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TIN RESOURCES
of
NORTH EASTERN TASMANIA
and
PROPOSED DRILLING PROGRAMME

No.130

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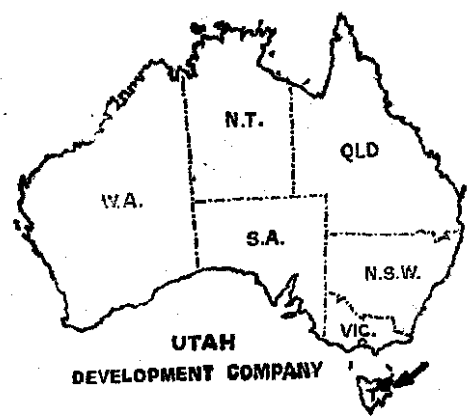

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AMG REFERENCE POINTS ADDED

Winnaleah,
Tasmania.

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SUMMARY AND CONCLUSIONS

A regional study of the Company's 384 square mile Exploration Licence (EL.6/63) covering the North-East Tasmanian Tinfield, has been completed. The primary object of the study has been to gain an overall understanding of the tinfield and the relationship of particular alluvial deposits to the field as a whole. The tin of the field is contained in deposits related to ancestral drainage patterns, and therefore particular attention has been given to geomorphology, vegetation patterns and other surface features which may reflect old drainages.

The basis of the work has been the preparation of a geological map (Plate 2) at the photo scale of approximately 1" to 2000 ft. Other investigations have included the detailed study and comparison of the Tertiary section exposed in old workings throughout the tinfield, and detailed mapping of the best exposed old workings on base maps compiled from enlarged air-photographs (1" to 400 ft.). The basement configuration has been studied in individual pits, from old drilling records and regionally by barometric levelling. Palynological studies to aid stratigraphic correlation are still in progress.

The alluvial tinfield has a recorded production in excess of 41,000 tons metallic tin, and actual production is likely to be higher. The bulk of the tin has been won from deposits of the deep lead type, particularly from the Cascade Lead (Briseis Mine) 20,787 tons, the Wyniford Lead (Pioneer Mine) 9,180 tons, the Endurance Lead (Endurance Mine) 2,630 tons, and the Branxholm Lead (Arba Mine) 2,180 tons. These leads represent basal gravels with heavy mineral concentrate deposited in early Tertiary river channels and subsequently blanketed by valley fills capped by basalt flows of later Tertiary age.

Granitic rocks of Devonian age are the primary source of the tin. The Tertiary deposits fill valleys cut into a bedrock formed of these Devonian granites and the Silurian meta-sediments which they intrude. Fine tin may be shed by all the weathering granite, but the coarse tin which forms the bulk of the rich alluvial deposits is shed from localised patches and pods of fine-grained late-stage acid "tin granite" and associated greisen and aplite veins intruded near the roof of the cupola of the main granite mass. These tin shedding areas are seen today on the Blue Tier, a broad granite high to the south-east of the alluvial field, and on the north side of the Mt. Cameron ridge, an east-west ridge that cuts across the alluvial field. The distribution of the early Tertiary leads suggests that other shedding areas, now completely stripped, existed as the leads were forming.

The Tertiary section has been divided into three units, upper, middle and lower. Tin is concentrated towards the base of the lower unit, but some tin occurs more dispersed in the upper unit. The lower unit occurs only in the deep lead channels and is characterised by a dark grey to brown humic clay or siltstone containing lignitised wood and abundant secondary marcasite.

Selection of areas for testing depends on the prediction of the course of the early Tertiary leads. In the past, a broad reconstruction of early Tertiary drainage has been used and testing has concentrated on an effort to locate a "main lead" at some distance from the known leads. The present study has cast doubt on this broad interpretation, and has emphasised the importance of a period of late Tertiary faulting which disrupted the early Tertiary lead system which now exists only as lead remnants below a late Tertiary cover.

Ten areas have been selected for testing therefore, with priority given to areas closest to known leads where the minimum of extrapolation is necessary in forecasting the position of target leads. A table (Table E) is presented summarising the proposed testing and estimating the size and grade of the targets that could be expected in each Test Area. The majority of areas have been chosen having in mind a low capital operation, using hydraulic mining, that could be brought into production rapidly. Two test areas, the North Mussel Roe (Test Area 5) and the Ringarooma Bay Beaches (Test Area 10), are larger targets and are thought of as possible dredging operations with consequent higher initial capital outlay.

The expected depth of leads in the test areas is also shown in Table E. One mine in production at the moment (the Endurance Mine) is mining to a depth of 110 ft. by hydraulic mining.

Test Area 1 may contain 17 million cu. yds. of material with a possible grade of 0.5 lbs Sn/cu.yd. in two leads, the Arba Lead and a newly recognised lead, the Ruby Flat/Mt. Joseph Lead. Test Area 2 may contain upwards of 5½ million cu. yds. of material with a possible grade of 0.6 lb Sn/cu.yd. in three suspected leads which have been recognised chiefly from mapping old workings. Test Area 3 may contain 5 million cu. yds. of material with a possible grade of 0.4 lbs Sn/cu. yd. in tributary leads of the Scoloch Lead that has already been defined by Government boring. Test Area 4 may contain 25 million cu. yds. of material with a possible grade of 0.4 lbs Sn/cu. yd. in suspected west flowing leads between the Endurance and Pioneer Leads.

It is proposed to test these four test areas with a programme of 12,000 ft. of boring during the summer months. This footage is considered sufficient to bring these four areas to an initial feasibility. If boring at any of these areas shows insufficient tin to justify continuing, it will be possible to move before the total proposed footage at each area has been drilled. A further five areas (Test Areas 5 to 9) are then available as targets. These five target areas are not as well defined as the first four, and generally are situated further from known lead deposits.

A separate 4000 ft. of drilling is proposed to test for heavy mineral deposits rich in cassiterite in the beaches of Ringarooma Bay.

A new development in the field has been the recognition that the lower unit of the Tertiary deep leads is characterised by abundant marcasite, and that marcasite is absent from the other Tertiary units. It is intended to use this concentration of marcasite in the deep lead channels as a target for geophysical exploration by the Induced Potential method. Initially it is proposed to run I.P. traverses at three localities where drill information exists and the marcasite content of the leads is known to be high. If the method appears workable, an I.P. survey will be integrated with the drilling programme to limit the areas of interest by broadly delineating the lead channels.

Evidence from past and present mining operations in the area suggests that the alluvial tin of the leads is concentrated into thin, narrow runs that are very restricted horizontally and vertically, and constitute a very small target for drilling. For example, a seam of pure cassiterite 1/10th inch thick is sufficient to bring ground that is 100 ft. deep to a grade of 0.5 lb SnO_2/cu. yd. A thorough examination is therefore being made of available drill rigs and of possible new techniques, to ensure accurate, fast hole sampling.

PART I.

INTRODUCTION

GENERAL STATEMENT.

During late 1963, Mr. Don King, the Company's Chief Geologist, compiled a comprehensive report (King, 1963) on the tin potential of Tasmania, based on his previous knowledge of tin properties throughout the State and on the results of a field trip made in September and October, 1963. Mr. King described the tin potential of Tasmania as a whole, and was particularly impressed by the possibility of developing alluvial tin deposits in the north-east Tasmanian tinfield; accordingly he recommended that the Company seek an Exploration Licence covering the major part of the tinfield, and in addition, negotiate an option agreement with Mr. Vernon Wood of Pioneer over the latter's Mussel Roe River property.

An Exploration Licence (EL.6/63) covering 300 square miles north and east from an origin at Derby railway station (see Plate 1) was issued to the Company by the Minister for Mines on October 29, 1963, for an initial period of six months. At about the same time, an option agreement was negotiated with Mr. Wood. An assessment of the Mussel Roe River Property, firstly by geological mapping and then by drilling, was run concurrently with the regional investigation of the Exploration Licence area. Initially, priority was given to the drilling of the Mussel Roe River property (Appleby, 1964), but as this work neared completion, progressively more attention was given to the investigation of the Exploration Licence area.

The initial Licence was renewed for a further six months on April 29, 1964. As the regional investigation continued, an advantage in extending the area of the original Exploration Licence to the south along the Ringarooma River (see Plate 1) became apparent. An approach was made to the Director of Mines, and an additional area of 84 square miles was granted and added to the Company's original Licence area in June, 1964.

From mid-January, 1964, two geologists, O.N. Warin and W.R. Appleby, and field assistant J.G. Bartlett, have been permanently stationed in Winnaleah making the field investigations on which this report is based.

In the initial stages the work was supervised by Dr. Howard, Staff Geologist. At the beginning of May, Dr. Howard left the Company to take up another appointment. In the subsequent Company staff re-arrangement, O.N. Warin was appointed Project Geologist in charge of the tin investigations in Tasmania, responsible to Mr. Don King, Chief Geologist.

Mr. Roy Appleby has worked equally with the author throughout this project and has contributed much to every phase of the field work and compilation of data. The work has generally been shared rather than divided, however, and it is impossible to indicate separate areas of responsibility. The author also wishes to acknowledge the assistance and ideas that others have contributed; in particular the help of Mr. Don King. Discussions with Mr. Edmund Gill (National Museum, Melbourne), Dr. Bruno Campana (Conzinc-Rio Tinto), Mr. Maxwell Banks (University of Tasmania) and Mr. John Rattigan (University of New South Wales), each of whom has specialist knowledge or experience have helped greatly in formulating the reconstruction of Tertiary history presented here. The help of the Department of Mines, and particularly that of Mr. Terry Hughes (Chief Geologist) and Mr. Ron Jack, is also gratefully acknowledged.

Initial palynological studies were carried out by Mr. J. Douglas (University of Melbourne) and more comprehensive studies are at present being made by Mr. Wayne Harris (Department of Mines, South Australia).

LOCATION AND ACCESS.

Tasmania is a State of the Commonwealth of Australia comprising one large and several smaller islands situated on the Australian continental shelf to the south of the mainland and separated from it by a 150 mile wide stretch of shallow sea (30-40 fathoms), known as Bass Strait. The island is shield shaped, tapering towards the south, with a maximum length of 180 miles (N-S), a maximum width of 190 miles, and an area of 26,215 square miles; somewhat smaller, that is, than the State of Maine (33,215 square miles). It has a population of 361,000. The capital is Hobart, a city on the south-east coast, with a population of 121,000.

In many respects Tasmania is quite unlike the major part of the Australian mainland. Climatically it lies in a belt of westerly winds and antarctic lows, which bring a weather markedly variable from day to day, from season to season, and from year to year, but generally cooler and wetter than even the most southerly part of the mainland. Physiographically, the island is characterised by rugged relief and swiftly flowing rivers with irregular gradients, unlike the peneplain of the Australian shield. The natural vegetation of heavy temperate rain forest on the highlands, and the man-made pattern of close spaced mixed farming on the lowlands, also have no counterpart on mainland Australia. In addition, its isolation from the mainland and its small size have helped to preserve the State's individual character.

Agriculture, mining, fishing, light manufacturing and food processing are the main occupations in Tasmania. Light industries are generally based on the State's own production of wool, milk and other animal products. From the earliest days of settlement, mining has made an important contribution to the State's wealth. Of recent years the extensive development of hydro-electric power has greatly assisted the mining industry. Now the mining industry consumes between 50 and 60% of the State's hydro-electric power production. In spite of its small size, Tasmania has produced more tin than any other State in the Commonwealth. Its production to 1962 totals 210,000 tons (70% Sn concentrate) compared to the 196,000 tons of its nearest rival (New South Wales).

The north-east Tasmanian tinfield occupies most of the north-east corner of the island. It is reached from the north coast centre of Launceston (58,000) by a sealed highway passing through Scottsdale, Branxholm, Derby, Moorina, and on to St. Helens on the east coast. The chief towns associated with the tinfield in the early days were Branxholm, Derby, Pioneer, Gladstone and the port of Boobyalla (now deserted) at the mouth of the Ringarooma River. Pioneer, roughly the centre of the tinfield, is 71 miles by road from Launceston. A railway runs from Launceston, through Scottsdale, Branxholm, Derby and Winnaleah to terminate at Herrick. The area is reasonably well served internally with graded gravel roads connecting the smaller townships, and with bush tracks elsewhere.

The area depends largely on intensive mixed farming of the basalt soils of the Scottsdale, Ringarooma and Winnaleah areas, but recently attention has shifted to the coastal lowlands where extensive tracts of peaty soils, previously neglected, are now being developed. The other local industries are tin mining and timber cutting and milling.

CLIMATE AND VEGETATION.

The climate in the north-east is the most equable and the least wet of any part of Tasmania. Rainfall records of the Mt. Cameron Water Race Board show an average of about 40 inches annually in the Great Mussel Roe catchment area, with a variation of up to 20 inches on either side of the average. The majority of the rain falls in the winter, particularly in the late winter. The summer temperature would probably average about 65^{o}F; possibly about 50^{o}F in winter, with regular overnight frosts for the deeper parts of the winter and with occasional snow above about 2,000 feet.

The natural vegetation of the higher land of the north-east is a eucalypt forest containing some species which have been exploited for timber (notably Eucalyptus regnanis, E. obliqua and E. gigantea). She-oaks

(Casurina species) and wattles (Acacia species) are conspicuous in places. On the lower slopes and alluviated areas, patches and more extensive flats of acid waterlogged soil support a plant community named after a conspicuous tussocky grass, button grass (Gymnoschoenus sphaerocephalus). These button grass flats are commonly waterlogged for much of the year. Where the ground is wetter still, and the water-table is at or near the surface, reed swamps are common, while along some rivers tree swamps (Paperbarks) occur.

As the button grass flats, reed swamps and tree swamps mark present day and ancestral drainage in part their distribution is indicated on the geological map (Plate 2).

HISTORY OF THE NORTH-EAST TASMANIAN TINFIELD.

By the second half of the nineteenth century the north-eastern part of Tasmania began to be opened up by farmers in search of good arable land. The first land in the Scottsdale area was occupied in 1860, and settlers reached the basalt soils of the Ringarooma valley shortly afterwards.

Tin ore was reputedly found by prospectors before 1870 but not developed. The first applications for licences to search for tin east of Scottsdale were made in 1872. In the same year Benjamin Brooks discovered tin ore near Mt. Maurice (South of Ringarooma), but failed to get capital to develop it. Early in 1874, a well-known prospector, C.R. Bell (after whom the west coast Renison Bell mine is named), found alluvial tin in the Boobyalla River near Little Mt. Horror; he and others formed the Boobyalla Tin Mining Company and took out 8 eighty acre leases. The Company apparently failed very shortly afterwards after forwarding only $4\frac{1}{2}$ cwt. of ore to Launceston, but Bell, late in 1874, made further discoveries of alluvial tin in the upper Cascade River area and at Thomas Plains (now Weldborough). Prospectors were apparently very active and it appears that between 1874 and 1876 all the major discoveries (except the Pioneer and Arba leads*) were made.

Discoveries were commonly made in shallow ground or where present day streams unearthed tin-bearing Tertiary alluvials. These first shallow finds were made in the headwaters and followed down to the deeper ground of the true lead. Working this deeper ground was generally too big an undertaking for the individuals and small syndicates who had successfully mined the shallower ground, and companies were floated to raise the necessary

*Lead: An ancient river valley, now largely filled with fluviatile sediments, towards the base of which concentrations of heavy minerals occur.

capital to equip and work larger mines. Thus in the southern part of the field in 1883, the Arba Tin Mining Company was formed to work the deeper ground of the Branxholm Lead; in 1885 the Briseis Tin Mining Company began work on the Cascade Lead and, also in 1888, the Ringarooma Valley Tin Mining Company began mining the Valley Lead. To the north-east the Weld Lead (Echo Mine) was discovered on the north-west side of the Ringarooma in 1901 after shallow ground had been worked in its headwaters on the south-east side of the river. Further north still only two major deep leads have been worked, the Wyniford (Pioneer Mine) where the deeper ground was mined from 1900 onwards, and the Endurance Lead. Though probably first exposed in the early 1900's, the Endurance does not seem to have been worked until 1945 when the Clifton Creek workings were followed down into the lead. Many finds were made in the late 19th century to the east and north of Mt. Cameron in the Gladstone area, but no single easily-followed lead, comparable with the Cascade or Wyniford Leads for example, was located and workings tended to be small, scattered and operated by individuals and small syndicates.

From as early as 1884, the Government was interested in the problem of getting an adequate all year round water supply to service mines throughout the area, particularly those in the Gladstone area. Schemes were considered using the water of the Ringarooma, the Boobyalla and the Mussel Roe Rivers. Meanwhile the Mt. Cameron Hydraulic Tin Mining Company Ltd. had begun making a race from the Mussel Roe to their leases at Gladstone. Their capital ran out before they had completed the race, and they offered to sell the half completed race to the Government. The purchase was authorised and the race completed in 1887. The new race serviced ground from the headwaters of the Mussel Roe through Edina, Garfield, etc. to Lochaber, Scotia, and on to the Aberfoyle mine.

By 1921 local miners were claiming that ground on the race from Edina through to Lochaber was largely worked out, and were asking for the installation of a "west branch" to cross the Ringarooma and to service the mines on the northern slope of Mt. Cameron. This was done, and by 1929 this west branch had been extended as far as the Native Lass dam on the north side of Mt. Cameron. Initially the water from the original race (the "East Branch") was diverted completely into the new west branch, but later the discontinued supply was restored and both branches supplied water. For some time now the west branch has been abandoned, but the east branch still supplies operating mines such as Wood's Mussel Roe and Lawry's Star Hill workings (Plate 2). The construction and maintenance of the race has played an important part in making possible the working of most of the properties in the Gladstone area. Users of the race may elect to either pay for water by a royalty on the amount of tin ore won, or by the volume of water used (measured in sluice heads).

Other Government assistance has been given to the tin mining industry in the area by the work of Government geologists, by boring campaigns, and latterly by geophysical surveys undertaken by the Bureau of Mineral Resources at the request of the State Government.

Exploration work within the tinfield has also been carried out by companies already mining in the area; e.g., Briseis Tin Mining Company, Endurance Tin Mining Company, and Storey's Creek Tin Mining Company, by individual prospectors and by tin mining companies from elsewhere; e.g., Austral-Malaya Tin Dredging Company, Malayan Tin, etc. During 1957 and 1958, Rio Tinto Australian Exploration Pty. Ltd. held a large area under an Exploration Licence. Their investigations included geological mapping, examination of old workings, an aeromagnetic survey, and a very limited drilling programme.

The largest single producer of the district has been the Briseis Mine on the Cascade Lead, with a recorded production of 20,787 tons* of metallic tin. Next has been the Pioneer Mine (Wyniford Lead) with a total production of 9,180 tons tin, then the Endurance (2,630 tons tin), the Arba (2,180 tons tin) and the Dorset Dredge (1,691 tons tin). Production figures have been kept by the Tasmanian Department of Mines from 1873, but those for the early years are generally accepted as not complete. It is therefore difficult to assess the relative importance of some properties. A number of properties for which records are incomplete are believed to have produced between 500 and 1,000 tons of tin, and should therefore rank just below the five major producers. These include the Valley Mine (Valley Lead), the Echo (Weld Lead), Garibaldi (Wyniford Lead), and the Scotia.

Broadly, the history of the field is that all the major finds and a great deal of production from medium sized properties were achieved during the period 1870 to 1900; then follows a period of consolidation when many medium sized properties were exhausted and companies were formed to mine the deeper ground of the recognised leads. During the next stage (say 1910 to 1930), production from the southern leads, the Branxholm, the Valley, the Cascade and the Weld, was more important than any to the north. As the southern mines worked down into greatly increasing overburden, and particularly basaltic overburden, the Endurance workings, the Pioneer workings and the Dorset Flats which are beyond the area of basalt cover came into greater prominence because of the easier overburden situation.

Only four moderately large operations are still in production in the field: Endurance, Dorset Dredge, Wood's Mussel Roe Property and the Star Hill Syndicate (Lawry's).

* All tonnage figures throughout this report are long tons (2,240 lbs).

Mining and treatment methods have varied little from before the turn of the century. The majority of the mining has been by hydraulic sluicing. In the 1900's, however, a number of groups built dredges, but most had a very short life. The records are not very clear; it is difficult even to be sure how many dredges were built or where they were sited, but it seems their failure was generally due to lack of any preliminary drilling assessment of the property, possibly due to the assumption that any river flat would contain tin distributed through the section as is common in Malaya. One bucket dredge, the Dorset dredge, has successfully dredged the Dorset Flats (South Mt. Cameron), the Endurance Flats to the immediate north, and has recently been moved to a new site closer to the mouth of the Ringarooma River near the old Aberfoyle mine workings.

All mining, apart from this, has been by hydraulic sluicing. Water is derived either from the Government water race or from private dams. Nozzle pressure for the monitors is boosted by diesel or electric pumps. If the floor of the deposit is above the local river level, the sluiced material drains directly into a long trench dug into bedrock (ground sluicing); if the floor is below local river level, the material drains first into a sump from which it is elevated, by diesel or electric gravel pumps or by vacuum water lifts, to high-level sluice boxes. In the early days steam power was widely used for pumps. Electricity was often locally generated, but is now supplied by the State's Hydro-Electricity Commission.

A cycle of operations is established; a prolonged period of sluicing is followed by a clean-up of the sluice box. The clean-up may take a few days or a week; the period between clean-ups may be anything from a month to six months. Some operators check ground by panning at the face: none seem to check on recovery by panning tailings. The clean-up of concentrate from the sluice boxes is carried out with water pressure jigs (Willoughby box). Where the concentrate contains much ilmenite (e.g. Wood's Mussel Roe mine) a good deal of cassiterite appears to be lost with the rejected ilmenite of the lighter fraction from the Willoughby box.

Overburden removal is generally effected by sluicing. In the larger operations provision is made for overburden to be diverted to one side of the sluice box, but in smaller operations all material sluiced passes across the sluice box. Puggy clays, which occur to varying degrees in most mines, are difficult to sluice, tending to ball up and to carry off fine tin by adhesion as they roll along the sluice box. A bulldozer is used successfully for overburden removal by one currently operating two-man syndicate.

In the early days, some ground is said to have been rich enough to allow trucking, by horse-drawn drays, from a face to a sluice box some distance away. Within workings, ground was also on occasion trucked in wheelbarrows from a face to the sluice box. One man who presently holds a small parcel of ground is hoping to use a truck and loader to work shallow ground that has no nearby water.

GEOLOGY

TYPE OF WORK UNDERTAKEN.

The primary objective of the survey has been to obtain an integrated picture of the tinfield as a whole and the relation of individual alluvial deposits to the field as a whole, rather than to examine the potential of individual properties independently. Particular attention was paid to geomorphology, to patterns of vegetation, and to other surface features which might reflect ancestral drainages.

Accordingly, the basis of all the work has been the preparation of the geological map which forms Plate 2. Air photos, flown from 1949 to 1952 by the R.A.A.F. (12,000 feet, approximate scale 1 : 23,760) were available. Unfortunately, as this area has not yet been included in the Lands Department series of detailed topographic maps, no slotted template assemblies of the air photographs are available. The Company therefore prepared a base from radial line plots of the photo runs at photo scale, and this base was utilised throughout the mapping. When this mapping was well advanced, the whole area was reflown by the Lands Department (12,500 feet, scale approximately $\frac{1}{2}$ mile to 1 inch); these new photos were used to give details of workings since 1952 in the area of EL.6/63, and were also used to compile a base map for the southern extension to EL.6/63.

Both ground traversing and air-photo interpretation were used in compiling the geological map.

Other investigations made include the detailed study and comparison of the Tertiary section exposed in old workings throughout the area and the detailed mapping of selected old workings on base maps compiled from enlarged air-photographs. Coupled with these studies, aneroid barometers were used to obtain the basement configuration in individual pits and in an attempt to get relative basement elevations over longer distances. It was found that Tasmanian weather conditions would not allow the use of aneroid barometers over long distances without very considerable loss of accuracy. The weather is determined to a very large extent by small rapidly-moving lows, so that the base instrument and the travelling instrument must be within at least two or three miles of each other. The basement configuration was also studied from old drilling records.

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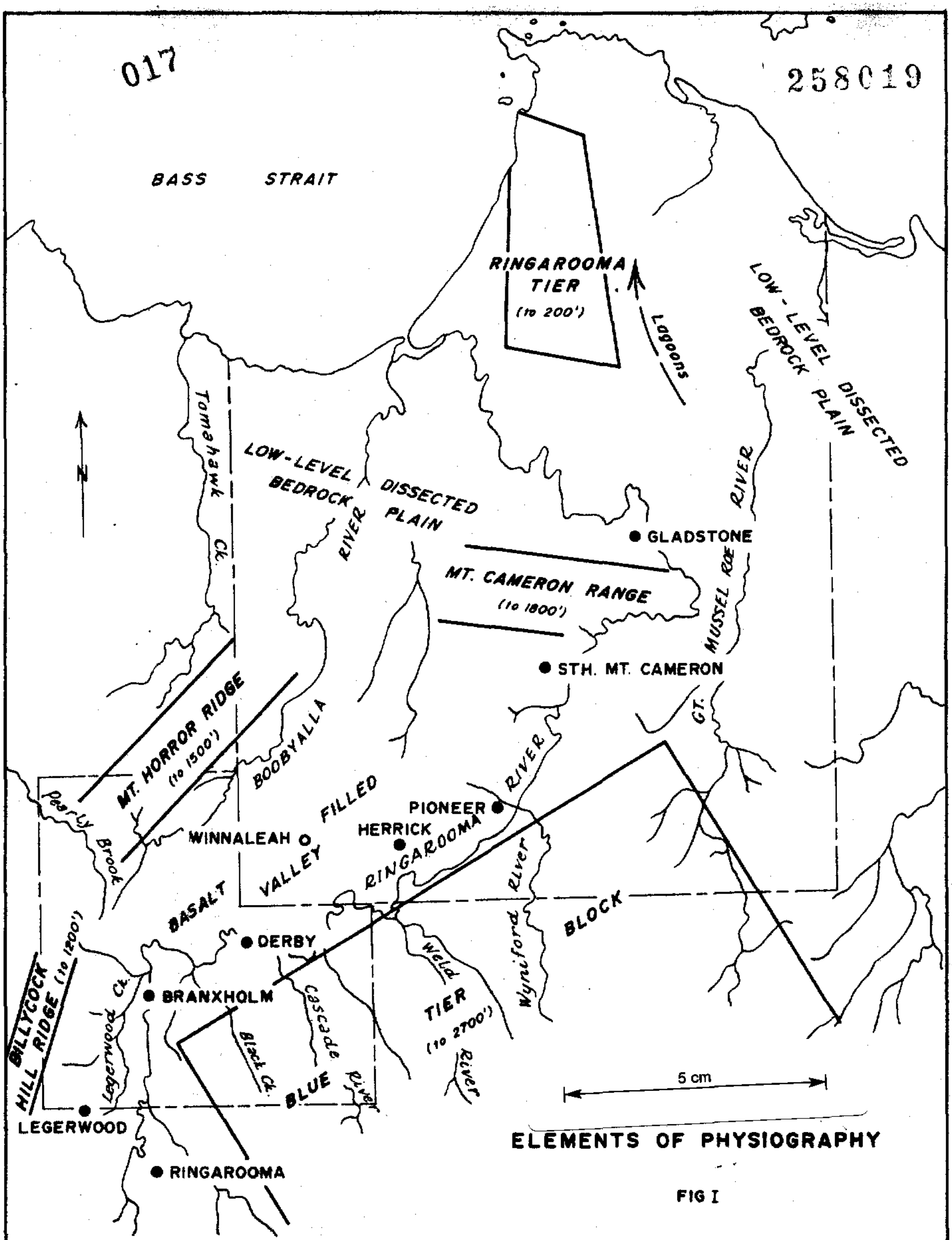

ELEMENTS OF PHYSIOGRAPHY

FIG I

Scale : 1 inch = 4 miles

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It was originally hoped to have a contoured topographic map of the whole area prepared from the latest air-photos, but this was found impossible in the time available without prohibitive cost. Rough form-line maps of selected areas have been made using available survey data and air-photos, and these have been used in the drawing of physiographic diagrams included in this report.

PHYSIOGRAPHY.

The main elements of the physiography are shown in Fig. I. The dominant feature is the massive, even topped Blue Tier, a complex block uplift composed mainly of granite, which fills the south-east corner of the area. The Ringarooma River flows north-east along the north side of the Tier, collecting a series of sub-parallel, north-west flowing tributaries from it. The Ringarooma River continues north-east to the south-east of the Mt. Cameron ridge, but swings sharply north-west around the east end of the range and discharges into the sea at Ringarooma Bay. Mt. Cameron is an east trending ridge of granite which has been deeply dissected by streams controlled by faults cutting transversely across the range. The west boundary of the area is formed by two ridges, the Billycock Hill ridge and the Mt. Horror ridge, trending north and north-north-east, respectively.

The valley between Mt. Horror and the Blue Tier is filled by Tertiary sediments and basalt, forming a flat floor some 900 ft. above sea level. The present Ringarooma River is deeply incised (200 ft.) into this flat floor close up against the edge of the Blue Tier block.

To the north, Cape Portland is the northern extension of a low dolerite-covered "tier" known as the Ringarooma Tier.

The river profiles are generally youthful but complex, and each of the major rivers has at least one tract, not near its mouth, where it follows a meandering mature course across river flats (e.g., the Dorset Flats on the Ringarooma and the Northern Swamp on the Mussel Roe). Of the three major rivers, the Boobyalla, the Ringarooma and the Mussel Roe, only the Ringarooma has any semblance of a true flood plain, and that only small (Foster's Marsh). In their lower reaches the Boobyalla and the Mussel Roe both traverse low-level dissected bedrock plains. In these areas and generally throughout their courses all the major and minor streams are very rigidly held in the planes of faults and joints (see Section on Tectonics).

SUMMARY OF STRATIGRAPHY - N.E. TASMANIA TINFIELD

Age	Lithologies	Related Surface Features
CAINOZOIC		
Recent	Alluvium, beach sand, etc.	Button grass flats, swamps, etc.
Quaternary	Wind blown sand.	Sand dunes, lunettes, swamps.
Tertiary	Fluviatile gravel, sand, silt and clay. Basalt.	Sandy rises, button grass flats. Farmed land on basalt.
BASEMENT		
Jurassic	Dolerite.	Flat topped rocky hills.
Permian	Shales, siltstone (fossiliferous).	Low hills.
Devonian	Granite.	Dissected country with angular drainage pattern.
Silurian	Meta-sediment, shale, quartzite.	Rocky ridges or shallow clayey soils.

TABLE A.
Follows Page 12

STRATIGRAPHY.

For the purpose of this study, the exposed rocks of the mapped area are best thought of in a two-fold division; (1) a basement of pre-Cainozoic rocks, and (2) the Cainozoic fluviatile sequence. The basement rocks are meta-sediments of Silurian Age (Mathinna Beds) intruded by Devonian granitic rocks, overlain by a sequence of fossiliferous marine Permian rocks intruded by dolerite sills of Jurassic age. The Cainozoic rocks are fluviatile sequence deposited in valleys cut into the basement and are overlain in places by thin basalt flows.

The stratigraphy is summarised in Table A.

The oldest rocks exposed in the area are metamorphosed lutites and arenites believed to be of Silurian age (Spry and Banks, 1962), to which the name Mathinna Beds has been given pending their fuller description and stratigraphic definition. These rocks occur widely throughout north-east Tasmania; they are generally quite strongly folded, dips from 75° to near vertical being common. In this area their general strike is north-north-west. Good exposures are rare, the rocks generally being covered by a very shallow clayey soil, but artificial exposures in road cuts and on the floor of old workings suggest a constant strike and generally uniform monotonous lithologies.

Where Mathinna Beds have been exposed in workings by removal of the overlying Tertiary fluviatile sequence, they are always deeply weathered; the original bedding planes, etc., are preserved intact but the lutites have rotted chemically to a soft, light-coloured pasty kaolinitic material. The quartzose rocks typically form a friable very fine-grained aggregate of sugary quartz from which a characteristic very fine-grained sand of the Tertiary sequence is derived. The exact nature of the original fine-grained quartz rock has not been determined, but appears to owe its sugary texture to metamorphism. In the few natural exposures that occur, both the lutites and the arenites are commonly hardened and silicified, and have been termed slate and quartzite. It seems unlikely that their silicification is anything more than a superficial weathering effect; it may in fact date from the late Tertiary and be related to the formation of siliceous cemented horizons within the Tertiary sequence.

Generally in this area the Mathinna Beds are not far removed, either vertically or horizontally, from the intruding Devonian granite rocks, and most commonly they show innumerable short north-east trending quartz veins. In other places, particularly where the contact with the granite rocks is exposed, other veinings from the granite are seen entering the meta-sediments (see below).

Devonian.

Granitic rocks of Devonian age intrude the Mathinna Beds and crop out widely in the area. The most abundant rock is a coarse-grained grey granodiorite or adamellite composed essentially of quartz, oligoclase, orthoclase and biotite, with or without hornblende. The feldspars commonly are strongly porphyritic and enclose mica flakes. The main mass is intruded by a more acid late stage "tin granite"; a coarse uniform grained biotite, muscovite, granite, commonly greisenised. Reid and Henderson (1928) describe a very complex sequence of intrusions in the Blue Tier.

Some fine-grained cassiterite probably occurs dispersed through the main granite mass, but the great bulk of the cassiterite is localised in the late stage intrusions of "tin granite" and in greisen veins and aplite veins associated with them. A relationship that is probably typical is well illustrated at the old Mt. Paris mine, where a muscovite granite roofed by Mathinna Beds is cut by a series of north-west trending tin-bearing greisen veins which can be seen also cutting the Mathinna Beds. The old workings exploited eluvial material on the surface of the granite; the lower part of the greisen veins, intersected in drills, are not sufficiently mineralised to be payable.

Permian.

Permian siltstone, probably dipping regionally to the north below the Jurassic dolerite forming the Ringarooma Tier, crops out in an east-west ridge along the north side of the Great Northern Plain. It is possible that coarse cobble rubble to the south of this ridge is the residual of weathering out of a Permian basal conglomerate. Mt. Littlechild, on the top of the Blue Tier near Lottah, is a granite rise capped by a basal conglomerate and a feldspathic sandstone of Permian age. Most authors believe that this is a residual of a once much more extensive sheet of Permian sediments, and that the even surface to which the interfluves of the dissected Blue Tier now rise records the pre-Permian peneplain.

The fall of this pre-Permian peneplain from 2,700 ft. on the top of the Blue Tier to close to sea level at the Great Northern Plain, is discussed further under "Tectonics".

Jurassic.

During the Middle Jurassic period large-scale intrusion of dolerite sills and ring dykes took place throughout Tasmania. The dolerite formed a nearly continuous body through the relatively flat lying Permian and Triassic sediments over most of the island. In the north-east a sill intruding the Permian succession occurs almost to sea level (The Ringarooma Tier); elsewhere throughout the area dykes occur, particularly in the headwaters of the Mussel Roe River.

Tasmanian dolerites have been extensively studied and are said to belong to the tholeiitic quartz dolerite association, and to be similar to the Karroo dolerites of South Africa, and to show some of the same differentiation features.

Weathering dolerite is thought to be the most likely source of abundant ilmenite which accompanies the cassiterite in some of the Tertiary deposits

Tertiary.

The Tertiary rocks consist of as much as 300 ft. of generally unconsolidated sand, gravel and clay, covered in places by up to 200 ft. of basalt. The Tertiary sediments and basalt occur filling depressions in the bedrock surface, and therefore vary a great deal in thickness from place to place. They are complexly interfingered and individual members are not continuous over long distances.

The Tertiary sediments are not generally exposed in any natural exposures; the unconsolidated sediments weather rapidly to give alternating sandy rises and broad alluviated button grass flats. In some places where gravel beds are weathering, the sandy rises are littered with pebbles. In other places, the Tertiary sediments have been cemented with iron or silica and cemented rocks are exposed at the surface. The ferruginous rock generally forms a rubble of one foot diameter, angular, somewhat friable aggregates at the surface; the siliceous rocks form large smooth-surfaced blocks, very hard and known locally as "clinker".

In the field, and in air photographs, the major areas of Tertiary sediments can be distinguished from granite because of the distinctive alternation of sandy rises and button grass flats. However, weathering granite produces a medium-coarse quartz sand which is indistinguishable from the sand which weathers out of the Tertiary deposits. In general, in the regional mapping the attempt has been made to limit the area shown as "Tertiary" in Plate 2. Thus some parts of the area shown as Devonian granite in fact contain pockets of granite sand and may even contain areas of Tertiary sediments.

GENERALISED SECTION: TERTIARY SEQUENCE
N.E. TASMANIAN TINFIELD

TABLE B.
Follows Page 15.

UNIT	LITHOLOGY		AGE	THICKNESSES (feet)(approx.) Briseis Mine (Nye, 1925)	Endurance	Lawry's	Lochaber
Basalt	Dense, fine-grained olivine-basalt.		Pliocene	190	-	-	-
Upper Unit	Interbedded drift, fine sand, clay and wash. "Birdseye" wash typical; scour and fill structures commonly ferruginously stained, underlying surface (top of middle or lower unit) commonly ferruginously stained and guttered. Wash with tin at base, and in wash bands throughout sequence.	Re-worked material deposited following late-Tertiary uplift.	Pliocene)	225		15-25	15-20
Middle Unit	Predominantly either drift (derived from weathering granite) or fine sand (derived from weathering siliceous meta-sediments) but containing scattered horizons of clay and wash. Tin (traces) scattered through unit.	Main valley fill as rivers matured.	Miocene)			0-25	0-25
Lower Unit	Generally capped by heavy brown clay with fragments of lignitised wood; humic, lignitic and marcasitic. Underlain by drift with bottom boulder, cobble or pebble wash. Wash with high tin at base.	Wash and heavy minerals remain from valley cutting stage - clays represent ponding of creeks by depression of land surface.	Eocene/ Oligocene	85		0-?25	0-?25
Basement	Devonian granite or siliceous meta-sediments.						

Though natural exposures are lacking, the Tertiary sequence can be seen quite well exposed in old workings throughout the area, and its depth and lithology are known elsewhere from drilling. The most complete exposure was probably that at the Briseis mine (described by Nye, 1925), but this is now partly covered with water and partly slumped, and therefore not available A deep section (without basalt) is exposed in the present Endurance workings. Deeper pits not worked are generally water filled (e.g. Pioneer, Echo workings); the threefold division of the Tertiary that is presented here has mostly been worked out in exposures in the numerous pits in the Edina-Lawry's-Elizabeth area, and in the Lochaber-Scotia area.

The generalised Tertiary sequence is shown in Table B. The sediments have been divided into lower, middle and upper units. Any part of the section may be missing; for example, in Lawry's central workings, the upper unit rests directly on bedrock, while at other localities the lower unit only is preserved, the upper two units having been stripped. In general the upper unit is geographically the most extensive, and the middle and lower units are progressively less so, the lower unit being probably only of very limited extent. The lower unit, in fact, is restricted to the true "deep leads" only.

The lower unit consists generally of a basal wash with heavy minerals, including cassiterite, some overlying drift, and a well marked upper member of brown to grey humic clay with lignite. The lower unit is particularly characterised by the presence of this humic clay with lignite, and by the presence of secondary disseminated and nodular marcasite throughout the unit. The lignitic beds are apparently coeval with the lignites throughout South Australia (Moorlands, Inkerman) and Victoria (e.g., Yallourn and Bacchus Marsh). The basal wash may be of boulder size, granite boulders at Briseis, Endurance and Wood's Flat for example, or of cobbles or pebbles. Where the main area of shed is granite, the wash tends to be a quartz pebble wash with occasional granite boulders. Generally, granite appears to have rotted chemically too rapidly to form boulders. In the Scotia-Lochaber workings, where the main area of shed was Mathinna Beds, the basal wash is of large sub-angular opaque quartz boulders, derived from quartz veins intruding the Mathinna. The Edina and Purdue workings are characterised by a wash of even sized cobbles of Mathinna slate with a matrix of interstitial drift material. On balance of evidence, this wash is placed in the lower unit.

In the thicker washes, the high tin values extend from the bedrock through most of the wash. At Briseis, for example, the high tin values extend through the lowest 50 ft. of the section. However, the cassiterite is apparently very erratically dispersed through the wash, the great majority of the tin being in what local miners term "runs" and "pools" of almost pure heavy mineral concentrates. This type of occurrence is described for the Briseis mine in early reports (Harcourt-Smith, 1899), is apparent from UDC's drilling of Wood's Flat (Appleby, 1964), and is reported by miners in all the operating mines. It is an important factor which should be considered in assessing drilling results. (See later section "Distribution of Tin").

The middle unit is characterised by drift, when the area of shed is granite, or very fine sand, where the area of shed is Mathinna meta-sediments. The material is commonly cross bedded, but bedding generally is rather indistinct

"Drift" is the local name for a sub-angular to sub-rounded clean quartz sand of coarse, medium or fine grain size. The sand grains are of black glassy quartz, derived from granite. Small lenses of quartz pebble gravel and of clay occur throughout the drift. Generally it is unconsolidated, but may be siliceously cemented to form the "clinker" of the Edina area.

Where the shedding area has been meta-sediments, the place of drift in the sequence is generally taken by a very fine grained white sand. The individual grains of the sand are finer than the finest grain size seen in the drift, and are an opaque white rather than the glassy black of the drift grains. Pebble horizons occur in the fine sand and are generally of sub-angular opaque white quartz evidently derived from quartz veins in the Mathinna Beds. In the past the very fine grained sand has generally been referred to as a "sea sand" or "beach sand", or locally as "marine bottom", and has been used as evidence of a marine origin for much of the Tertiary sequence. Our work has shown that the fine sand is derived directly from very fine grained siliceous meta-sediments in the Mathinna Beds, and that the lithology implies a very special provenance rather than a particular depositional environment. This conclusion is confirmed by the larger pebbles in this fine sand, which are all of opaque white quartz (Mathinna derived), rather than black glassy quartz from granite. In some localities, for example, Lawry's and Vulcan, interbedded drift and fine sand occur; evidently indicating a provenance containing both granite and meta-sediments.

The upper unit of the Tertiary sequence is believed to have been formed chiefly from material stripped after late Tertiary faulting had uplifted sections of the old lead system. Lithologically it consists of lenticular interbeds of wash, drift and clay. The wash is characteristically the well rounded, well sorted pebble wash termed locally "birdseye" wash. Drift generally makes up less of the section than it does of the middle unit. In places the upper unit is iron stained and it commonly rests on a strongly ferruginously stained surface. Close to the present land surface, the unit shows humic and iron stainings, and slight siliceous cementation from ground water movements.

Quaternary.

Superficial deposits of wind blown sand in the form of seif dunes now fixed by vegetation cover much of the northern part of the mapped area. The dunes are elongated east-south-east. Associated with them are "lunettes" along the east side of broad oval depressions now occupied by reed swamps. Similar depressions and lunettes have been described from South Australia, and are thought to be deflation hollows and ridges formed during the latest "warm" of the Pleistocene glacial epoch. The whole of the superficial sand sheet is here regarded as a Pleistocene feature, and the drainage indicated by the deflation hollows (Rushy Lagoon, etc.) is regarded as a Pleistocene drainage. This drainage was evidently modified by movements of parts of the sand sheet from west to east across it so that at the north end diversions of the drainage to the east round the end of dunes are apparent. (Plate 3c). The sand of the dunes is very fine and even grained; in one place a road cut shows that some ferruginous cementation of the core of a dune has occurred.

To the west of the Pleistocene dunes along the shores of Ringarooma Bay are shorter present-day dunes, again elongated east-south-east, formed of sand blown back from the present beach. These dunes are presently mobile and where one has been removed an interesting form of calcareous cementation that follows old shrub roots is seen.

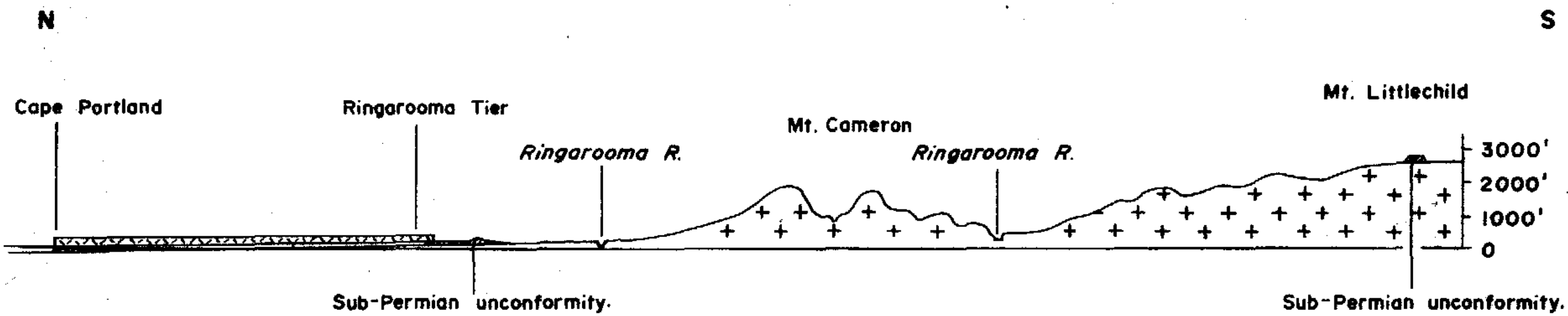
Other features of late Pleistocene or Recent age are low, continuous lines of beach cobbles thought to be the remains of ancestral storm beaches behind the present beach at the south end of Ringarooma Bay.

TECTONIC HISTORY

Pre-Cainozoic.

Dominating the whole of Tasmanian geology and geomorphology is the Pre-Permian surface. The pre-Permian rocks had a complex history of faulting, folding and intrusion which need not be detailed here, but were peneplained before marine and fluvio-glacial deposition began in the Permian. The Permian and younger rocks have been domed, broadly warped and intensely block-faulted, but their sub-horizontal attitude has normally been retained, and in most places distinguishes them clearly from the strongly folded rocks below the unconformity.

In N.E. Tasmania the pre-Permian rocks are the folded and meta-morphosed Mathinna Beds (Silurian) which are intruded by granite rocks of Devonian age The fold axes of the Mathinna Beds seem generally to trend NNW; dips of 75^{o} to vertical are common. The granite rocks, according to Carey (1953),



LEGEND

Dolerite

Granite

Permian

5 cm

DIAGRAMMATIC SECTION — CAPE PORTLAND-BLUE TIER

FIG II

Horizontal scale: 1 inch = 4 miles

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occupy the axial parts of a series of north trending anticlinoria - notably here the Scottsdale Anticlinorium and the Ringarooma Anticlinorium. If this is so, the axial trends would correspond to the trends of the Tasman Geosyncline Zone of the Victorian mainland (see Tectonic Map of Australia). Carey's interpretation has, however, been questioned by later workers (Rattigan, pers. comm.).

The pre-Permian unconformity surface is exposed at Mt. Littlechild (near Lottah) on the top of the Blue Tier at about 2,700 ft. above sea level, and should be present at about 70 ft. above sea level below the Permian rocks which crop out on the Great Northern Plain (see Sketch Section, Fig. II). Permian rocks are also exposed at a number of places on the top of the Blue Tier. The general summit and interfluve level of Blue Tier (about 2,700 ft.) which gives the Tier its flat-topped appearance when seen from a distance, possibly marks the unconformity surface.

Permian glacial and marine sediments, several thousand feet thick in some parts of Tasmania, were deposited above the unconformity. A thinner sequence of lacustrine and fluviatile Triassic sediments conformably overlie the Permian succession.

In Jurassic times, the whole of the area that is now Tasmania was subjected to tension which allowed, during a single short episode, several thousand cubic miles of dolerite magma to well up through the basement to the horizontal Permian and Triassic sediments. The dolerite spread out laterally, lifting or floating its roof of barely consolidated sediments (Spry and Banks, 1962, p.337). Generally the dolerite sills formed only just above the unconformity, but probably the ultimate control in their choice of a horizon at which to spread laterally was a function of their injection pressure and the weight of the superincumbent load; in other words, sills were formed where the weight of the superincumbent load was low enough to allow the dolerite magma to spread sideways between two beds of the succession.

The dolerite injection was evidently accompanied by faulting, but according to Spry (1962, p.337) "because of the difficulty in distinguishing between Jurassic and later structures, it is not yet possible to recognise a Jurassic tectonic pattern".

Once solidified, the dolerite sills formed a layer comparatively resistant to erosion which has had a marked effect on Tasmanian geomorphology.

Throughout the upper Mesozoic, the Tasmania land mass was evidently a shedding area and much of the cover of Triassic and Permian sediments and of the Jurassic dolerite sills was eroded and the surface peneplained. In places this erosion may have exhumed the old pre-Permian surface, in other places it may have produced a peneplain on the top of the dolerite by stripping of Triassic and Permian unconsolidated sediments. This period of Tasmanian history is poorly recorded - there are no rocks remaining that may have been deposited at that time; there are no major igneous intrusions of that date, nor is there a clear record of tectonism or of the initial or final land-form of the period.

Cainozoic.

The Cainozoic was an era of block faulting and epeirogenic movements throughout Eastern Australia. Recently Gill (1964 and pers. comm.) has established by a detailed study of fossil soil horizons dated by palynology, a pattern of Cainozoic tectonism and climate throughout Eastern Australia. Much of Gill's field evidence has been collected in Victoria, but sufficient has been done in New South Wales and in Tasmania to suggest that his broad conclusions are applicable in these States also.

Gill (1964) states: "In E. Australia, tectonic movements continued through the Cainozoic Era, but there were two maxima associated with the extrusion of the Older Basalts and the Newer Basalts respectively (Gill and Sharp, 1957). The span of time during which the second period of movements took place was called by Andrews (1910) the Kosciusko Epoch. The effects of these movements are widely recognised throughout E. Australia. A similar term is needed for the earlier series of movements; it is proposed that this time interval be called the Bass Strait Epoch because Bass Strait was formed (shown by marine encroachments) at that time." (Gill, 1964, p.347).

Gill has dated these two peaks of tectonic activity as Eocene/Oligocene (Bass Strait Epoch) and Pliocene/Pleistocene (Kosciusko Epoch), but emphasises that he considers tectonic activity to have been continuous throughout the Cainozoic. The present day seismic activity of the Kosciusko region and of Tasmania represents a waning of the tectonism.

Tasmanian authors have generally proposed a single episode of tectonic disruption in the early Tertiary from which the present land forms developed (e.g., Carey, 1947). The last few years have, however, brought forward evidence of later Tertiary faulting; for example, Solomon (in Banks and Spry, 1962, p.339) presents evidence of substantial fault displacements that can be clearly established as post-Pliocene, and also discusses the evidence of present day earthquakes and of recently displaced drainage. Others (Campana, pers.comm.) recognise that the Tasmanian land forms we see today are clearly youthful and could not have been preserved through the 70 million years since the early Tertiary.

In N.E. Tasmania, the question of the age of faulting is of major importance in relation to the distribution of early Tertiary placer tin deposits.

In the early Tertiary, in an epoch of tectonic activity (the Bass Strait Epoch) culminating in the Eocene-Oligocene, the late Mesozoic-earliest Tertiary peneplain was block faulted into horst and graben structures. The predominant elongation of these horsts and grabens throughout Tasmania is north-west and north. The faults which bound uplifted or down thrown blocks are generally complex - individual faults being difficult to trace over any distance, and each uplift being multiple. Carey (1947) describes this faulting in the Launceston area as "...most complex. Each uplift was the summation of a bundle of parallel faults, rather than a single fracture."

In the area mapped in the study, this complexity is confirmed. Faults in the basement rocks are followed by drainage and can be very easily distinguished on air photographs. Unfortunately there is generally no means, on the air photographs or on the ground, of measuring displacement along them or distinguishing faults from joints. Where the exposure is best, the drainage more deeply incised, e.g. on Mt. Cameron and on the north-western slopes of Blue Tier, these lineaments can be traced for the greatest distances.

The fractures that have been mapped are close to the main compass directions; predominantly north and north-west, but also north-east and east, and a direction to the west of north-west. They are shown on Plate 3e In broad areas of exposed basement rocks, fractures with a particular direction may predominate - as for example in the headwaters of the Mussel Roe River where north-east trending fractures are the rule.

The only plane of reference in the bedrock formations of the area is the sub-Permian unconformity. This surface is near sea level below the Ringarooma Tier, and at 2,700 ft. or so on the top of the Blue Tier block. There is no assurance that part of this differential movement is not pre-Tertiary, and part of it was probably late-Tertiary (Kosciuscan). However, the movement on each occasion was probably in the same sense controlled by the subsidence of Bass Strait.

Some distinction between early and late Tertiary block uplifts may be possible on the basis of the presence or absence, within the confines of the block, of early Tertiary sediments. The early Tertiary leads of the Southern Ringarooma area, the Branxholm Lead, the Valley Lead and the Cascade Lead, "back up" into the Blue Tier mass; clearly any late Tertiary movement must have affected them as a whole rather than singly. Likewise the

Clifton Creek Lead, which runs off Mt. Cameron into the Endurance Lead, suggests that an initial uplift of Mt. Cameron must have taken place before the leads formed during the early Tertiary.

Thus during the early Tertiary movements the Blue Tier block and the Mt. Cameron block were evidently uplifted while the Ringarooma Tier was relatively depressed. The essential elongation of the Blue Tier block is north-easterly. The faults forming its north-west edge were probably well beyond the present north-west margin of the block as erosion through the Tertiary must have cut back the initial fault scarps. The original scarp was probably close to the present south-east edge of the Mt. Horror ridge, and the uplift which raised the Mt. Horror ridge (in the late-Tertiary) may well have used the same north-easterly line of weakness.

During the Bass Strait Epoch, the early Tertiary drainage pattern developed, finally consolidating itself as the fault movements subsided. The early Tertiary lead system is known only in part: Plate 3a shows those parts of the system that have so far been unearthed. The north-west trending leads coming off the Blue Tier block may have joined into a river system flowing off to the "Bass Strait Sea" well to the north of the present shoreline.

Among the effects of the late-Tertiary faulting (Kosciusko Epoch), was the uplift of the north-east trending Mt. Horror ridge and the north trending Billycock Hill ridge. A late Tertiary age is preferred for these two ridges as Tertiary drainage channels comparable to the tributary leads of the Blue Tier are absent. Some rejuvenation of other faults accompanied by disruption of the drainage and destruction of parts of the original lead system took place, as for example at Wood's Flat (Appleby, 1964).

The upper unit of the Tertiary sequence began to be deposited as soon as the late Tertiary faulting began. Towards the close of the faulting, parts of the newly formed Valley System were invaded by basalt flows. In at least one place, namely the Ruby Flat area, post-basaltic uplift and stripping of the Tertiary sediments and basalt took place. A residual of the uplifted Tertiary basalt fill forms Grey's Hill on the north side of Ruby Flat.

The events described here are illustrated by Plate 3b and Fig. IV. A map of Bass Strait, with submarine contours and tectonic features on the Victorian mainland and the Tasmanian north coast (Jennings, 1959) is presented as Fig. III. It will be seen that the presumed late-Tertiary north-east trending uplift (Mt. Horror Ridge) of the mapped area is only a very minor counterpart to the late-Tertiary uplifts of the Otway Ranges at the opposite end of the Bass Strait depression. As the Otways were raised in late-Tertiary times, they dammed a southerly flowing, supra-basaltic drainage (Gill, 1964, p.346).

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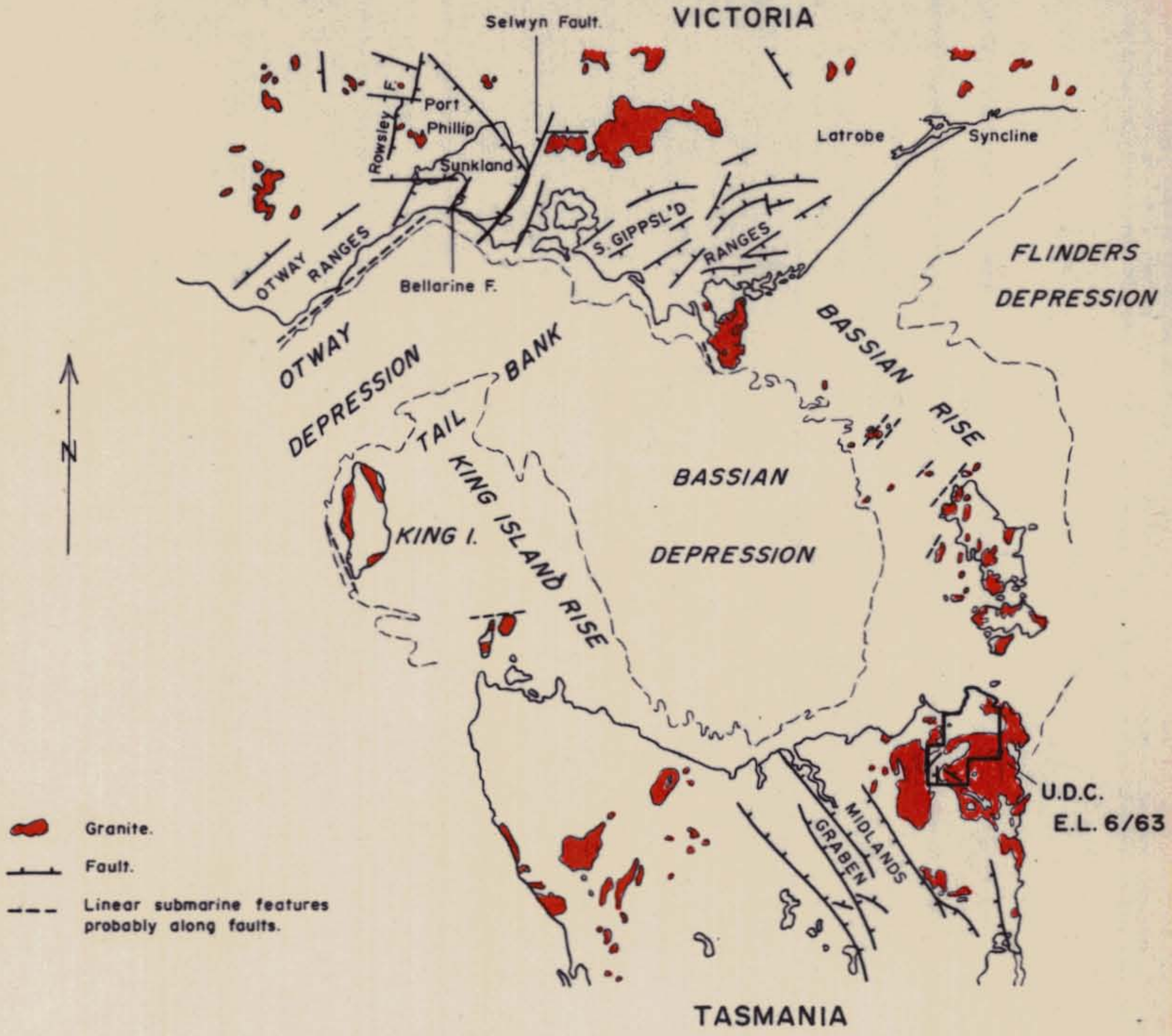

THE 'BASS STRAIT BASIN' STRUCTURES AND SUBMARINE TOPOGRAPHY (JENNINGS 1959) TO ILLUSTRATE THE REGIONAL SETTING OF THE N.E. TASMANIAN TINFIELD.

5 cm

FIG III

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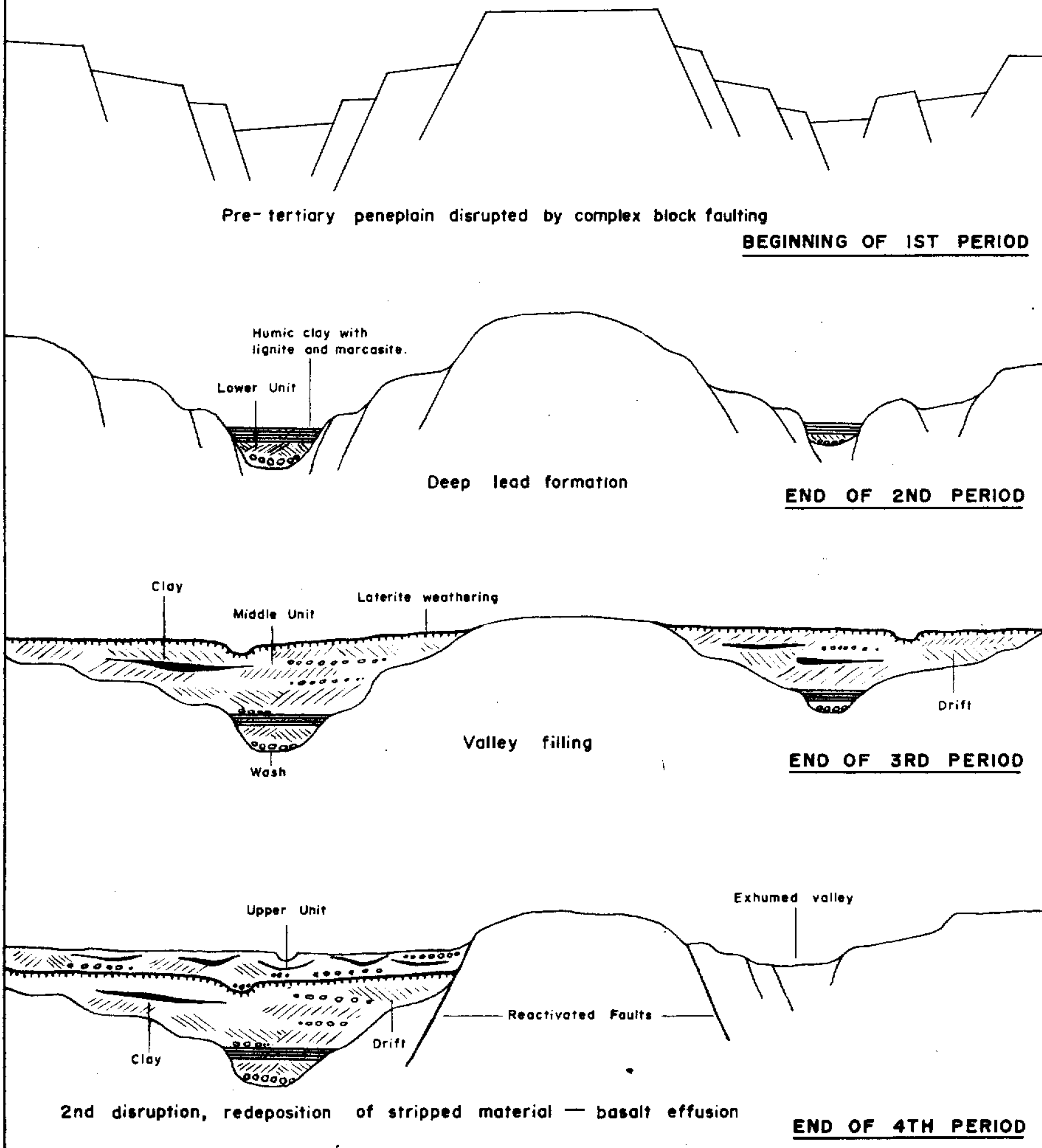

DIAGRAMMATIC SECTIONS ILLUSTRATING PROBABLE CAINOZOIC HISTORY

FIG IV

RECONSTRUCTION OF CAINOZOIC HISTORY.

The Tertiary and Quaternary history of the area can be divided into five periods. These five periods and a summary of events during each are shown in Table C. Figure IV shows a reconstruction of the Cainozoic history diagramatically in a series of sections. Plates 3a-3d show the history in a series of maps. The relation of the lower, middle and upper units of the Tertiary succession to the different periods of the Tertiary history is also indicated in Table C. The lower unit was deposited during periods 1 and 2, the middle unit during period 3, and the upper unit during period 4.

Period 1.

The first period probably extending through the Eocene and part of the Oligocene, began with the disruption by block faulting of the pre-Tertiary peneplained surface (Bass Strait Epoch). Regionally the block fault movements in N.E. Tasmania represented a doming about a centre some miles south of Derby, and the depression of the area now occupied by Bass Strait. In detail the fault movements were generally normal and were aligned N-S, E-W, N-W and N-E (see "Tectonic History").

As the peneplained surface was gradually uplifted and faulted, a drainage pattern established itself (Plate 3a). At this time the streams had very steep gradients and were rapidly cutting back their headwaters and cutting down their valleys. Initially the whole of their course was juvenile, but gradually they began to develop a delta and a flood plain. These features, however, are believed to have been far to the north of the present coast line, as Bass Strait was then only an east-west arm of the Pacific near the present Victorian mainland. As the land form stabilised, the streams continued their rapid down cutting and scouring action, but as the steepness of their gradients began to decrease the deep leads of heavy minerals and boulder and cobble gravels (wash) began to form in those streams draining a stanniferous catchment. The leads formed downstream first, and then progressed upstream as the gradient flattened.

Period 2.

There is no sharp break between periods 1 and 2. The extremely high rainfall and run-off of the first period continued with no change. In period 1, although rocks were decaying rapidly by chemical weathering, there was no chance for deep soil or regolith mantle to accumulate because of the rapid scouring and steep slopes. In period 2, however, there seems to have been a slight landward tilting which ponded up the drainage and allowed the accumulation, in still steep-sided gutters, of some granitic drift, and then clay and siltstone with lignite in swamps.

Period 3.

Period 3 evidently began with regional uplift and a return of a gradient to the drainage which, while not so extreme as that of period 1, was considerably steeper than that at the close of period 2. The exposed steep slopes and high standing hill masses were reduced by intense chemical rotting and the slumping of the decomposed material into the drainage channels. Chemical decay of the bedrock was hastened by the presence of humic acid and was taking place below the original channels of period 1 as well as on the exposed hillsides. Much of the disintegrating material was carried out to sea to form the thick accumulations of sediments of the Bass Strait basin, but much remained as drift, gravel and clay to choke up the river valleys.

Probably by the close of period 3 the general landscape was of moderately subdued relief with deeply alluviated, flat floored valleys, across which the streams were beginning to migrate laterally.

Rainfall decreased gradually through period 3, but weathering was still kaolinitic rather than lateritic; presumably rainfall was still non-seasonal and the climate still hot.

Period 4.

Period 4 is marked climatically by a change from non-seasonal to seasonal rainfall and hence the change from kaolinitic to lateritic weathering. Thus the top of the Midd Unit (period 3) of the Tertiary succession is commonly ferruginised and the rocks of the overlying Upper Unit (period 4) are commonly ferruginously stained.

The main events of period 4 were the re-activation (Kosciusko Epoch) of the early Tertiary faulting and the disruption of the lead system of periods 1 and 2. Parts of the old lead system were apparently uplifted and stripped to form the characteristic re-worked sediments of the Upper Unit of the Tertiary Sequence.

Streams and rivers apparently tended to be non-perennial and had courses that were partly on recently uplifted bedrock and partly meandered across the top of Tertiary sediments. Present day rivers in the area have the same complex character caused by flowing over alternations of bedrock and easily eroded unconsolidated Tertiary sediments (see Physiography).

The upper unit of the Tertiary succession deposited during this period is characterised by the presence of re-worked material (notably "birdseye wash"), a well rounded and sorted pebble size gravel, by scour and fill structures and other features typical of flood plain deposition. The gutters at the base of the upper unit are generally anastomosing and not very deep, but they contain some wash with tin values.

Period 5.

The onset of the fluctuating glacial and warm climate that characterised period 5 was probably gradual. The only sediments clearly referable to this period are the wind-blown sands of the seif dunes and lunettes of the northern part of the mapped area. Initially the main drainage channel, probably inherited from the close of period 4, flowed north-north-west through Rushy Lagoon (see Plate 3c). The coast line was at many times during the Pleistocene much further to the north than the present coast. The Tasmanian aborigines and some members of the present Tasmanian fauna are thought to have migrated from the Australian mainland while Bass Strait was drained during a Pleistocene low sea-level. Broad alluvial plains stretched to the sea from the higher land. Remnants of these plains exist today in the Great Northern Plain and in the alluvial plains to the north and east of Rushy Lagoon.

The complex river captures which created the present river system also belong to period 5. The Mussel Roe River, at the beginning of period 5, was probably the north-north-west flowing stream through Rushy Lagoon mentioned above. This stream was deflected a number of times to the east by drifting sand, and finally captured by the present lower Mussel Roe River, the point of capture being $2\frac{1}{2}$ miles north of the Anson's Bay Road crossing. Other rivers had equally complex histories. Some tectonism continued through the period and contributed to the complexity of river development. At some point the base level of streams was lowered by about 70 ft. by a negative sea level shift which has allowed streams to incise themselves into the alluvial plains and into bedrock.

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SUMMARY OF TERTIARY HISTORY

N.E. TASMANIAN TINFIELD

TABLE C.
Follows Page 25.

Period	Corresponding Unit	Age	Tectonism	Characteristic Deposits	Description of Environment	Climate
5th	-	Pleistocene and Recent.	Intensity relatively stable.	Dune sands.	Development of Present drainage and landform. Tectonic activity waning. Complex stream captures. Alternating glacial and warm climates. Oscillating sea level. Coastal dunes and lunettes of the Cape Portland-Rushy Lagoon area.	Alternating glacial and warmer.
4th	Upper	Pliocene	Renewed faulting and block uplifts. Basalt effusion.	Drift, clay. "Birdseye" wash with tin.	Renewed tectonic activity. Reactivation of older faults raises up some parts of old lead system and allows them to be stripped and redistributed. Tin from stripped leads reconcentrated in wash horizons. Scour and fill structures characteristic. Basalt effusion occurs; probably after main peak of tectonic activity. Weathering lateritic.	Monsoonal - hot, wet, seasonal.
3rd	Middle	Miocene	Relatively stable.	Drift or fine sand with some clay and wash interfingered.	Valleys choked up with drift, derived from granite, or very fine sand, derived from Mathinna Beds. Deposition mainly from streams migrating laterally across valleys, depositing interbedded, interfingered drift, wash and clay. Relief subdued. Climate drier than Period 2, run-off less intense. Weathering kaolinitic.	Hot, wet, becoming seasonal.
2nd	Lower (Upper part)	Oligocene	Decreasing activity.	Clay - humic, lignitic and marcasitic, siltstone and drift.	Valleys fill as land ceases to rise. Quiet water episodes at end due to ponds and swamps forming along streams. Relief less extensive. Weathering Kaolinitic.	Tropical, hot, heavy-non-seasonal rainfall.
1st	Lower	Eocene-Oligocene	Intense faulting followed by continuous uplift.	Wash and heavy minerals. Tin.	Valleys scoured continuously as they are formed on steep, block faulted landform. Relief extreme. Run-off extreme. Heavy mineral concentrate retained in valleys as lighter, finer debris is carried out to sea or to flood plain below present sea level.	Tropical: hot, heavy, non-seasonal rain.

PART II

DISTRIBUTION OF TIN

Two distributions of tin must be considered: The primary distribution of tin-bearing granite and veins and the alluvial distribution resulting from the weathering of the primary areas and the dispersal of the liberated tin.

Primary Distribution

The primary source of all the tin is the granitic rocks of Devonian age which intrude the other basement rocks of the area. The composition of these granitic rocks has been mentioned already (see Stratigraphy, Devonian). The most abundant rock is a coarse-grained grey grano-diorite or ademellite composed essentially of quartz, oligoclase and biotite with or without hornblende. The feldspars commonly are strongly porphyritic and enclose mica flakes. The main mass is intruded by a more acid late stage "tin granite", a coarse uniform-grained biotite, muscovite granite, commonly greisenised. Reid and Henderson (1928) describe a very complex series of at least six intrusions in the Blue Tier, but consider that all six intrusions are differentiates from a single magma.

Some fine-grained cassiterite probably occurs dispersed through the main granite mass but the great bulk of the cassiterite is localised in the late stage intrusions of "tin granite" and in greisen veins and aplite veins associated with them. The highest values are said to occur in the more micaceous greisen veins.

No tin minerals except cassiterite, the oxide, are recorded in the field. Reid and Henderson (1928) record a large number of minerals found with cassiterite in the primary deposits of the Blue Tier. These include wolfram, scheelite, molybdenite, chalcopyrite, galena, bismuthinite, fluorspar, apatite, zircon, sapphire and abundant topaz. Very common in the alluvial deposits of the field is "black jack" (pleonaste, an iron magnesium spinel). This was not seen in place in primary veins by Reid and Henderson and it may, in fact, be derived from the weathering of Jurassic dolerite rather than of the granite. Ilmenite is a very common constituent of the heavy mineral concentrate of some alluvial deposits in the field, particularly of Wood's deposit at the Mussel Roe River. The ilmenite also could possibly be derived from dolerite rather than granite.

Outcrops of "tin granite" and greisen veins known to shed tin are indicated on Plate 3a. These outcrops occur in two main areas; the top of the Blue Tier and at the north-east end of the Mt Cameron ridge. This outcrop pattern substantiates the view that the late stage magmatic differentiates containing tin were concentrated in patches in a narrow zone just below the roof of the granite cupola. These relationships are well illustrated at the old Mt Paris mine, at the west end of the Blue Tier. It appears here that a small mushroom-shaped mass of "tin granite" formed just below a roof of Mathinna meta-sediments and that tin-bearing greisen veins were emplaced in the "tin granite" and extended a short distance horizontally into the barren granite and vertically into the Mathinna roof rocks.

Alluvial Distribution

In this section the relation of shedding areas to the deep leads will first be considered, then the distance that cassiterite can travel and, finally, the detailed distribution and sorting of heavy mineral seams within deposits.

Relation of Shedding Areas to Deep Leads

The distribution of the alluvial tin in the field is determined in the first instance by the position of the tin-shedding areas. The tin-shedding areas that remain today, however, have been partly stripped by erosion, and in reconstructing the alluvial distribution probable extensions have to be considered. For example, the tin of the Endurance Lead generally and of the tributary Clifton Creek Lead in particular appears to have been derived from the southern slopes of the Mt Cameron ridge. No outcrops of "tin granite" or of greisen veins are known today along the southern slopes and the original tin-shedding rocks have probably been stripped.

Known remnants of the early Tertiary lead system are shown in Plate 3a. The southern leads, the Ruby Flat, Branxholm, Black Creek, Valley, Cascade and Echo Leads are clearly derived from the western part of the Blue Tier and may represent erosion of a more extensive shedding zone that once covered all the top of the uplifted block of the Blue Tier. Further north, the present Wyniford River reaches back into rich primary deposits of the Lottah-Poimena area (east Blue Tier), but probably much of the tin of the early Tertiary Wyniford Lead was derived from the weathering of north and north-westerly extensions of this shedding area that have now been completely removed. The same sort of argument can be applied to the tin at Wood's Mussel Roe mine; the present Mussel Roe headwaters stretch back south towards the Lottah-Poimena area, but the tin at the Mussel Roe mine may not have come from that area but from a northerly extension of it.

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The tin deposits east, north and west of Gladstone appear to be derived from the northern slopes of the Mt Cameron ridge. Primary tin areas exist at Fly-by-night Creek and on the southern side of Harden's Ravine towards the east end of the northern slope of the Mt Cameron ridge. This shedding zone was probably originally semi-continuous along the northern slope of the Mt Cameron ridge. Deposits such as Dobsons at Dugarde Creek, Vulcan, Native Lass, etc, are thought to have been derived from this zone. These deposits seem to feed into a river system termed the Scoloch Lead, which is known from Government boring over a length of about two miles under the Great Northern Plain.

Tin in the deposits of the White Rocks and Banca areas has not been closely studied, but appears to be locally derived and not part of any recognisable lead system.

Distance Travelled from Shedding Area

The distance of the original source of the tin from any particular alluvial deposit in the tin field is generally doubtful. For example, the detrital cassiterite of the Pioneer mine may have travelled the twelve miles or so from the Lottah shedding area on the top of the Blue Tier, or it may have had a more immediate source that is now eroded. It seems most likely that the tin at the northern limit of the Scoloch Lead (below the Great Northern Plain) has travelled some three to four miles from shedding areas on the northern slopes of Mt Cameron. However, here again the possibility that tin was being shed from a Permian basal conglomerate that must have overlaid the area at some time cannot be entirely discounted.

An interesting example of the transportation of cassiterite is provided by fine-tin presently being worked between Derby and Herrick on gravel (tailings) banks along the Ringarooma River. This tin occurs as a very thin layer on top of the banks and is said to have been carried down the river from the Briseis mine during an exceptional flood following the failure of the Cascade dam (1929). The distance travelled is evidently about seven miles and the fall of the river bed over that distance is believed to be about 250 feet.

Factors Governing the Distance Tin Can Travel

There can clearly be no single answer to the question of how far tin will travel, as the grain size of the cassiterite, the volume and velocity of the water, the gradient of the stream, and the muddiness (and hence density) of the water are all important factors.

No detailed study has been made of the grain size of the cassiterite from various deposits. In fact, with all the major old workings now water-filled, it would be impossible to attempt such a study. The grain size of tin from Wood's Mussel Roe mine is presently being investigated for UDC, with other features, by Mr. Ken Blaskett of the University of Melbourne. The coarsest cassiterite grains seen in Mr. Wood's sluicing operations are about half an inch in their largest dimension, the bulk of the cassiterite being much finer. The ground presently being worked by the Dorset dredge (old Aberfoyle workings) yields cassiterite of fine to medium grain, with about 50% of the product falling between 50 and 100 mesh size. Tin in the lower wash at the Briseis mine is said to have been very coarse, that from the Arba and Pioneer mines moderately coarse. There is a record of tin nuggets weighing one ounce being found at the Empress mine.

It is not possible now to reliably establish the gradient of early Tertiary streams as faulting and tilting in the late Tertiary have altered the original gradient. In Victoria the gradient of many sub-basaltic leads has actually been reversed by late Tertiary movements (Baragwanath, 1923, and Gill, 1964). It should also be noted that the profile of a valley in which a heavy mineral concentrate is now found indicates the gradient at which heavy minerals settled out, rather than the gradient at which they were transported. The cutting down of the stream bed, the cutting back of the stream head, and the deposition of heavy minerals in the channel so formed, are closely inter-related. The zone of deposition, originally well down-stream, should migrate back up the channel as the stream lowers its gradient by erosion.

Further practical evidence of the type of gradient and water velocity needed to transport tin is provided by the races constructed by operators engaged in ground sluicing throughout the field. The part of the race in which the tin is retained has a fall of about $2\frac{1}{2}$ feet per chain (66 feet) or 1 in 26. The retention of the tin is aided by riffling.*

The content of suspended matter, and hence the density of the water used in sluicing operations is occasionally a factor that has to be considered. In Lawry's east pit, for example, care has to be taken to avoid sluicing the fine sand of the false bottom, as a thick suspension of fine sand in the water entering the sluice forms a heavy density medium capable of carrying the tin out with the tailings.

*The fall of the Ringarooma River between Derby and Herrick is approximately 1:150, and the fall between Derby and the coast 1:500. By contrast, rivers at grade have much flatter gradients. The Murray-Darling system crosses the Murray Basin at a gradient of approximately 1:15,000, and the Amazon has a gradient of about 1:17,500 for 2,000 miles of its course.

Under natural conditions, the abnormal transporting power of the rare heavy flood, creating a large body of water moving with a high velocity and heavily charged with clay and fine detrital matter, is the key factor in estimating the ability of streams to transport tin. While for many years the heavy minerals might remain undisturbed, a single flood might succeed in moving the whole bed load a considerable distance downstream.

The Distribution of Tin within Deposits

Another important aspect of the alluvial distribution of tin is its detailed distribution within a deposit. The occurrence, throughout the field, of concentrations of tin in an upper wash zone in the Tertiary upper unit, and in a rich lower wash zone resting on bedrock in the Tertiary lower unit has already been described (see Stratigraphy - Tertiary). In contrast, the tin of the Pleistocene alluvial deposits of Malaya and Thailand is distributed more or less evenly throughout the section in innumerable discrete layers.

The tin of the upper wash zone bears some resemblance to the Malayan type of distribution. In places (Lawry's) the tin is spread through most of the Tertiary upper unit associated with thin seams of "birdseye" wash pebbles. In other places, however, tin values are concentrated mainly close to the false bottom on top of the Tertiary middle unit and the false bottom is guttered (Eastern Terrace, Wood's).

The tin of the lower wash zone is, however, quite unlike the Malayan tin in its distribution. The tin values are entirely contained within major bedrock depressions (Leads). In detail, however, the distribution of cassiterite and other heavy minerals within the Leads is very irregular. Local miners talk of the occurrence of "runs"* of tin with "pools"* along the runs. Runs and pools seem commonly to occur in the flanks, rather than the bottom, of bedrock gutters. In Wood's mine the runs of tin are commonly from five to ten feet wide, while a typical pool could be of the order of 20 feet in diameter. The Endurance Lead is said to contain a single very rich run in a bedrock gutter that is shallow (four feet deep) and only 15 feet to 20 feet wide (Rattigan, 1958).

*"Runs" are sinuous gravel bodies containing high tin values, or higher values elongated through broader gravel bodies, within a lead; "pools" are broader, irregular patches of higher values in gravel.

At the Brieseis mine on the Cascade Lead, the largest lead worked on the field, the high tin values occur through the lowermost 50 feet of the section and across a width of about 500 feet. Within this exceptionally large lead, however, the tin, by repute, occurs in narrow, very rich seams which are thicker and more abundant towards the base of the lead.

The three types of distribution -

(1) in discrete layers throughout the section (Malaya);

(2) partly throughout the section, partly in gutters on a "bottom" (upper wash zone); and

(3) concentrated in a Lead (lower wash zone)

are evidently related to climate and to the maturity of the drainage. The first is evidently due to annual floods across a broad flood plain, while the third is developed where perennial streams are flowing in bedrock-cut channels. The second may be related to a complex drainage produced by faulting and tilting, in which short stretches of "flood plain" (river flats) alternate with stretches of bedrock-cut channels.

Factors Governing the Distribution of Tin within Deposits

In general, cassiterite and other heavy minerals, gravel, sands, silt and clay will be carried or deposited by a stream in accordance with their respective specific gravities, their grain size and their angularity. The original grain size and angularity of any transported material, however, is modified as soon as transport begins in relation to its abrasion resistance (a function of hardness). Thus the three factors that are important are specific gravity, initial grain size and hardness. The specific gravity and hardness of a number of mineral species found with cassiterite in this field are given in Table D.

Theoretically, any particular grain size of tin should be found associated with a particular size of wash gravel. This is known to be broadly true in the field - the coarsest tin is generally associated with boulder washes in the finer tin with drift and pebble washes.

An additional complication arises, however, because streams carry two loads, a suspended load and a "bed" load that is rolled along the stream bed. For this reason stream gravels (in contrast to beach gravels) are generally bimodal (Pettijohn, 1957). The perfect theoretical grain size distribution for a wash gravel and its contained cassiterite should show, therefore, four components - a gravel (bed load) with interstitial sand (suspended load) and two sizes of cassiterite, one associated with each. All wash gravels seen in the field appear to have the bimodal character, but the equivalent data on cassiterite grain sizes has not been obtained.

Apart from the purely physical capture of cassiterite grains in very small irregularities in the stream bed, a particular grain size of cassiterite will be dropped by a stream as its velocity falls below a critical value. In a hypothetical fully graded stream, the decrease of velocity would take place evenly throughout the length of the stream. In any actual stream, and particularly in a newly developing drainage such as that of the early Tertiary in this area, rapid changes of velocity are likely to occur at points along the stream course. Four examples of stream bed conditions of this kind are illustrated in Fig. V. In each instance a rapid change of stream velocity is produced by some change in the stream bed, and two zones of laminar flow of different velocities are separated by a turbulent zone. If the critical velocity (the velocity at which heavy minerals begin to deposit) lies between the first and the second velocities, deposition of heavy minerals would take place.

An example of present day deposition of alluvial cassiterite on sand and gravel banks in the Ringarooma River, just below Herrick, is shown in Fig. VI. The cassiterite is of fine grain and is material believed to have been released into the Ringarooma from the old workings at Briseis mine, Derby. At low water levels the river waters are contained in the deeper channel, but as the river rises, shallow water begins to flow across the sand banks on either side of the main channel. The velocity across the banks is much reduced and fine-grained heavy minerals are deposited. In detail the heavy minerals are preferentially deposited in eddies behind cobble stones, etc.

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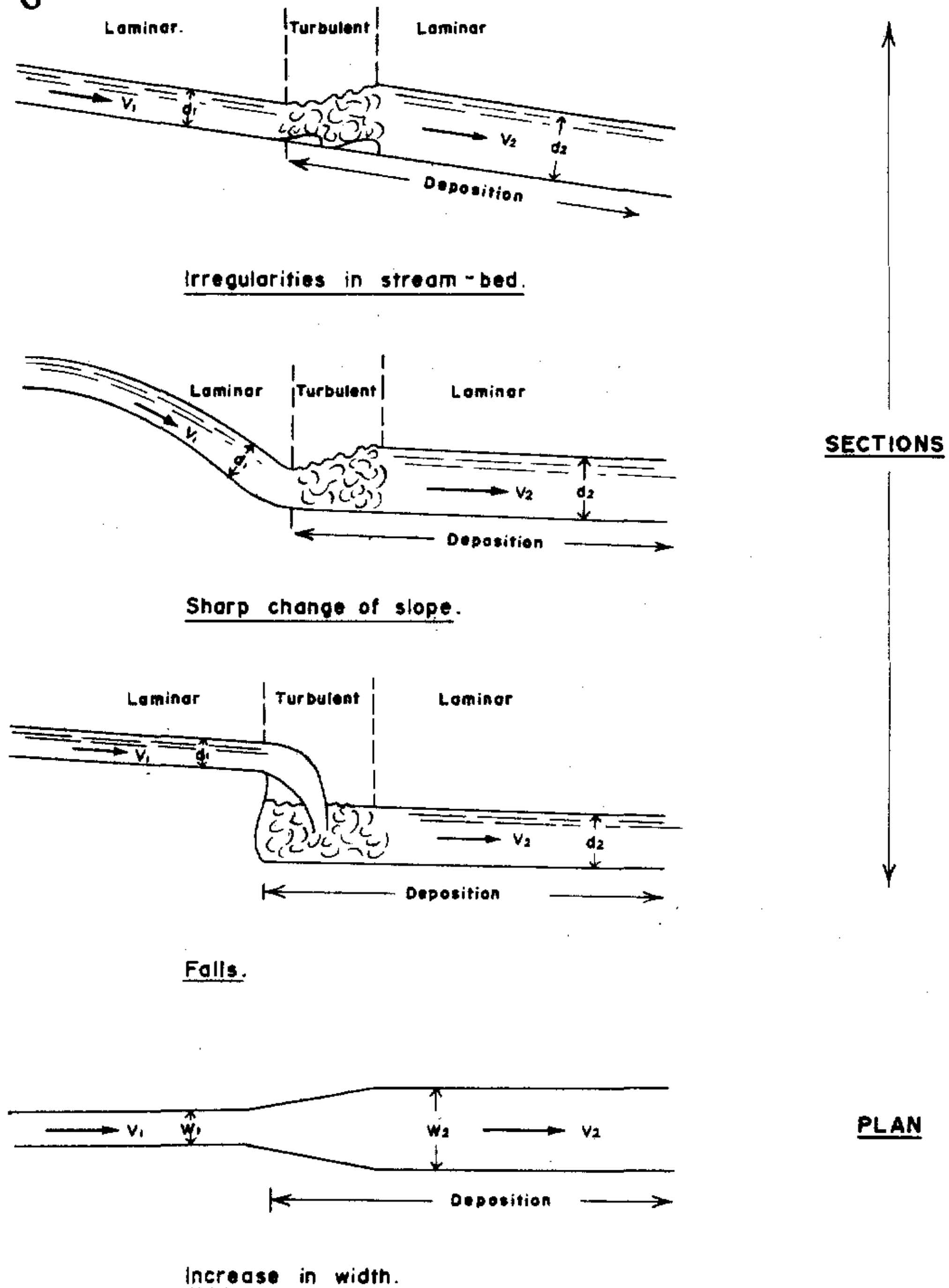

FEATURES CONTRIBUTING TO VELOCITY CHANGES IN STREAMS.

FIG V

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Follows p. 32

TABLE D

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Comparison of Some Physical Properties of Minerals Occurring in Placer Deposits, N.E. Tasmanian Tinfield

Mineral	Composition	Hardness	Specific Gravity	Ratio of Specific Gravities to that of Quartz
Cassiterite	SnO_2	6 to 7	6.8 to 7.1	2.57 to 2.68
Quartz	SiO_2	7	2.65	1
Ilmenite	$FeTiO_3$	$5\frac{1}{2}$ to 6	4.7	1.77
Pleonaste	$(Fe, Mg)Al_2O_4$	8	3.6 to 4.0	1.36 to 1.51
Corundum	Al_2O_3	9	4.02	1.52
Gold	Au	$2\frac{1}{2}$ to 3	15.0 to 19.3	5.66 to 7.28
Topaz	$Al_2(SiO_4)(F, OH)_2$	8	3.4 to 3.6	1.28 to 1.36

Data from Dana : Manual of Mineralogy (1959).

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TABLE E.

TASMANIAN TIN - SUMMARY OF PROPOSED TESTING

Area	Name	Description of Targets		SIZE OF TARGETS: Possible Length (feet)	Poss. Width (feet)	Poss. Depth (feet)	Poss. Ydge. (mill. cu. yd)	Poss. Tonnage (Sn per 1000 ft length)	Poss. Total Tonnage	Poss. Grade (lb Sn/ cu. yd)	Type of Mining Proposition	Proposed Drilling: Footage	Proposed Drilling: No. of Holes	Geophysics
1	Southern Ringarooma	Continuation of 3 known leads	(a) Ruby Flat/ Mt Joseph (b) Arba Lead (c) Valley Lead	3,500 5,000 3,000	500 500 500	100 100 100	7 10 6	500 500 180	1,750 2,500 640	.5) .5) .2)	Open pit, hydraulic mining.	3,000	30	Not recommended.
2	Edina-Lawry's-Elizabeth	Three suspected leads	(a) Edina (b) Watt's (c) Lawry's	2,000+ 8,000 1,000	300 300 300	50 50 50	1+ 4 ½	150 150 150	300+ 1,200 150	.6) .6) .6)	Open pit, hydraulic mining.	2,500	50	Recommended.
3	Lochaber-Scotia	Search for tributary leads to Scoloch Lead	(a) "Doone" Lead	9,000	300	50	5	100	900	.4	Open pit, hydraulic mining.	2,500	50	Recommended.
4	Endurance-Pioneer	Search for suspected w-flowing leads	Possibly 3 leads of similar size	3 x 5,000	500	90	25	300	4,500	.4	Open pit, hydraulic mining.	4,000	50	Recommended.
5	North Mussel Roe			25,000	1,000	30	28				Dredge.	1,500	50	Not recommended.
6	Hastie's	S-flowing continuation of Hastie's Lead		5,000	300	50	3				Open pit, hydraulic mining.	1,000	20	Recommended.
7	South of Anson's Bay Road	Test of n-flowing ancestral drainage to Rushy Lagoon		10,000	500	80	17				do.	4,000	50	Recommended.
8	Amber Hill area	Possible tributary leads		4,000	300	50	2			? .4	do.	2,000	40	Recommended.
9	Herrick Surrey	Possible lead remnant		5,000	300	50	3				do.	1,000	20	Not recommended.
10	Ringarooma Bay Beaches			34,000	5,000	40	250				Dredge.	4,000	100	Not recommended.

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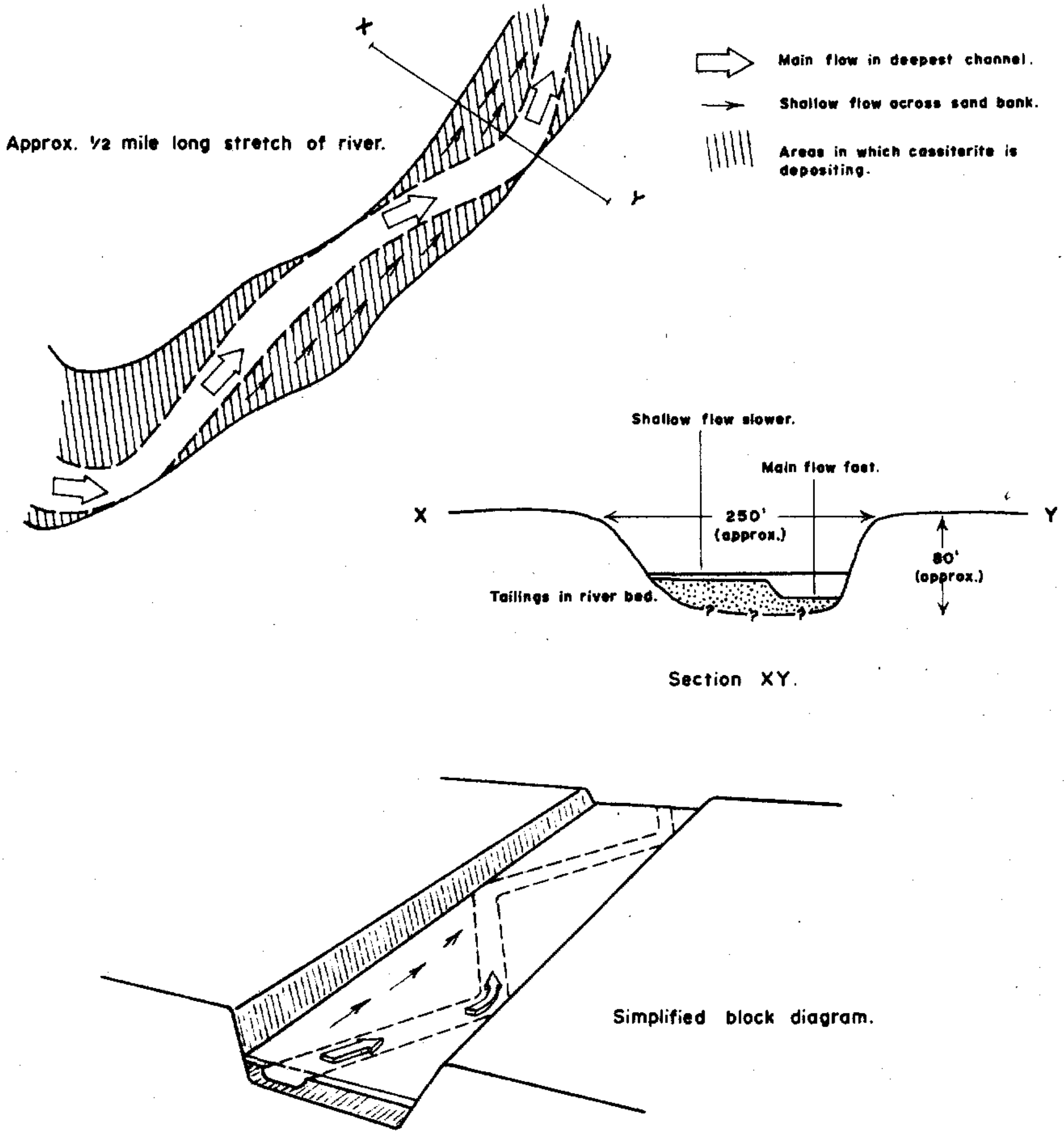

EXAMPLE OF PRESENT DAY DEPOSITION OF ALLUVIAL CASSITERITE NEAR HERRICK.

FIG VI

SELECTION OF AREAS FOR TESTING

The areas selected for testing are summarised in Table E. The table gives an indication of the targets within the individual test areas and of the size of deposit which might be discovered at each.

The foremost consideration in choosing target areas has been the ability of each to provide a viable mining proposition for the Company. As a guide to local economic conditions it was known that a preliminary feasibility study made at Wood's Mussel Roe mine has shown that particular property would have been of interest to the Company if it could have provided $4\frac{1}{4}$ million cubic yards of material with a recoverable grade of 0.43 lb Sn/cu.yd (Rodgers, 1963). The study showed that such a property could be profitably mined at a rate of 1,000,000 cubic yards annually by a combination of dry mining of the overburden and hydraulic mining of the ore zone. These calculations included a £100,000 purchase price for the property.

A further guide to economics is provided by mines presently operating successfully in the field, notably the Endurance mine, where the values contained in a single narrow rich gutter make possible hydraulic mining to a depth of 120 feet at an overall grade of 0.25 lb Sn/cu.yd.

In order to estimate the grade of material that might be expected from various test areas, an assessment has been made from old production records of the tonnage of tin that has been extracted per thousand feet length of lead for leads throughout the field. These results are shown in Table F. The richest leads in the field have been the Cascade Lead producing more than 2,000 tons per 1,000 feet length of lead, the Wyniford Lead, 1,500 tons per 1,000 feet, the Branxholm, 500 tons per 1,000 feet, and the Endurance, 450 tons per 1,000 feet. The leads to the north of Mt Cameron appear generally to be smaller and less rich; the Government drilling of the Scoloch Lead indicating about 100 tons per 1,000 feet. In places the proposed testing is directed at finding an extension of one of these known leads; in other places the search is for previously unrecognised leads.

The majority of areas for testing have been chosen having in mind a low capital operation, using hydraulic mining, that could be brought into production rapidly. Two areas, the North Mussel Roe Swamps (Test Area 5) and the Ringarooma Bay Beaches (Test Area 10) are larger target areas and are thought of as possible dredging operations with consequent higher capital outlay.

TABLE F

Tonnage of Tin Extracted from Various Leads

Lead	Main Mine	Length of Lead Extracted (Feet)	Tons of Tin Won	Approx. Tonnage of Tin per 1000' Length of Lead
CASCADE	Briseis	10,000	20,787	2,000
WYNIFORD	Pioneer	6,000	9,180	1,500
BRANXHOLM	Arba	4,000	2,180	500
ENDURANCE	Endurance	6,000	2,630	450
VALLEY	Valley	2,000	370	180
(SCOLOCH	Non-Mined	7,000	750	100)

The picture of Tertiary history, and in particular of early Tertiary drainage, that has gradually emerged during these investigations has emphasised the need to test from known leads towards possible extensions rather than to test areas that are far removed from known leads, on the basis of an overall interpretation of the early Tertiary drainage. Previous authors have generally accepted, at least in broad outline, the interpretation of the early Tertiary lead system proposed by Nye (1925). Nye's hypothesis supposed that an ancestral Ringarooma River in the early Tertiary used to head towards the sea to the west of Mt Cameron. This view led to a concentration of interest in the area from four miles north of Winnaleah to the coast; an area in which Tertiary sediments are exposed at the surface and which should, on Nye's hypothesis, conceal the Ringarooma main lead.

In the last few years the Bureau of Mineral Resources have carried out extensive gravity and seismic surveys over this area for the Tasmanian Department of Mines in a search for the main lead. Their indications have been drilled in two drill traverses at the north end by Rio Tinto. This drilling located no tin and no clearly defined channel. The area is presently held under reserve by the Department of Mines, but is available for any exploration company willing to drill the geophysical indications. BHP, who at present are testing Wood's Monarch property, are apparently proposing to test the Government reserve area very soon.

As the whole of Nye's reconstruction of early Tertiary drainage is open to serious objection, and as previous drilling has cast doubts on the validity of seismic and gravity anomalies, this Government reserve area is not considered of high priority and no approach has been made to have it included in our testing. Of much higher priority is the testing of Area 4 (Endurance - Pioneer) to the east. Area 4 has known tin-bearing ground immediately to the north, east and south. Any leads located in Area 4 might, of course, be followed across Area 4 to the west and north-west into the Government reservation.

The order given in Table E is broadly an order of priority, with the exception that the Ringarooma Bay Beaches area (Test Area 10) is proposed as a separate programme and is not accorded a particular priority within the Table. The first four test areas all could yield considerable yardages of material of better than 0.4 lb Sn/cu. yd, and it is proposed to test these four areas first. Other areas are not necessarily smaller, but are given lower priority because they are less close to previously worked ground and hence represent a more distant extrapolation from a know shedding area. For example, the Edina/Lawry's/Elizabeth area (Test Area 2) is given higher priority than the North Mussel Roe Swamps (Test Area 5) and the South Anson's Bay Road area (Test Area 7) which both adjoin it on the east because each is progressively further from the Mt Cameron shedding area and because they have fewer adjacent old workings or drilling.

Probably the most attractive target on the field is the Arba Lead of Test Area 1. The Branxholm Lead, a tributary, has produced at least 500 tons of tin to 1,000 feet of lead, and there seems the possibility of a 5,000 feet extension with an average depth of 100 feet; say 10 million cubic yards of 0.5 lb Sn/cu. yd.

The description of individual test areas gives details of the particular targets sought at each test area.

GEOPHYSICAL TESTING

Previous Geophysical Testing

Five geophysical techniques have been tried in this area in the search for alluvial tin deposits; in addition an air-radiometric search was carried out for uranium. The areas in which the various techniques were tried are shown on Fig. VII. Area H is actually outside our Exploration Licence area but tests a similar Tertiary sequence on granite.

Seismic refraction surveys were made by the Bureau of Mineral Resources in Areas A, B, D, E and H. In general "in line" shooting was used. At Endurance "in line" shooting was adopted to define the course of the lead, then "fan" shooting from centres along the defined course to give cross-profiles (Keunecke, 1957). Authors have attributed widely differing seismic velocities to the Tertiary sediments (see comparison in Table G). Four of the areas, A, D, E and H, have had some checking by drilling. Plate 4 shows a comparison of bedrock profiles from drilling and profiles predicted from seismic traverses. In Area D the broad trend of the Endurance Lead was shown by the seismic work. In Area E it is possible to correlate over a short distance the profile of unweathered bedrock revealed by drilling with a weakly defined seismic horizon. In Area A, by selecting a particular velocity for calculation, a very rough correlation was possible.

In general two bedrock profiles exist below the Tertiary sequences; the top of the weathered bedrock and the top of the unweathered bedrock. The first is the interface at which the tin occurs in gutters, but the second is evidently a much stronger refracting horizon. Unfortunately, the two profiles may bear little or no relation to one another, and drilling on seismic lows corresponding to depressions in the unweathered bedrock has found neither gutter nor tin at the weathered bedrock profile.

As the two profiles bear so little relation to one another, it is clearly not worth defining only the second; and the first, the weathered bedrock profile, is evidently not a sufficiently pronounced physical boundary to be reliably predicted by the seismic method. In Area E, the weakly refracting horizon along Traverse U that was thought, from the drilling, to correspond to the weathered bedrock profiles could not be followed for more than 750 feet.

An upper high velocity layer, such as the basalt layer of the Derby/Winnaleah area, blankets off the lower sequence and prevents any successful use of the seismic method where such a layer is present. A similar, but less marked, effect may be produced by clay layers in the Tertiary sequence. The Tertiary sediments have generally been treated as an homogenous single unit while in fact the velocity contrast between drift and clay within the Tertiary sequence may be considerable and may produce an identifiable refracting horizon at the top of a clay layer.

This matter was explored theoretically and practically in a somewhat similar but possibly more compacted sequence from the Triassic of Arizona and Utah (Pakiser and Black, 1957). From the data presented in this paper, it seems that it could be difficult to recognise a lead channel if the channel was masked by a clay cover. In this area all the known deep leads have such a clay seal. Recent drilling by the Mines Department near a target delineated by a seismic and gravity survey by the Bureau of Mineral Resources (Area H) located a deep clay-filled channel, not indicated by either the seismic or gravity surveys (Hughes, Jack, pers. comm.), where apparently the bedrock profile was completely masked by the clay.

Gravity surveys have been carried out in areas B, C and E. They have been used in conjunction with seismic surveys, and in place of seismic surveys where the Tertiary sequence is covered by basalt. Broadly, the gravity surveys have indicated the same deeper areas of Tertiary as those indicated by seismic means, but authors suggest that gravity also indicated the unweathered rather than the weathered bedrock profile.

In areas of basalt cover the variable thickness of the basalt is a factor which can not be adequately predicted. The thickness of the basalt varies not only because of the uneven erosion of the upper surface but also because of irregulatiries in the surface on to which it was extruded.

An aeromagnetic survey of the whole area north of Derby and west of the Cape Portland road was carried out in 1957 by Adastra for Rio Tinto Australian Exploration. The results of this survey were made available to UDC. Areas of basalt and dolerite are clearly indicated on the magnetic contour plans but there are not sufficient differences in magnetic susceptibilities for areas of Tertiary sediments to be distinguished from areas of bedrock granite or meta-sediments. The known deep leads (e.g., Endurance Lead) are not evident. There would be no justification in covering the rest of the area by an aeromagnetic survey.

Two ground magnetic traverses across the Endurance Lead (Keunecke, 1957) failed to show any anomalies. Area H was primarily investigated by seismic and gravity techniques but a few ground magnetic traverses were also run. Very slight magnetic anomalies were located and these were found later to indicate broadly the deeper gutter. The gutter contains a large amount of ilmenite and a very thick layer of basalt, both of which may have contributed to the anomalies (Jack, pers. comm.) Ground magnetic traverses at the Eastern Lead (Wood's Mussel Roe mine) showed no recordable variation although UDC drilling showed the lead to contain abundant ilmenite.

Two resistivity traverses, using "expanding electrode" and "constant separation" techniques, were made across the Endurance Lead (Keunecke, 1957). The results are said to have been inconclusive. Water samples taken from different levels in the Endurance mine and elsewhere by UDC were tested for conductivity. Only small differences in conductivity were found, the results ranging from 1700 μmhos/cm to 3800 μmhos/cm.

Proposed Geophysical Testing

As none of the previous geophysical surveys has had notable success, additional geophysical work can only be justified if some new or improved techniques can be developed. The seismic refraction method might be improved by test work in existing pits to determine experimentally the actual seismic velocity in individual lithologies of the Tertiary sequence. The knowledge that has been gained of the Tertiary sequence, in particular of the existence in all deep lead channels of a thick layer of heavy clay may make more precise interpretation of seismic results possible. Gravity methods may be effective in areas without basalt cover.

A new approach to geophysical prospecting in the area was suggested at an early date by the Company's Manager, Mr. R. D. Ellett, who was impressed by the amount of disseminated and nodular marcasite present in

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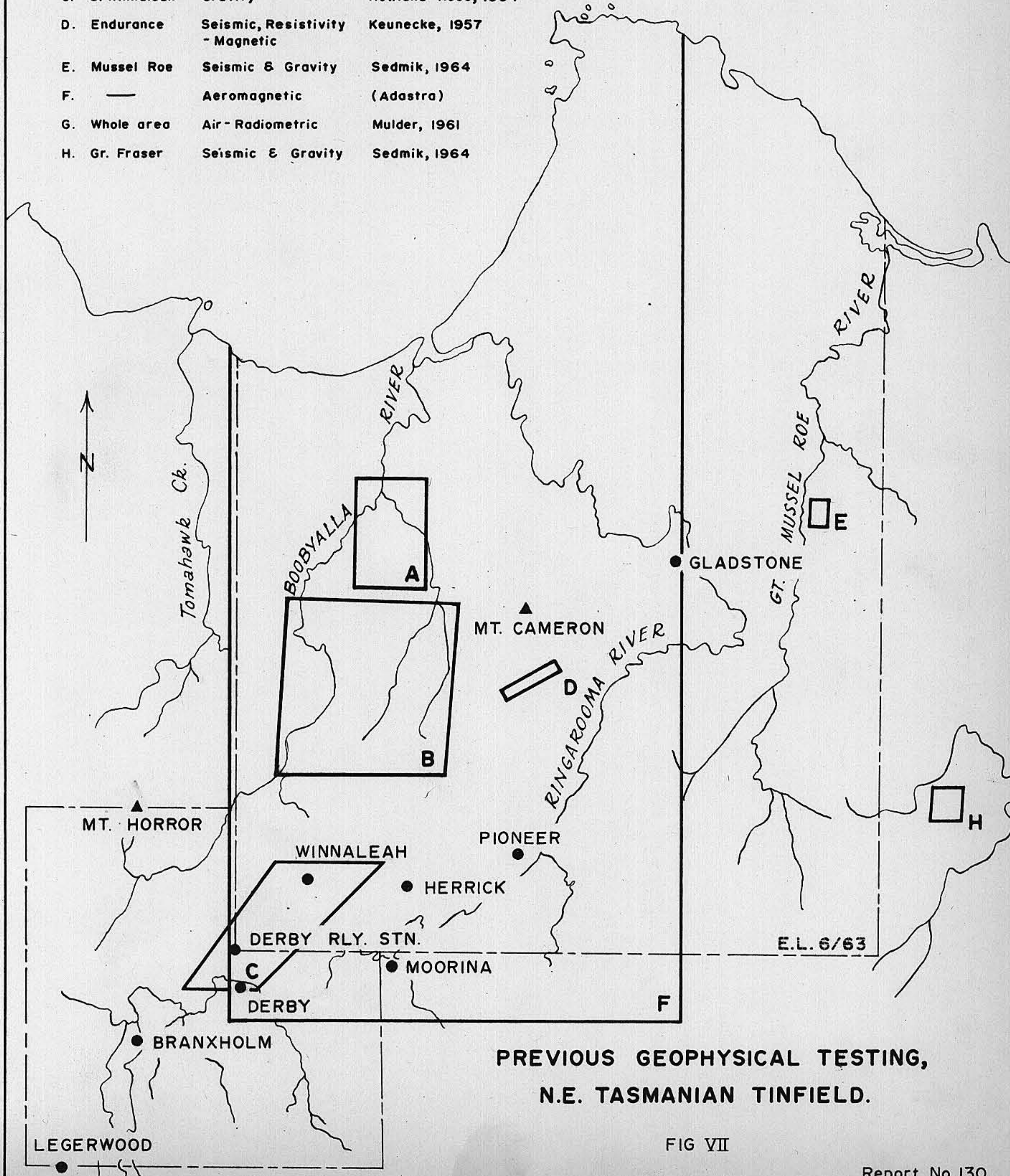
AREA	GEOPHYSICAL METHOD	REFERENCE
A. Nth. Exit	Seismic	Rowston, 1961
B. N. Winnaleah	Seismic & Gravity	Sedmik, 1964
C. S. Winnaleah	Gravity	Howland Rose, 1964
D. Endurance	Seismic, Resistivity - Magnetic	Keunecke, 1957
E. Mussel Roe	Seismic & Gravity	Sedmik, 1964
F. ——	Aeromagnetic	(Adastra)
G. Whole area	Air - Radiometric	Mulder, 1961
H. Gr. Fraser	Seismic & Gravity	Sedmik, 1964



PREVIOUS GEOPHYSICAL TESTING, N.E. TASMANIAN TINFIELD.

FIG VII

TABLE G

COMPARISON OF SEISMIC SURVEYS - NORTH EASTERN TASMANIAN TINFIELD

Area	Reference	Layers Distinguished		Velocity (ft/sec.)	Geology	Boring
Endurance (D)	Keunecke (1957)	Surface layer, not always present	V_0	2,100 to 3,800	Soils, etc.	1 line of 18 bores to the east suggests the deep lead lies within the V_1 layer. The top of the V_2 layer probably gives broad indication of the course of the lead but not the depth.
		Upper layer	V_1	5,200		
		Lower layer	V_2	16,000 to 17,000	Tertiary sediments and weathered granite. Unweathered granite.	
Northern Exit (A)	Rowston (1961)	Upper layer	V_1	5,000	Sediments and weathered bedrock.	4 bores by Rio Tinto show rough correlation with the top of the V_2 layer when the 3,100 fps velocity used for V_1.
		Basement refractor	V_2	15,000 to 20,000	Unweathered bedrock.	
Rowston also did a calculation based on V_1 equals 3,100 f.p.s.						
North of Winnaleah (B)	Sedmik (1964)	No report yet available.				
Mussel Roe River (E)	Sedmik (1963)	Surface layer, not always present	V_0	3,600	Soils, etc.	1 line of 11 bores in S.W. corner suggest poor correlation with the top of the V_{1b} layer - but this layer could not be distinguished on all traverses.
		Upper layer	V_{1a}	4,000 to 5,500	Tertiary sediments.	
		Second upper layer	V_{1b}	6,000 to 9,500	Weathered bedrock.	
		Lower layer	V_2	12,000 to 18,500	Unweathered bedrock.	

the lower part of the lead channel at the Endurance mine. Mr. Ellett considered that this marcasite would constitute a target for electrical geophysical methods, particularly for I. P; he suggested that this possibility should be borne in mind and that particular attention should be paid to the presence or absence of marcasite in mapping old workings and in the study of old reports. As the work proceeded, it became evident that marcasite and the associated lignitic clay were restricted to the deeper parts of the lead channels and were seen or reported in virtually every deep lead in the tin field.

The advice of the Company's Senior Geophysicist, Mr. Don Hansen, was also sought in correspondence. He recommended a trial of variable frequency I. P using a 5 amp. capacity unit. It is therefore proposed to include a trial of the I. P method in the forthcoming test programme. Drilling, prior to the geophysical traverses, will be used to give an immediate knowledge of the ground being tested.

DRILLING

In the Company's testing of Wood's Mussel Roe River property, a standard alluvial drilling technique was used and a sampling procedure probably in advance of methods previously used in the field (see Appleby, 1964). However, the drilling and sampling, in spite of the care taken, were both felt to be unsatisfactory, and a search has been made for new or different techniques to give more dependable results. The advice of various contracting firms has been sought in correspondence, and Mr. Rodgers, Assistant Manager, visited Malaya in July, 1964, to examine drilling and mining practice there. Mr. Appleby is collating this information and is visiting drilling companies, and will advise on the best available rig. The sampling procedure is also under review, with experimental work being undertaken by Mr. Ken Blaskett of the CSIRO at the University of Melbourne.

Responsibility for advice on the best drilling technique will be with Mr. Appleby. In this section some of the problems of this type of alluvial drilling and some of the possible techniques will be noted.

Perhaps the largest single problem in testing deposits of this type is the smallness of the target. For example, a seam of pure cassiterite one-tenth inch in thickness is sufficient to bring ground 100 feet deep to a grade of 0.5 lb SnO_2/cu. yd. Or alternatively, the same one-tenth inch seam of pure cassiterite in a wash horizon ten feet thick gives a value of 12 lb SnO_2/cu. yd. As has already been described, the cassiterite of these deposits is concentrated into thin, narrow runs that are very restricted in size both horizontally and vertically. Thus the drilling method used must certainly retain all the heavy mineral in a hole and must be cheap enough to allow the largest possible number of holes to be drilled.

There are other problems encountered in the drilling at Wood's, or that can be foreseen from the nature of the alluvials. The Tertiary section is mainly composed of unconsolidated water-saturated medium to coarse sand (drift). If there is any difference between the hydrostatic head in the drill pipe and in the ground outside the pipe, this sand will flow laterally into the pipe. In places also where drift occurs below clay, ground water under the clay is under a head and will cause the drift to rise into the hole as soon as the drill pierces through the clay. It is difficult to compensate for this kind of rising ground, because it is difficult to get accurate volume measurements of drift; small changes in the amount of interstitial water can make quite large differences to the measured volume.

Other problems that are inherent in drilling the Tertiary section are due to the presence of thick (up to 20 feet) seams of heavy, puggy clay and of logs, generally lignitised and rotten but in places solid, and of large wash boulders, in the critical bottom wash zone, that are larger than the pipe diameter. A further problem arises because of the settling of cassiterite grains through sand as soon as the material is disturbed; for example, the conventional sand pump probably stirs the sample within the casing and allows the cassiterite to settle out.

A number of different drilling techniques have been examined but most, in essence, involve the placing of a casing and the removal of material from within the casing. Variations arise in the means used to place the casing, the means used to excavate material from within the casing, and in the degree to which the casing is in advance of the excavator. In conventional rigs used in this type of alluvial boring the casing is placed by percussion or by rotation but less conventional means, such as placement by vibrators or by using a water jet at the cutting shoe, are being examined. Material is extracted from within the casing by various kinds of grabs, by a sand pump or by a vacuum pump. Another possibility is to remove material in the manner of a diamond drill by a liner with a closing valve at the bottom, or even to have such a closing mechanism on the casing and to remove the whole casing with contained material.

Other techniques that have been noted include screw augering and a type of fast setting plastic grout which makes possible any conventional boring technique.

TEST AREA 1 SOUTHERN RINGAROOMA

Location and Access

Test Area 1 is on river flats of the Upper Ringarooma River between Branxholm and Derby. The river flats are subject to flooding, and in places they are covered by thick secondary growth. In other places they are farmed and access is easy. The river flats immediately north of Branxholm are low-lying but are so rarely flooded that they are built on (see Fig. IX).

The road from Branxholm to Derby is a bitumen road, part of the Launceston to St Helens Highway, that is kept in good repair. There is a direct rail connection between Branxholm and Launceston.

The two large mines, Briseis and the Arba and their immediate sub-basaltic extensions, are leased. The lessees are Briseis Tin N. L. and Mr. A. S. Edwards of Branxholm, respectively. Much of the area of the river flats is farmed and it will be necessary to give notice to owners of the intention to enter before drilling.

Previous Mining

Previous mining in and adjoining Test Area 1 is summarised in Table H. The history of the three largest mines, the Briseis, the Arba and the Valley, is given in some detail in "The Tin Resources of Tasmania" (King, 1963), and will not be repeated here. No mines are presently operating though some tributors work on the Briseis leases.

All the tin of the area is in deep leads. Table H gives the names of the main companies and the periods during which work was proceeding on the major leads. It will be seen from the "total production column" of the table that the majority of the production came from two leads, the Cascade and the Branxholm. The history of development of these two leads has been similar; both were found where exposed by present drainage and followed down below increasing overburden until basalt cover prohibited economic operation.

Equidistant between the Cascade and the Branxholm Leads is the Valley Lead. This lead, unlike the other two, has had its basalt cover stripped by the present Ringarooma River. The Valley Lead appears to have been a smaller and shorter Tertiary river than the Cascade or the Branxholm Leads, and its headwaters did not extend back into the best shedding area.

Other mining activity was concentrated at Ruby Flat to the south of Branxholm where shallow rich alluvials were worked during the earliest history of the tin field. Removal of the alluvials revealed tin-bearing greisenous granite, which was worked with only limited success. Similar greisen veins and overlying eluvial material were also worked at Mt Paris and at other places to the south and east of Ruby Flat.

Geology

The broad elements of the geology (Plate 5) are a basement of granite and meta-sediments (Silurian, Mathinna Beds) now exposed only on the higher valley sides, a thick accumulation of Tertiary fluviatile sediments filling the valley and a layer of basalt of late Tertiary age, covering the sedimentary valley fill. The present Ringarooma River has cut through the basalt and has produced a "valley in valley" topography. The three elements of the topography are thus :-

1. the basement slopes of the main valley sides above the basalt;
2. the flat farmed land of the basalt covered Tertiary valley floor; and
3. the river flats about 100 feet below the basalt floor.

Nye (1925) proposed a simple scheme of Tertiary drainage - a system of tributary leads such as the Cascade, Valley, Branxholm and Black Creek Leads, feeding into a main lead, the Ringarooma Lead, flowing out north-east from Branxholm and into Bass Strait by a course to the west of Mt Cameron. Nye presumed that the essentials of this drainage had been established in the early Tertiary, and that the channels had gradually choked up with fluviatile sediments until finally, in the late Tertiary, a basalt effusion filled the main valley and in places backed up the tributaries Nye considered that the basalt flows were responsible for the diversion of the pre-basalt drainage to its present form.

Our work has led to the conclusion that two Tertiary drainage systems, and not only one, have to be considered; a late Tertiary pattern established by late Tertiary faulting immediately before the basalt effusion, and an early Tertiary pattern with which the bulk of the tin is associated, which now exists only as dislocated remnants below late Tertiary deposits. In this view it is unlikely that the Leads that have already been worked will be found united into a "main Ringarooma Lead" in this area. It is considered more likely that the Cascade and Valley Leads will persist in a north-westerly direction to the foothills of the Mt Horror ridge where they have been cut off by late Tertiary fault movements. Further south the north-flowing Branxholm Lead, mined at the Arba mine, is probably joined below Arba Hill by an unnamed tributary lead and the Black Creek Lead from the south-east and the resultant single Arba Lead probably flows north-west under the Ringarooma River flats north-west of Arba Hill. Further south again it is thought that Ruby Flat is a remnant of another north-west flowing lead that has been up-faulted and is now perched. The continuation of this Ruby Flat Lead is thought to be at the old Mt Joseph mine and may persist below the Legerwood Creek river flats to the north-west. These leads are briefly described below.

Cascade Lead

In its upper reaches this lead was well defined between granite walls and was easily followed. It continued on a north-west course below the Ringarooma River and under the basalt cover of the main valley. At Derby the Ringarooma River has cut itself a deep channel where the basalt lapped against the granite basement and in so doing has stripped out the granite wall that originally contained the Cascade Lead on the south-west side. This stripping has given a false impression that the lead channel broadened at this point as it left a mountain tract. In fact whatever changes did occur in the width and gradient of the channel seem to have been gradual. Two thousand feet north of the Ringarooma River bridge at Derby the basalt appears to rest directly on bedrock (Mathinna slates) and on this northern side the lead is evidently well contained.

Production figures show a total production of 20,787 tons metallic tin from the Cascade Lead. The length of lead that has been mined is something less than 10,000 feet, and the tonnage of tin per 1,000 feet of lead is more than 2,000 tons therefore. This lead is clearly the richest lead in the tin field. Its extensions lie under 200 feet of basalt and 200 feet or more of Tertiary sedimentary valley fill to the north-west of the Briseis mine. Drilling ahead of the working face has indicated nine million cubic yards of 0.30 lb Sn/cu.yd up to 400 feet deep (Braithwaite, 1963). The high values of the lead are confined to the lowermost 50 feet above bedrock. In spite of the richness of the lead, the cost of removing the thick basaltic over-burden makes a continuation of mining by open pitting impossible. To mine the lead underground would also be prohibitively expensive because of the thickness (50 feet) containing the high values.

Valley Lead

The north-west trend of this lead is well established from the old workings and from the trend of the present day Valley Creek running into the south-east end of the old workings. This creek has evidently exhumed the early Tertiary valley. The lead appears to have provided about 370 tons of tin over a worked length of about 2,000 feet, or approximately 180 tons of tin to each 1,000 feet of length. Several boring campaigns have been undertaken to test the north-westerly continuations of the Valley Lead. The reliability of these various drilling campaigns is not known. Nye suggests that 900,000 cubic yards of a grade between 0.39 and 0.8 lb Sn/cu. yd of down to 150 feet depth is indicated. From the old production records (which may, however, be incomplete) this would appear to be an overstatement of grade. The lead appears never to have had extensive headwaters (cf. the Cascade Lead or the Branxholm Lead) and it is likely to be much poorer than other leads in the area.

The Arba Lead System

The lead mined in the Arba workings was the north flowing Branxholm Creek Lead. At the extreme north end of the old Arba workings a second lead, flowing north-west, joined the Branxholm Creek Lead and the united lead is thought to continue to the north-west under Arba Hill. Further north again the Black Creek Lead flowed north-west under Arba Hill and probably joins the other two. The united leads, termed here the Arba Lead, which Nye thought would emerge at the north-east end of Arba Hill and head north to join his "main Ringarooma Lead", is now thought likely to emerge at the north-west corner of Arba Hill and to follow a predominantly north-westerly course under the Ringarooma River flats.

Drilling ahead of the Arba face has indicated approximately $4\frac{1}{2}$ million cubic yards of 0.28 lb Sn/cu. yd at depths of up to 200 feet (King, 1963). This drilling may not have been across the full width of the lead, particularly on the south side. The basalt cap on Arba Hill is said to be about 60 feet thick and to be made up of 30 feet of fairly solid basalt and 30 feet of solid, decomposed material. The depth of the Arba Lead when it emerges from Arba Hill is likely to be about 100 feet. The Branxholm Lead seems to have averaged more than 500 tons of tin to each 1,000 feet of lead, and the Arba Lead emerging from under Arba Hill might be of comparable richness.

Ruby Flat/Mt Joseph Lead

Topographically Ruby Flat is a broad, flat-floored north-west trending valley cut into bedrock. The valley is perched and ends abruptly at the north-west end at the Ringarooma River (Fig. VIII). The river is here rigorously contained along a strong north-south lineation, with basalt on the west side and basement granite and slate on the higher east side. The Ruby Flat valley is perched above the Ringarooma, its floor being at about the same height as the top of the basalt on the west side of the River. An isolated remnant of basalt, some 200 feet higher than the basalt of the main valley, forms Grey's Hill on the north side of Ruby Flat. It appears that the Ruby Flat valley was once part of an early Tertiary lead flowing north-west but that it has been faulted up and has most of its basalt and alluvial fill stripped out. Its continuation is thought to be at the Mt Joseph mine where Nye (1925) records that mining of a lead type of deposit was hampered by the presence of a great deal of marcasite. This newly recognised Ruby Flat/Mt Joseph Lead may persist on a north-westerly course under the narrow basalt-capped ridge and under the Legerwood Creek flats.

Proposed Testing

The proposed testing is designed to search for extensions to the Arba Lead, the Ruby Flat/Mt Joseph Lead, and possibly the Valley Lead (Plate 5).

Of these three, the most important is thought to be the Arba Lead where a 5,000 feet long extension may exist below the Ringarooma River flats. It is hoped to be able to locate this lead where it emerges from the basalt-capped Arba Hill. The first holes proposed are in a line running along the north and north-west edge of Arba Hill. Further lines will be placed on the basis of the basement configuration revealed by the first line.

The Ruby Flat/Mt Joseph Lead may persist under the Legerwood Creek flats. The possible extension is here shorter, 3,500 feet, and is partly basalt covered at the south-east end. The main road and railway cross this possible extension. It may be best to first establish the direction of the extension by drilling through the basalt-capped ridge to the immediate north-west of the Mt Joseph mine.

The Valley Lead offers a possible 3,000 feet long extension below the Ringarooma River flats. The grade of the lead is thought to be low, however, and this target is not given high priority within this test area. From recorded production the lead may only contain about 180 tons of tin

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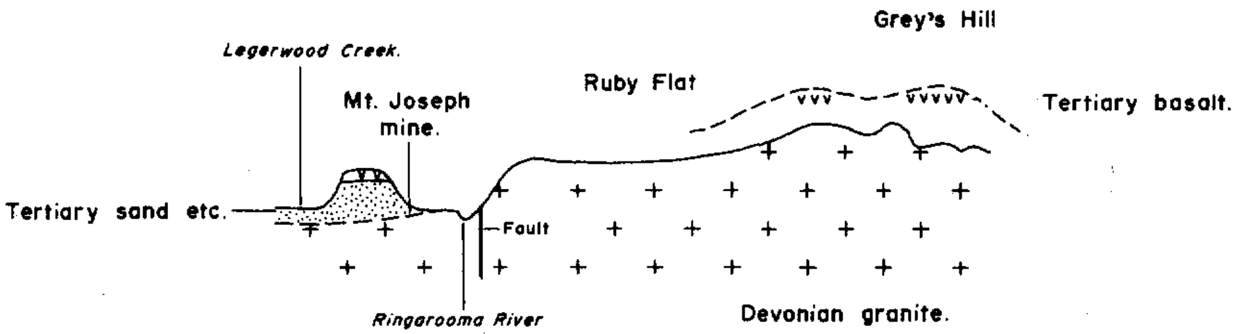
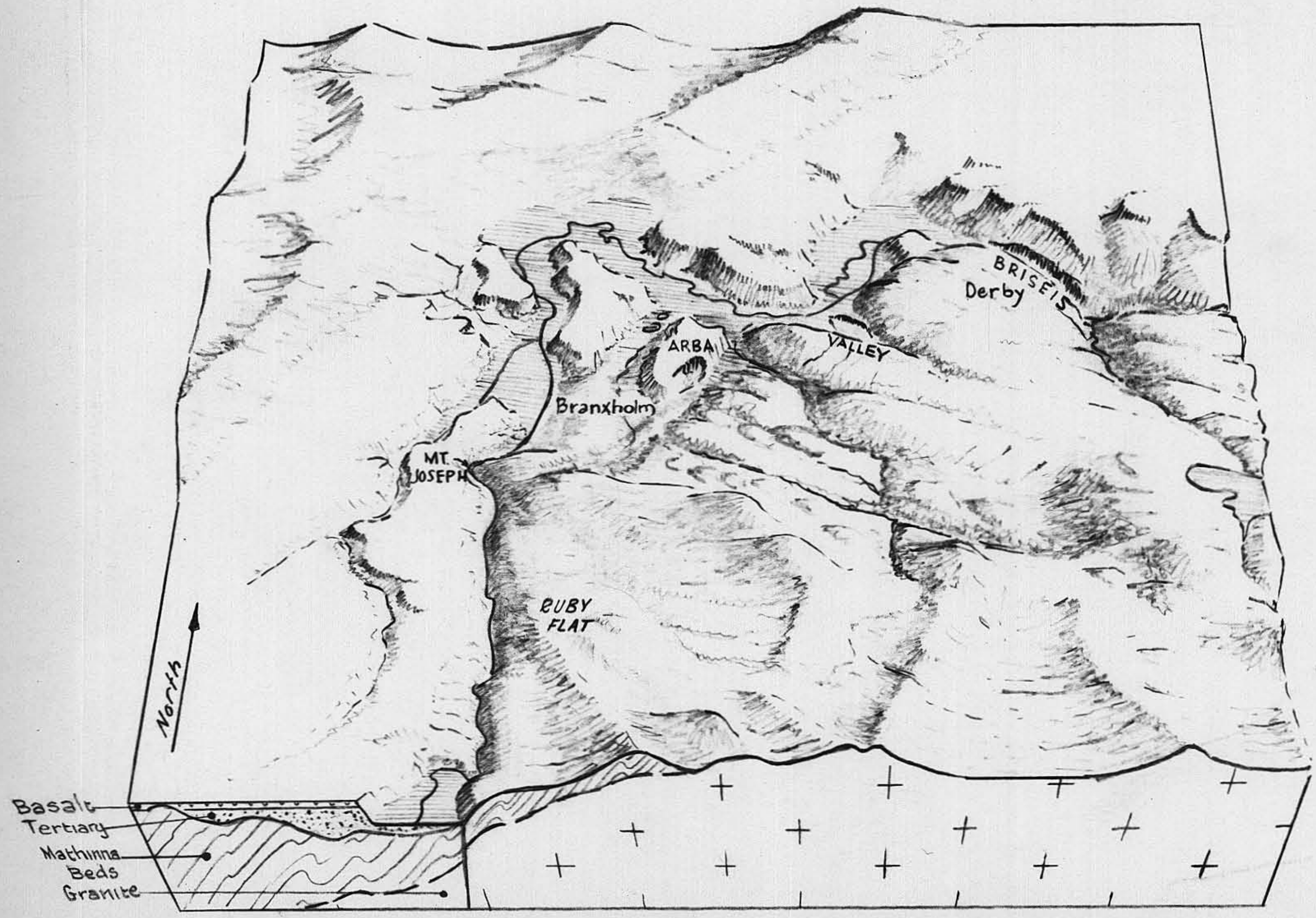


SKETCH SECTION (N.W.) THROUGH RUBY FLAT AND THE MT. JOSEPH MINE.

FIG VIII



PHYSIOGRAPHIC SKETCH - TEST AREA No. I.

FIG IX

Report No. 130

Report No. 130.

TABLE H.
Follows Page 44.

TEST AREA 1 - (SOUTHERN RINGAROOMA)

Summary of Previous Mining and of Proposed Drilling

		PREVIOUS MINING					PROPOSED DRILLING	
Lead	Companies, etc.	Working Period	Geology	Indicated Extensions	Total production (tons Sn)	Possible Tonnage tin/1000'	Possible Extension (feet)	Proposed Footage
Cascade	Krushka Bros., Brothers Home, etc., Briseis TMC.	1875-1959	Lead trending NW and NNW. Remaining extension covered by 200 ft. of basalt.	Approx. 9 million cu.yds. of .30 lbs Sn/cu.yd.; 1200 tons Sn, up to 400' deep (Braithwaite, 1963).	20,787	2,000	All extensions sub-basaltic.	None
Valley	Ringarooma Valley TMC (1885), Briseis Extended TMC, Briseis Central TMC, and Briseis TMC.	1882 first lease. 1885-1892 1904-1910	Lead trending NW. Basalt cover removed by Ringarooma. Short headwaters.	Approx. 900,000 cu.yds. of .39 to .8 lb Sn/cu.yd. 225 tons Sn, 150' to 200' deep (Nye, 1925).	363	180	3,000	750
Branxholm, Black Ck. & Arba	Arba T.M.Co. Ormuz Co.	Before 1883 to 1899. 1899-1902 development. 1902-1919 continuous production.	Leads trending N and NW unite under Arba Hill to form single NW(?) trending lead.	Approx. 4½ million cu.yds. of .28 lb Sn/cu.yd. 550 tons Sn, 200' deep (King, 1963).	2,180	500	5,000 (+2000' below basalt)	1,750
Ruby Flat-Mt.Joseph	?	Ruby Flat let to Chinese tributors by 1886. Mt.Joseph worked before 1925.	Possible lead trending NW.	None.	?	?500	3,500*	500
Lode Mines	-	Generally before 1900.	Greisen veins in aplitic granite.					None

* Including about 1000 ft. with thin basalt cover.

per thousand feet length of lead. This would mean that the extension could contain six million cubic yards of 0.2 lb Sn/cu. yd.

The Cascade Lead is thought likely to follow a north-westerly course under the basalt until cut off by the uplift of the Mt Horror ridge. It is possible, however, that it may follow a westerly course and be found under the Ringarooma River flats between Branxholm and Derby. It is not proposed to test for this possibility in this programme.

TEST AREA 2

Location and Access

The location of Test Area 2 is shown on Plate 1, and the area is shown in detail (1 inch to 400 feet) on Plate 6. The area can be reached from the north, through Lawry's workings from the Gladstone-Anson's Bay Road, or from the south along the Ogilvie's Bridge Road. The area is about six miles from Gladstone by either route.

Test Area 2 is an area of low rolling hills between the Ringarooma and the Mussel Roe Rivers, where the two rivers are at their closest. Weathering and erosion of unconsolidated Tertiary sand, siltstone and clay has produced sandy rises with scattered medium-sized eucalypts among bracken and coarse grasses alternating with lower flats, commonly swampy and characterised by peaty soils, button grass, some scrubby acacia and no large eucalypts. The surface of the sandy rises is always firm and dries quickly even after heavy rain; the button grass flats may remain swampy and treacherous for most of the year, but are usually sufficiently firm to allow a Land Rover to be driven over them. A heavier vehicle, a Land Rover with heavy load or a Land Rover towing a trailer, soon loses traction and bogs down.

Previous Mining

There has been some mining activity in this area since before the beginning of the century. Individual properties have each only been worked for a short time, but interest in the general area has been almost continuous. Although these early workings were very numerous, no operator found a single traceable deep lead deposit with consequent assured production over a long period of time. In this regard the area has a similar early history to that of the Endurance area, but by contrast early scattered workings there were eventually overshadowed in importance by the finding of the Endurance Lead.

No reliable production figures are available at all before 1900. From that date onwards the annual reports of the Director of Mines give a summary of the returns from the Gladstone districts. As the mines in Test Area 2 were generally only one-man shows, or operated by small syndicates, their returns are not separately listed, and it is not possible to determine how much tin was won from an individual property. Fifteen properties are listed in Table I, with some indications as to the type of ground exposed in the workings, notes on the periods over which properties appear to have been worked, and some estimate of the yardage moved.

The Government geologist reported on the area in 1901 and again in 1916 (Twelvetrees, 1901, 1916). By 1901 the area had already a history of more than 30 years' mining and a majority of the workings were already in existence (Edina, Traceys, Watts, Moores, Garfield, Tamar, The Empress and Murray's Lode). The largest workings, and probably the most productive mine at this time were the Edina. Twelvetrees (1901) reports that the operator was producing about 1½ tons of concentrates a month.

The most impressive mine before this date was evidently the Empress. Here a north-south lead remnant was found crossing the east-trending ridge separating Harden's Ravine and Tamar Creek. The remnant of lead was perched, its floor being some 40 feet higher than the valleys at either end. The wash was evidently of coarse sub-angular cobbles and boulders and the tin very coarse (nuggets of up to 1 oz are reported), but the remainder of the sequence is not described. There is a report of a production of about 100 tons metallic tin for 1885 - 1886, but the total production may have been considerably more.

The Watts, Garfield and Tamar properties were all in existence by 1901 but generally only an upper sequence was worked. In Watt's workings the false bottom was a brown lignitic clay which may cover a deep lead (see drilling recommendations); in the Garfield and Tamar area the false bottom is more generally the middle sequence (see "Geology") of fine sand, drift and wash carrying only trace amounts of tin. The tin in the upper sequence was found to be sporadic and operators evidently made only a precarious living. In 1904 the newly formed Cybele Tin Mines Company took up a large area, including Watts, Garfield and Tamar, and made a determined effort to design a systematic mining operation with an extensive preliminary drilling programme. By the end of 1906 they were ready to begin mining, but their first sluicing (apparently at the old

Garfield mine) was so disappointing that they closed down operations in 1907.

From 1907 to 1911 the Purdue and Purdue Extended (Jewel Flats) mines were worked, apparently with considerable success. The ground at the Purdue appears to have been similar in every way to that of the Edina; Jewel Flats may have been the same also but alternatively they may have been deposits of the present Ringarooma River. The returns of Purdue for 1908 to 1910 total 192.10 tons SnO_2 concentrate (124.8 tons Sn @ 65%); for part of 1907 and 1908 the sluicing of 46,000 cu.yd gave 63 tons SnO_2 (40.95 tons Sn) - equivalent to a grade of 1.99 lb Sn/cu.yd. Apparently by 1911 the ground was practically worked out and the plant was sold.

Some mining activity continued on Garfield Hill, at least during 1913 and 1914, no large-scale work was done until the Garfield Tin Mining Company was established in 1926. They evidently used the 1904 - 1905 boring of Cybele Tin Mines as a basis for their programme. They began operating in 1927 but ceased early in 1928 after a return of 4.36 tons (Sn) out of 41,454 cu.yd sluiced (0.23 lb Sn/cu.yd) during 1928.

The Star Hill Syndicate, which had previously worked extensive areas of eluvial material and soft greisenous granite on the north side of the Ringarooma River to the west of Ogilvie's Bridge (see Plate 2), took up leases in the Garfield-Tamar-Watts area in about 1952, and now hold a consolidated lease covering the north-west corner of Test Area 2. They have mined away most of the top of the original Garfield ridge, but the operation has only been marginal. At the extreme east end, these workings are on a false bottom of the middle sequence. In the centre the workings are to bedrock and at the west end they are again to a false bottom of the middle sequence. In some workings at the west end there are indications of the lower sequence and of the possible existence of a deep lead below the old workings (see "Proposed Testing").

The production records for the Star Hill Syndicate from 1952 - 1962 indicate the winning of a total of 186.57 tons Sn. A calculation of grade for those years for which a yardage is available suggests an average grade of 0.45 lb Sn/cu.yd.

In 1956 a local syndicate was formed to mine a new property now called the Elizabeth mine. The returns were apparently not adequate, and the syndicate disbanded. The Star Hill Syndicate leased the same ground and mined an upper wash in a few places during 1961 and 1962. At present the ground is leased by a local syndicate of two men.

SUMMARY OF MINING ACTIVITIES - TEST AREA 2

Property	Geology	History	Approx. Ydge Removed (by calculatn)	Recorded Productn (tons Sn)	Comment
Arcadia	Mathinna cobble wash below sequence with siliceous cemented drift.	Taken up in 1926.			
Purdue	Mathinna cobble wash below sequence with siliceous cemented drift.	Worked from 1907 to 1911.	400,000	124.8	
Jewel Flats (Purdue extended)	May have been similar material to Purdue mine, but overlain by recent river deposits, tailings, etc.	Began working about 1910.	400,000		
Edina	Mathinna cobble wash below sequence with siliceous cemented drift.	Worked before 1901 - continued on small scale at least to 1921.)		$1\frac{1}{2}$ tons per month reported 1901.	
Daws (Originally part of Edina)	Tertiary sequence on granite bedrock - without the characteristic Mathinna cobble wash.	)	750,000		Possible extension to N.E.
New Edina	Later workings at New Edina, with characteristic Mathinna cobble wash.				Some wash remains, possible extension to N.

Property	Geology	History	Approx. Ydge Removed (by calculatn)	Recorded Productn (tons Sn)	Comment
Moores	Mathinna cobble wash below sequence with siliceous cemented drift (reported by Twelvetrees, 1901)				
Traceys	Tertiary sequence on granite bedrock.	Worked in 1901.	80, 000	5 tons SnO_2 reported by 1901.	
Watts (Cybele)	Upper wash worked to false bottom of brown lignitic siltstone.	Worked before 1901 and in 1913, 1914.			Possible lead exists below old workings.
Garfield	Generally only upper wash worked. Full Tertiary sequence in places on granite or Mathinna bedrock.	Worked 1926 to early 1929 (Garfield TMC)		4. 35 (1928)	
New Esk	Eluvial material and soft greisenous granite on south side of Harden's Ravine.				
Empress	Perched "lead" remnant running N-S across ridge between Harden's Ravine and Tamar Creek.	Worked from 1885-1886.	100, 000	98. 1	
Murray's Lode	Greisen dyke in Mathinna, strikes 330°, 1 foot wide.				

Previous Drilling

Previous drilling in the area is summarised in Table J; the positions of boreholes are plotted, with the best accuracy possible on Plate 6.

The initial campaign was that of the Mines Department in 1901. The drilling, proposed by the Government geologist (W. A. Twelvetrees) after his survey of the Gladstone district in 1901, was designed to locate the northern continuation of an ancestral Mussel Roe Lead which he thought probably continued from Carrol's Flat (the "Eastern Terrace" of Wood's Mussel Roe River property) north and north-west across the area, passing through the Watts, Garfield and Tamar mines and continuing through the Lochaber mine to the Great Northern Plain. It now seems evident that no such Mussel Roe Lead exists, but that the drainage in this area was in various directions off a high that existed in the centre of the present Star Hill workings. The 1901 drilling did locate some gutters and some tin, and it is proposed to further test one of these (Watt's workings).

In 1904 Cybele Tin Mines undertook an extensive testing programme on Garfield Ridge. Subsequently some doubt has been cast on the tin values obtained, the Government geologist later saying that the actual values were closer to one-third of the Cybele values (McIntosh, Reid, 1928). Much of the ground tested has now been worked out by the Garfield Tin Mining Company or by the Star Hill Syndicate.

From 1916 onwards the Government boring plant was operating in the Gladstone district, testing ahead of small workings as an assistance to small operators. In places this testing was not to bedrock, as in general the operators could only work comparatively shallow ground (less than 50 feet deep).

Further boring by the Mines Department in 1937, 1945 and 1953 is shown on Plate 6, and listed in Table J. The 1937 drilling (c) showed rapidly falling bedrock at the north-west end of the line and is thought to be on the south-east slope of a north-east trending gutter. The 1945 drilling (e) indicates about 90,000 cu.yd of 0.31 lb Sn/cu.yd material filling a short length of gutter trending north-west. This small area is important as it is not limited at all to the north, south or west, and not seriously limited to the east, so that extension in any direction may exist. The small gutter feeds into the Northern Mussel Roe Swamp - one of the areas proposed for separate testing. The 1953 testing (f) also tests part of the Northern Mussel Roe Swamp and indicates interesting values near the junction of Garfield Creek and the Mussel Roe River.

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Follows p. 48.
TABLE J.

SUMMARY OF DRILLING - TEST AREA 2

Year	Symbol on Plate 6	Mines Dept Plan No.	No. of Bores	Av. Depth to Bedrock (Feet)	Deepest Bore	No. of Bores with Tin	Av. Grade of Bores with Tin (lb Sn/cy)	Locality	Comment
1901	A 2		11	30.5	54.5	-	-	East of Edina.	Bored in 1902 on recommendation of Government Geologist (Twelvetrees 1901, reported 1902). Attempt to find "Mussel Roe Lead". Not successful in that, but did locate gutters and some tin. Upper ground of A3 worked out.
	A 3		32	61.5	102	8	-	Watt's.	
	A 4		3	33.5	64	-	-	Tamar Creek.	
1904		915	142					Garfield Ridge.	Drilling by Cybele Tin Mines (Capt. Thomas) mainly on Garfield Ridge. Indicated considerable yardage of shallow ground. Grades from drilling evidently unreliable. Ground later mostly worked by Garfield Tin Mining Co, and latterly by Star Hill Syndicate.
1916	B 2	248	13	13	36.5	-	-	South east Purdue.	Programme designed as an assistance to individual miners and small syndicates. Drilling for extensions of workings. Located some gutters and some tin; some of the indicated ground subsequently worked out. No collar elevations available and only limited descriptions of lithology. B8, B9 and B10 now largely worked by Star Hill Syndicate.
	B 3	249	13	21	44.5	1	.17	Jewel Flat.	
	B 4	250	32	23	40	6	.20	Edina Flat.	
	B 5	251	14	12	28	-	-	Lark Creek.	
	B 6	252	8	16	15.5	5	.18	Ridge N of Edina.	
	B 7	253	11	24	37.5	1	.13	East of Moores.	
	B 8	254	30	14	35.5	3	.35	Garfields Creek.	
	B 9	255	10	18.5	42	3	.27	Lawry's Hill.	
	B10	256	16	11	22	11	.17	East end of Harden's Ravine.	
	B11	257	11	15	27	1	.13	S of Tamar Creek.	
1937	C	741	15	37	102	Trace only		North of A2	No collar elevations available, but appears to indicate SE slope of a gutter.
1945	E	987.25	27	25	29	5	.31	East side of Mussel Roe.	Indicates about 90,000 cy with grade of 0.31 lb Sn/cy, and possible extension to north and south.
1953	F 1	1311-25 & 1311A-25	144	24	59	33	.27	North Mussel Roe/ Garfield Creek.	E-W line across Garfield Creek and Mussel Roe River in north-east corner of area.

Leased Land

The three sections of leased ground within Test Area 2 are shown on Plate 6.

The largest holding is of 118 acres by the Star Hill Syndicate (late Mr. H. C. Lawry) to the north. The Syndicate have mined the upper part of the Tertiary section; in the central part of their leases this upper part rests directly on bedrock, elsewhere the workings have a "false bottom" of siltstone or fine sand.

Mr. E. K. King and Mr. M. J. Dunstan hold 20 acres at the Elizabeth mine. These two operators are stripping overburden with a bulldozer and ground sluicing the underlying wash in shallow (maximum 12 feet) workings on a granite bedrock.

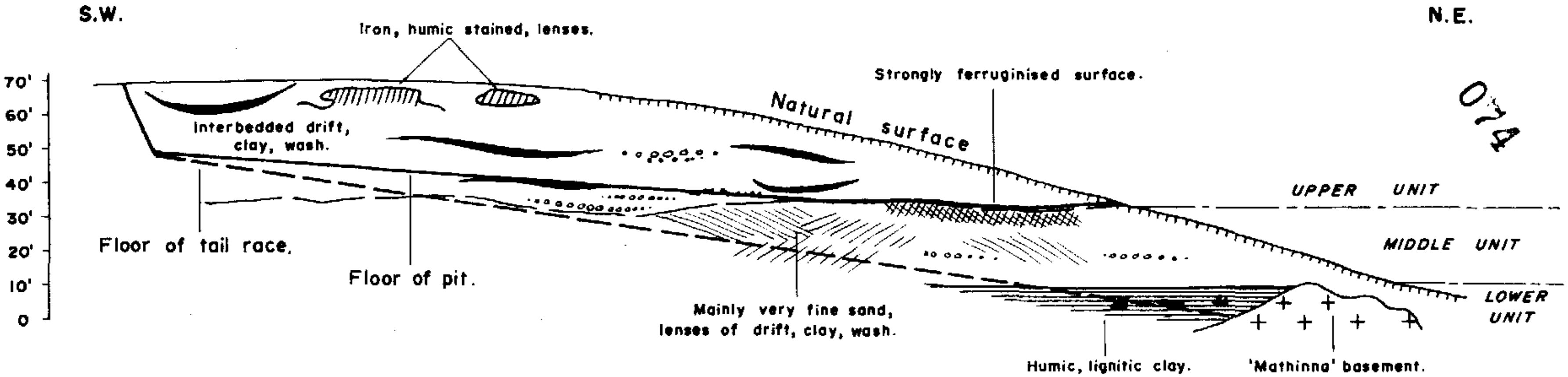
Mr. S. R. Fletcher holds 20 acres of shallow ground near Daw's workings to the north of the Edina workings. No activity has been observed on this lease during the tenure of our Exploration Licence. The ground held is shallow and has been partly sluiced.

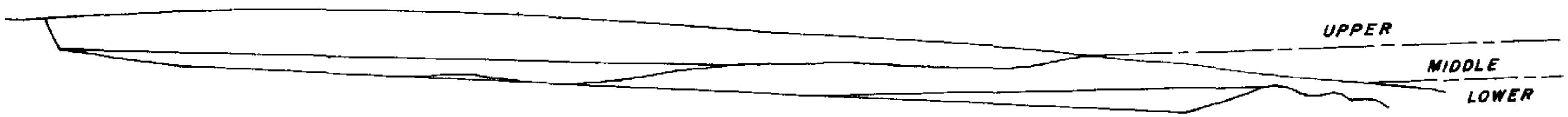
Our proposed testing is not seriously hampered by these holdings except in the north-west where we would like to drill for a possible deep lead below part of Lawry's Consolidated Lease.

Geology

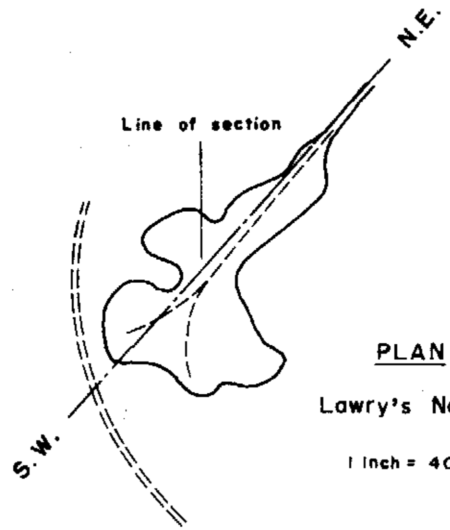
The Tertiary sequence that has been reconstructed from the exposures in old workings is shown in the generalised section in Table B. The sequence is divided broadly into upper, middle and lower units. All exposures of the section are incomplete, but Lawry's No. 1 Pit exposes each of the three units progressively along a deeply cut tail race (see Fig. X).

The lower unit is characterised by a purple/brown humic, lignitic and commonly marcasitic clay. In places this clay laps directly on to basement but in other places the clay may cover deeper gutters in the bedrock containing drift and wash. The lignitised wood occurs as logs, branches and tree stumps randomly distributed in the massive unlaminated humic clay.





Natural scale.



PLAN

Lawry's No. 1 Pit.

1 inch = 400 Ft.

GENERALIZED SECTION
ALONG PIT AND TAIL-RACE, LAWRY'S No. 1 PIT.

FIG X

Horizontal scale: 1 inch = 100 ft.

5 cm

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The middle unit is a thick accumulation containing various lithologies interbedded but dominantly either drift derived from weathering granite or fine-grained sand derived from weathering Mathinna group siliceous metasediments. Interbedded with the drift or fine sand are clay and wash lenses. The middle unit commonly has a ferruginous upper surface; the lower surface resting on bedrock, or the humic clay of the lower unit, does not generally have a marked wash horizon.

By contrast the upper unit generally begins with a well marked wash horizon resting on bedrock or on the ferruginous top of the middle unit or on the top of the humic clay where the middle unit is missing. The sediments of the upper unit are typical flood-plain types, interbedded gravel, sand, silt and clay with scour and fill features marking the lateral migrations of drainage channels. A typical lithology is the well-rounded, well-sorted quartz pebble gravel, known locally as "birdseye" wash. Much of the material of this upper unit appears to be re-worked material redistributed after a period of late Tertiary faulting.

The majority of the mining so far in the area, particularly in the Garfield, Tamar and Watts mines and in the present Star Hill Syndicate workings, has been of the upper unit only. The central parts of the Star Hill workings are to bedrock but the sequence is apparently the upper one resting directly on bedrock; there are none of the characteristic lithologies of the middle and lower units, nor any large, well defined gutters cut into the bedrock as there would be for a true lead. The south-west workings, however, the Arcadia, Purdue and Edina workings, seem to have been in a true deep lead - with thick Mathinna cobble gravels resting directly on basement and overlain by some drift and in part by humic clay. It seems in fact that here was a deep lead from which most of the cover had been stripped, presumably by the erosive action of the present Ringarooma River (Fig. XI). Other evidence, particularly the presence of humic clay, points to the existence of deep leads below the mined sequence in the northern workings.

Proposed Testing

The testing programme is designed to locate the deep leads described above and not to assess whatever still exists in unmined upper unit ground in the area. The target is an elusive one; it appears certain that the original early Tertiary drainage pattern, to which the true deep leads belong, has been dismembered by late Tertiary faulting and that all that remains are lead remnants, separated from one another and blanketed by a late Tertiary cover.

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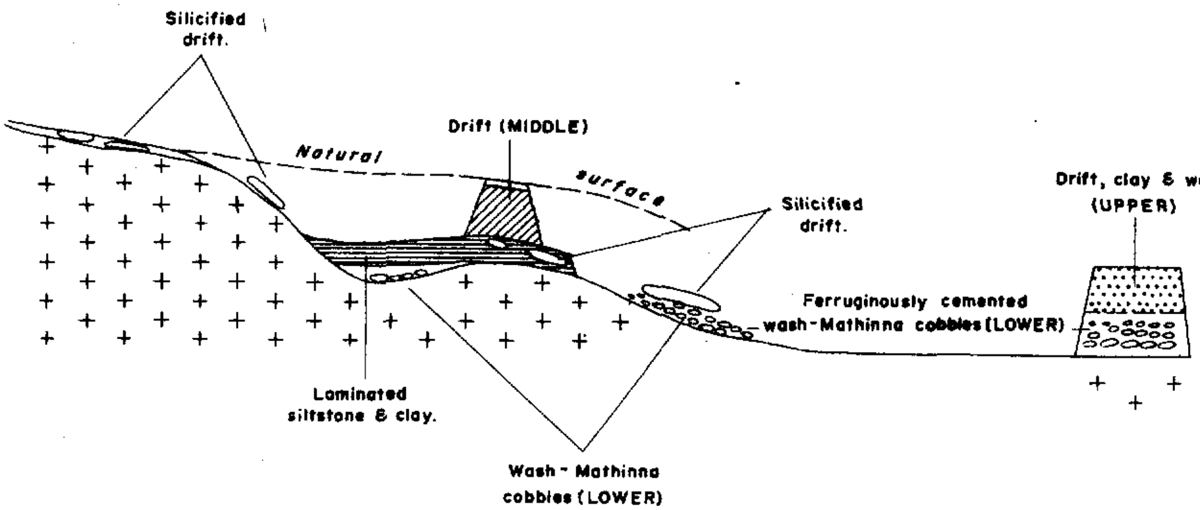

DIAGRAMMATIC SECTION - EDINA WORKINGS

FIG XI

Testing is concentrated in three areas :-

(1) Area A : for a possible northward continuation of the continuation of the Arcadia, Purdue, Edina Leads.

(2) Area B : where a humic clay false bottom to Watt's workings may cover a deep lead which may be trending to the north-east.

(3) Area C : where a small pit on the south side of a ridge exposes a granite boulder wash covered by a humic siltstone. This may be part of a lead running north or north-east across the ridge. It is close to the rich north-trending "Empress Lead" remnant.

It is proposed initially to test these areas by drilling without preliminary geophysics. In each instance there is a starting point, and the first drill traverses are designed to pick up the continuation. Each subsequent drill traverse may be modified to accommodate the findings of the previous traverse. The proposed drill traverses are shown on Plate 6.

TEST AREA 3 LOCHABER/SCOTIA

Location and Access

Test Area 3 is an area of mild relief to the north of the Ringarooma River on the south-east corner of the Great Northern Plain. The area to be tested is about two miles from Gladstone, close to a formed, all-weather gravel road from Gladstone to the Dorset Dredge.

Previous Mining

The two most productive mines in the area have been the Scotia and the Lochaber (Plate 7). Both were worked before 1900 and very few production figures are available.

The Scotia was worked by the Scotia Tin Mining Company in the 1880's and by J. Galloway at the turn of the century. Nye, writing in 1932, reports local hearsay that the Scotia Company produced 500 tons (concentrates) and Galloway a further 500 tons. The only Mines Department returns available are for 1901-1910 - totalling 201.9 tons

SUMMARY OF PREVIOUS MINING - TEST AREA 3

Property	Production	Working Period	Geology
Scotia	May total 1,000 tons (Nye, 1932)	1881-?1891 (Scotia TMC) 1900- 1908 (J. Galloway)	Three part Tertiary sequence exposed. Best values reputedly in bottom sub-angular boulder wash and in shallow tributary ground to south and west. Lowest part of Tertiary sequence marked by lignitic clay. Possible extensions to N and NE (small).
Newhaven Workings - Name given to northern part, earliest worked part, of Scotia Mines.			
Lochaber	2 - 4 tons a week in 1885. ½ ton a month in period before 1901.	1880's (Imperial TMC) In production in 1904. Not worked in 1926. 1932-? (Standage).	Three part Tertiary sequence exposed. Best values reputedly in bottom wash of coarse, round to sub-round cobble and boulder wash and in shallower tributary ground to south, west & southwest. Lowest part of Tertiary sequence marked by lignitic clay. Possible extensions below old workings and possible renewal of similar ground to NW or to north.
Mallinson's Workings			Workings may be on eastern edge of area drilled by Mines Branch to west.
Doone	2.8 tons Sn listed in 1912.	Probably early and worked in a small way since.	Shallower than Lochaber or Scotia. Some possibility that similar lead of lower Tertiary may exist to immediate north of Doone workings.

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TABLE L.

SUMMARY OF PREVIOUS DRILLING - TEST AREA 3

Year	Symbol	Mines Dept Plan No.	No. of Bores	Av. Depth to Bedrock (Feet)	Deepest Bore	No. of Bores with Tin	Av. Grade of Bores with Tin (lb Sn/cy)	Locality	Comment
1901	A 5	-	31	61.5	114.5	4	Trace only		Part of programme proposed by Government Geologist (Twelvetrees, 1901, 1902) to locate "Mussel Roe Lead".
1916	B13	259	11	25	31.5	4	.24	Ringarooma Flats (Gladstone).	Part of programme to assist operators by boring ahead.
	B14	260	5	58	66.5	-	Trace	West of Mallinson's Workings.	
	B15	261	13	28	72	1	.29	Newhaven.	
	B16	262	24	6	10.5	21	.37	West of Scotia.	
	B17	263	27	25	44.5	13	.68	South of Scotia.	
	B18	264 & 265	19	20	38	2	.20	South of Ringarooma, (Filumena).	
	B19	266	36	22	43	5	.22	Doone.	
1926-1932	G		25	Boring by Alluvial Tin Co. at some time prior to 1932 - no records exist.					
1935-1944	H		855	91	-	185	.34	Scotia/Lochaber Lead.	Extensive boring campaign summarised in Table M.
1958	I		9	99	104	8	.07	Scotia/Lochaber Lead.	Check boring of one line of Government boring by Rio Tinto Australian Exploration Pty Ltd in Scotia/Lochaber Lead area.

(concentrates) with a maximum of 94 tons in 1904. The total production is clearly more than 200 tons but may not be as high as the 1,000 tons estimated by Nye. Parts of the Scotia ground produced gold values as high as 1 oz gold to 1 ton of tin (Twelvetrees, 1901).

The Lochaber was worked by the Imperial Tin Mining Company in the 1880's, and was reported to be producing between two and four tons of concentrates a week in 1885. The mine was reopened in a small way by a local syndicate in the 1930's, but the production was not separately listed in the returns for the Gladstone area and cannot be estimated. Mallinson's workings (Plate 7) are small, shallow (12 feet) workings probably worked in the early 1900's. Their significance is that they may show the eastern lip of the deeper ground, possibly a true lead remnant to the west of that shown by Mines Department drilling.

The Doone mine (Plate 7) is an old working, probably dating from the 1880's, for which no production figures are available. There is reportedly deeper ground to the east of the old workings, and there may be a lead remnant here as at Lochaber and Scotia.

Previous Drilling

Previous drilling in Test Area 3 is summarised in Table L.

In 1901 the Mines Department put in a single line (A5) trending north-north-east to the west of the Scotia and Lochaber mines. The line was designed to test for a north-west flowing "Mussel Roe Lead" which Twelvetrees thought had once skirted the north-east corner of Mt Cameron, and flowed out to sea via the Great Northern Plain (Twelvetrees, 1901, 1902, 1916). The bores located only negligible tin but were wide spaced. However, some located angular quartz wash and lignitic clays similar to those exposed in the Lochaber mine.

In 1916 the programme of assistance to operators by bores ahead of their workings was continued from Test Area 2 into this area. Of these areas (B13 - B19), the shallow ground to the west of the Scotia mine (B16) has probably now been mined out, but there is no record of the river flats to the south of the Scotia mine (B17) being dredged.

Unfortunately no records exist of the 25 bores put down some time between 1926 - 1932 by the Alluvial Tin Company between the Scotia and MacGregor mines. Nye (1932) records that the ground along the road between the two mines was found by this boring to be shallow but no other reference can be found.

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TABLE M

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STATISTICS OF THE LOCHABER-SCOTIA LEADS INDICATED BY GOVERNMENT BORING

(after Blake, 1955)

Block No.	No. of Holes	Total Depths (feet)	Area (sq. yd)	Average Depth (feet)	Volume (cu. yd)	Tin Oxide (lb Sn/cu. yd)
1	25	2,199	10,745	88.00	315,000	0.31
2	46	4,723	16,940	102.67	579,687	0.32
3	25	3,017	34,364	120.68	1,384,525	0.39
4	10	1,052	7,260	105.20	258,964	0.45
5	57	6,744	31,944	118.31	1,259,871	0.29
6	22	2,574	15,004	117.01	585,156	0.30
Totals :	185	20,309	116,257	109.78	4,383,203	0.34

TABLE M.

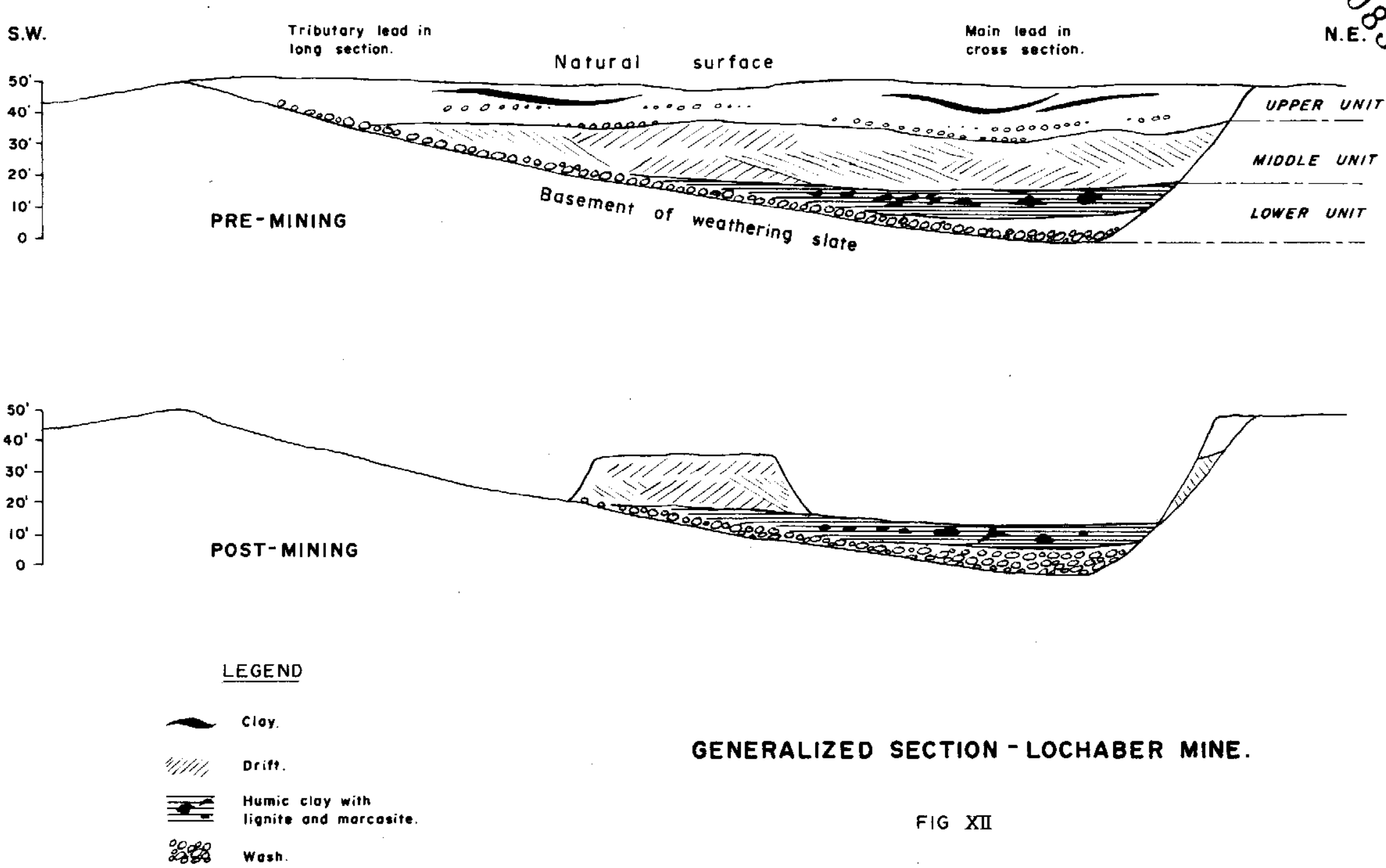
Between 1935 and 1944 the Mines Department carried out an extensive boring campaign in a search for north-westerly extensions of the ground mined in the Scotia and Lochaber pits. As a result of the boring, an extension of the Lochaber Lead was indicated over a length of 4, 900 feet to the junction with the Scotia Lead. Below the junction the Scoloch Lead (Blake, 1955) was closely bored over a length of 7, 000 feet and scout bored for a further 6, 300 feet. The Scotia Lead above the junction was closely bored over 4, 500 feet leaving an unexplored zone 2, 500 feet long. On the basis of this boring, Blake divided the indicated ground into six blocks totalling 4. 4 million cubic yards averaging 0. 34 lb Sn/cu. yd. In 1958 Rio Tinto Australian Exploration Pty Ltd undertook a single line (nine holes) as a check on a Mines Department drill line. Rio Tinto's line gave an average value of 0. 07 lb Sn/cu. yd, compared to 0. 22 lb Sn/cu. yd from the Mines Department line. Rattigan (1958) explains the discrepancy by supposing the Mines Department drilling to have been largely unsupervised and in error. The question remains unsolved. Blake's calculations on yardage and grade are summarised in Table M.

Geology

A generalised section at the Lochaber mine is given in Table N. It is very similar to the succession at mines such as Watt's and Lawry's in Test Area 2. It is again divisible into upper, middle and lower units. The upper unit is characterised by re-worked material, the middle by thick accumulations of drift or fine sand, and the lower unit characterised by a purple/brown humic and lignitic clay indistinguishable from that of exposures in workings in Test Area 2. Along the south and west sides of the main old pit, the bedrock of Mathinna slates is exposed and tributary gutters, containing boulder wash, lead down towards the main pit. It appears that this boulder wash goes under the humic clay of the lower unit of the sequence as shown in Fig. XII.

Judging from the exposures in the workings and from the written descriptions, the section appears to have been very similar at Scotia. The section at Scotia was somewhat thicker (probably because of less erosion of the upper unit) and it is reported that the bottom wash at the Scotia was a coarser, more angular wash than that at Lochaber. Exposures in the Scotia pit are not so distinct as those at Lochaber.

It is evident from mapping of the Lochaber mine that a considerable section of the floor of the old workings has been mined to a false bottom of the top of the humic clay and has not been taken down to bedrock. The apparent extent of the clay is shown on Plate 7. It



GENERALIZED SECTION – LOCHABER MINE.

FIG XII

Horizontal scale: 1 inch = 100 ft.

5 cm

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GENERALISED SECTION : LOCHABER MINE

Depth	Lithology	Unit
2' - 4'	Topsoil	
15' - 20'	Interbedded drift, fine sand, clay and wash. Commonly ferruginously stained. Scour and fill structures.	Upper
0' - 25'	Mainly fine sand derived from weathering Mathinna group meta-sediments and some interbedded drift derived from weathering granite. Small lenses of wash and white and grey clays.	Middle
0' - 5' to ?	Heavy humic brown clay with fragments of lignitised wood. Probably underlain by boulder wash seen in tributary gutters.	Lower

was thought at first that the clay might delineate a channel leaving the mine workings in a north-westerly direction. It now appears that the clay is restricted by a rising basement on that side also, for although the extreme north-west parts of the old workings do appear to be deepening to the north-west, a north-east trending ill-defined bar of higher slate basement separates the two areas of deeper ground.

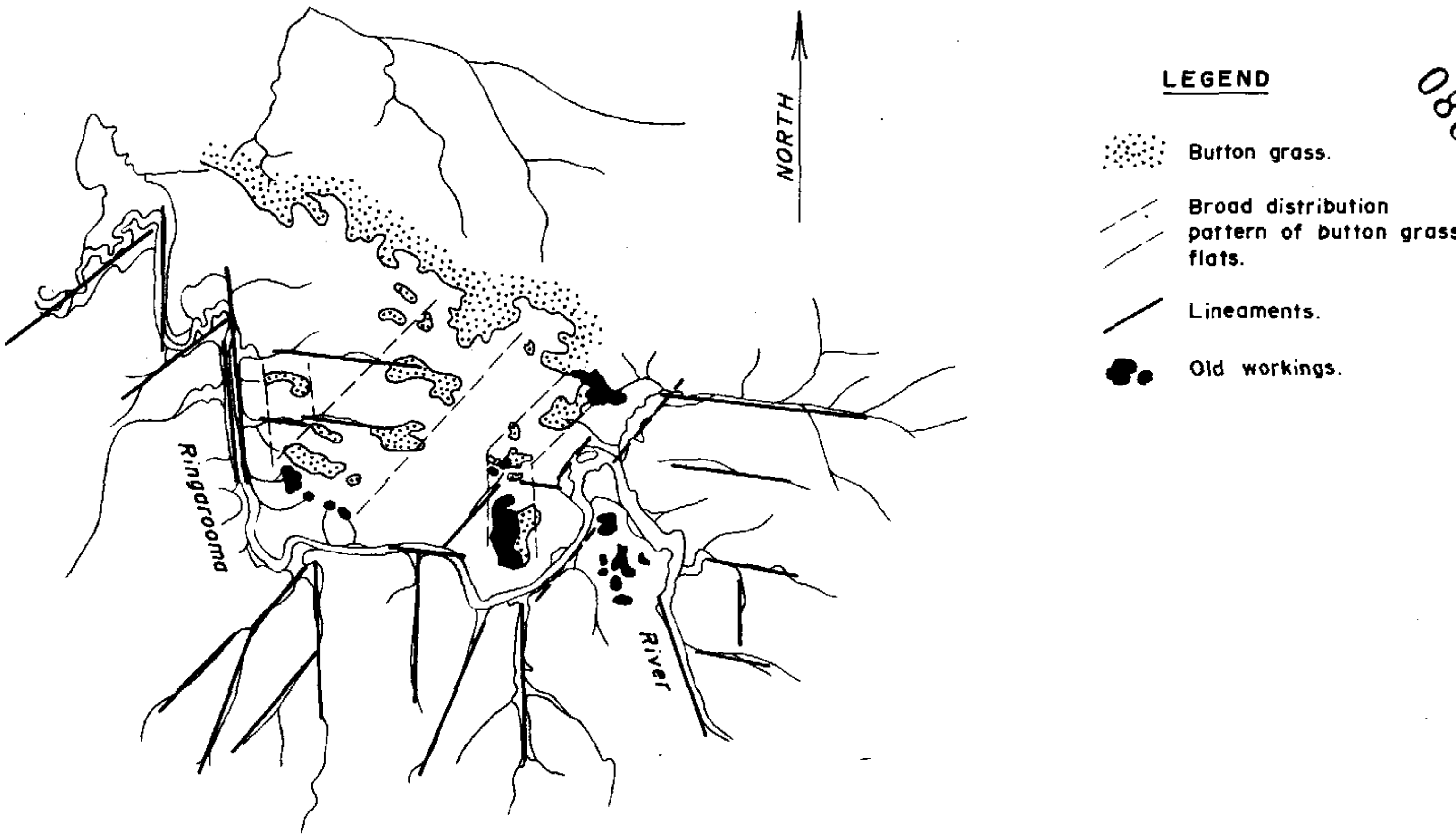
Proposed Testing

The basic supposition behind the proposed testing and of the inclusion of this area in the testing programme is that tributary leads, similar in size to the leads worked in the Scotia and Lochaber mines may exist in the areas to the north and north-west of Scotia and to the north of the Lochaber mine. These leads are likely to be shallower and richer than the Scoloch Lead itself and could serve to increase the attractiveness of the Scoloch Lead. In addition it is thought that small yardages may exist below clay false bottoms in the Lochaber pit and possibly in the Scotia also. At an early stage of the investigations it was thought that the clay false bottom at Lochaber was extensive and not limited to the west. Subsequent mapping seems to indicate that the clay bottom is limited to the area of the pit and that the available yardage is therefore likely to be small. Exposure in the old workings generally is not sufficient to be absolutely sure.

It is proposed to use geophysics to the west and north-west of Scotia to locate tributary leads in that area. The present day drainage is very strongly controlled by lineaments (see Fig. XIII), and it is thought that the deep leads will be found to follow the same directions. Most of the button grass flats in the area are elongated in a direction slightly north of west, but broad patterns of button grass flats running north and north-east from the Doone workings may indicate deeper Tertiary ground and may be over tributary leads. A similar pattern is evident in the ground now worked out from Scotia to Lochaber (see Fig. XIII and Plate 7). Initially I. P. traverses will be used across the north-west trending button grass pattern to attempt to locate a tributary lead.

The Government boring of the Scoloch Lead suggests that the tin tends to be in large "pools" between which the tin values are lower and in a much narrower zone. It is possible that the "pools" occur where tributary leads enter the main Scoloch Lead.

Some ground to the east of the main Scotia pit may not have been fully exploited, and two holes are proposed there to test this possibility; it



LINEAMENTS CONTROLLING DRAINAGE - SCOTIA - LOCHABER AREA.

FIG XIII

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is also proposed to test for a westward continuation of the Lochaber ground where the extreme westward workings do not expose bedrock.

TEST AREA 4 ENDURANCE/PIONEER

Location and Access

The location of Test Area 4 is shown on Plate 1; a detailed map (400 feet to 1 inch) forms Plate 8. The area can most easily be reached from the Pioneer-Gladstone road which runs along the east boundary of the area. Access to the west is provided by the old Boobyalla road.

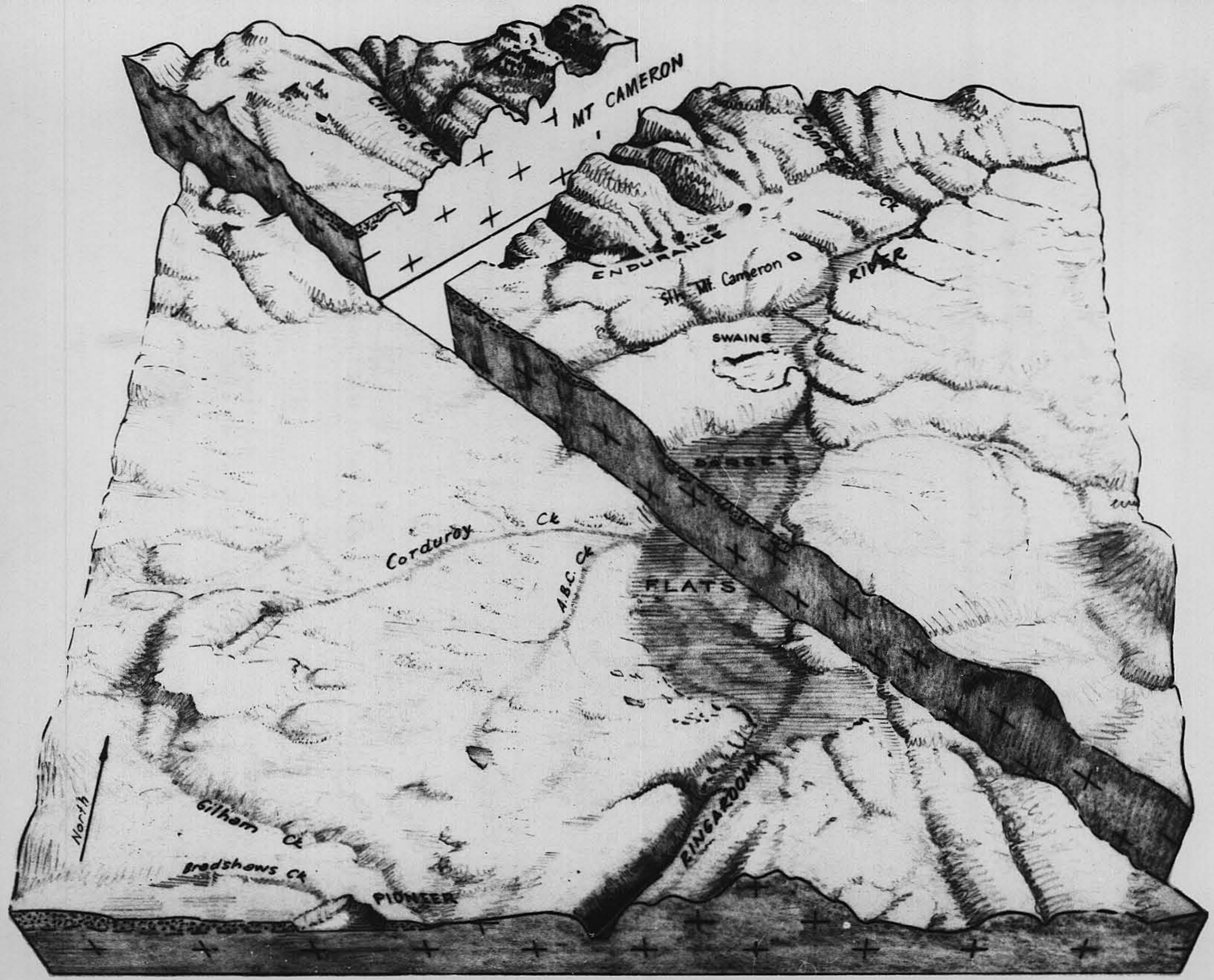
Test Area 4 is a broad area of button grass and low sandy rises without any outcrops of basement rocks (see Fig. XIV).

Previous Mining and Testing

Previous mining is listed in Table O. Mines adjoin the area on the north, east and south. Three of the largest operations on the field, the Pioneer mine, the Endurance mine and the Dorset Flats dredging operation border the area. The Endurance Lead appears to have produced about 450 tons of tin to every 1,000 feet of lead, the Wyniford Lead (Pioneer mine) about 1,500 tons per 1,000 feet. The Dorset and Endurance Flats have been dredged by the Dorset Dredge and have provided a total of 1,691 tons of tin. The deposits worked by the dredge appear not to have been deep lead deposits but largely recent and Quaternary gravels of the Ringarooma River.

Geology and Proposed Testing

Two deep leads that have already been extensively mined may be found to enter Test Area 4. They are the Wyniford Lead to the south and the Endurance Lead to the north. The Wyniford Lead was worked in the Pioneer mine as a wide, clearly defined lead on a granite bedrock. No reliable information is available concerning the ground which may contain the immediate extension of the Wyniford Lead. This ground is presently held by Mr. Vernon Wood who intends to reopen the Pioneer mine. To the north the Endurance Lead skirts the toe of Mt Cameron but may head south across Test Area 4.



PHYSIOGRAPHIC SKETCH - TEST AREA No. 4.

FIG XIV

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TEST AREA 4 - ENDURANCE/PIONEER - SUMMARY OF PREVIOUS MINING

Property	Total Recorded Production (tons metallic tin)	Period during which Worked	Geology	Notes
Pioneer	9,180	1900-1940	Wyniford Lead - well defined, wide, rich; leading west.	1900 saw first mining of lead; previous mining in Bradshaw's Creek of shallower ground. V. Wood presently attempting to reopen mine.
Endurance	2,630	1918 to present	Endurance Lead - well defined deep lead. Mining west along foot of Mt Cameron.	Endurance Tin Mining Co., present leases.
Dorset Flats (+ Dorset Extended Flats)	1,819 (+6900 oz Gold)	1944-1959 1959-1963 (Dorset Extended)	Flats dredged to depth of about 27', generally to bed-rock but may be west-flowing leads below north and south ends of flats.	Dorset Flats produced 25 million cu. yd of 0.133 lb Sn/cu. yd; Dorset Extended Flats produced 5.2 million cu. yd of 0.137 lb Sn/cu. yd. 2 dredges worked briefly on Dorset Flats in about 1900.
Clifton Creek Workings	415	1911-1918	Not known in any detail. May have been tributary lead to Endurance Lead.	Taken over by Endurance Tin Mining Co. in 1918.
Eastern Leads	69	1927-1946	Shallow (max. 10') not to bedrock. May overly deep lead.	
Swains	Not known.	-	Shallow (max. 10') on granite bedrock. Exploiting Mathinna cobble wash.	Previous history not known - presently being worked in a small way.
Watts	Not known.	-	Shallow (max. 15') on granite bedrock.	

There are reports of deeper ground below both the north and south ends of the Dorset Flats. The suggestion is that these areas of deeper ground are part of east-west flowing leads entering the area.

A short Government boreline has indicated steeply falling basement that may be on the northern flank of a third deep lead to the south of the old Watts workings.

It is proposed to try to locate and follow these three possible deep leads by geophysical means and also to try to follow the Endurance Lead and the Wyniford Lead once they leave already leased ground. The programme at this test area depends on it being possible to locate the deep lead channels by the I. P. method. Drilling reconnaissance drill-lines across the area in the hope of locating lead channels is likely to be very time consuming, expensive and non-productive. The detailed planning of drill lines here is left until a test of the I. P. method has been made.

TEST AREA 5 NORTH MUSSEL ROE SWAMP

The swamp is about four miles long and has an average width of about 1, 000 feet. It occurs in the middle course of the Mussel Roe; at either end the river flows in a steep walled channel cut into bedrock. The river meanders somewhat within the swamp, but generally keeps to one channel and appears to be fast flowing within that channel. The swamp occurs where the Mussel Roe River flows across Tertiary sediments; the sediments form sandy rises and button grass flats on either bank of the swamp. In places the banks on either side of the swamp are steep; the general level of the sandy rises being perhaps 60 to 80 feet above the level of the swamp.

The swamp can be reached from the south, through Wood's mine, or from the west through Area 2, and from the north-east from the Anson's Bay road. Access within the swamp is very difficult. In the main it is a tree swamp, with species of paperbark predominating, but there are patches of reed swamp and patches of open water as well as the river channel itself. The depth of water in the tree and reed swamp is not known with any accuracy, but is probably about three to four feet. There may be a buried bedrock bar about half way along the swamp, as it is there narrower and a good deal drier for a stretch of about 1, 000 feet. It is possible at this point to walk across the swamp and cross the river channel on fallen logs when the river is not in flood. In the main body of the swamp there is a great deal of dead and fallen timber which would greatly impede movement of a rig.

It will probably be necessary to cut out much of the timber along drill traverse lines, and the rig will have to be mounted on a pontoon or else on a very low surface loading crawler vehicle.

Similar, but not identical, swampy mid-sections occur on the other main rivers, the Boobyalla and the Ringarooma. Their origin is not clear. Bedrock is evidently some depth below the river channel in these swampy sections (e.g., average 30 feet below at Dorset Flats, and about 30 feet below at the north end of the Mussel Roe Swamp), but the rivers flow through steep valleys cut into bedrock at either end of the swampy sections. It seems possible that the swampy sections are on down faulted blocks where Tertiary sediments have been let down between bedrock blocks. To define the area of these blocks is not easy, however. The swamps themselves may form where the river's erosion reaches a clay horizon in the Tertiary sequence.

Another possible explanation is that the swampy sections of the river courses may be related to comparatively recent drainage reversals.

The Mussel Roe River swamp has mined ground to the south (Wood's mine) and along its western side (Edina-Lawry's-Elizabeth area). There are no workings on the eastern side, but the only drilling on this side located a small tin-bearing gutter apparently trending north-west into the swamp (see Plate 6). One line of boring has crossed the swamp towards the north end. A gutter with tin was located to the west of the swamp; bedrock under the swamp was about 30 feet below the ground surface - no tin was found. UDC boring of the Eastern Lead at Wood's mine (Appleby, 1964) revealed a fairly narrow, well-defined gutter running north into the swamp. Only trace amounts of tin were recorded in the lower wash of the Eastern Lead; the Lead contained abundant marcasite and a humic laminated siltstone.

The swamp is of interest because it is a considerable area of dredgeable ground with evidence of leads entering from the south, east and west.

It is proposed to test the swamp by a series of five traverses. As this area poses particular access problems, it is being given special attention in the planning for drilling. At the moment a pontoon-mounted rig, towed across the swamp by cable along lines cleared of logs by a chain saw, is being considered.

TEST AREA 6 HASTIES

Hasties workings consist of two open pits, about 50 feet deep, on the west side of the Little Boobyalla River, about $2\frac{1}{2}$ miles west of the Endurance workings. The lower part of the Tertiary succession exposed in the larger, more westerly, of the pits is a succession of humic drift. No clear indication of the clay with lignite and marcasite thought to characterise the true deep leads has been seen. The pit is oriented north-south with a tail race flowing out to the east into the Little Boobyalla River. Early reports speak of a stanniferous gutter trending unexpectedly to the south rather than to the north. No production records for the property are available. No mineral claims are held in the area but the southern limit of Mr. Wood's Special Prospecting Licence over 14.5 square miles surrounding the Monarch mine is to the immediate north of Hasties workings.

It is proposed to test for a southern continuation of the gutter that was evidently being mined in the Hasties workings. There is a very considerable area of Tertiary ground to the south with no old workings and no known previous drilling.

TEST AREA 7 SOUTH OF ANSON'S BAY ROAD

The mapping of surface features has shown that reed swamps in the northern part of the mapped area commonly form a pattern related to an ancestral, now disused, drainage. Individually the swamps are oval in plan and are oriented with their long axes north-south. The largest (Rushy Lagoon) is almost $1\frac{1}{2}$ miles long and $\frac{1}{2}$ mile wide; the majority are much smaller. In section the swamps appear as slight depressions with a low (15 feet high) sand or silt mound along their east side. By analogy with similar features in South Australia (Hills, 1949), the hollows in which the present day swamps exist and the associated east-side ridges are thought to have formed by deflation during the Pleistocene. Hills relates the South Australian features to a dry climate at the close of the Pleistocene when fine sand, silt and clay particles from the bed of the intermittently flowing rivers were blown out to form the hollow and piled up on the leeward side.

Another possibility, however, is that the swamps may have formed over clay lenses in the Tertiary upper unit. In either instance their significance, from the economic viewpoint, lies in the possibility that they may indicate a drainage which at one time concentrated tin. For example, the hollows and dunes may be a Pleistocene development, as suggested by Hills, but the river system from which they formed may be a late Tertiary system and may contain the stanniferous upper wash zone.

It is proposed to test the swamps by drill traverses across the elongation of the swamps.

TEST AREA 8 AMBER HILL AREA

The old Amber Hill workings are situated to the north of a fairly extensive area of Tertiary ground on the south side of the Ringarooma River between Peacock and Amber Creeks. These two creeks have cut down well into the granite bedrock and the Tertiary material is left perched on the watershed between the two creeks.

Four faces have been opened up in the Amber Hill area, the east and west face before 1916, the central face at some time between 1916 and 1935, and a fourth face between the central and east faces between 1949 and 1952, mining out an area drilled by the Mines Department in 1937. The Mines Department drilling located a small narrow gutter on bedrock trending south-east, and the configuration of the other pits suggests that they were exploiting the same or similar gutters. The grade, from incomplete returns of 1949 to 1952, varied from 0.30 to 0.50 lb Sn/cu.yd.

From the size of the gutter (from the drilling) and from the exposed Tertiary section, it does not appear that a true Tertiary deep lead has been located, but rather that the area is one in which tributary gutters occur. There may be other similar gutters in the area, and it is proposed to test for these by geophysics first and then by scout boring.

TEST AREA 9 HERRICK SURREY

The Herrick Surrey is a swampy backwater of the Ringarooma River about 3/4 mile long and 1/4 mile wide at its junction with the river. There is granite exposed on either flank of the Surrey for about 1/4 mile from the river junction, and it is evident that the Surrey has formed in a fairly wide depression in the bedrock. David Creek enters the head of the Surrey, but is too small to have cut out a bedrock depression of this size. The depression may have been cut during the early Tertiary, and the Surrey may represent part of an old lead. There is some report of alluvial tin being won there in the early days of the field, but no production figures are available. To the north is an old working 40 feet deep on bedrock which was abandoned as the fall to the Ringarooma River became too little.

The present form of the Surrey is due to the dumping, by the present Ringarooma River, of a bank of tailings across the mouth of the Surrey. This gravel bank has barred off the Surrey and caused it to become swampy.

It is proposed to test for a deep lead by three drill traverses across the Surrey.

TEST AREA 10 RINGAROOMA BAY BEACHES

The present beach at Ringarooma Bay is an arc about 12 miles long, broken only close to its southern end where the Ringarooma River discharges into the Bay. Behind the present beach there are traces of ancestral beaches. For example, at the south end there are long low ridges of cobbles that parallel the present beach and are thought to be the remains of old storm beaches.

It is proposed to test the beaches, particularly the ancestral beaches behind the present beach for accumulation of heavy mineral beach sand deposits high in cassiterite. Such deposits could be very extensive. The source of cassiterite in such deposits could be granitic rocks to the north of the present coast, the minerals having been released from the granite during a period of marine transgression.

The area appears at one time to have been held for beach sand minerals but there is no record of testing undertaken during that time.

GLOSSARY OF LOCAL TERMS

Black Jack	Pleonaste (iron spinel, $FeAl_2O_4$ - particularly hercynite). Occurring in large (up to 0.5 inch) characteristically shaped rounded detrital fragments in heavy mineral concentrates with cassiterite.
Boiling	Using a Willoughby Box (a water pressure jig) to clean up a heavy mineral concentrate.
Chat	Coarse grain of cassiterite with adherent quartz and therefore a lower specific gravity.
Clinker	Siliceously cemented drift occurring in large smooth surfaced flat blocks generally about nine inches thick and up to 20 x 20 feet on their upper surfaces.
Drift	Sub-angular to sub-rounded clean quartz sand, generally unconsolidated but may be cemented (with siliceous or ferruginous cement). Evidently derived more or less directly from weathering granite, by removal of feldspars as clay; drift makes up the bulk of the Tertiary valley-fill. The grain size may be fine, medium or coarse.
False Bottom	The upper surface of a clay or other well marked horizon to which workings are taken when they are not carried to bedrock. False bottoms generally represent disconformities at which concentrations of tin occur.
Gutter	Elongate depression in the bedrock surface, generally shallow and narrow, below Tertiary sediments and generally within the broader depression forming a lead.
Lead	An ancient river valley, now largley filled with fluviatile sediments, towards the bottom of which concentrations of cassiterite occur.
Pool	More or less circular patch of high tin values, generally along a run.
Pug	Clay, particularly a very tenacious, heavy clay.

Reef, or High Reef	The sides of the ancient valley in which a lead has been formed.
Run	Occurrence of higher tin values in sinuous gravel bodies elongated along the old stream course, but commonly along one side, rather than in the bottom of a gutter.
Shingle	A pebble or cobble gravel in which the pebbles or cobbles are formed of well-cleaved Mathinna Beds Slate and are hence elongated elipsoids.
Sluicehead	A local measure of water rate approximately equal to 150 gallons per minute. Officially defined as "the quantity of water passing through an aperture 16" wide and 1" deep in the outlet of a horizontal gauge box 12 ft long when the surface of the water is 6" above the centre of the aperture".
Tier	Relatively flat-topped mountain ranges typical of Tasmania.

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Sluice box, Wood's Mine -
Mussel Roe River.

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Tertiary Middle Unit, Lochaber Mine. Base of Middle Unit obscured by Sloughing; Top of Unit is top of distinct white fine sand.

Tertiary Upper Unit, Lawry's Central Pit. Upper Unit, showing scour and fill structures and torrential bedding, here rests on bedrock.

Basal Mathinna Cobble Wash - Edina Workings.

Basal Mathinna Cobble Wash Overlain by Silty Clay -
Edina Workings.

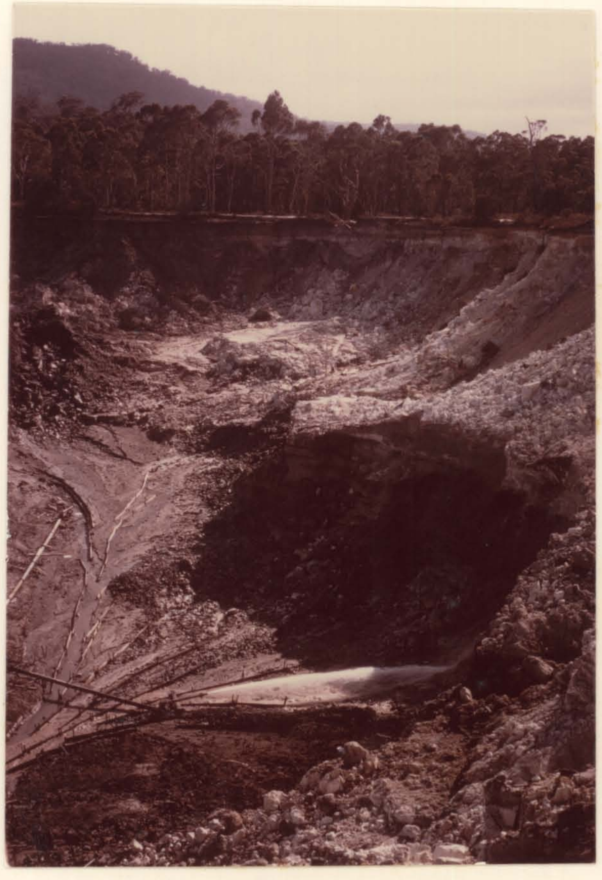
Silicified Drift, "Clinker" - Edina Workings.

Tertiary Lower Unit, Endurance Mine. Top of Lower Unit is top of well marked dark grey clay Horizon immediately above roof of pump barge.

Overgrown Workings - Scotia Mine.

View South from Crest of Mt. Cameron. Endurance workings in foreground. Dorset Flats (dredged) in middle ground. Blue Tier in the distance.

Sluicing - Endurance Mine.



Sluicing - Endurance Mine.

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"Birdseye" Wash. Tertiary Upper Unit - Endurance Mine.

Humic Clay with Lignitised Logs - Wood's Mine, Mussel Roe River.

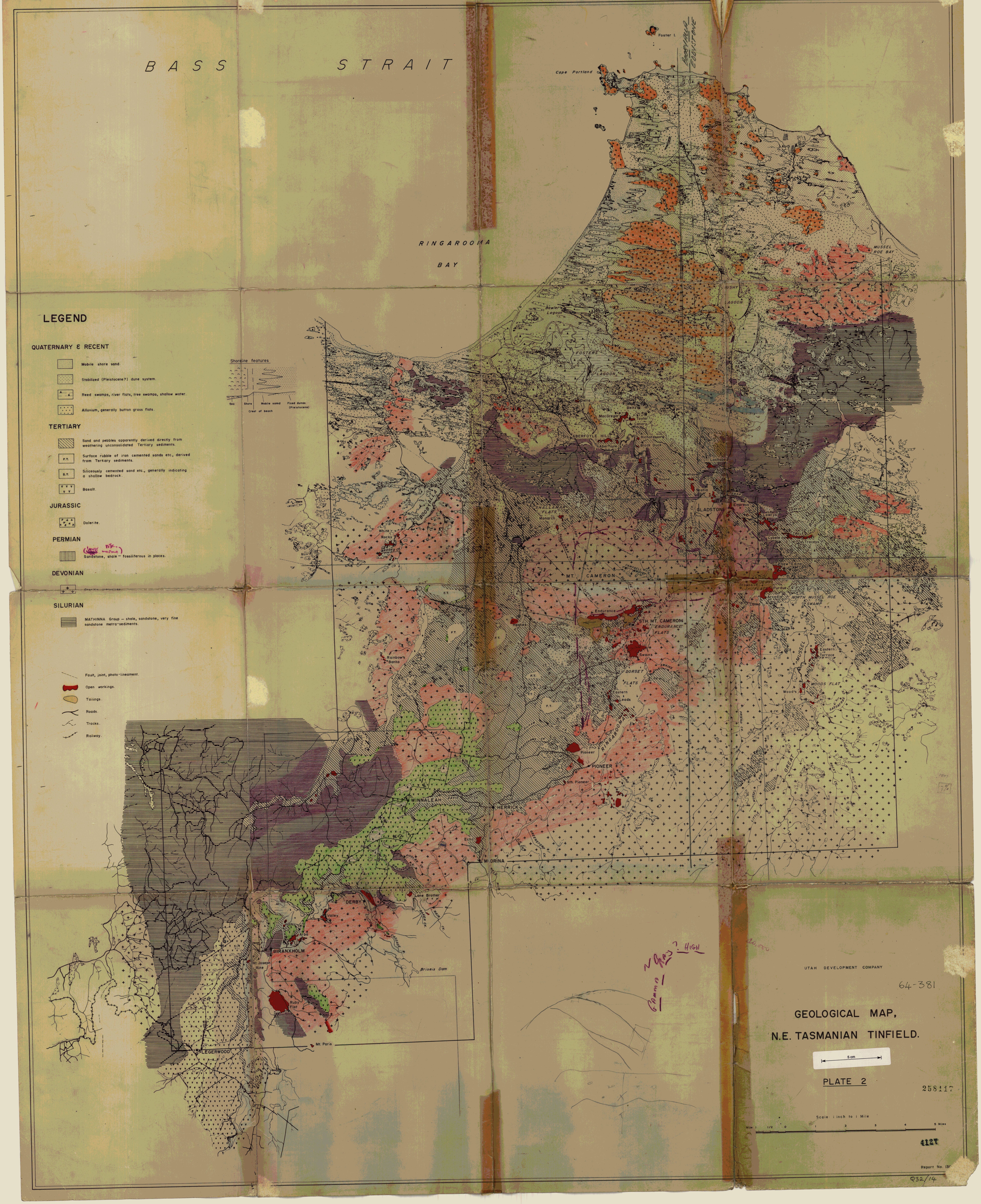
Clay Horizon - Wood's Mine, Mussel Roe River.

Laminated Humic Siltstone with Marcasite Nodules.
Eastern Terrace, Wood's Property, Mussel Roe River.

Soft Pasty Weathered Granite. Endurance Tailings Easement.

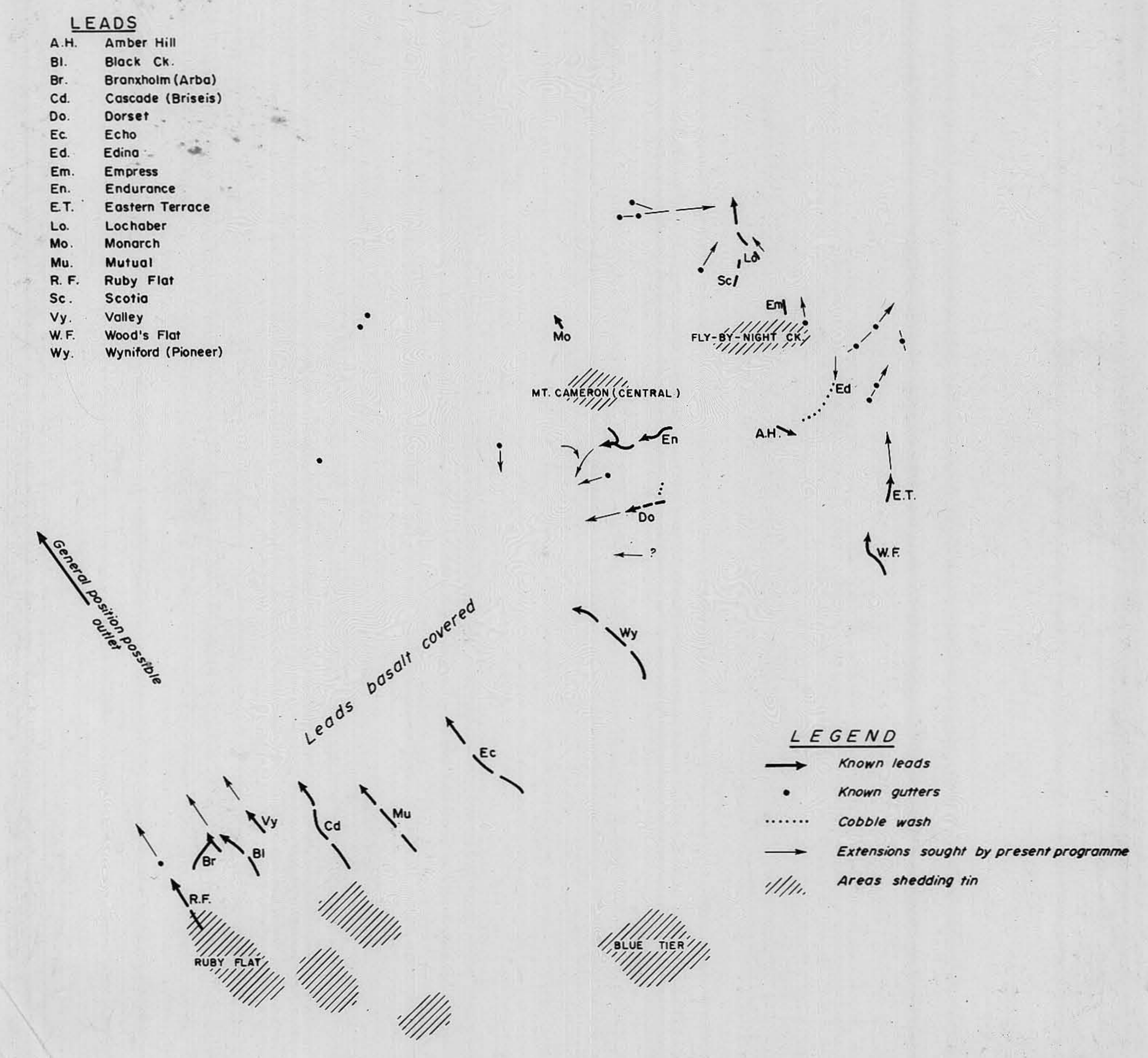
Soft, Weathered Mathinna Shales. Scotia Mine.

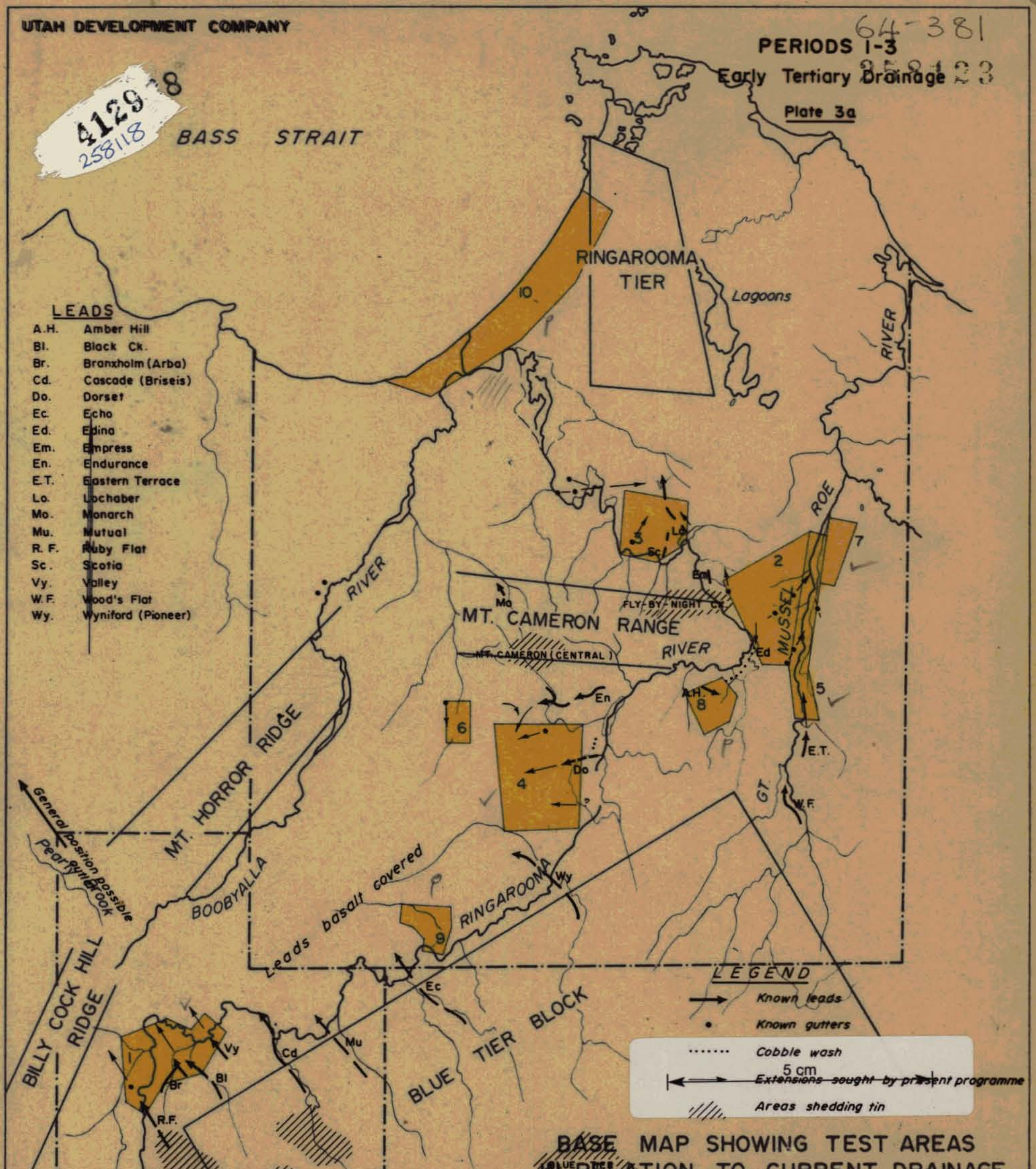

BASS STRAIT
BANKS STRAIT
Foster I.
Cape Portland
RINGAROOMA BAY
AREA 10
Bowler's Lagoon
RUSHY LAGOON
MUSSEL ROE BAY
Little Mussel Roe River
BOOBYALLA PORT (Abandoned)
RINGAROOMA TIER
FOSTERS MARSH
RINGAROOMA
BOOBYALLA RIVER
Dobsons
Delta
Dry Gut
MacGregor
Beltz
Taylor
Canary
ABERFOYLE HILL
Aberfoyle
M.L. F
Richardson's
Black Duck
EX. 2
AMG 572000E 5468300N
Vulcan
AREA 3
Lochaber
Mallinsons
Newhaven
Doone
Native Loss
Scotia
Mary
Bridge
GLADSTONE
Empress
Lowrys
Elizabeth
AREA 7
EX 3
AREA 2
M.L. E
Cybele (Watts)
Traceys
NORTH MUSSEL ROE SWAMP
AREA 5
New Edina
Edina
Old Star Hill
Browns
Purdue
Arcadia
Amber Hill
Lanka
AREA 8
North Mussel Roe Pty.
White Rocks
Shallamar Flats
Monarch
S.P.L. 399
MT CAMERON
EX1
Hasties
AREA 6
Rainbow's Banks
Endurance
STH. MT. CAMERON
M.L. D
ENDURANCE FLATS
Swains
AREA 4
Eastern Leads
DORSET FLATS
Eastern Terrace
WOODS FLAT
Wood's
MUSSEL RIVER
GREAT MUSSEL ROE
Bradshaws
M.L. C
Pioneer
PIONEER
Sth. Pioneer
E.L.6/63
(384 sq.ml.)
WINNALEAH
AREA 9
HERRICK
RINGAROOMA RIVER
Echo
AMG 574400E 5447700N
MOORINA
RAILWAY
AREA 1
Briseis
DERBY
Lone Brother
Sarah Ann
MUTUAL HILL
Mutual
Roma
M.L. A
Valley
Arba
M.L. B
BRANXHOLM
Mt. Joseph Mine
Briseis Dam
Ruby Flat
S.P.L. 400
Mt. Paris
LEGERWOOD
LEGEND
WORKED GROUND SHOWN :— Swains
AREAS FOR TESTING SHOWN :—
SPECIAL PROSPECTING LICENSES, MAIN MINERAL LEASES AND EXEMPT AREAS WITHIN E.L. 6/63 SHOWN :— (See reference below)
S.P.L. 399 V. Wood 14·5 sq. ml.
S.P.L. 400 W.C. Burrows 4 sq. ml.
M.L. A A.S. Edwards 151 ac.
M.L. B Briseis Tin N.L.
M.L. C V. Wood
M.L. D Endurance Tin Mining Co. N.L.
M.L. E H.C. Lawry
M.L. F Storeys Ck. Tin Mining Co. N.L. 760 ac.
EX. 1 Exempt from the Mining Act 1929 13980 ac.
EX. 2 " " " 1750 ac.
EX. 3 " " " 360 ac.
All boundaries approximate only.
5 cm
AMG REFERENCE POINTS ADDED
UTAH DEVELOPMENT COMPANY
64-381
PLAN SHOWING AREAS PROPOSED FOR DRILLING AND GEOPHYSICAL TESTING, N.E. TASMANIA.
PLATE 1
Scale 1 Inch to 1 Mile
Mile 1 1/2 0 1 2 3 4 5 Miles
258116
4126
Report No. 130


BASS STRAIT
RINGAROOMA BAY
Cape Portland
MUSSEL ROE BAY
LEGEND
QUATERNARY & RECENT
Mobile shore sand.
Stabilized (Pleistocene?) dune system.
Reed swamps, river flats, tree swamps, shallow water.
Alluvium, generally button grass flats.
TERTIARY
Sand and pebbles apparently derived directly from weathering unconsolidated Tertiary sediments.
F.T. Surface rubble of iron cemented sands etc., derived from Tertiary sediments.
S.T. Siliceously cemented sand etc., generally indicating a shallow bedrock.
Basalt.
JURASSIC
Dolerite.
PERMIAN
Sandstone, shale — fossiliferous in places.
DEVONIAN
SILURIAN
MATHINNA Group — shale, sandstone, very fine sandstone metra-sediments.
Shoreline features
Sea
Shore
Mobile
Crest of beach
Fault, joint, photo-lineament.
Open workings.
Tailings.
Roads.
Tracks.
Railway.
MT. CAMERON
PIONEER
WINNALEAH
HERRICK
MORINA
DERBY
BRANXHOLM
LEGERWOOD
Mt. Paris
Briseis Dam
UTAH DEVELOPMENT COMPANY
64-381
GEOLOGICAL MAP,
N.E. TASMANIAN TINFIELD.
5 cm
PLATE 2
258117
Scale: 1 inch to 1 Mile
Mile 1 1/2 0 1 2 3 4 5 Miles
4127
Report No. 130
Q32/14

UTAH DEVELOPMENT COMPANY

PERIODS 1-3
Early Tertiary Drainage
Plate 3a



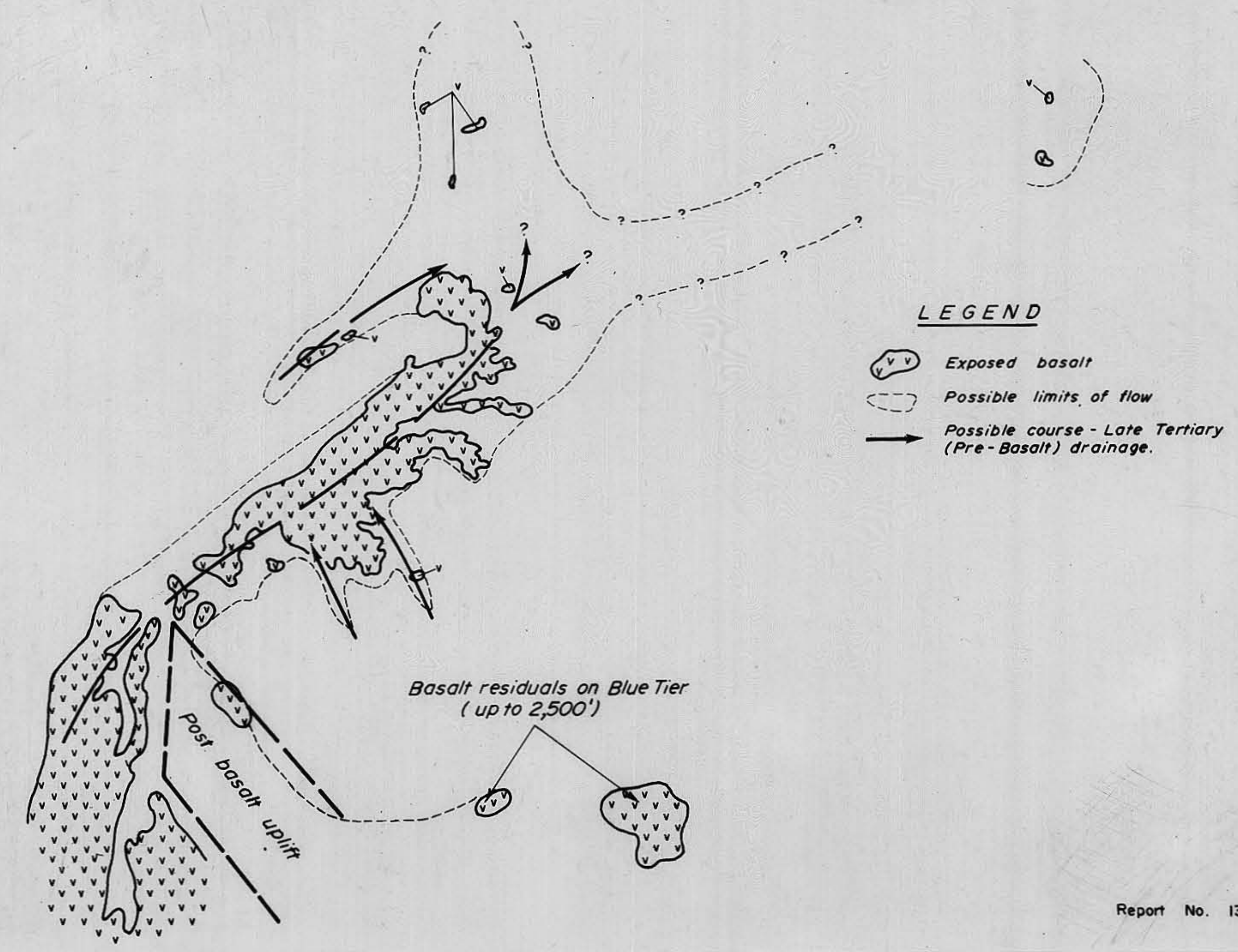

UTAH DEVELOPMENT COMPANY
64-381
PERIODS 1-3
Early Tertiary Drainage
Plate 3a
4129
258118
BASS STRAIT
RINGAROOMA TIER
Lagoons
RIVER
10
LEADS
A.H. Amber Hill
Bl. Black Ck.
Br. Branxholm (Arba)
Cd. Cascade (Briseis)
Do. Dorset
Ec. Echo
Ed. Edina
Em. Empress
En. Endurance
E.T. Eastern Terrace
Lo. Lochaber
Mo. Monarch
Mu. Mutual
R.F. Ruby Flat
Sc. Scotia
Vy. Valley
W.F. Wood's Flat
Wy. Wyniford (Pioneer)
RIVER
ROE
MUSSEL
MT. CAMERON RANGE
FLY-BY-NIGHT CK.
MT. CAMERON (CENTRAL)
RIVER
MT. HORROR RIDGE
General position possible Pearly Brook
BOOBYALLA
Leads basalt covered
RINGAROOMA
BILLY COCK HILL RIDGE
BLUE TIER BLOCK
GT.
E.T.
W.F.
LEGEND
Known leads
Known gutters
Cobble wash
Extensions sought by present programme
Areas shedding tin
5 cm
BASE MAP SHOWING TEST AREAS IN RELATION TO CURRENT DRAINAGE
PLATE 3
Test areas shown 2
SCALE 1 INCH = 4 MILES
Report No. 130

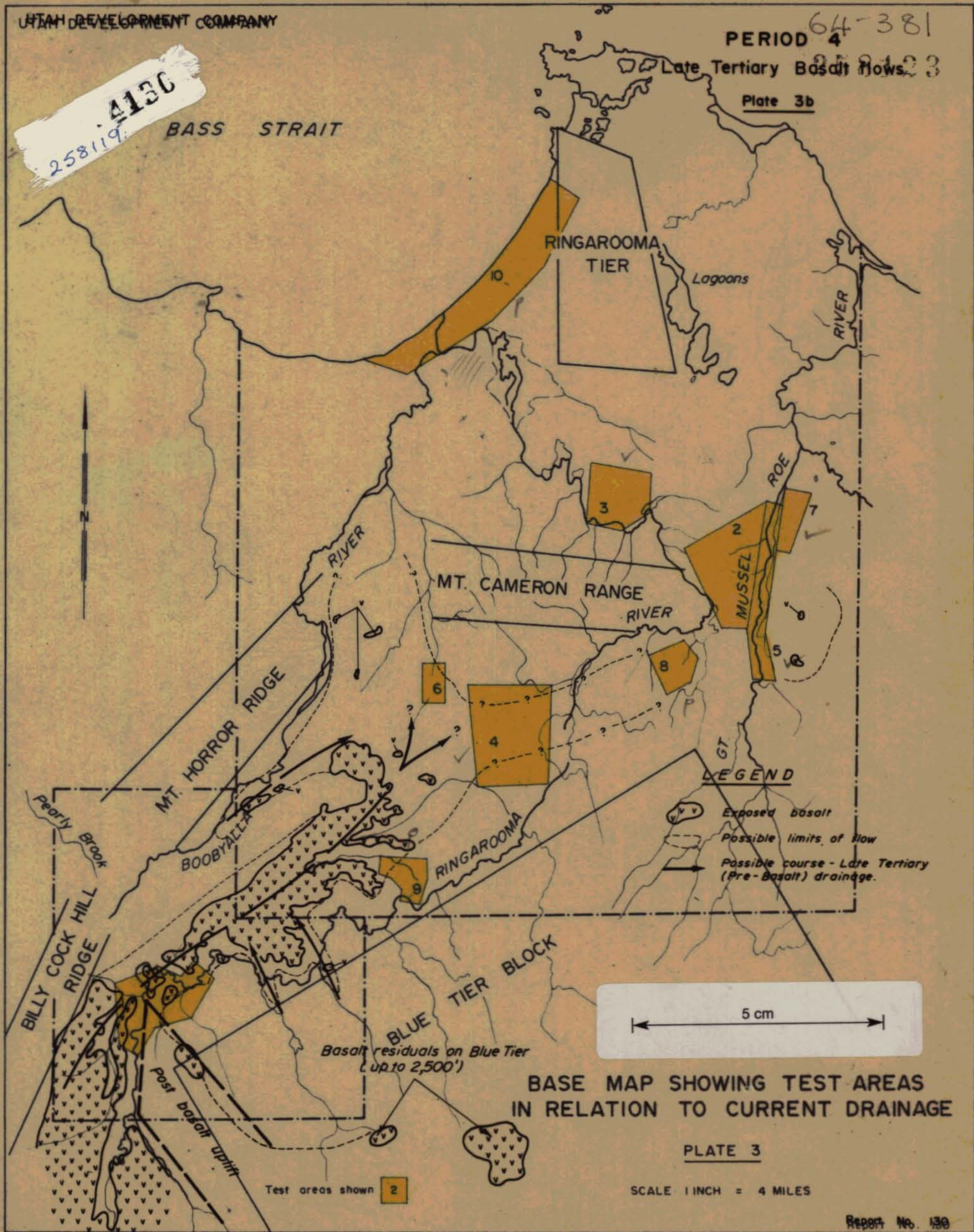
UTAH DEVELOPMENT COMPANY

PERIOD 4

Late Tertiary Basalt flows

Plate 3b



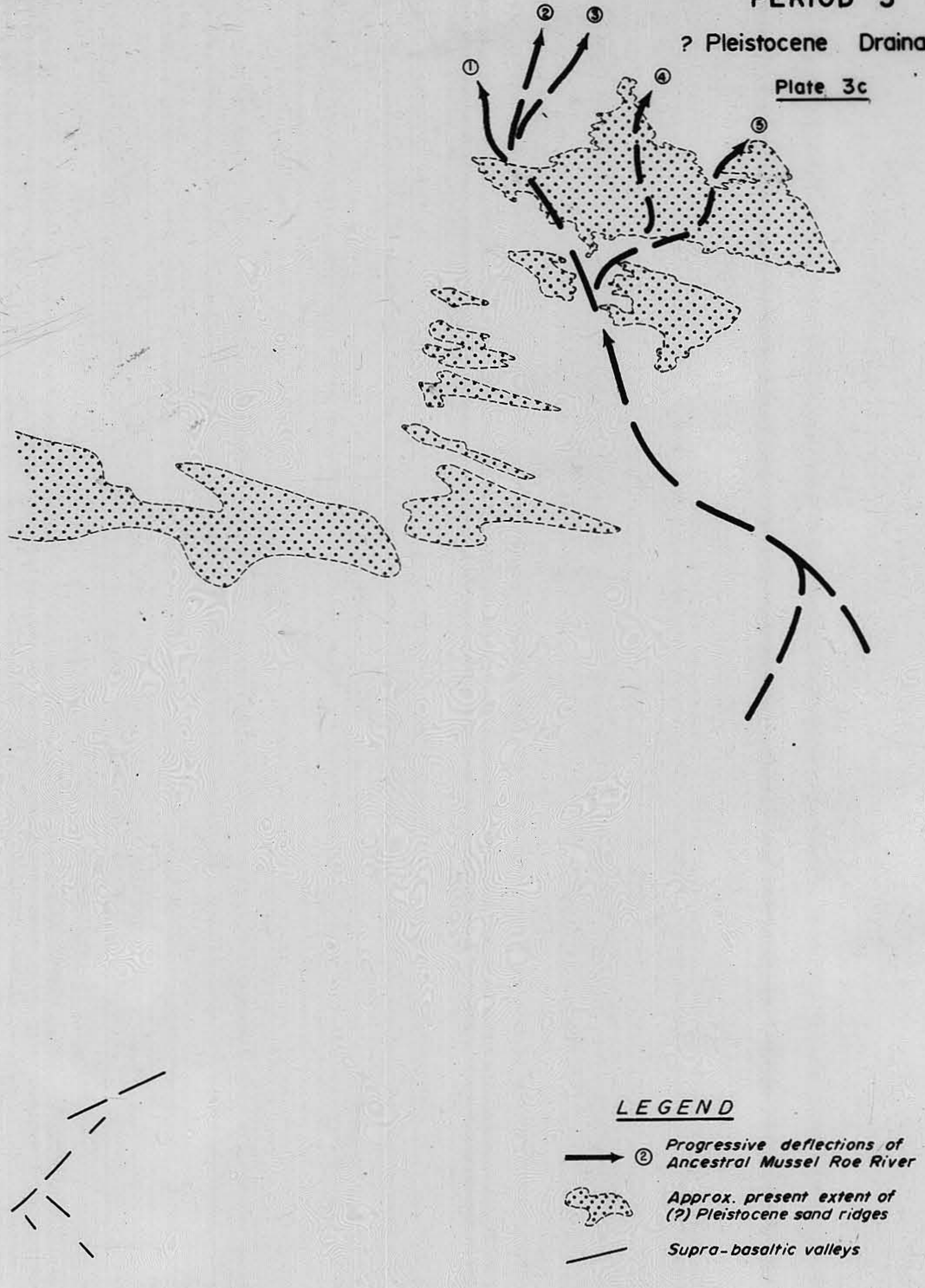

UTAH DEVELOPMENT COMPANY
PERIOD 4
Late Tertiary Basalt flows.
Plate 3b
BASS STRAIT
RINGAROOMA TIER
Lagoons
RIVER
10
3
2
7
ROE
MUSSEL
MT. CAMERON RANGE
RIVER
RIVER
8
5
6
4
MT. HORROR RIDGE
BOOBYALLA
Pearly Brook
BILLY COCK HILL RIDGE
RINGAROOMA
9
GT.
LEGEND
Exposed basalt
Possible limits of flow
Possible course - Late Tertiary (Pre-Basalt) drainage.
BLUE TIER BLOCK
Basalt residuals on Blue Tier (up to 2,500')
Post basalt uplift
N
5 cm
BASE MAP SHOWING TEST AREAS
IN RELATION TO CURRENT DRAINAGE
PLATE 3
Test areas shown 2
SCALE 1 INCH = 4 MILES
Report No. 130

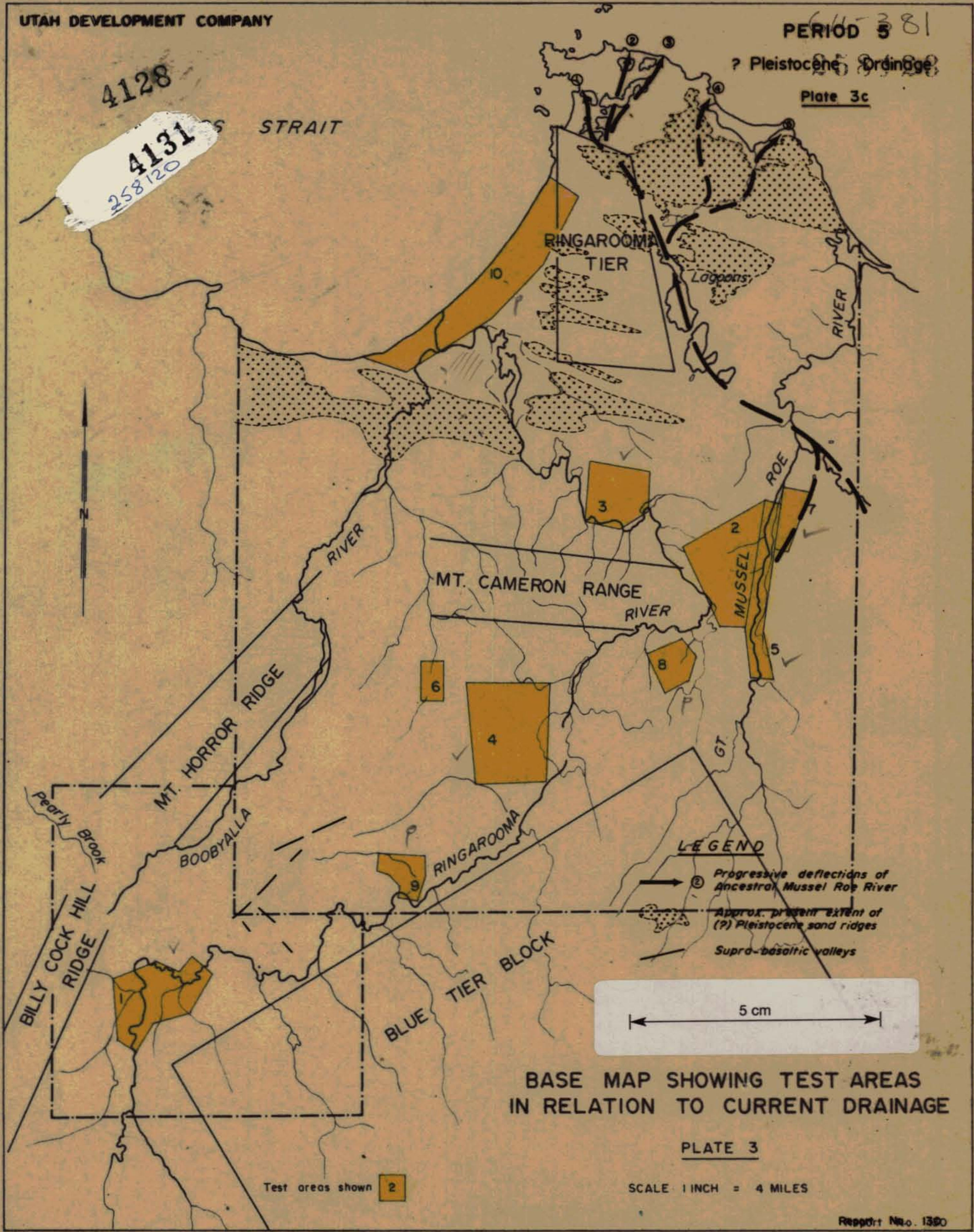
UTAH DEVELOPMENT COMPANY

PERIOD 5

? Pleistocene Drainage

Plate 3c





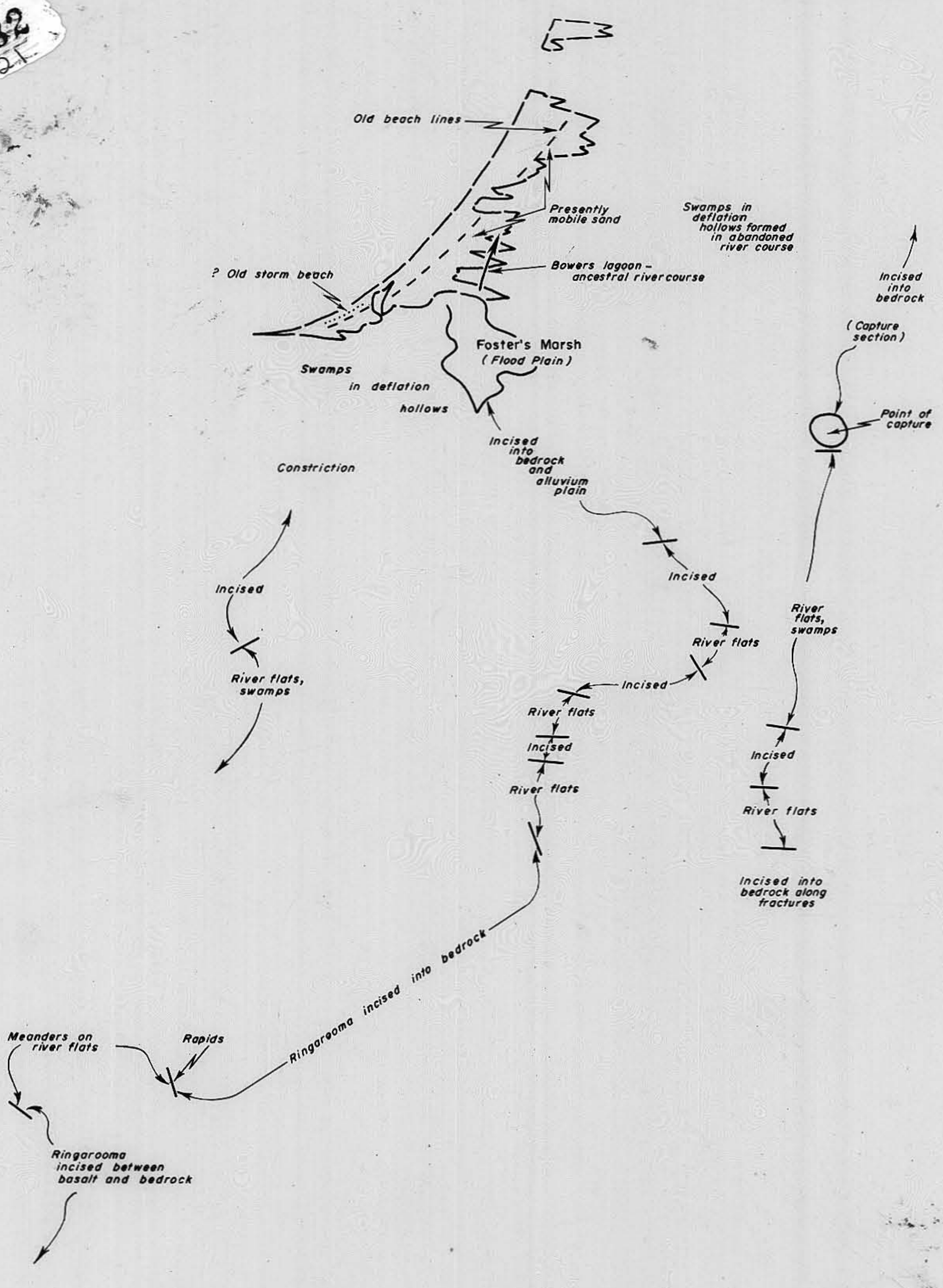
BASE MAP SHOWING TEST AREAS IN RELATION TO CURRENT DRAINAGE

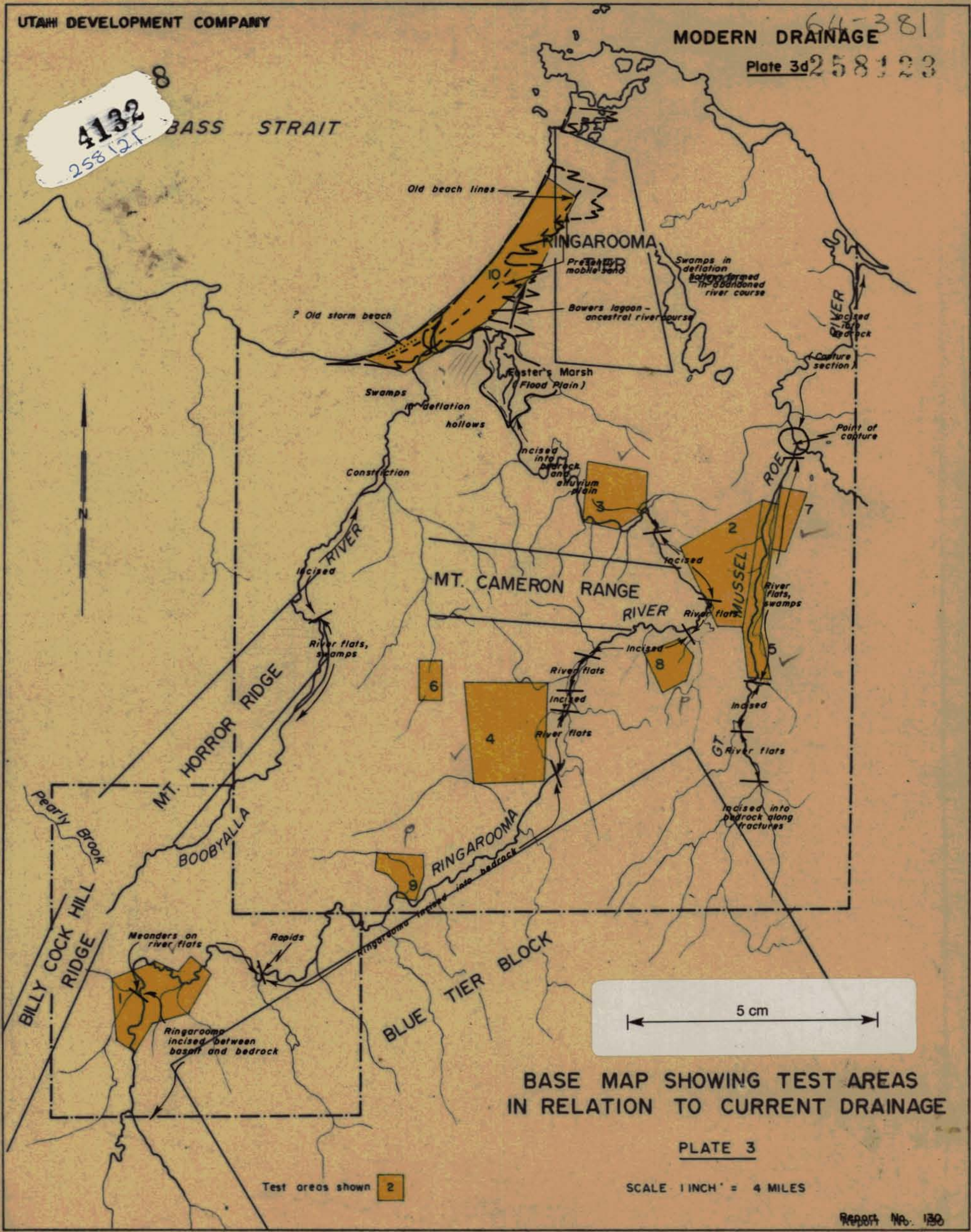
PLATE 3

UTAH DEVELOPMENT COMPANY

MODERN DRAINAGE

Plate 3d





BASE MAP SHOWING TEST AREAS IN RELATION TO CURRENT DRAINAGE

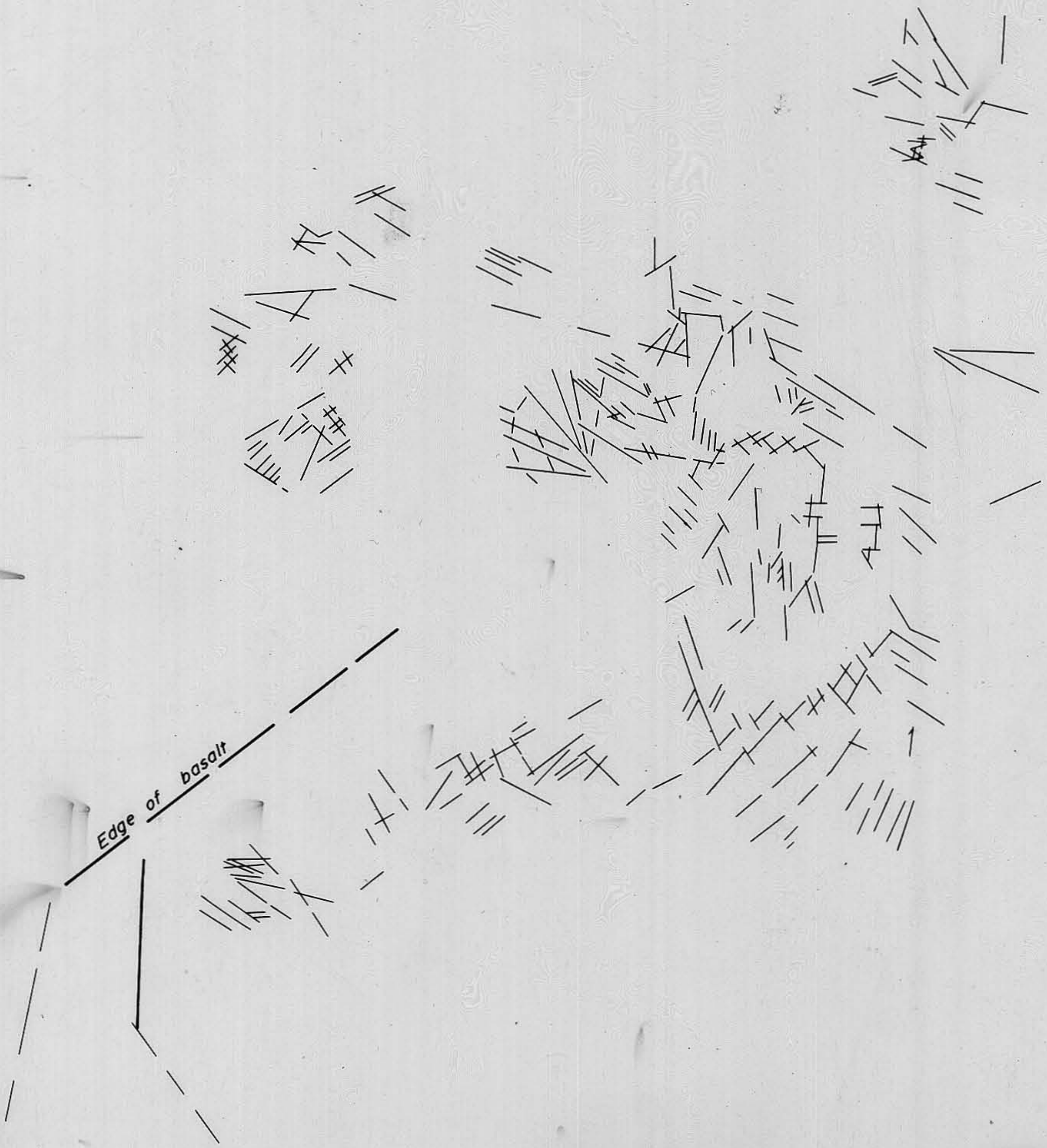
PLATE 3

SCALE 1 INCH = 4 MILES

UTAH DEVELOPMENT COMPANY

LINEAMENTS

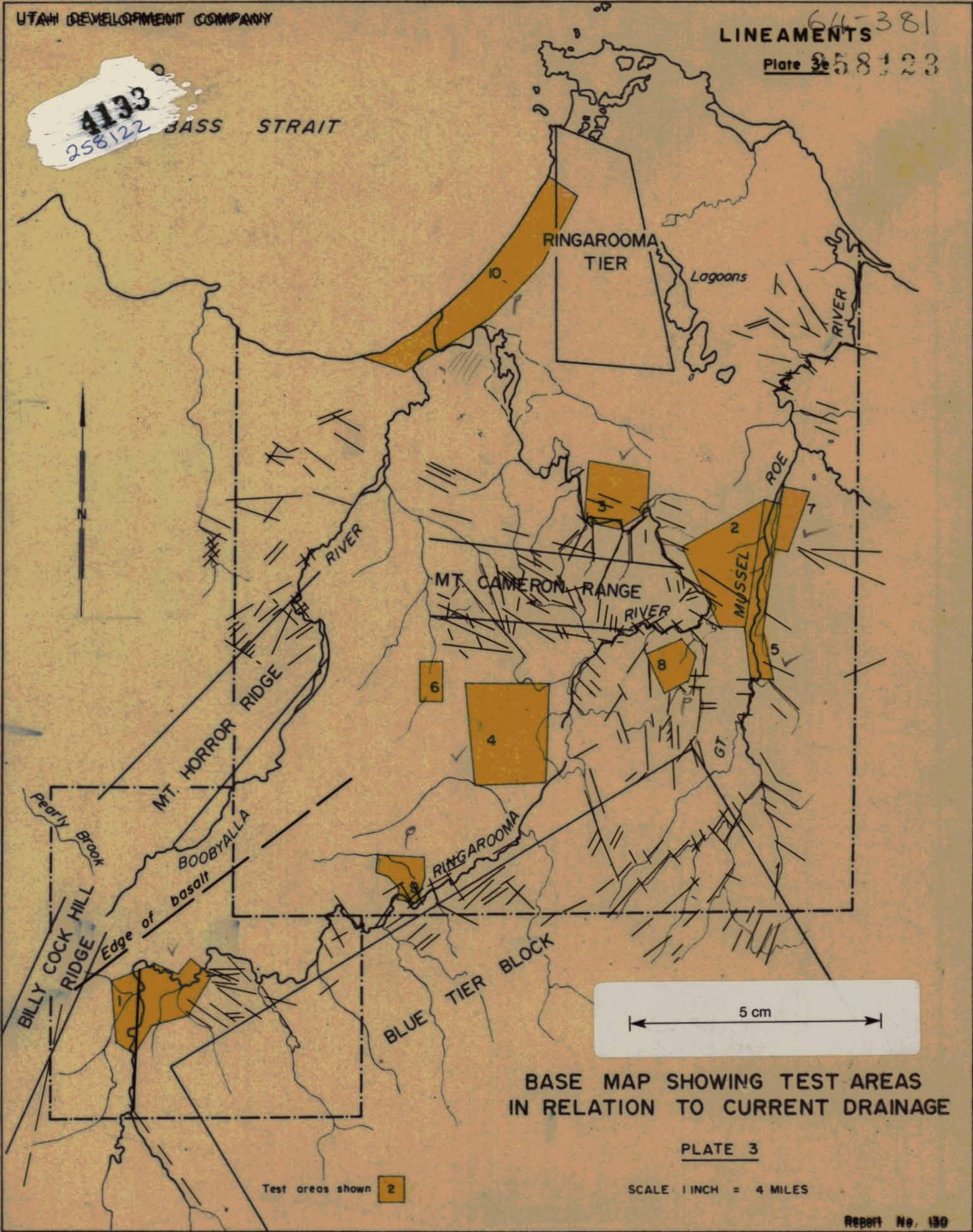
Plate 3e



UTAH DEVELOPMENT COMPANY

LINEAMENTS 64-381

Plate 3e 258123



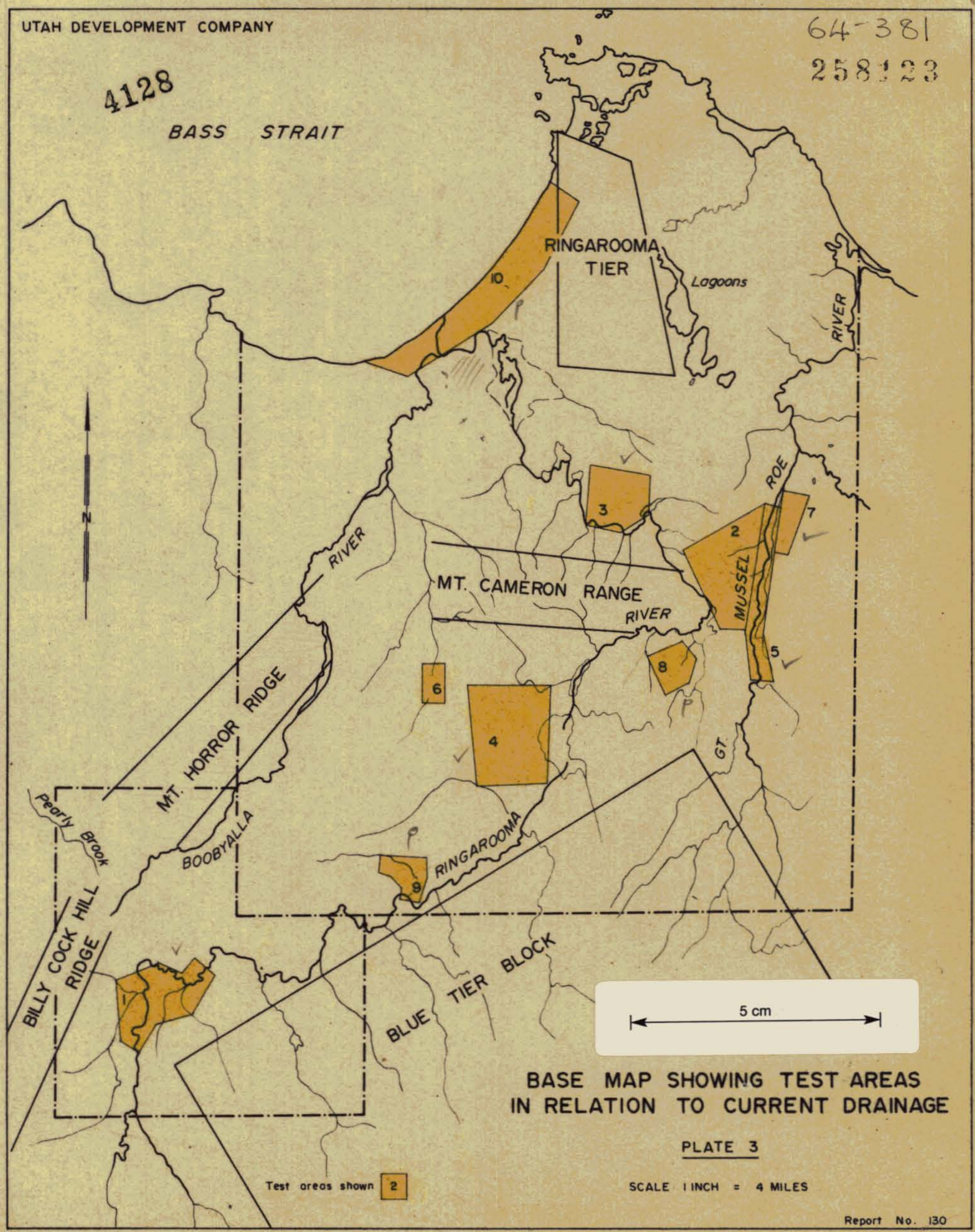
BASE MAP SHOWING TEST AREAS IN RELATION TO CURRENT DRAINAGE

PLATE 3

Test areas shown 2

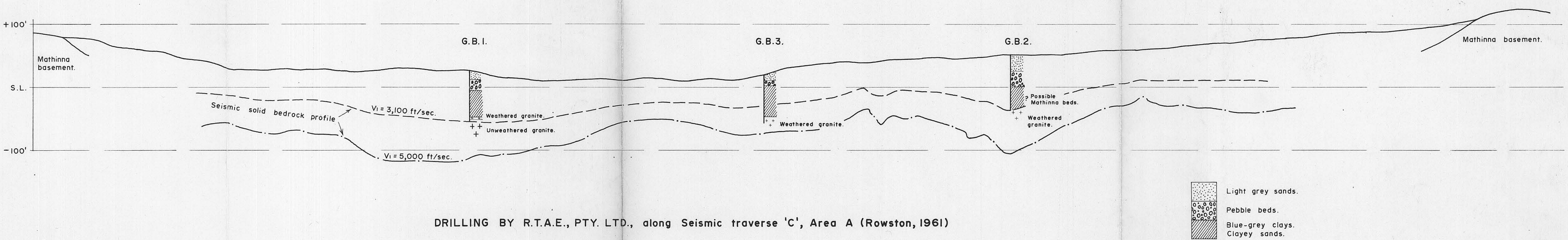
SCALE 1 INCH = 4 MILES

Report No. 130

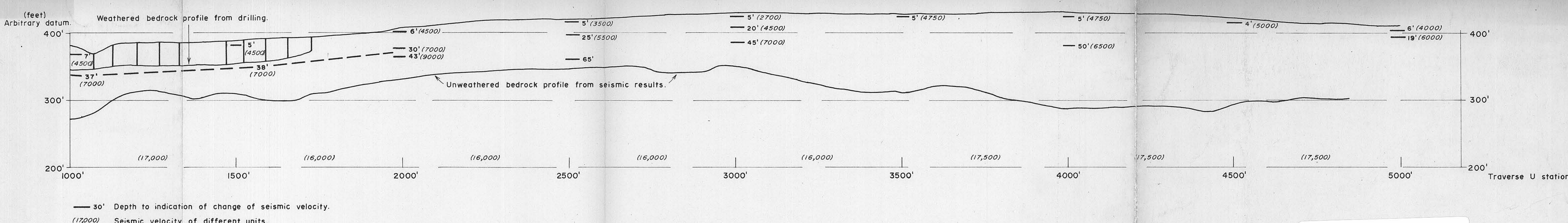


BASE MAP SHOWING TEST AREAS IN RELATION TO CURRENT DRAINAGE

PLATE 3



DRILLING BY R.T.A.E., PTY. LTD., along Seismic traverse 'C', Area A (Rowston, 1961)



DRILLING BY DEPT. OF MINES (1953) Seismic traverse U, Area E (Sedmik, 1964)

UTAH DEVELOPMENT COMPANY

64-381

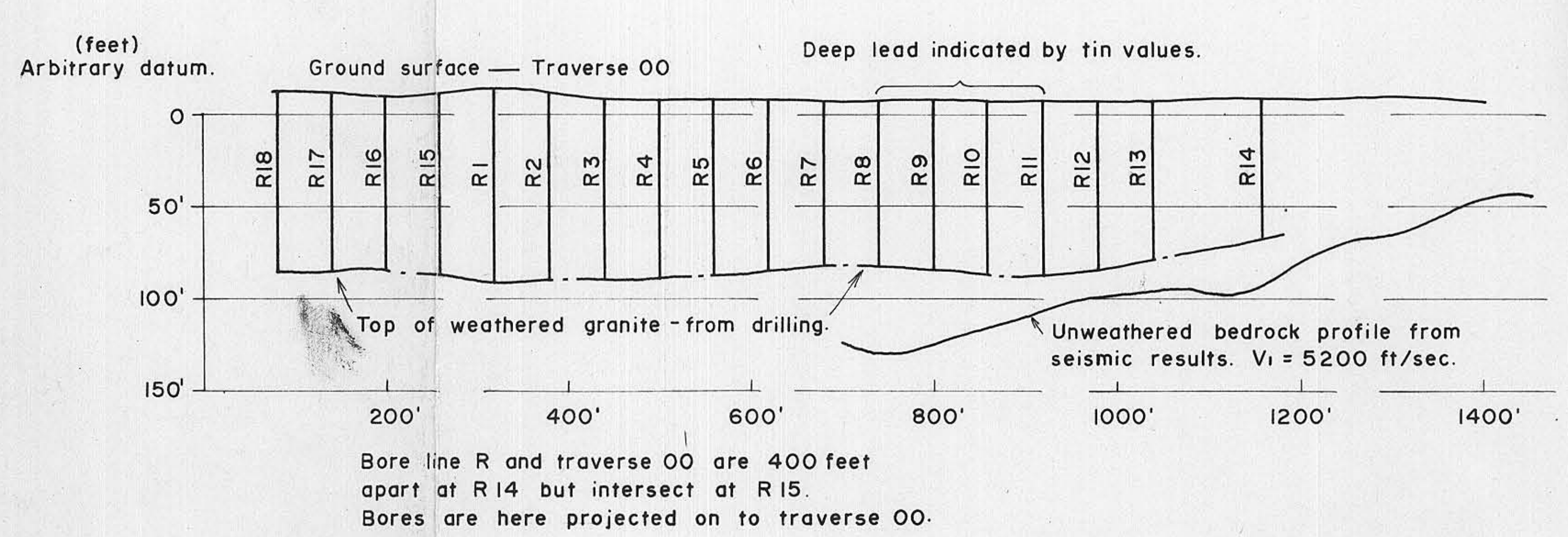
COMPARISON OF SEISMIC PROFILES WITH DRILLING RESULTS.

PLATE 4

258124

413

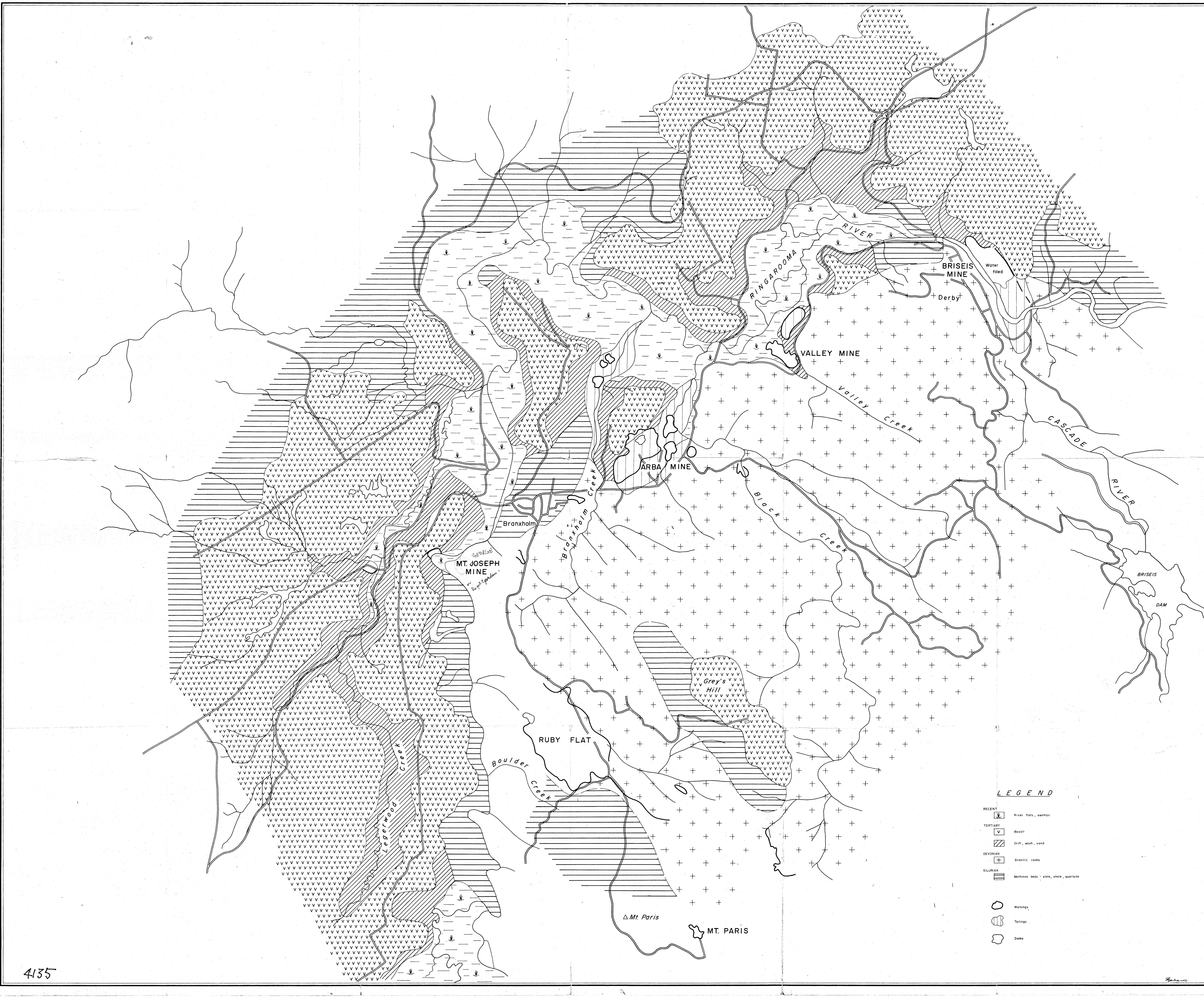
Horizontal scale - 1 inch = 200 ft.
Vertical scale - 1 inch = 100 ft.



DRILLING BY ENDURANCE TIN MINING CO., N.L., Seismic traverse 00, Area D (Keunecke, 1957)

OCT. 1964
Drawn and transposed by B. Madex.

Report No. 130



UTAH DEVELOPMENT COMPANY

64-381

GEOLOGICAL MAP
TEST AREA No. 1

5 cm

PLATE 5

258125

SCALE: 1 inch = 1000 feet

4135

Geology by: O.N. WARIN
Drawn by: P. STEWART
Date: October 1964

Report No. 130


4136
ELIZABETH
LAWRY'S No.1
HARDEN'S RAVINE
B10
B9
B8
LAWRY'S CENTRAL PIT
Garfield
Creek
A3
2b3
2b2
2b1
2b4
WATTS (CYBELE)
Cybele Creek
TRACEYS
B7
B6
2a3
2a2
2a1
NEW EDINA
B5
B4
Lark Creek
DAWS
EDINA
B3
Tailings
RINGAROOMA RIVER
JEWEL FLATS (Purdue Extended)
PURDUE
ARCADIA
B2
A2
S.T.
GREAT MUSSEL ROE RIVER
LEGEND
RECENT
Alluviated areas - button grass flats - in part on Tertiary clays.
River flats, swamps - subject to flooding
TERTIARY
Sandy rises - derived from weathering of Tertiary drift and wash.
DEVONIAN
Granitic rocks
SILURIAN
Mathinna Beds - shale and fine grained siliceous meta sediment
Previous drill traverses - see table "J"
Indications of deeper ground - possible leads.
Proposed drill traverses (U.D.C)
Approximate boundaries main areas of proposed testing.
Areas with outcrops of silicified Tertiary drift - thought to imply shallow bed rock.
Workings
Tailings
O gr Borehole drilled to granite bedrock
O u/b Borehole "un-bottomed"
O 265' Total depth of borehole
64-381
UTAH DEVELOPMENT COMPANY
GEOLOGICAL MAP
TEST AREA No.2
5 cm
PLATE 6
258126
SCALE : 1 inch = 400 feet
4136
Geology by: O.N. WARIN
Drawn by : P. STEWART
Date : October 1964
Report No.130


N
ELIZABETH
Tamar
Creek
B11
Dam
A4
2c1
Tailings
HARDEN'S
RAVINE
B10
LAWRY'S No.1
B9
LAWRY'S CENTRAL PIT
Water filled
Garfield
B8
Creek
A3
2b3
2b2
2b1
S.T.
WATTS (CYBELE)
Cybele
Creek
TRACEYS
2b4
GREAT MUSSEL ROE RIVER
B7
2a3
B6
2a2
2a1
B5
NEW EDINA
Lark
Creek
S.T.
B4
DAWS
EDINA
C
Dam
S.T.
A2
Shallow granite
Indications of deeper ground
B3
Tailings
RINGAROOMA RIVER
River flats
JEWEL FLATS
(Purdue Extended)
PURDUE
ARCADIA
B2
Shallow granite
5 cm
LEGEND
RECENT
Alluviated areas - button grass flats - in part on Tertiary clays.
River flats, swamps - subject to flooding
TERTIARY
Sandy rises - derived from weathering of Tertiary drift and wash.
DEVONIAN
Granitic rocks
SILURIAN
Mathinna Beds - shale and fine grained siliceous meta sediment
B2
Previous drill traverses - see table "J"
Indications of deeper ground - possible leads.
2a3
Proposed drill traverses (U.D.C)
Approximate boundaries main areas of proposed testing.
ST
Areas with outcrops of silicified Tertiary drift - thought to imply shallow bed rock.
Workings
Tailings
O gr Borehole drilled to granite bedrock
O u/b Borehole "un - bottomed"
O 265' Total depth of borehole
UTAH DEVELOPMEN
GEOLOGICA
TEST ARE
5 cm
PLATE
258
SCALE : 1 inch =
Geology by: O.N. WARIN
Drawn by : P. STEWART


4137
AREA EXEMPT FROM THE MINING ACT FROM 31-1-1938
N
Stinking Creek
BLOCK No.6
585,166 cub. yds at 0·30 lbs Sn/cub. yd indicated
BLOCK No.5
1,259,871 cub. yds at 0·29 lbs Sn/cub. yd indicated
BLOCK No.4
258,964 cub. yds at 0·45 lbs Sn/cub. yd indicated.
No drilling information available
BLOCK No.3
1,384,525 cub. yds at 0·39 lbs Sn/cub. yd indicated.
BLOCK No. 2
579,687 cub. yds at 0·32 lbs Sn/cub. yd indicated.
BLOCK No. 1
315,000 cub. yds at 0·31 lbs Sn/cub. yd indicated.
GEOPHYSICAL TARGET 3b
GEOPHYSICAL TARGET 3a
3e1
3d1
3f
3c1
LOCHABER MINE
MALLINSON'S WORKINGS
NEWHAVEN WORKINGS
Bedrock falling
Thin Tertiary (<5') on Mathinna
DOONE WORKINGS
Shallow workings (<5') on bedrock
MURRAY AND RICHARDS
(Workings about 20' deep on bedrock)
SCOTIA MINE
RINGAROOMA
RIVER
Tailings
DAM
LEGEND
TIN VALUES OF BORES
Nil and trace
Less than 0·1 lbs Sn/cub. yd
0·1 - 0·2 lbs Sn/cub. yd
0·2 - 0·4 lbs Sn/cub. yd
0·4 - 0·6 lbs Sn/cub. yd
0·6 - 0·8 lbs Sn/cub. yd
0·8 - 1·0 lbs Sn/cub. yd
Greater than 1·0 lbs Sn/cub. yd
RECENT
Alluviated areas - button grass flats.
River flats, swamps.
TERTIARY
Drift, wash, fine sand, clay.
SILURIAN
Mathinna beds - slate, shale, fine grained siliceous meta - sediment - generally soft, deeply weathered and not exposed except in old workings.
Workings.
3c1 Proposed initial drill traverses.
200 Approx. basement surface contours (assumed data).
64-381
UTAH DEVELOPMENT COMPANY
GEOLOGICAL MAP
TEST AREA No.3
5 cm
PLATE 7
258127
SCALE : 1 inch = 400 feet
Geology by : O.N. WARIN
Drawn by : P. STEWART
Date : October 1964
4137
Report No.130


JOINS NORTHERN SHEET
DORSET
RIVER
FLATS
F.T.
A.B.C. Creek
EASTERN LEADS
WORKINGS
N
Dam
Power Line
Endurance
Gilham Creek
RIVER
RINGAROOMA
Bradshaws Creek
Dam
PIONEER
WYNIFORD
MINE
(Water filled)
LEAD
LEGEND
RECENT
Alluviated areas - button grass flats -in part on Tertiary clay.
River flats - swamps, subject to flooding
TERTIARY
Sandy rises - derived from weathering of Tertiary drift and wash.
F.T. Ferruginously cemented drift
DEVONIAN
Granitic rocks
Workings
Tailings
64-381
UTAH DEVELOPMENT COMPANY
GEOLOGICAL MAP
TEST AREA No.4
5 cm
PLATE 8
(Southern Sheet)
258128
SCALE : 1 inch = 400 feet
4138
Geology by: O.N. WARIN
Drawn by : F.C. BARBARO
Date: October 1964
Report No.130

LEGEND

RECENT

Alluviated areas - button grass flats -in part on Tertiary clay.

River flats - swamps, subject to flooding.

TERTIARY

Sandy rises - derived from weathering of Tertiary drift and wash.

DEVONIAN

Granitic rocks.

Approximate course of Endurance Lead.

Indications of deeper ground - possible leads.

4a Preliminary drilling / geophysical traverses.

Workings

Tailings

64-381

UTAH DEVELOPMENT COMPANY

GEOLOGICAL MAP TEST AREA No.4

5 cm

PLATE 8

(Northern Sheet)

258129

SCALE : 1 inch = 400 feet

4139

Geology by : O.N. WARIN

Drawn by : F.C. BARBARO

Date : October 1964

Report No.130

4139