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10 GEOLOGY OF THE LEFROY GOLDFIELD

by D. I. Groves

ABSTRACT

A detailed geological examination of the Lefroy Goldfield was conducted between June and September, 1964. The investigation was designed to delineate the known gold-bearing lodes as accurately as possible and investigate the possibility of gold-bearing leads throughout the area in order to select possible targets for diamond drilling by the Department of Mines. The mine workings are now inaccessible and any information about them is taken from earlier reports and mine plans available at the Department of Mines.

INTRODUCTION

Lefroy is situated on the north coast of Tasmania some 27 miles from Launceston and 5 miles from the northern coastline. It is connected to both George Town and Launceston by a sealed road, the final 2-3 miles in each case being a first class gravel road. It is also connected to Pipers River and to the coast (Currie River) by gravel roads.

The topography of the area is one of gentle slopes and sluggish streams. The hills rise to about 650 feet and descend gradually into the main valleys some 200 feet above sea level. The central area is drained by Blanket Creek which flows along the eastern edge of the auriferous belt. Sludge Creek and New Chum Creek drain the NW gold-bearing area and both flow NE to join Blanket Creek. The SW area is drained by Slaty Creek and its tributaries.

A fairly detailed account of mining at Lefroy was given by Broadhurst (1935) and only a brief summary is given below.

Gold was first discovered at Specimen Hill by S. Richards and party in 1869 and the Reward Mine was opened. The eastern part of the Land-O'-Cakes and the East Volunteer were opened at this time and the township of Nine-Mile Springs was formed centring on these mines. A westward extension of prospecting resulted in the discovery of the rich Golden Point and Native Youth lodes and Lefroy township sprang up around this nucleus. These mines were worked out within three years and the town became practically deserted. Discovery of the Chum, Land-O'-Cakes and Golden Era reefs revived mining in the area and by 1881 rich returns were being obtained from the Chum Reef and further values obtained from the New Native Youth Mine. By 1884, however, these reefs had become exhausted and once more the field collapsed. A further revival occurred in 1891 with the discovery of the Pinafore lode by J. T. Stubs and party which indirectly led to re-opening of the Volunteer reef. Production from the field steadily increased until 1895 when 21,544 oz gold valued at £86,401 was recovered.

A mining boom was prevalent in 1895 with 20 companies working in the Lefroy field, the main producers being the New Pinafore and Volunteer Mines and later the West Volunteer Mine.

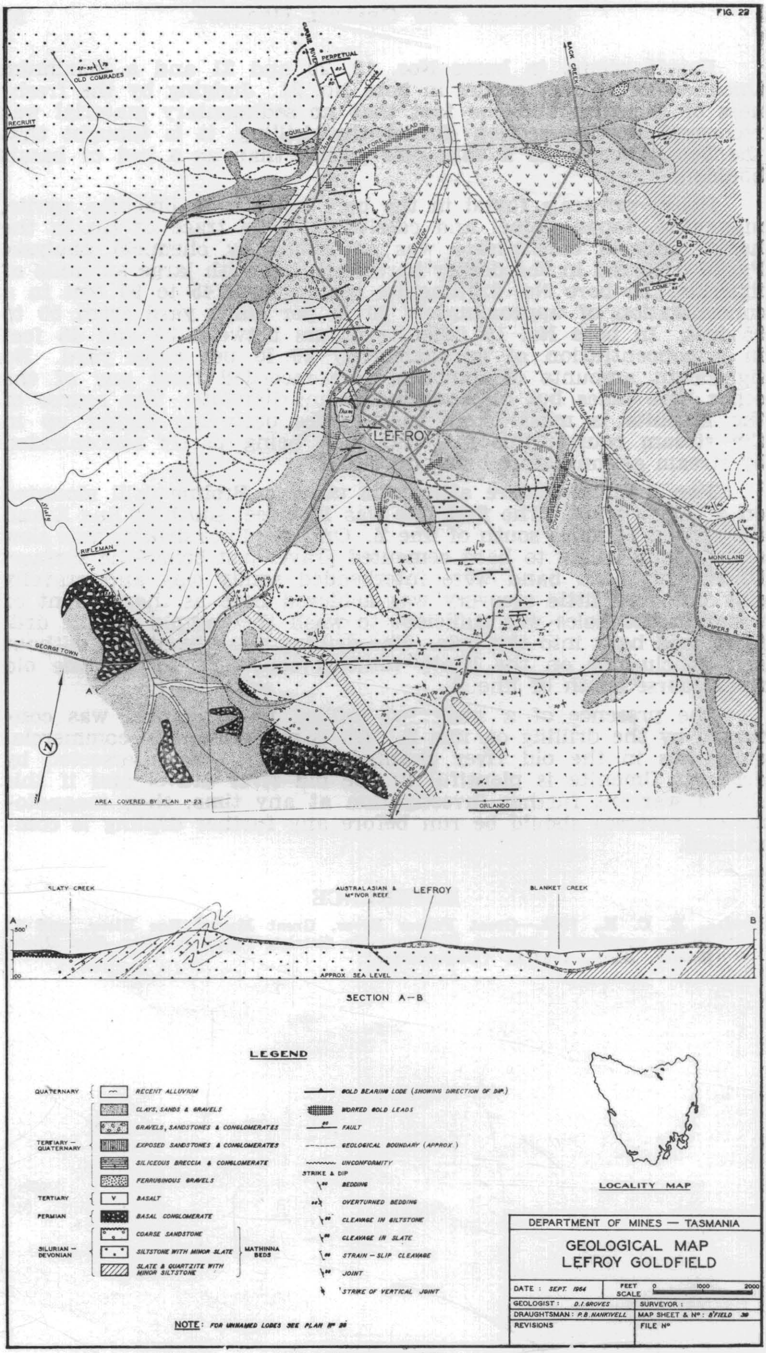


FIG. 22
OLD COMRADES
RECRUIT
PERPETUAL
EQUILLA
PINAFORE LEAD
BACK CREEK
WELCOME
LEFROY
POVERTY GULLY
RIFLEMAN
GEORGE TOWN
MONKLAND
PIPERS R.
ORLANDO
AREA COVERED BY PLAN Nº 23
SLATY CREEK
AUSTRALASIAN & McIVOR REEF
LEFROY
BLANKET CREEK
APPROX. SEA LEVEL
SECTION A–B
LEGEND
QUATERNARY
RECENT ALLUVIUM
CLAYS, SANDS & GRAVELS
GRAVELS, SANDSTONES & CONGLOMERATES
TERTIARY – QUATERNARY
EXPOSED SANDSTONES & CONGLOMERATES
SILICEOUS BRECCIA & CONGLOMERATE
FERRUGINOUS GRAVELS
TERTIARY
BASALT
PERMIAN
BASAL CONGLOMERATE
SILURIAN – DEVONIAN
COARSE SANDSTONE
SILTSTONE WITH MINOR SLATE
SLATE & QUARTZITE WITH MINOR SILTSTONE
MATHINNA BEDS
GOLD BEARING LODE (SHOWING DIRECTION OF DIP)
WORKED GOLD LEADS
FAULT
GEOLOGICAL BOUNDARY (APPROX.)
UNCONFORMITY
STRIKE & DIP
BEDDING
OVERTURNED BEDDING
CLEAVAGE IN SILTSTONE
CLEAVAGE IN SLATE
STRAIN – SLIP CLEAVAGE
JOINT
STRIKE OF VERTICAL JOINT
NOTE: FOR UNNAMED LODES SEE PLAN Nº 26
LOCALITY MAP
DEPARTMENT OF MINES — TASMANIA
GEOLOGICAL MAP
LEFROY GOLDFIELD
DATE: SEPT. 1964
FEET
SCALE
0
1000
2000
GEOLOGIST: D.I. GROVES
SURVEYOR:
DRAUGHTSMAN: P.B. NANKIVELL
MAP SHEET & Nº: B'FIELD 30
REVISIONS
FILE Nº

FIGURE 12.

In 1896 another slump in mining occurred and the New Pinafore and Volunteer Mines engaged in a project of deep sinking with Government assistance to a depth of 1200 feet, but little payable ground was found. Following this exploration no large reefs were discovered although several small reefs have been worked near the surface and some old mines re-opened. A consistent handicap to mining throughout the history of the field was the sharp decline in gold values with increasing depth of operation.

Total production of gold from lodes in the field, according to Department of Mines statistics, has been estimated as 166,193 oz the greater part of which (valued at £100,000) was taken prior to 1900. Since that date the estimated yield has been only 7,500 oz. Alluvial gold estimated at 5,000 oz has also been recovered.

The literature available on the Lefroy Goldfield is not extensive. The area was first examined in 1882 and 1883 by Thureau who described the geology of the area and the mining operations current at that time. Thureau considered that the lodes were likely to prove permanent in depth and recommended deep drilling on the main lines of lode. In 1883, the possibility of extensive sub-basalt deep leads was investigated by the Department of Mines by means of four vertical diamond drill holes, the results being rather disappointing. Four more holes were drilled in 1892, again with disappointing results. Montgomery (1897) conducted a more extensive study of the field, and he also recommended prospecting at greater depths in the existing mines.

Twelvetrees visited the area in 1899 to study the deeper workings in the Volunteer Mine to a depth of 1253 feet. Although no payable lode was found below the 463 feet level, Twelvetrees recommended deeper prospecting as the lode channel was distinct at depth and he considered " that there was a likelihood of the fissure recovering its original filling of quartz ". A further report by Twelvetrees in 1907 drew attention to the area between the known auriferous areas of Lefroy and Back Creek and suggested extensive prospecting there.

Nye visited the area in 1925 to investigate the Golden Zone Mine, and no further work was undertaken until a general survey by Broadhurst in 1935. Broadhurst emphasized the importance of exploitation of the sub-basalt deep lead deposits, which were subsequently drilled by the Department of Mines between 1937 and 1938 with little more success than the previous investigations. Blake (1938) described the drill cores and concluded that the gold obtained was negligible and provided little encouragement for further drilling. Broadhurst further suggested that the decline of gold values with depth in the lodes (most being unpayable at 100-400 feet) was due to surface enrichment and concluded that deep drilling of existing mines was unwarranted, and that future development of the field depended on the discovery of new reefs. However, further investigation of several of the known lodes was carried out by the Department of Mines with diamond drilling designed to intersect the lodes at depths of 120-800 feet. This drilling also met with little success.

The latest report on the area is a summary of the geology of the Lefroy Goldfield by Hughes (1953).

STRATIGRAPHY

The basement rocks of the area are strongly cleaved siltstone, sandstone and slate of the Mathinna Beds. The gold deposits are virtually confined to a sequence of cleaved coarse siltstone and fine sandstone which are apparently overlain to the SW by coarse sandstone and underlain to the NE by slate and quartzite. The sequence trends NW and dips generally to the SW. Basal conglomerate of Permian age unconformably overlies the Mathinna Beds to the SW of Lefroy, and Tertiary gravel, conglomerate and siltstone overlie the Mathinna Beds in the Lefroy area. This Tertiary sequence is covered by basalt flows which are themselves possibly overlain by further gravel, conglomerate, siltstone and clay, ascribed to the Tertiary-Quaternary.

MATHINNA BEDS

Slate and Quartzite

Slate and quartzite occur in a NW-trending succession to the NE of Lefroy, forming a series of steep NW ridges. They also occur as thin but traceable units within a predominantly siltstone succession to the SW of the main slate sequence. Here they again form distinct NW-trending ridges and can be traced continuously for a little more than a mile.

The slate where fresh is dark grey to black, strongly cleaved and phyllitic in places. It exhibits strongly developed strain-slip cleavage with associated crenulation folding. The quartzite (64-235 and 64-239) is pale to dark grey in colour and is an even, fine-grained rock consisting almost entirely of small recrystallized quartz grains from 0.03 to 0.05 mm in diameter. Small quartz veins are common and small flakes of muscovite occur sporadically, paralleling a poorly defined cleavage. The evenness of grain size is a striking feature of the quartzite and may be a result of original good sorting or of recrystallization.

Associated with the slate and quartzite is fine quartz siltstone (64-233), dark grey to black in colour, comprising predominantly recrystallized quartz grains ranging from 0.005 to 0.1 mm in diameter. Muscovite flakes are entrained almost continuously along both the primary and strain-slip cleavages, the latter being well developed. Small irregular patches of recrystallized quartz up to 0.1 mm in diameter occur sporadically.

Siltstone and Sandstone

A succession of cleaved siltstone and sandstone beds with minor slate is exposed in the central part of the area, with a structural thickness of about 8000 feet. The major auriferous lodes are limited to this succession which apparently overlies the slate-quartzite succession to the NE.

The siltstone is generally yellow-brown and friable with poor outcrop at the surface. Underground it is pale to dark grey in colour, with strongly developed cleavage and secondary development of muscovite in places. The siltstone is generally poorly sorted, a typical example, 64-229, having angular quartz, feldspar and quartz-siltstone grains with low sphericity from 0.1 to 0.5 mm in diameter in a matrix of similar grains averaging 0.025 mm in diameter. The quartz grains exhibit strong undulose extinction and are probably recrystallized. The feldspar grains are largely un-

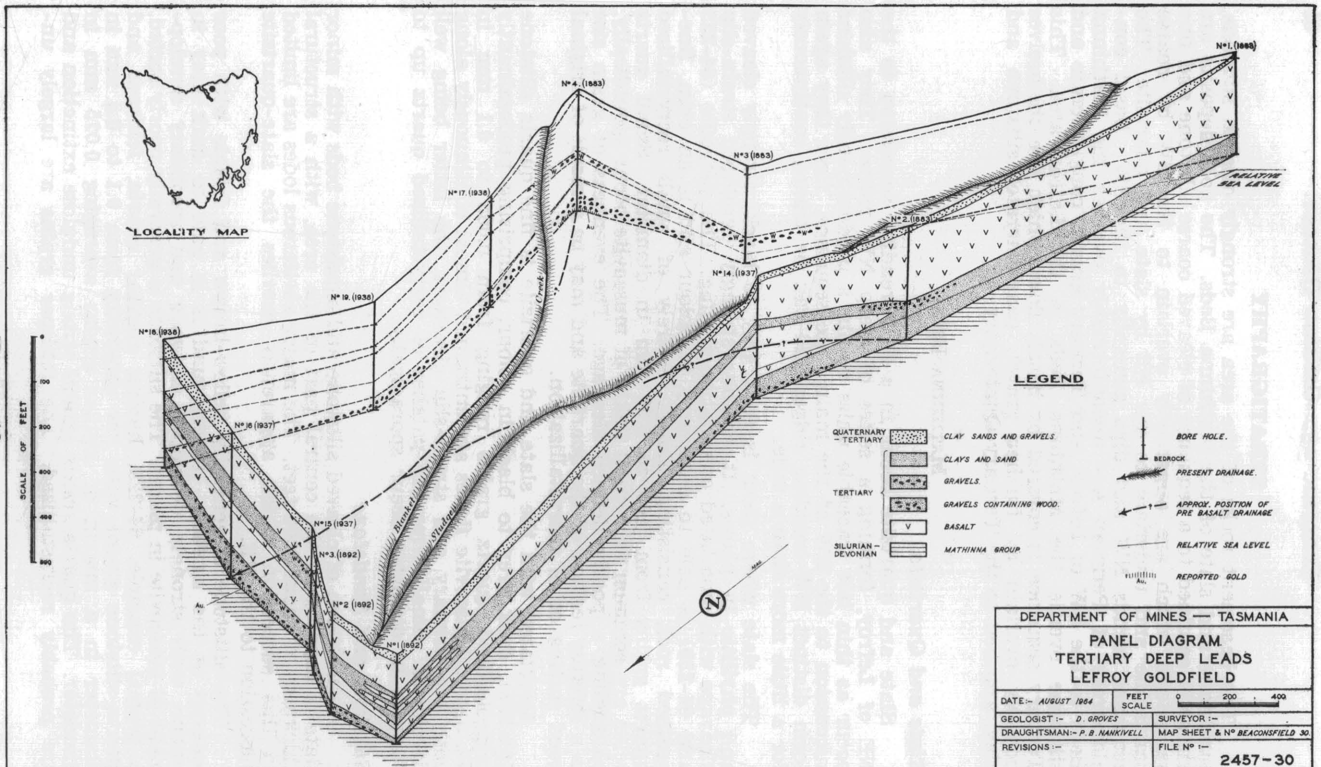

LOCALITY MAP
No 18. (1938)
No 19. (1938)
No 17. (1938)
No 4. (1883)
No 3 (1883)
No 1. (1883)
No 2. (1883)
No 14. (1937)
No 16 (1937)
No 15 (1937)
No 3. (1892)
No 2 (1892)
No 1 (1892)
Blanket
Sludgy
Creek
RELATIVE SEA LEVEL
SCALE OF FEET
LEGEND
QUATERNARY - TERTIARY
CLAY SANDS AND GRAVELS.
CLAYS AND SAND
TERTIARY
GRAVELS.
GRAVELS CONTAINING WOOD.
BASALT
SILURIAN - DEVONIAN
MATHINNA GROUP.
BORE HOLE.
BEDROCK
PRESENT DRAINAGE.
APPROX. POSITION OF PRE BASALT DRAINAGE
RELATIVE SEA LEVEL
REPORTED GOLD
DEPARTMENT OF MINES — TASMANIA
PANEL DIAGRAM
TERTIARY DEEP LEADS
LEFROY GOLDFIELD
DATE:- AUGUST 1964
FEET SCALE 0 200 400
GEOLOGIST :- D. GROVES
SURVEYOR :-
DRAUGHTSMAN:- P. B. NANKIVELL
MAP SHEET & No BEACONSFIELD 30.
REVISIONS :-
FILE No :-
2457-30

FIGURE 13.

twinned although some twinned plagioclase does occur. Small muscovite flakes up to 0.25 mm in length are common and occur both as single grains and fine shreds elongate along the cleavage. Calcite veinlets are common in 64-324 and small rounded grains of green pleochroic to non-pleochroic mica occur. These exhibit properties of mica ranging from chlorite to biotite in composition and appear to be detrital grains.

Sedimentary structures are rare within the siltstone although well developed load casts are present in the coarse siltstone, and poorly developed flame structures, somewhat modified by the later cleavage, occur in interbedded slate and siltstone. Graded bedding occurs in the coarse siltstone-fine sandstone and is reflected by curved cleavage faces passing through the graded horizon.

Coarse Sandstone

A sequence of predominantly cleaved coarse sandstone beds crops out in the SW part of the area and apparently overlies the thick siltstone sequence previously described. The maximum thickness exposed is 800 feet and the sequence is unconformably overlain by basal Permian conglomerate to the SW.

The sandstone is typified by a massive character and tendency to form large angular float blocks. It is compositionally similar to the siltstone but contains more siliceous rock fragments and consists of grains up to 1 mm in diameter. The cleavage is less well defined than in the siltstone and strain-slip cleavage is generally absent.

PERMIAN

Basal Conglomerate

Basal conglomerate of Permian age occurs in the SW corner of the area where it unconformably overlies coarse sandstone of the Mathinna Beds. The conglomerate rarely crops out at the surface but can be traced by the occurrence of pebbles and boulders derived from it. The boulders generally consist of quartzite, quartz, granite and conglomerate lithologically similar to the Owen Conglomerate and its correlates, including the Cabbage Tree Hill Conglomerate at Beaconsfield. Broadhurst (1935) described outcrops of the conglomerate in a prospecting shaft at the Londonderry Mine and recorded faceting and grooving of pebbles in several cases.

TERTIARY

Sub-basalt Sedimentary Sequence

Deposits of gravel, sandstone and clay occur beneath the basalt which forms the bottom of the present valleys in the area. Diamond drill holes suggest that two main basalt flows filled an original Tertiary river valley, and that accumulations of sediments were deposited on the valley floor to a maximum proven depth of 90 feet prior to extrusion of the first basalt flow. Deposition also occurred between extrusion of the basalt flows to a maximum depth of 50 feet. The basalt sediments have also been intersected in workings of the Pinafore, Golden Era, Golden Heart and Morning Star mines where they have been mined for alluvial gold. Fossilized tree stumps and fragments of lignite were common in the workings and were also found in the two major sedimentary horizons intersected in the drill cores (Fig. 13).

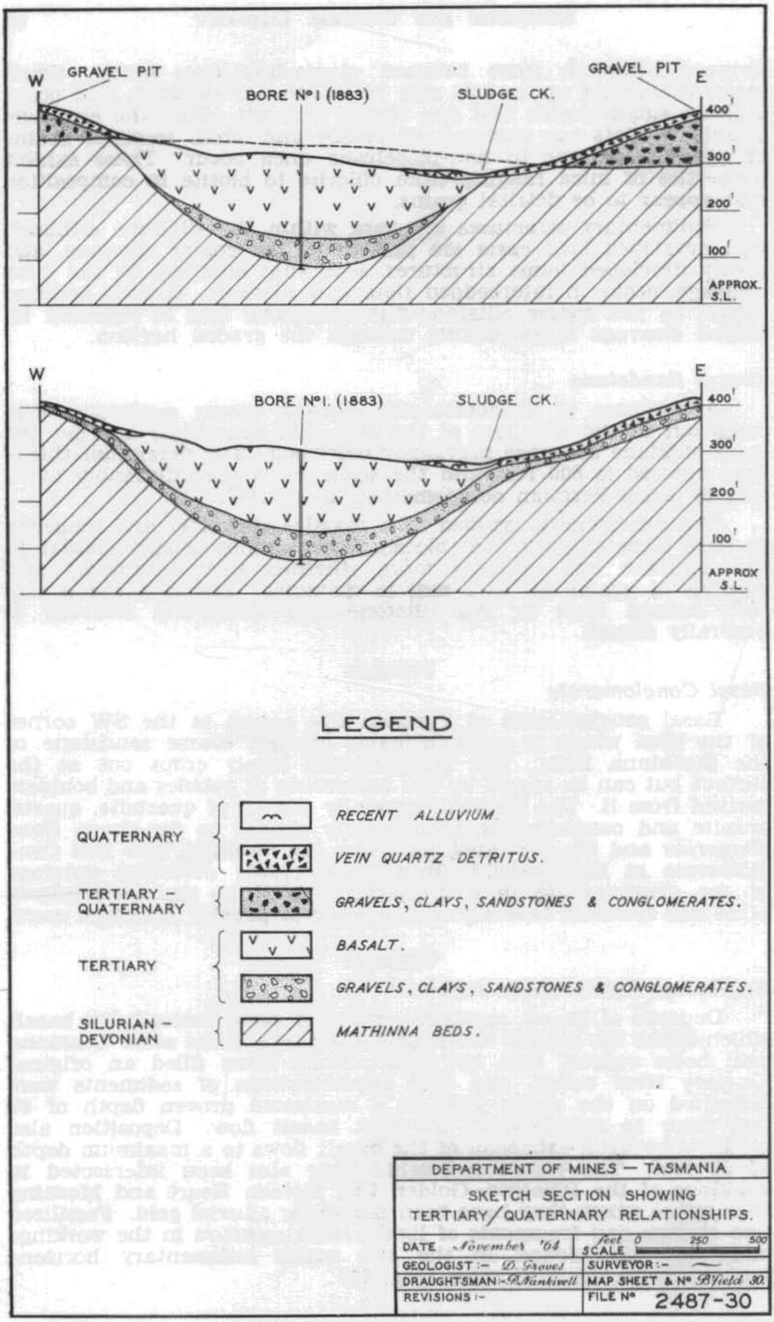


FIGURE 14.

5 cm

The original stream beds can be interpreted from Fig. 13 as the base of the sub-basalt sediments indicates the shape of the original land surface. It can be seen that the pre-basalt streams flowed just E of the present streams and that probably a junction occurred SE of the present junction. The gradient of both pre-basalt streams indicated on this diagram is approximately 1 in 25 while the gradient of the present drainage is 1 in 50. The depth of the pre-basalt stream bed in the Pinafore Company workings was about 230 feet below the present surface. This indicates an average grade of 1 in 5 for the pre-basalt stream in this area. The banks of the stream in the Morning Star workings apparently had a slope of 1 in 2, suggesting that precipitous conditions existed with rapids and waterfalls probably present.

Precipitous conditions are also suggested by the occurrence of immense boulders of sandstone found in the workings of the Pinafore alluvial deep lead mine and by coarse gold in most of the alluvial workings.

Basalt

A fairly extensive sheet of basalt fills the valley floors of Sludge and Blanket Creeks. It crops out rarely in the stream beds and on the flanks of the hills but is generally represented on the surface by red clay soil partially covered by surface gravel.

The bore holes put down to test sub-basalt leads intersected two basalt flows separated by a maximum thickness of 50 feet of sediments. Boreholes Nos. 1, 2 and 3 (1883) apparently intersected continuous basalt which may be a single flow as represented in Figure 13 or two flows with no intervening deposition. The latter is possible as these boreholes were drilled furthest upstream. In borehole No. 1 (1892), four basalt layers separated by thin beds of sediments were intersected. The uppermost basalt is approximately the same thickness as the second basalt in the other boreholes and is considered equivalent. The other basalts are approximately 11 feet, 11 feet and 28 feet thick, the last being the lowest. The total thickness of the lower basalts corresponds with the thickness of the lower basalt elsewhere and it is possible that it comprises three separate flows with only local intervening deposition. However, as borehole No. 2 (1892) was only 300 feet E of No. 11 (1892) and did not intersect intervening sediments, the hypothesis appears less sound. Further drilling would be required to determine the shape of these bodies before their origin can be fully discussed.

The basalts could not be examined at depth as the drill cores are no longer available. Basalts examined at the surface differ slightly in composition, particularly in their olivine content. The most common variety present is an olivine basalt (64-231, 64-340) comprising a high proportion of subhedral olivine crystals up to 3 mm in diameter, associated with labradorite laths up to 1 mm in length and augite grains up to 0.5 mm in diameter, which tend to be sub-ophitic towards the feldspar. The pyroxene granules are generally pale pink in colour and rarely pleochroic indicating that they are possibly titaniferous. A fine felsitic groundmass is rarely present interstitial to the feldspar and pyroxene. In specimen No. 64-340, granules of partially devitrified green-brown glass, up to 0.4 mm in diameter, are present in the interstices and are spatially associated with fine needles of ilmenite or magnetite. The rock approaches an olivine-dolerite in texture and exhibits features akin to the Branxholm Type of Edwards (1950) which is common in NE Tasmania.

A further variety of basalt occurring near Lefroy comprises large phenocrysts of labradorite, up to 5 mm in length, in a fine grained groundmass of feldspar laths and augite granules. Olivine is extremely rare. Amygdales of calcite are common throughout the rock and brown and green devitrified glass is commonly interstitial to the augite and feldspar. Small cubes of magnetite or ilmenite are commonly associated with the groundmass.

The consistent coarse grain size of the basalts suggests slower cooling than in the majority of basalt flows in NE Tasmania. It is probable that at Lefroy the basalts occupied a series of steep river valleys thus becoming locally thicker and cooling at a slower rate.

Evidence of baking by the basalts is rare. Siliceous conglomerate occurs on the NE side of Sludge Creek and comprises angular blocks of vein quartz, cleaved siltstone and slate in a cement of quartz. The conglomerate appears to have been formed by fusion of quartz grains in the original sedimentary rocks.

TERTIARY-QUATERNARY

A sequence of gravel, clay, siltstone and conglomerate occurs widely throughout the area, overlying the Mathinna Beds and apparently overlying the basalt in places. The sequence is generally expressed at the surface by accumulations of angular vein-quartz fragments and is difficult to distinguish from the poorly exposed Mathinna Beds beneath. It is also difficult to determine whether at least a proportion of these sediments extends beneath the basalt, as the vein-quartz migrates down slope tending to blanket the basalt. Previous authors considered that the sediments extended beneath the basalt and that auriferous leads traced in these sediments passed beneath the basalt. Due to this uncertainty and lack of an exact age for the basalt, the deposits are ascribed to the Tertiary-Quaternary.

Alternative relationships of the Tertiary, Tertiary-Quaternary and Quaternary sediments are shown in Figure 14. The sediments, termed Tertiary-Quaternary gravel, clay, sandstone and conglomerate, may have been deposited following basalt extrusion or may represent the earliest Tertiary deposits which had been partially eroded prior to basalt extrusion. The latter is more probable as silicified conglomerate occurs locally and probably represents remobilization of quartz due to contact with basalt lava at the time of extrusion.

The sedimentary sequence generally occupies the low-lying country in the Lefroy district. However, well exposed gravel, siltstone and conglomerate occur both capping and flanking low rounded hills and have been quarried for road metal in places. They occur continually over a vertical distance of 100 feet although they may be merely forming a thin veneer over local bedrock. The conglomerate generally consists of a high proportion of angular to sub-rounded vein-quartz pebbles and boulders, minor well rounded quartzite and conglomerate pebbles and angular blocks of cleaved siltstone and slate in a sandy to silty matrix. Lenses of well compacted siltstone and sandstone, sometimes lignitic, are common. Ferruginous gravel is rarely present in close association with areas of basalt outcrop. Bedding in the sediments is generally horizontal to 6°.

A subdivision is made into two major sections (*a*) clay, sand and gravel and (*b*) gravel, sandstone and conglomerate. This is based on infrequent exposures in gravel pits and topographic expression of the sediments as surface exposure of both sequences is remarkably similar. Both sequences contain alluvial gold and have been worked in places.

RECENT

Alluvium

Thin deposits of clay and gravel occur in the present river valleys and probably represent Recent re-working of Tertiary-Quaternary deposits. Small swampy areas generally delineate the areas of Recent alluvium which are very limited. The alluvium is auriferous and has been worked in places.

STRUCTURAL GEOLOGY

FOLDING

Evidence of folding in the Mathinna Beds is limited by poor exposure. The sedimentary rocks generally strike at 310°-340°M and dip W at varying angles, although in the vicinity of the lodes they are somewhat disturbed.

The sequence is not demonstrably overturned generally but an exposure of overturned siltstone and slate does occur on the George Town road. The sequence strikes at 310°M and dips 70°-80° SW, while the cleavage dips W at only 10° in the siltstone and 40°-70° in the slate. Small flame structures, slightly modified by the cleavage, are also inverted. The cleavage is strongly 'refracted' and in the slate horizons is practically parallel to bedding. The exposure indicates the existence of at least one anticline, slightly overturned to the east (Figure 23) and it is probable that folds of equivalent style occur throughout the area.

Secondary deformation is suggested by the occurrence of widespread strain-slip or crenulation cleavage (Rickard, 1961), particularly in thin slate horizons interbedded with cleaved siltstone. In thin section (64-233, 64-234) it is evident that the crenulation cleavage in places is far stronger than the primary cleavage. The latter is crenulated, the micro-folds being bounded by discrete zones of oriented sericite parallel to their axial planes. Some cleavage slip occurs. In general, the crenulation cleavage and primary cleavage have a similar strike but dip in opposition.

Folded primary cleavage occurs at several localities. It can be demonstrated that cleavage planes, oblique to bedding, form small asymmetrical flexural folds. Crenulation cleavage is strongly developed in the axial region and is generally parallel to the axial plane of the folds although slightly oblique examples occur rarely. Lineations markedly oblique to the fold axes occur but are apparently not related to the crenulation cleavage. Lineations generally indicate a plunge of less than 10° for these folds. Anastomosing macroscopic crenulations are associated with the crenulation cleavage in places. The flexural style of folding shown by

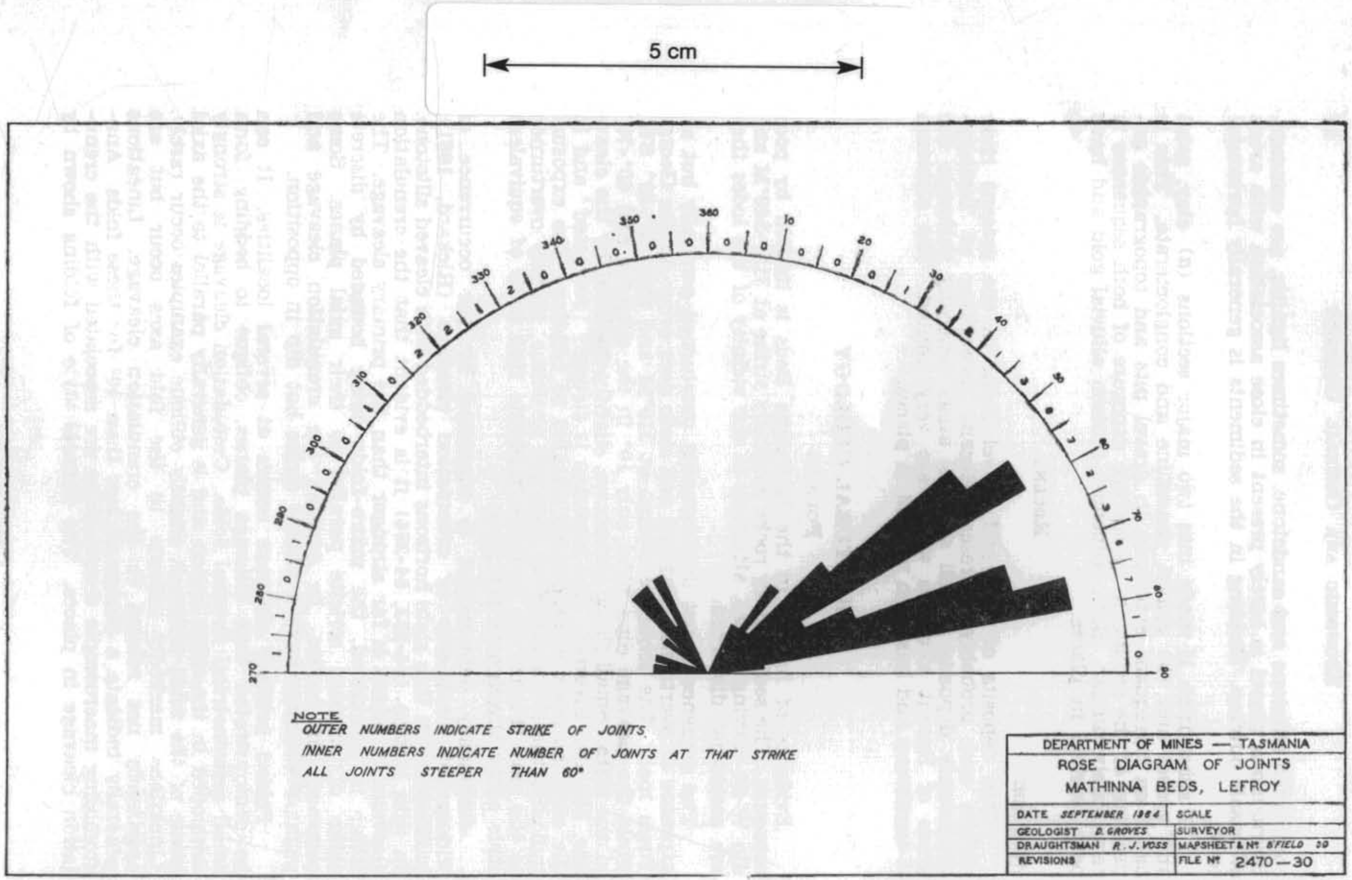

5 cm
NOTE
OUTER NUMBERS INDICATE STRIKE OF JOINTS
INNER NUMBERS INDICATE NUMBER OF JOINTS AT THAT STRIKE
ALL JOINTS STEEPER THAN 60°
DEPARTMENT OF MINES — TASMANIA
ROSE DIAGRAM OF JOINTS
MATHINNA BEDS, LEFROY
DATE SEPTEMBER 1964
SCALE
GEOLOGIST D. GROVES
SURVEYOR
DRAUGHTSMAN R. J. VOSS
MAPSHEET & Nº 8'FIELD 30
REVISIONS
FILE Nº 2470 — 30

FIGURE 15.

cleavage blocks indicates that the crenulation cleavage formed as a result of folding and not vice versa.

The distribution of strain-slip or crenulation cleavage in the slate-quartzite sequence was found to be heterogeneous. The examination was confined to adjacent strike ridges, where float blocks in places exhibited strong crenulation cleavage and in others none. Primary cleavage throughout the area predominantly dips west but in the NE section several easterly dips were recorded. This, together with the occurrence of the folded cleavage previously described, and structures described by Marshall (in press) from Back Creek suggest that gentle secondary folds subparallel to the overfolded primary folds occur in the area. By analogy with the smaller folds, the large folds are probably open flexural folds which form a gentle anticlinal structure, indicated by reversal of dip in the cleavage. The occurrence of zones where crenulation cleavage has been more intensely developed than in other similar lithologies suggests zones of more extreme deformation. Such zones may represent the axial regions of the larger gentle folds.

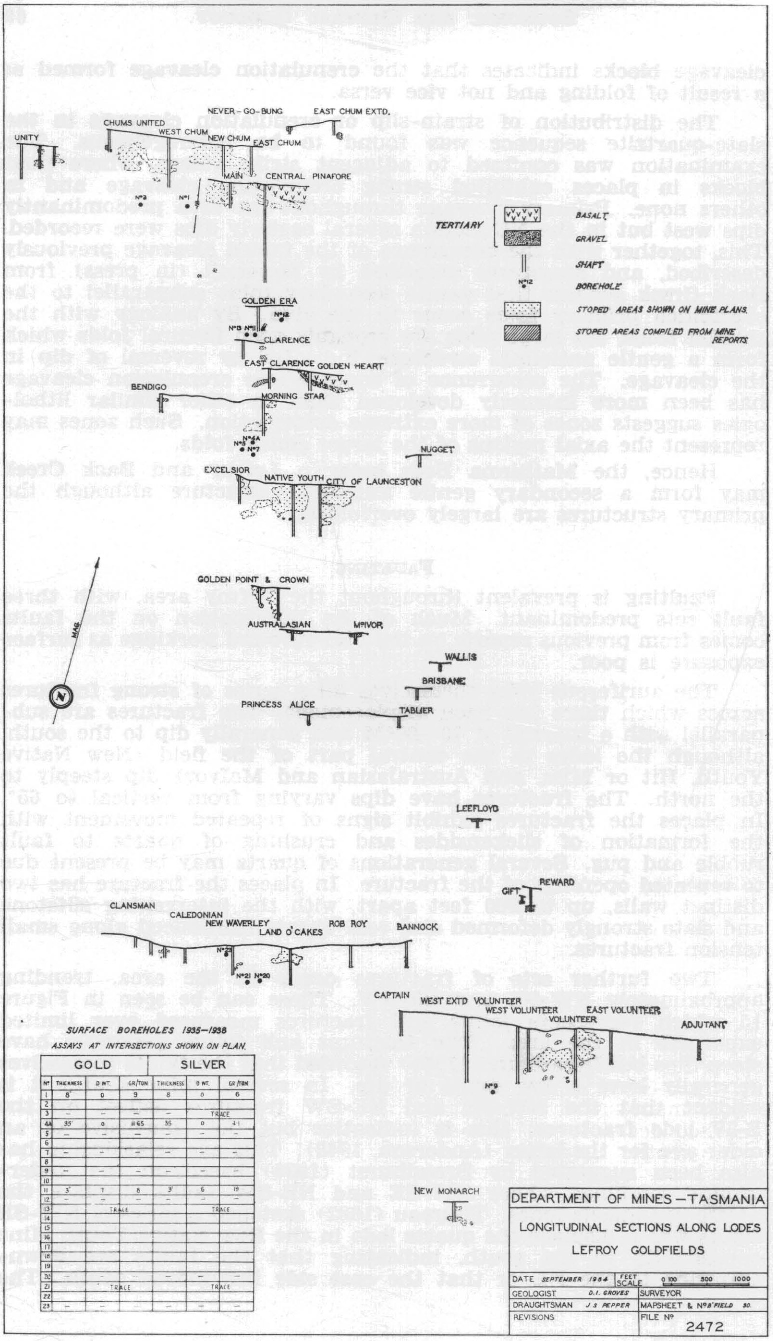
Hence, the Mathinna Beds between Lefroy and Back Creek may form a secondary gentle anticlinal structure although the primary structures are largely overfolded.

FAULTING

Faulting is prevalent throughout the Lefroy area, with three fault sets predominant. Much of the information on the faults comes from previous reports on the underground workings as surface exposure is poor.

The auriferous lodes themselves fill a series of strong fractures across which there has been displacement. The fractures are subparallel with a bearing of 70°-80°M and generally dip to the south, although the lodes in the central part of the field (New Native Youth, Hit or Miss, and Australasian and McIvor) dip steeply to the north. The fractures have dips varying from vertical to 65°. In places the fractures exhibit signs of repeated movement with the formation of slickensides and crushing of quartz to fault rubble and pug. Several generations of quartz may be present due to repeated openings of the fracture. In places the fracture has two distinct walls, up to 200 feet apart, with the intervening siltstone and slate strongly deformed and vein quartz introduced along small tension fractures.

Two further sets of fractures occur in the area, trending approximately NW-SE and NE-SW. These can be seen in Figure 15 which represents joints and fractures measured over limited exposures in the area. The fractures and joints generally have steep dips but Broadhurst (1935) recorded that the faults themselves generally have a low angle of dip. In several mine shafts it is evident that the NW-SE and NE-SW fractures deflect on the E-W lode fractures; this is indicative but not conclusive of an older age for the latter (Anderson, 1942). This age relationship has also been suggested by Broadhurst (1935) based on the underground workings where NW-SE and NE-SW faults displace the auriferous quartz lodes. Thureau (1882) sketched a series of NW-SE faults which displace the quartz lode in the New Native Youth Mine consistently to the south, indicating that the faults are downthrowing to the NE or that the east side has moved south. The



SURFACE BOREHOLES 1935—1938

ASSAYS AT INTERSECTIONS SHOWN ON PLAN.

	GOLD			SILVER		
No	THICKNESS	D WT.	GR/TON	THICKNESS	D WT.	GR/TON
1	8'	0	9	8	0	6
2						
3	—	—	—	—	TRACE	
4A	35'	0	11·65	35	0	4·1
5	—	—	—	—	—	—
6						
7	—	—	—	—	—	—
8						
9	—	—	—	—	—	—
10						
11	3'	7	8	3'	6	19
12	—	—	—	—	—	—
13		TRACE			TRACE	
14						
15						
16						
17						
18						
19						
20	—	—	—	—	—	—
21		TRACE			TRACE	
22						
23	—	—	—	—	—	—

FIGURE 16.

resultant movement is probably due to a combination of both horizontal and vertical movements.

The auriferous lodes are confined to the thick siltstone sequence in the central part of the area, the E-W fractures lying in a NW trending zone. This suggests that the fractures were formed preferentially due to difference in competence between successions. If differential movement has occurred, it would have taken place on planes subparallel to the boundaries of the different successions. As Broadhurst (1935) suggested, under this stress pattern the E-W lode fractures would have been tension fractures and the NW-SE and NE-SW faults conjugate shear fractures. Geometrically this is identical with fracture patterns produced experimentally by Mead, as shown in Billings (1947, p. 105). This would also explain the age relationships of the sets, as the tension fractures would have been the first formed.

ECONOMIC GEOLOGY

LODE DEPOSITS

The extent and formation of the gold-bearing lodes have been discussed previously. The fractures can be traced on the surface for about a mile and proved continually to a depth of 1250 feet. The gold, however, is limited in economic quantities both laterally and at depth although present in trace amounts throughout the fractures (Figure 16).

The gold is generally associated with vughy quartz on the footwall and/or hangingwall of the fractures. It is found in association with stibnite and cervantite, a mixed antimony oxide formed by oxidation of stibnite, and more rarely with pyrite, chalcopyrite and arsenopyrite. Vitreous white quartz is common, particularly in fault zones and small fractures but is generally non-auriferous. The association of gold with sulphides was most clearly shown in the Clarence Mine where free gold was extremely rare but pyrite assayed up to 22 oz gold per ton. A small pocket of pyritic ore at the 800 feet level in the New Pinafore Mine is reported to have assayed 33 dwt gold per ton, and represents the only concentration of gold found below 400 feet in the mines.

The predominant feature of the mining field is the consistent decline in gold values below the 300-400 feet levels, and, in many of the smaller mines, the marked decrease at only 100 feet, although quartz may fill the lode channel. The New Pinafore and Volunteer Mines were extended to a depth of 1200 and 1250 feet respectively but yielded very little gold although the lode channel in each case was distinct. Gold values generally declined from about 1 oz per ton in the upper levels to less than 2 dwt per ton at depth.

The decline in gold values was attributed to a process of surface enrichment by Broadhurst (1935) who quoted figures showing a marked decrease in fineness, i.e. increase in impurities, of the gold with depth. Broadhurst calculated that at least 2000 feet of the upper lode must have been eroded and much of the gold from this lode carried down in solution to attain the gold values encountered between 0-400 feet. This is dependent also on the relative rates of erosion and solution of the gold, the rate of the latter essentially being the greater. Broadhurst also suggested that the gold was precipitated from solution by the sulphides and that pyrite, which is fairly common in the lodes, formed ferric sulphate which was a solvent for gold. However, both Krauskopf (1951) and Cloke and Kelly (1964) have since shown that the solubility of gold is negligible except in acid chloride solution in the presence of a strong oxidizing agent.

Surface enrichment of gold is poorly documented but examples given by Lindgren (1933, p. 859) indicate that there is little enrichment of gold in oxidized zones or as at Mt Morgan, Queensland, deposition of supergene gold occurs only in the lower part of the oxidized zone. Enrichment in gold values to the extent suggested at Lefroy does not appear to be supported by the literature. The presence of free sulphides and general absence of oxidized minerals other than cervantite in the upper levels is also unusual for an enriched zone, although decrease in quality of the gold with depth is generally indicative of increase in sulphides, as at the Tasmania Mine, Beaconsfield (Noldart, 1964). However, gold enrichment is not recorded from the upper levels at Beaconsfield although it is probable that surface oxidation has taken place. It would therefore appear that special conditions must have prevailed if surface enrichment has resulted in the recorded distribution of gold values at Lefroy.

Many of the lodes contained satisfactory gold values at the surface but were only worked at very shallow depths, presumably due to a rapid decline in gold values below 100 feet. These include the Old Comrades, Perpetual, Equilla, White Pinafore, Welcome, Nugget, Australasian and McIvor, Prince of Wales, Brisbane, Tablier, Monkland, Windermere, Rifleman and Leefloyd Reefs. These were all described in some detail by Montgomery (1897) and Broadhurst (1935) and the known workings are shown in Figures 16 and 23. A brief description of the larger mines and exploration carried out since Broadhurst (1935) is given below.

Chum Reef

The Chum Reef is one of the longest and most continuous reefs in the Lefroy field and consists largely of gold-bearing quartz with minor pyrite and stibnite. It has been worked to a maximum depth of 500 feet and from the mine plans appears to have been stoped out almost continually over the explored length and depth. Three boreholes were drilled by the Department of Mines in 1935 to intersect the lode along its proven length at a depth of 800 and 900 feet with very little success: 8 feet of core at 825 feet in No. 1 bore assayed 9 grains of gold and 6 grains of silver per ton and No. 3 and 4 bores intersected only a trace of gold.

Pinafore Reef

The Pinafore Reef comprises a series of quartz veins in a wide fault zone, and is generally obscured by overlying Tertiary gravel and basalt. It has been worked extensively to a depth of 300 feet with fair success. The reef was tested in depth by underground mining to 1200 feet, small pockets of fairly rich ore occurring at 800 and 1080 feet. Extensive driving and crosscutting was carried out at 1200 feet and five lodes were intersected, all proving unpayable. Small amounts of gold were found in the Pinafore lode at this level but were uneconomic.

Golden Era Reef

This reef has been worked to a maximum depth of 240 feet, where gold values were high in the east drive on the main lode. The auriferous quartz extended underfoot but the mine was closed due to water problems and lack of capital. Four boreholes were drilled by the Department of Mines in 1936-37 to intersect this lode at depths ranging from 175 to 350 feet, generally with poor results. Borehole No. 11, however, intersected 3 feet of pyritic material at 332 feet assaying 7 dwt 8 grs gold and 6 dwt 19 grs silver to the ton.

Clarence Reef

Broadhurst suggested that the Clarence Reef has been faulted to form two main branches, the North Clarence and South Clarence Reefs. The North Clarence Reef has been worked from the Clarence Shaft to a depth of 209 feet and two small patches of ore stoped out to the east of the shaft. The gold was associated with pyrite which assayed up to 22 oz 8 dwt per ton. The South Clarence Reef has been worked from the East Clarence and Golden Heart Shafts to a maximum depth of 220 feet. In the East Clarence Mine the main ore shoot pitches shallowly to the west and several good crushings have been taken from this shoot.

Morning Star Reef

This reef has been worked to a depth of 420 feet in the Morning Star Mine. Satisfactory gold values were obtained to the east of the shaft in the upper levels and to the west in the lower levels. The available information suggests a west plunging ore-body which became unpayable at the 420 feet level. Four boreholes were drilled by the Department of Mines to intersect the orebody along the probable extension of the westerly plunge. Results of the drilling were not encouraging, borehole No. 4A intersecting the only gold recorded, which occurred in a zone 35 feet wide averaging 11.65 grs gold and 4.1 grs silver per ton at a depth of 562 feet.

New Native Youth Reef

The New Native Youth Reef was one of the richest in the field and included the City of Launceston, New Native Youth and Excelsior Mines. The reef, a hard quartz lode, was investigated to a depth of 800 feet. Stoping was carried out along its length to a depth of 400-500 feet but below this the lode proved uneconomic. A few small patches of gold are recorded from the 800 feet level.

Golden Point and Crown Reef

This reef is unusual as it trends NE. It is a short reef and occurs in strongly fractured siltstone and slate, with numerous irregular quartz veins. The longitudinal section of the reef indicates two near-vertical shoots of ore to a maximum depth of about 330 feet. It is not recorded whether the reef was investigated at a greater depth.

Land-O'-Cakes Reef

This line of lode has been traced for nearly a mile on the surface but was only worked to any extent in the Land-O'-Cakes Mine. It was stoped to a depth of about 200 feet, exploration down to the 400 feet level indicating a rapid decline in gold values. Four boreholes were drilled by the Department of Mines in 1938, three to test the lode at depth and one to test the western extension of the lode. A trace of gold was found in most of the boreholes but the results were not encouraging.

Volunteer Reef

The Volunteer Reef has been worked over a length of about 4000 feet and lodes probably continuous with the reef have been cut over a greater distance. The main workings were the Volunteer, West Volunteer and East Volunteer Mines which worked the lode to a depth of about 630 feet although the better gold values occurred above 460 feet, with the richest ore between 225 and 300 feet. The lode was explored at depth by underground mining to 1250 feet but only very small quantities of gold were found at this depth. The longitudinal section of the reef indicates a fairly shallow westerly plunge. A possible extension of the ore along this plunge was drilled by the Department of Mines in 1936-37, two boreholes failing to intersect any gold-bearing lode.

SECONDARY DEPOSITS

Sub-Basalt Leads

The distribution of the pre-basalt sediments has been discussed previously and is shown in Figure 13 which is based on diamond drilling in the area.

The basal lead beneath the earliest basalt flow has been worked from several shafts, generally on the western branch of the pre-basalt stream. The East Pinafore workings intersected gravel and clay on the western bank of the old stream bed and fairly high gold values were obtained in the gravel. The old stream bed was intersected in the Golden Era workings and very coarse gravel was found containing coarse gold and giving satisfactory pan prospects on the western bank. The stream bed was also investigated in the New Golden Heart workings where coarse gravel was intersected containing 13 dwt of alluvial gold per ton, with subsidiary gold in vein-quartz pebbles and boulders. The Pinafore Company shaft, about 10 chains north of the Morning Star Shaft, also intersected the old stream bed which was filled by at least 28 feet of boulder gravel containing samples of free gold up to 2½ dwt. In this mine, work proved unpayable due to the immense boulders which hampered mining operations. Alluvials were also investigated in the Morning Star Mine by the King Prospecting Association but no gold was found.

Diamond drilling of the deep leads has been largely unsuccessful, except in delineating the old stream beds. The No. 4 bore (1883) is reported to have intersected a basal gravel some 6 feet 10 inches thick which contained some gold. A further bore No. 4 (1892), was sunk ½ chain SE of the No. 4 (1883) bore but no gold was found. Two boreholes drilled in 1937 intersected gold-bearing gravel filling the old valley floor. Bore No. 15 intersected 2 feet 6 inches of coarse gravel assaying 2 dwt 11 grs gold per ton at 260 feet and Bore No. 16 a trace of gold at 297 feet. Blake (1938) indicated that all the sediments below the lowest basalt were assayed for gold in the 1937 boreholes although the sediments between flows were not assayed.

The drilling results, although not very encouraging, indicate the presence of gold in the sub-basalt gravel. The prospects encountered in the workings where the alluvials were investigated were far better than those reported from the boreholes although mining conditions were difficult. This suggests that results from the old boreholes should not be taken as a true indication of the quantity of alluvial gold but rather as a guide to its presence.

Tertiary-Quaternary Leads

Several leads have been traced on the surface to the point where they appear to pass beneath the basalt, at which point the workings have generally been discontinued. The leads of this type include the Pinafore, Golden Point and Native Youth Leads.

The Pinafore Lead has been worked from just east of the Pinafore main shaft to where it passes beneath the basalt near the Lefroy Deep Leads Company Shaft. Some coarse gold was obtained from the gravel. Broadhurst suggested that the gravel passes beneath one of the higher basalt flows, but with precipitous conditions existing it is possible that it passes steeply beneath the lowest basalt. A similar lead runs along the east side of Sludge Creek and again appears to pass beneath the basalt north of the Native Youth lode.

A reconnaissance magnetometer survey was carried out over the basalt and Tertiary-Quaternary sediments to determine the presence or absence of basalt beneath the gravel. The project met with little success.

Post-Basalt Leads

In places, gold bearing gravel occurs in the Recent streams in the area and may be in part reworked Tertiary or Tertiary-Quaternary deposits.

CONCLUSIONS

The lode deposits of the area have been extensively prospected both by mining and drilling with little success. Various theories have been put forward to explain the sudden decline in gold values below about 400 feet. Economically, the importance lies in the fact that the gold reefs do apparently decline in values below this depth throughout the field.

The resources of the sub-basalt leads have been virtually untapped. Several workings have intersected sub-basalt gravel upstream from the confluence of Sludge and Blanket Creeks and economic deposits have been worked although mining was difficult. Drilling results further downstream were rather discouraging but probably do not give a true indication of the quantity of gold present. Further drilling should be carried out on these deposits with special care to ensure maximum recovery of core, before they are dismissed as uneconomic. A preliminary borehole to test the gravel could be sited adjacent to borehole No. 16 (1937), drilled by the Department of Mines, which intersected gravel containing minor gold in the pre-basalt stream bed.

References

ANDERSON, E. M., 1942.—The Dynamics of Faulting. Oliver and Boyd Ltd., Edinburgh.

BILLINGS, M. P., 1947.—Structural Geology. Prentice-Hall, Inc., New York.

BLAKE, F., 1938.—Supplementary report on drilling at Lefroy. *Rep. Dep. Min. Tas.*, (*Unpublished*).

BROADHURST, E., 1935.—Lefroy and Back Creek Goldfields. *Bull. Geol. Surv. Tas.*, 42.

CLOKE, P. L. and KELLY, W. C., 1964.—Solubility of gold under inorganic supergene conditions. *Econ. Geol.*, 59, 259-271.

EDWARDS, A. B., 1950.—The petrology of the Cainozoic basaltic rocks of Tasmania. *Proc. Roy. Soc. Vic.*, 62, 97-121.

HUGHES, T. D., 1953.—The Beaconsfield and Lefroy Goldfields; *in* The geology of Australian ore deposits. *5th Emp. Min. Met. Cong.*, 1, 1233-1241.

KRAUSKOPF, K. B., 1951.—The solubility of gold. *Econ. Geol.*, 46, 858-871.

LINDGREN, W. L., 1933.—Mineral Deposits. McGraw-Hill Book Co. Inc., New York.

MARSHALL, B., in press.—Pipers River. *Explan. Rep. Geol. Surv. Tas.*, 1 mile Geol. Map Ser. K/55-7-31.

MONTGOMERY, A., 1897.—On the geological structure and mining development of the Lefroy Goldfield. *Rep. Sec. Min. Tas. for* 1896-97.

NOLDART, A. J., 1964.—Notes on auriferous deposits, Beaconsfield Goldfield. *Tech. Rep. Dep. Min. Tas.*, 8, 11-23.

NYE, P. B., 1925.—On the Golden Zone Mine, Lefroy, *Rep. Dep. Min. Tas.* (*Unpublished*).

RICKARD, M. J., 1961.—A note of cleavages in crenulated rocks. *Geol. Mag.*, 98, 324-333.

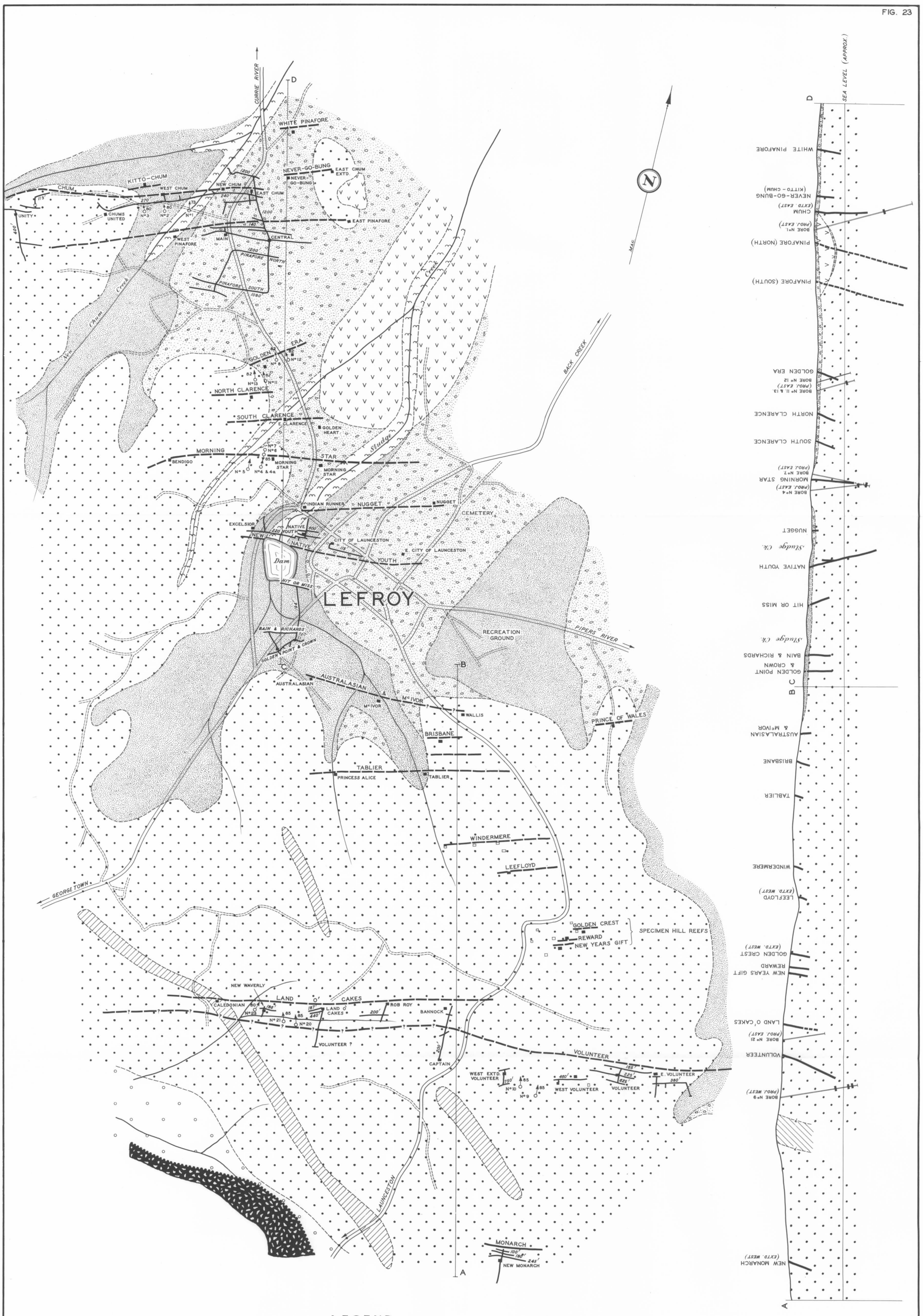
THUREAU, G., 1882.—On the mineral resources and permanency of the Lefroy Field. *Tas. House of Assembly Pap.* 118 (*for* 1882).

————, 1883.—On the future prospects of deep mining of gold-bearing quartz lodes at Lefroy. *Tas. Legislative Council Pap.*, 107 (*for* 1883).

TWELVETREES, W. H., 1899.—Volunteer Gold Mining Company. *Tas. Parl. Pap.*, 63 (*for* 1899).

————, 1907.—On the country between Back Creek and Lefroy. *Rep. Sec. Min. Tas.*, (*for* 1907), 7.

FIG. 23



LEGEND

QUATERNARY		RECENT ALLUVIUM.	
TERTIARY – QUATERNARY		CLAYS, SANDS, & GRAVELS.	
		GRAVELS, SANDSTONES, & CONGLOMERATES.	
TERTIARY	V	BASALT.	
PERMIAN		BASAL CONGLOMERATE.	
SILURIAN – DEVONIAN		SILTSTONE, & SANDSTONE WITH MINOR SLATE	MATHINNA BEDS
		SLATE & QUARTZITE	
		COARSE SANDSTONE	

PLAN

- GEOLOGICAL BOUNDARY (APPROX.)
- UNCONFORMITY (APPROX.)
- SURFACE LINE OF REEF
- 100' UNDERGROUND LEVEL
- MAIN SHAFT
- MINOR SHAFT
- 85 Nº1. SURFACE BORE HOLE.
- TRACK.
- ROAD.
- CREEK.

SECTION

- LODE WORKED TO MAXIMUM DEPTH ON LINE OF REEF.
- EXTENSION OF UNWORKED LODE TO LOWER LEVELS.
- BORE HOLE SHOWING LODE INTERSECTIONS.

5 cm

DEPARTMENT OF MINES — TASMANIA

DETAIL PLAN AND SECTIONS
LEFROY GOLDFIELD

DATE: SEPT. 1964	FEET SCALE 0 500 1000
GEOLOGIST: D.I. GROVES	SURVEYOR:
DRAUGHTSMAN: P.B. NANKIVELL	MAP SHEET & Nº B'FIELD 30
REVISIONS :-	FILE Nº 2469 – 30

TR9_58_76