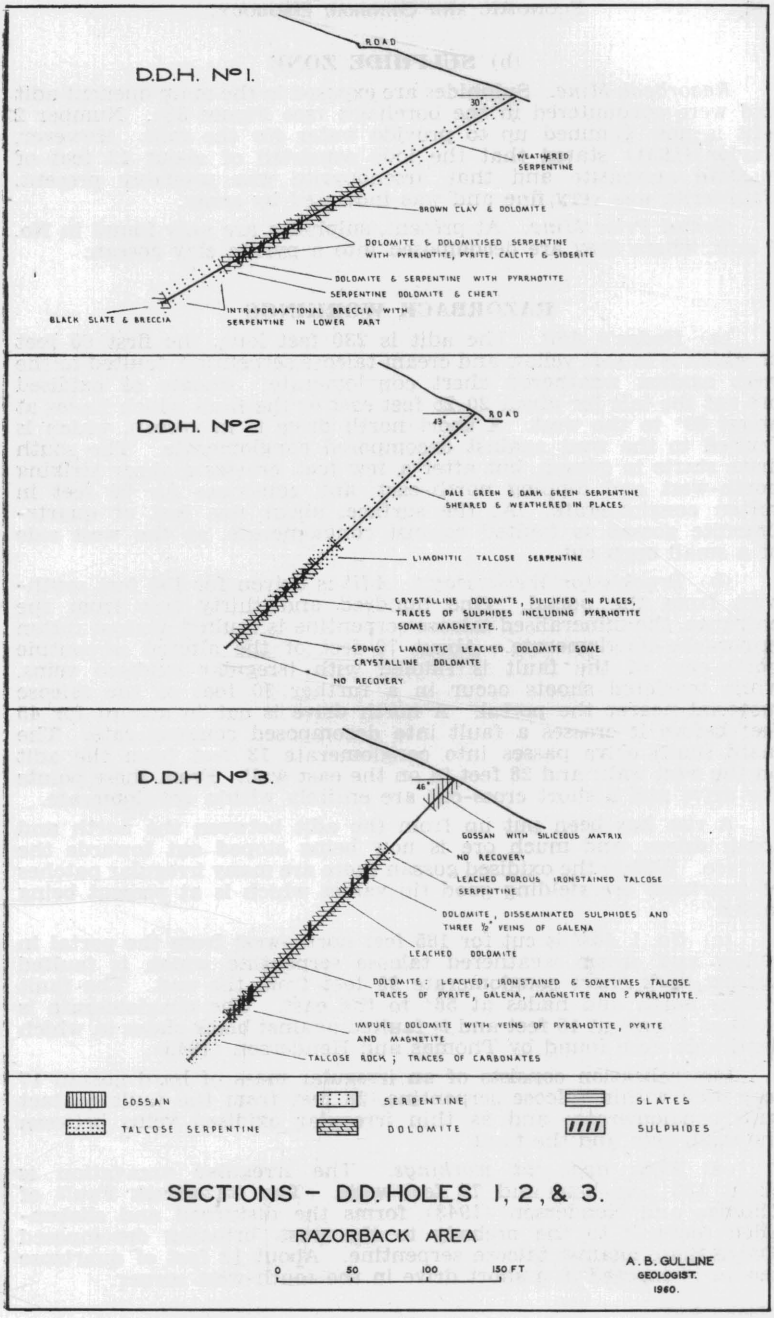


FIGURE 38.

5 cm

(b) SULPHIDE ZONE

Razorback Mine. Sulphides are exposed in the main opencut adit and were encountered in the boreholes (see Figure 38). Number 2 adit is now dammed up to provide water for the mill. However, Taylor (1951) stated that the lode consisted of about 12 feet of massive marcasite and that arsenopyrite was probably present. Cassiterite was very fine and was indicated by assay.

Grand Prize Mine. At present, sulphides are only found in No. 4 adit, where they are decomposed into a pyritic clay gossan.

RAZORBACK WORKINGS

(*a*) *Hodge's Adit.* The adit is 230 feet long, the first 65 feet of which is in soft yellow and cream talcose serpentine, faulted to the west against weathered chert conglomerate. Shoots of oxidised ore cut the talc for about 20-25 feet east of the fault which hades at about 60° to the west. A short north drive is in gossan, which is faulted to the west against decomposed conglomerate. The south drive starts in gossan, but after a few feet, crosses a shear striking north-west and dipping north-east, and continues for 50 feet in rotten conglomerate. At the surface, about five feet of quartz-limonite gossan is faulted against conglomerate, at the west side of a small open cut.

(*b*) *Brock's* (*or Westerway's*) *Adit* is driven for 155 feet south-west from the portal. One hundred and thirty feet from the entrance, the mineralised talcose serpentine is faulted against rotten greywacke-conglomerate. About 70 feet of the altered serpentine north-east of the fault is riddled with irregular oxidised veins, while scattered shoots occur in a further 30 feet of the talcose material nearer the portal. A north drive is cut in gossan for 45 feet before it crosses a fault into decomposed conglomerate. The main south drive passes into conglomerate 13 feet from the adit on the west wall; and 28 feet in on the east wall. From these points the drive and a short cross-cut are entirely within conglomerate.

A rise has been put up from the adit between the north and south drives, and much ore is now being stoped out towards the surface. Within the oxidised gossan there are many irregular patches of quartzose ore yielding good tin values which is at present being milled.

(*c*) *No. 1 Adit* is cut for 185 feet north-west from the portal in yellow and cream weathered talcose serpentine which is faulted against dark chert conglomerate 35 feet from the end. The fault strikes north and hades at 56° to the east. The conglomerate is exposed for about 15 feet and is faulted against black slates in which dendroids were found by Thomas and Henderson (1945).

Mineralisation consists of an irregular mass of hard gossan 17 feet wide within talcose serpentine, 28 feet from the fault contact with conglomerate; and as thin irregular oxidised veins between the main vein and the fault.

(*d*) *Main open-cut workings.* The irregular excavation is about 130 feet long and 75 feet wide. The Razorback Fault of Thomas and Henderson (1943) forms the disturbed and slickensided footwall to the orebody to the west, bringing decomposed Hodge Slate against talcose serpentine. About 12 feet of quartzose gossan is exposed in a short drive in the south-west corner.

At the north end, an adit has been driven 80 feet north-north-west towards No. 1 adit through talcose serpentine with patches of gossan. Fifty feet from the portal, a cross-cut has been put in for about 100 feet north-east, 10 feet along the cross-cut, a short drive connects with a second cross-cut about 15 feet further north, while at 16 feet, a winze has been sunk about 30 feet to water level. About 50 feet of oxidised sulphides are exposed in this cross-cut, with altered serpentine to the east. The end of the northern cross-cut is in dolomitised serpentine. Near the junction of this cross-cut and the adit, a drive has been cut about 95 feet north-north-west, the first 75 feet of which is in partly oxidised sulphides and the remainder in dolomite. An inclined ore-pass and manway rise to surface (about 90 feet) from a short western cross-cut, about 110 feet from the portal. Partly oxidised sulphides were encountered in the lower 30 feet so that here the depth of oxidation is about 60 feet below surface.

(*e*) *No. 2 Adit.* The adit is now blocked to supply water to the mill. According to Thomas and Henderson (1943), it is about 50 feet below the opencut and was cut for 170 feet north of east. At this point, it splits, one branch bearing north-west for 23 feet, then 24 feet in a westerly direction. The other branch was driven 42 feet north where it intersects a north-dipping plane; past this point the drive was mullocked. A west cross-cut was also filled after 12 feet, while a drive was cut for 40 feet north-west. Thomas and Henderson concluded that the drives are apparently along irregular and impersistent enrichments.

(*f*) *No. 3 Adit.* According to Thomas and Henderson (1943), the adit is 136 feet long, and passes through talcose serpentine and then pistomesite bordering a gossan zone 40 feet wide. The fault is vertical with conglomerate to the west.

(*g*) *No. 4 Adit.* Thomas and Henderson (1943) state that the fault was met 193 feet from the portal, with slate to the west, and 20 feet of gossan on the east. A rise at 140 feet could not be examined, but Reid (1925) records that it reached the surface and that rich ore occurred from outcrop to a depth of 20 feet.

(*h*) *No. 5 Adit.* This adit was inaccessible in 1943. Reid (1925) states that it is 115 feet long. The first 56 feet are in massive serpentine, with decomposed unpayable lode material from that point to the end.

(*i*) *No. 6 Adit.* The following description has been compiled from Reid (1925) and Thomas and Henderson (1943). The adit is 121 feet long and passes first through 24 feet of sheared serpentine, then soft ferruginous talc. At 70 feet, four feet of gossan was encountered, with silicified serpentine (cherty quartz) to the end of the adit, where a vertical fault exposes slates to the west.

(*j*) *Miscellaneous trenches or pits.* There are at least 10 trenches south of the main opencut, which are now chiefly overgrown. While there are traces of oxidised sulphides, mineralisation at surface is apparently poor, and southwards there is much barren chert.

About 200 feet north of Hodge's Adit, a trench trending north-east crosses grid reference 3000 feet north/650 feet west (see Figure 55). Highly weathered dolomite and limonitic quartzose gossan is exposed, resembling that in the present workings.

A partly collapsed adit lies 400 feet north of Hodge's adit, grid reference 3180 feet north/620 feet west. The portal cuts decomposed serpentine, and there are fragments of limonitic gossan on the dump outside. At 3200 feet north/820 feet west, an old trench has been cut in deeply weathered talcose clay with some quartzose and limonitic gossan, near the contact of the serpentine and the Cambrian sediments.

GRAND PRIZE WORKINGS

(*a*) *Shaft.* The shaft was sunk about 1890 to a vertical depth of 240 feet from surface on the steep north slope of Nevada Creek. It is now filled to the No 4 adit level (about 200 feet from surface). The party now working the orebody is opencutting from surface down to No. 1 level, and the shaft is used as an orepass,with oxidised ore being taken out along No. 4 adit to the mill. The lode at the former top of the shaft, and in the present opencut is about 25 feet wide.

(*b*) *No.* 1 *Adit.* Driven 165 feet north-north-west from the portal which is about 220 feet higher than Nevada Creek. The opencut from surface has reached this level which is approximately 30 feet below the original surface level. The oxidised lode is about 25 feet wide in the opencut and also in a cross cut near the end of the adit.

(*c*) *No.* 2 *Adit.* Driven along the lode for 270 feet from the portal, about 50 feet below No. 1 level. The oxidised orebody is well-marked and has a maximum width of about 16 feet.

(*d*) *No.* 3 *Adit.* Following recommendations by Scott (1927), this level was driven 250 feet north-north-west, about 50 feet below No. 2 adit. The maximum width of oxidised ore is about 15 feet, as shown in two south-west crosscuts and two north-east crosscuts.

(*e*) *No.* 4 *Adit* is 330 feet long from the portal to the present bottom of the shaft. The adit is driven along the lode which is irregular, with a maximum width of 11 feet in a west crosscut near the shaft. At this point there is a six inch vein of partly oxidised pyrrhotite and pyrite. The quartzose gossan is irregular and patchy, with several veins of barren milky quartz.

(*f*) *North of Grand Prize Workings.* Oxidised gossan has been exposed in many trenches and shallow pits over a line extending at least 800 feet north-north-west of the shaft, beyond the summit of the ridge, which is about 300 feet vertically above the shaft.

(*g*) *South of Grand Prize Workings.* A few yards south-east of the mill, 17 feet of oxidised lode is exposed within Dundas Group sediments on the south-east bank of Nevada Creek. Here, the orebody is vertical and it can be traced for at least 500 feet to the south-south-east. For another 700 feet south-south-east, fragments and lumps of limonitic chert may represent the south end of the orebody, as in the Razorback area.

(*h*) *Craze's Adit.* The portal is on the east side of the track to the Grand Prize Mine, about 800 feet south of the mill. It was driven north-east many years ago and is now water-logged. According to Mr. W. J. Hodge, it is about 500 feet long but did not reach the southern extension of the Grand Prize lode. If the lode is present, an extension of the adit would cut it approximately 250 feet below surface.

SAMPLING—1. RAZORBACK MINE

Table 1 records assays made in different sections of the orebody at different periods. Although they do not represent a systematic detailed sampling of the orebody, they reflect the irregular pattern of mineralisation, with relatively rich shoots scattered throughout the mineralised zone. They show that cassiterite is apparently poorer south of the main opencut and that in the present workings, there are encouraging values in the opencut and Brock's adit Grade of ore calculated from production figures gives an indication of tin content. In 1950, 130 tons of oxidised ore were treated to yield 2.406 tons of concentrates containing 1.516 tons of metallic tin (see Table 2); or 1.17% tin. As the cassiterite is very fine, it is unlikely that recovery in the small mill exceeds 60% so that the ore probably contained about 2% tin. In 1951, 4.62 tons of concentrates were produced, containing 3.01 tons of metallic tin, i.e. 0.7% tin. Tin content in 1959 was 0.64% recovered from 426 tons of ore whose grade, after allowing for loss in mill tailings, was probably at least 1%.

In borehole No. 1, assays of core indicated 1.16% tin between 195 feet and 206 feet, associated with pyrrhotite in dolomite.

Much core was lost in No. 2 borehole which did not reach the Razorback Fault, and sludge assays should be taken with some reserve. (See log.)

Number 3 borehole was abandoned at 260 feet after loss of tools in the hole, and was still in talcose serpentine. Much core was lost, particularly in the upper part of the hole.

Owing to loss of core and the fact that neither crossed the Razorback Fault into Cambrian sediments, both No. 2 and No. 3 boreholes did not satisfactorily test the mineralised zone.

2. GRAND PRIZE MINE

Assay figures have been made available by courtesy of Rio Tinto Australian Pty. Ltd. Samplings show that, as in the Razorback Mine, cassiterite content is patchy and difficult to assess accurately. The highest assay in Nos. 2, 3 and 4 levels was 0.422. Values near the present opencut on No. 1 level near the shaft ranges up to 1.73%. Some samples were taken at the surface in trenches and shallow shafts north of the shaft; the highest assayed 1.49% but tin content again was very variable. In 1959, 526 tons of ore were treated for the production of 4.05 tons of metallic tin, i.e. 0.77%. As in the Razorback Mine, recovery is unlikely to exceed 60% so that the tin content of ore was about 1½%. In 1958, 95 tons of ore yielded one ton of metallic tin (1.05%).

PRODUCTION

Figures for the mines are shown in Tables 2 and 3 which have been compiled from the Annual Reports of the Director of Mines.

DIAMOND DRILLING

Following recommendations by Taylor (1951), three diamond-drilled boreholes were put down by the Department of Mines in 1958-1959, the logs of which are shown below. The sites are indicated on Figure 55. The holes passed through serpentine and dolomite below the oxidised zone and therefore where mineralisation was

present, the unaltered sulphides could be examined and assayed. Only No. 1 hole crossed the Razorback Fault into Dundas Group sediments. Number 2 and No. 3 holes finished within dolomite or talcose serpentine and losses of core rendered an assessment of mineralisation difficult.

GEOPHYSICAL SURVEY

Between January and March 1960, an electromagnetic survey, supported by a magnetic survey, was carried out by geophysicists from the Bureau of Mineral Resources, Geology and Geophysics, under the leadership of W. J. Langron. The survey will be the subject of a detailed report by Mr. Langron and is therefore not described here. The three grid layouts in Figure 1 were planned by Dr. J. Horvath of the Bureau and the authors in conjunction with T. D. Hughes, to attempt to cover the difficult country between the two mines by the end of March. A survey party from the Department of the Interior, Canberra under the leadership of B. Lynch laid out the lines between December 1959, and March 1960. Traverse lines were surveyed 200 feet apart and were pegged every 50 feet. Between 1800 feet north and 2400 feet north on the Razorback Grid, traverse lines were at 100 feet intervals. The three grid layouts involved the cutting of about 29 miles of lines through dense scrub by a party of trackcutters organised by the Department of Mines. In addition to the geophysical survey, the cutting facilitated detailed geological mapping illustrated in Figures 37, 54, 55.

ORE RESERVES

Taylor (1951) calculated that between the opencut and Hodge's Adit at the Razorback Mine, there may be about 320,000 tons of oxidised material containing some 960 tons of metallic tin. He assumed an average tin content of 0.3% over a length of 600 feet; a width of 60 feet and a depth of 120 feet, and his figures appear to be reasonable, provided that the average is maintained. Between No. 1 adit and Brock's adit particularly there are no underground drives and nothing is known of values here. Reserves in the Grand Prize will be considerably less but at present are difficult to assess.

CONCLUSIONS

(1) Fine cassiterite occurs with sulphides in the form of irregular veins within zones trending north-north-west. At the Razorback Mine the mineralised zone is in altered serpentine at or near the faulted contact with Cambrian sediments. In the Grand Prize mine, the lode occupies a tear-fault within the sedimentary rocks.

(2) At both mines, the mineralised zone has been oxidised down to an appreciable depth, and the oxidised ore is now being worked.

(3) Although available assays indicate variable amounts of cassiterite, the irregular nature of mineralisation makes difficult a fair assessment of reserves. Production figures show that when milling losses are considered, sections of the Razorback Mine, and the open cut at the Grand Prize Mine carry useful values of tin. However, at present, the extent of these sections is not known, and results from the three bore holes at Razorback were inconclusive.

(4) The country north of the Razorback Mine is largely obscured by recent down wash or alluvium and has a cover of dense scrub. However, limonitic gossan was noted at least 400 feet north of the present workings. There is insufficient evidence as yet to decide if such gossan represents an extension of the Razorback lode. Although the Grand Prize orebody has a similar trend to that at Razorback, faulting south of Grand Prize suggests that it is unlikely that they are sections of the same lode. Trenching and drilling would be necessary to test mineralisation between the mines.

(5) The few available assays indicate that the sulphide zone carries variable amounts of cassiterite but reserves are unknown. As Taylor (1951) pointed out, sulphide ore would have to be mined by normal methods. Crushing and treatment would be more complex than with friable oxidised ore.

(6) We support Taylor's conclusion that the topography at the Razorback Mine is favourable to opencut working of the oxidised zone north of the present main opencut. This method is now being used on a small scale at the Grand Prize Mine.

RECOMMENDATIONS

1. Razorback Mine

(*a*) It would be advisable to drive along the lode south from Brock's adit towards No. 1 adit. The present main south drive crossed the fault into rotten conglomerate and is therefore of little use.

(*b*) Similar drives should be cut between Brock's adit and Hodge's adit to the north. The north drive in Brock's adit crossed a fault into decomposed conglomerate. The fault apparently shifts the mineralised zone to the east on the north side. Similarly, the south drive in Hodge's adit is almost entirely in rotten conglomerate, and is therefore driven west of the mineralised zone.

(*c*) It would be necessary to cut trenches north of the present workings to at least 3180 feet north/620 feet West (400 feet to the north) on the Razorback Grid. Bulk sampling would be preferable.

(*d*) Drilling has proved disappointing. The deep weathering and disturbed ground make loss of core almost inevitable unless the greatest care is taken during drilling operations. In the decomposed serpentine, water flush often leads to caving of the hole. However, the use of drilling mud would involve more complex drilling equipment.

If trenches north of the present workings revealed favourable tin values, consideration should be given to drilling, despite the problems. A lode here would be vertical, or steeply dipping, so that a bore-hole could be sited to the east and inclined westwards. Even if an orebody were to dip steeply westward, the steep slope and rain forest would negative any advantage gained by siting the hole to the west.

2. Grand Prize Mine

(*a*) If possible, the lode should be tested below the present workings. The country rocks are of hard greywacke, siltstone and conglomerate, and drilling should give better results than at Razorback. Owing to the fact that the lode strikes across steep ridges, the only favourable site would be in the valley of Nevada Creek, near the track to the mine. The site would be 300 feet south-west of the mill along the track and should be inclined at 45° on a bearing of 70° (true). The position on the Grand Prize Grid is 400 feet south/470 feet east. The hole should cut the downward extension of the lode at 300-400 feet, between 300 and 350 feet vertically below the surface outcrop.

(*b*) If drilling results were encouraging, Craze's adit might be cleaned out and carefully surveyed. If the present end of the adit were close to the calculated position of the possible downward extension of the lode, the adit should be extended.

(*c*) Further trending and bulk sampling should be carried out on the ridge north of the workings.

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TABLE 1.

SAMPLES—RAZORBACK MINE

Material	Lode	Width Sampled	Tin Content %	Reference
1. Lode	Hodges Adit	20′ chip sample	0.37	Thomas & Henderson (1943)
2. Talc	....	60′	0.3	Taylor (1951)
3. Lode	Brock's Adit	40′ chip sample	0.69	Thomas & Henderson (1943)
4. Talc	....	110′	0.4	Taylor (1951)
5. Talc	No. 1 Adit	130′	0.1	Taylor (1951)
6. Gossan	....	15′	0.1	Taylor (1951)
7. Gossan, decomposed	Opencut (S. end)	4′	2.15	Reid (1925)
8. Decomposed serpentine and marcasite	Opencut (small drive below)	3′	0.18	Reid (1925)
9. Gossan and quartz	Opencut E. of 8	3′	0.89	Reid (1925)
10. Gossan and quartz	Opencut E. of 9	5′	1.07	Reid (1925)
11. Decomposed serpentine	Opencut S. of 10	6′	0.05	Reid (1925)
12. Decomposed serpentine	Opencut S. of 11	6′	0.05	Reid (1925)
13. Gossanous serpentine	Opencut S. of 12	6′	0.66	Reid (1925)
14. Marcasite	Opencut N. of 13 (end of winze)	3′	0.84	Reid (1925)
15. Gossan	N. end of No. 2 Opencut	4′	0.51	Reid (1925)
16. Gossan	E. of 15 in opencut	4′	3.51	Reid (1925)
17. Gossan	E. of 16 in opencut	4′	0.79	Reid (1925)
18. Lode (sulphides)	Opencut adit dumps	Grab sample	0.37	Thomas & Henderson (1943)
19. Gossan	Opencut	15′	0.9	Taylor (1951)
20. Talc	Opencut	25′	0.7	Taylor (1951)
21. Talc and gossan	Opencut adit main drive	70′	0.5	Taylor (1951)
22. Talc	Opencut adit 1st cross-cut	40′	0.7	Taylor (1951)
23. Decomposed dolomite	Opencut adit 1st cross-cut	50′	0.1	Taylor (1951)

TABLE 1—*Continued.*

Material	Lode	Width Sampled	Tin Content %	Reference
24. Sulphides	No. 2 adit	12′	0.48	Taylor (1951)
25. Talc	No. 3 adit	76′	<0.1	Taylor (1951)
26. Ferromanganiferous oxides	No. 4 adit at rise	4′	0.2	Reid (1925)
27. Ferromanganiferous oxides	No. 4 adit W. of rise	15′	0.18	Reid (1925)
28. Ferromanganiferous oxides and quartz	W. of 27	5′	0.08	Reid (1925)
29. Decomposed serpentine	End of No. 4 adit	3′	0.10	Reid (1925)
30. Lode	No. 4 adit	20′ chip sample	Nil	Thomas & Henderson (1943)
31. Talc	No. 4 adit	60′	<0.1	Taylor (1951)
32. Gossan	No. 4 adit	90′	<0.1	Taylor (1951)

TABLE 2.

PRODUCTION—RAZORBACK MINE

Year	Ore Treated (Tons)	Concentrates (Tons)	Metallic Tin Content (Tons)	Tin in Ore %
1909-1924	?	18	12.24	?
1925	?	?	1.368	?
1933	?	?	4.98	?
1934	?	?	5.25	?
1936	1,877	?	1.55	0.08
1939	?	2	1.22	?
1940	?	2.2	1.38	?
1942	?	2.11	1.239	?
1943	18	0.37	0.212	1.18
1950	130	2.406	1.516	1.17
1951	435	4.62	3.01	0.7
1952	353	4.043	2.273	0.64
1953	?	1.754	0.899	?
1955	40	?	0.165	0.41
1956	?	?	1.679	?
1957	?	?	3.00	?
1958	?	?	1.89	?
1959	426	?	2.75	0.64

TABLE 3.

PRODUCTION—GRAND PRIZE MINE

Year	Ore Treated (Tons)	Concentrates (Tons)	Metallic Tin Content (Tons)	Tin in Ore %
1941	?	3.610	2.359	?
1942	392	7.626	3.893	0.99
1943	120	1.890	1.094	0.91
1944	?	1.791	0.968	?
1945	?	0.453	0.230	?
1951	?	0.296	0.195	?
1954	?	1.492	0.925	?
1955	329	2.262	1.489	0.45
1956	86	1.144	0.608	0.71
1958	95	?	1.000	1.05
1959	526	6.530	4.051	0.77

CORE LOG—RAZORBACK No. 1

Drill: Goldfields No. 10 Diamond Drill.
Driller: W. Robinson.
Commenced: 8.7.58. *Inclination*: 30°
Completed: 31.7.58. *Bearing*: 290° magnetic

(Modified log after T. D. Hughes.)

From	To	Description
0′	120′	Weathered serpentine.
120′	135′	Brown clay and dolomite.
135′	143′	Hard dolomite with calcite veins. Pyritic in places. Brown clay in lower part.
143′	155′	Brown clay and dolomite passing down into hard dolomite and dolomitised serpentine.
155′	171′	Dolomite and dolomitised serpentine. Pyrite and pyrrhotite in lower part.
171′	181′	Dolomite with sparse pyrite and pyrrhotite in depth. A few calcite veins and some red siderite.
181′	188′	Dolomite with pyrrhotite. Red siderite in lower part.
188′	194′	Dolomite with a few calcite veins. Little mineralisation.
194′	200′	Dolomite. Nearly all pyrrhotite in centre.
200′	206′	Dolomite and serpentine. Pyrrhotite towards end.
206′	214′	Serpentine with carbonate-calcite veins and pyrrhotite.
214′	215′	Serpentine, dolomite and chert. Little pyrrhotite.
215′	226′	Serpentine, dolomite and chert. Breccia at end.
226′	270′	Intraformational breccia, with some weathered serpentine in lower part.
270′	271′	Breccia.
271′	275′	Black slate and breccia.

Assays of Core

From	To	Tin %	Nickel
167′	180′	0.15	Trace
180′	185′	0.24	Trace
185′	195′	Trace	Trace
195′	206′	1.16	Trace
206′	220′	0.23	Trace
206′	209′	0.17	....
209′	212′	0.10	....
212′	215′	Nil	....
215′	220′	Nil	....

CORE LOG—RAZORBACK No. 2

Drill: Goldfields No. 10 Diamond Drill.
Driller: W. Robinson.
Commenced: 12.8.58. *Inclination*: 43°.
Completed: 17.9.58. *Bearing*: 227° magnetic.

(After log by T. D. Hughes and A. H. Blissett.)

From		To	Description
0′	—	40′	Pale green, cream and greenish-black serpentine. Weathered yellowish brown in places.
40′	—	60′	Mottled pale green and cream serpentine sheared between 50′ and 60′.
60′	—	77′	Weathered serpentine.
77′	—	104′	Green and dark green serpentine. Altered in places.
104′	—	119′	Poor cores of greenish-black and greenish-yellow serpentine.
119′	—	128′	Yellowish brown weathered serpentine. Some dolomite.
128′	—	c145′	Limonitic talcose serpentine. (Only a few fragments 136′ to 145′.)
c145′	—	155′	Fragment of pale crystalline dolomite.
155′	—	195′	Pale grey and faintly pinkish dolomite. Silicified in places. Traces of sulphides, including pyrrhotite; and magnetite.
195′	—	216′9″	Spongy textured limonitic leached dolomite.
216′9″	—	220′	Coarsely crystalline pale grey and pinkish dolomite.
220′	—	228′	Core lost.

After diversion: Cement from 180′ to 216′ 9″.

216′9″	—	217′	Dolomite.

Recovery:

From	To	Core Length	From	To	Core Length
0′	— 30′	1′ 6″	123′	— 127′	7″
30′	— 35′	3′ 6″	127′	— 136′	1′ 5″
35′	— 40′	3′ 2″	136′	— 145′	4″
40′	— 45′	2′ 5″	145′	— 155′	4″
45′	— 50′	3′ 3″	155′	— 158′	1′
50′	— 55′	3′ 1″	158′	— 176′	13′
55′	— 60′	3′ 6″	176′	— 186′	2′ 6″
104′	— 109′	1′ 6″	186′	— 195′	8′
109′	— 115′	2′ 3″	195′	— 220′	1′ 5″
115′	— 118′	1′ 6″	220′	— 228′	Nil
118′	— 123′	1′10″			

Assays:

Material	From	To	Tin %
Core	136′	155′	Nil
Sludge	136′	155′	2.26
Core	155′	166′	Nil
Core	166′	170′	Nil
Sludge	186′	195′	Nil
Sludge	195′	215′	2.32
Sludge	215′	225′	0.98
Sludge	225′	228′	3.21

CORE LOG—RAZORBACK No. 3

Drill: Goldfields No. 10 Diamond Drill.
Driller: W. Robinson.
Commenced: 20.1.1959. *Inclination*: 46°.
Completed: 27.2.1959. *Bearing*: 254° magnetic

(After log by A. B. Gulline.)

From		To	Description
0′	—	25′	Gossan material with siliceous matrix.
25′	—	65′	No recovery.
65′	—	70′8″	Leached porous ironstained talcose serpentine.
70′8″	—	93′	Grey dolomite with specks of pyrite, magnetite and galena. Veins of galena 86′10″ to 86′10½″ and 88′2″ to 88′2½″.
93′	—	95′	Dolomite. Contorted and brecciated.
95′	—	105′	Dolomite with specks of magnetite. Veins of galena 99′5″ to 99′5½″.
105′	—	115′	Leached dolomite.
115′	—	126′7″	Dolomite.
126′7″	—	136′	Highly leached limonitic and silicified dolomite.
136′	—	142′6″	Dolomite. Slightly leached and ironstained.
142′6″	—	143′6″	Dolomite with thin veins of pyrite and magnetite. Traces of galena.
143′6″	—	151′6″	Grey dolomite with specks of magnetite.
151′6″	—	194′	Talcose dolomite. Traces of sulphides.
194′	—	201′3″	Dolomite with thin veins and streaks of pyrite and magnetite.
201′3″	—	217′5″	Impure dolomite with veins and disseminations of magnetite, pyrite and ? pyrrhotite.
217′5″	—	227′	Talcose rock with residual carbonates. Traces of iron oxide.
227′	—	260′	Fine to medium grained talcose rock. Traces of carbonates.

RAZORBACK No. 3

Recovery:

Drillers Measurement				Core Recovery
0′	—	15′	15′	1′ 0″
15′	—	21′	6′	0′ 2″
21′	—	25′	4′	0′ 4″
25′	—	65′	40′	No recovery
65′	—	71′	6′	0′10″
71′	—	80′	9′	4′ 8″
80′	—	85′	5′	5′ 0″
85′	—	90′	5′	4′10″
90′	—	95′	5′	5′ 3″
95′	—	105′	10′	9′ 9″
105′	—	115′	10′	1′ 6″
115′	—	125′	10′	9′10″
125′	—	130′	5′	2′ 0″
130′	—	135′	5′	0′ 8″
135′	—	143′	8′	3′ 2″
143′	—	150′	7′	6′ 0″
150′	—	155′	5′	5′ 0″
155′	—	165′	10′	10′ 0″
165′	—	170′	5′	5′ 5″
170′	—	180′	10′	8′ 5″
180′	—	190′	10′	10′ 0″
190′	—	200′	10′	9′ 9″
200′	—	210′	10′	9′11″
210′	—	220′	10′	9′10″
220′	—	229′	9′	9′ 0″
229′	—	240′	11′	10′ 2″
240′	—	250′	10′	9′11″
250′	—	251′	1′	0′11″
251′	—	255′	4′	3′ 7″
255′	—	260′	5′	1′ 4″

Assays:

From	To	Tin
		%
0′	65′	Nil
105′	143′	Nil
194′	200′	0.46
200′	210′	Nil
210′	220′	0.22
220′	230′	Nil
230′	250′	Nil
250′	260′	Trace

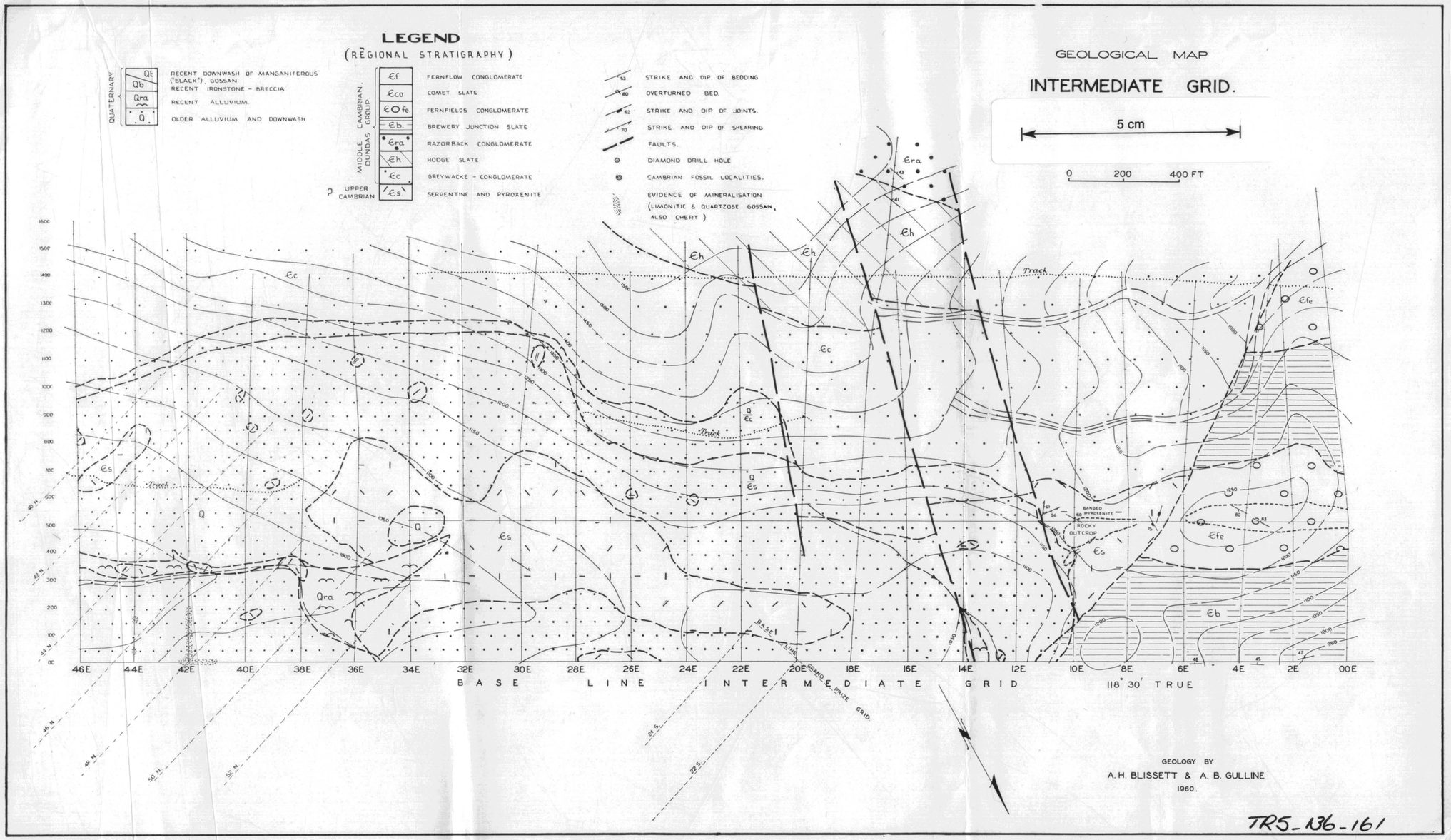

FIGURE 54.

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LEGEND
(REGIONAL STRATIGRAPHY.)

QUATERNARY
- Qt — RECENT "DOWNWASH" OF MANGANIFEROUS ("BLACK") GOSSAN
- Qb — RECENT IRONSTONE - BRECCIA
- Qra — RECENT ALLUVIUM.
- Q — OLDER ALLUVIUM, AND DOWNWASH

CAMBRIAN GROUP
MIDDLE DUNDAS
- Ef — FERNFLOW CONGLOMERATE
- Eca — COMET SLATE.
- Efe — FERNFIELDS CONGLOMERATE
- Eb — BREWERY JUNCTION SLATE TUFF.
- Era — RAZORBACK CONGLOMERATE
- Eh — HODGE SLATE.
- Ec — GREYWACKE - CONGLOMERATE.

? UPPER CAMBRIAN
- Es — SERPENTINE AND PYROXENITE.

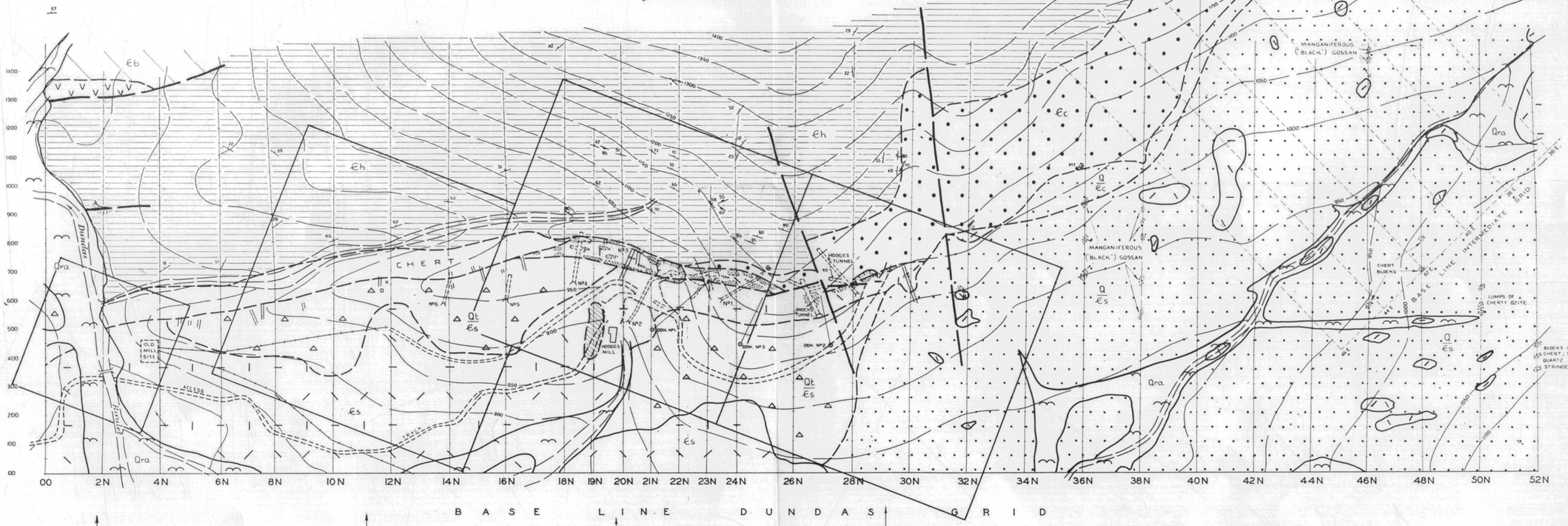
- 53 — STRIKE AND DIP OF BEDDING.
- 60 — OVERTURNED BED
- 62 — STRIKE AND DIP OF JOINTS
- 70 — STRIKE AND DIP OF SHEARING.
- FAULTS.
- DIAMOND DRILL HOLE.
- CAMBRIAN FOSSIL LOCALITIES
- EVIDENCE OF MINERALISATION (LIMONITIC & QUARTZOSE GOSSAN, ALSO CHERT)
- TRENCHES
- ADITS

GEOLOGICAL MAP
RAZORBACK GRID.

5 cm

0 200 400 FT.

True North



45M/30 5 ac. W. J. Hodge. M.L.

38M/50 20 ac. W. J. Hodge. M.L.

3M/40 20 ac. W. J. Hodge. M.L.

2M/40 20 ac. W. J. Hodge. M.L.

GEOLOGY BY
A.H. BLISSETT & A.B. GULLINE
1960.

TR5-136-161

FIGURE 55.