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Tasmania

DEPARTMENT OF MINES

GEOLOGICAL SURVEY BULLETIN

No. 24

Reconnaissance of Country

BETWEEN

Recherche Bay and New River, Southern Tasmania

BY

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PLATE I

AMG REFERENCE POINTS ADDED

GEOLOGICAL SKETCH MAP OF COUNTRY ALONG TRACK FROM RECHERCHE TO NEW RIVER

SCALE OF MILES
0 2½ 5 7½

5 cm

New River
Precipitous Bluff
AMG468400E, 5176700N
Sand dunes
Rocky Boat Harbour
Rocky Boat Plains
Hen
Chicken
I. du Golfe
Pretty's Pt.
Surprise R.
Densely timbered country
La Perouse △3800'
D'Entrecasteaux R.
AMG490900E, 5177600N
Catamaran R.
RECHERCHE BAY
Shoemaker Pt.
Granite Beach
Sandstone Ck.
Flat Rock Plain
Fluted Range
Cape Range
Table Hill
Black Hole Ck.
Coal Hill
Cockle Creek Plains
Rocky Bay
Bare Hill 900'
Fluted Pt.
Littlefd
Black Hole
SOUTH CAPE BAY
South Cape
S.E. Cape
Whale Head

QUATERNARY
TERTIARY
TRIAS-JURA
PERMO-CARBONIFEROUS
SILURIAN LIMESTONE
CAMBRO-ORDOVICIAN
DIABASE

W. H Twelvetrees
GOVERNMENT GEOLOGIST
31·8·15

Photo Algraphed by John Vail, Government Printer, Hobart, Tasmania.

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At end of Report.

Reconnaissance of Country Between Recherche Bay and New River, Southern Tasmania.

I.—Introduction.

THE wild, unexplored country along the south coast has been entered only by a few hunters, fishermen, and prospectors, who have at different times pushed their way through the dense scrub or landed on its inhospitable beaches. The beaches are few in number, as for the most part the coastal cliffs descend sheer to the water's edge, presenting a vertical front to the sea from 100 to 500 feet high. The only spot where vessels can run in shore between South-East Cape and New River is the small inlet a couple of miles south-east of New River, known as Rocky Boat Harbour, where craft drawing 7 or 8 feet of water can take shelter when the surf at the entrance permits: once in the little rocky basin, boats are protected from all winds except from the south-east. New River has a sand-bar at its mouth, and boats cannot pass into it. South Cape Creek or Rivulet is from 10 to 20 feet deep, but flows out into South Cape Bay over a flat sandy beach. The Surprise River, east of Rocky Boat Harbour, has also a shallow outlet in sand.

These conditions impede landing and prospecting by way of the shore. The numerous steep-sided ravines in the vicinity of the coast have also interposed obstacles in the path of the prospector inland. Messrs. W. H. Tyler, G. H. Smith, Adams, Lancaster, Langdon, Fazackerly, and a few others have penetrated certain parts of the country—Mr. Tyler especially has a wide knowledge of it, having traversed it numerous times—but the present journey constituted the first geological examination of the coast-line.

The first recorded exploration of this coast was in 1815, when Captain James Kelly passed along it in a small open whaleboat. He reported that they attempted to haul the boat up on the south side of Recherche Bay, but found themselves prevented from doing so by a large body of

natives, who gave them a tremendous volley of stones and spears.(1)

In 1824 J. Hobbs made a boat voyage round Tasmania, and noticed the horizontal edges of the seams of coal in the cliffs in South Cape Bay. He suggested the cutting of a canal from the south coast to the Cockle Creek inlet for the conveyance of the fuel to a safe shipping port. He went on from there to examine the New River, about the existence of which there was some doubt. He found it impossible to enter it with the boats, and travelled up it by wading along its side for a distance of 3 miles. He found a salt-water lagoon 2½ miles wide, receiving at its northern end the waters of a narrow river, up which he took his boat 5 or 6 miles, when he had to abandon further attempts in consequence of the stream being blocked by logs. In 1826 he reported on the South Cape Bay coal, and brought some samples to Hobart, which showed it to be of a stony and uninflammable nature.

In March, 1906, Messrs. W. H. Tyler and W. T. Harper journeyed right through this country to Cox Bight. They had to cut their own way through cutting-grass and scrub, and the fact that to-day their line could pretty well be adopted as the course for a permanent track speaks well for their bushcraft.

The writer's journey in February, March, and April this year was designed with the object of ascertaining the geological structure of the country, and especially for the purpose of examining alleged indications of the existence of petroleum near Rocky Boat Harbour and New River.

II.—Personnel of the Expedition.

The writer was accompanied by Mr. W. H. Tyler and Mr. W. H. B. Wallace, both of whom rendered efficient services throughout the journey. Mr. Tyler's intimate knowledge of the route, and his resourcefulness in difficulties, from first to last were invaluable.

On Cockle Creek Plain the Government track-cutting party, which was constructing a path to Cox Bight, was overtaken. This party was supervised by Mr. W. Whitton, under the auspices of the Public Works Department. Mr. F. Robinson laid out a course for it in advance. The party was kept in touch until New River was reached, when exceptionally stormy weather set in, destroying the

(1) House of Assembly Paper No. 107,1881.

bridges which had been built over the streams, cutting communications with supplies, and necessitating a return of the united expeditions at the middle of April. To enable the track to be used in any weather, means of crossing the South Cape Rivulet and the New River will have to be devised, not to speak of Sandstone Creek, near Granite Beach. In dry weather the South Cape Rivulet, known locally as Big Creek, can be crossed at low tide near its mouth by wading, but this is not practicable at high tide; and in flood time the crossing-places are buried beneath a broad sheet of water.

III.—Line of Route.

The line followed starts from the mouth of Cockle Creek, in Recherche Bay, first pursuing a south-westerly direction for about 4 miles, then turning west and winding along the coastal hills for 7 miles as far as the foot of the South Cape Range, when a more or less north-westerly course is followed, parallel with the coast, to the mouth of the New River for 14 miles; in all, 24 miles. The writer continued across the river for a further distance of nearly 4 miles. A pack-track for horses was constructed as far as South Cape Rivulet, beyond which point the track is only a footpath.

The track begins at the upper bridge over Cockle Creek, and skirts the hills for the most part in lightly timbered country along the east side of Cockle Creek Plain. After about 4 miles it crosses the plain, and passes west into wooded country, keeping about a mile or less from the sea-coast. The same direction is followed past South Cape Rivulet and on the south side of Black Hole Creek, negotiating a rise of 400 or 500 feet, and descending to the Black Hole Plain at the foot of the Great South Cape promontory. From this plain the track bends a little north of west, and climbs the promontory to a height of 1600 feet, passing through myrtle forests, 2 or 3 miles from the sea. It crosses this range, which consists of a double ridge, in a distance of about 3 miles or more, and passes out on the Flat Rock Plain, a treeless, wind-swept tableland, 1500 feet above the sea. Descending this vertical height in an hour's walk through timber and cutting-grass, Granite Beach (on Shoemaker Bay) is reached at about 16 miles from Cockle Creek. The bridge of logs constructed here over Sandstone Creek has been swept away by gigantic

floods during the present journey. From this bay the track crosses the Shoemaker promontory in wooded country, and in 3 miles reaches the Surprise River. Beyond the Surprise River beach, Pretty's Point is crossed, and the track winds through high forest land for 3 miles, when it enters the Rocky Boat Plains, which it crosses, and finally passes through a mile of scrub to the banks of the New River not far from its mouth. The advent of tempestuous weather put an end to further construction work, and when seasonable climatic conditions permit, it will be necessary to go over the track again and complete any unfinished or destroyed work, and make any deviations which may seem advisable.

Prospectors are now able in ordinary weather to get along as far as the New River, and the camping-places of the expedition, which are near creeks or waterholes, can be used. Mr. Whitton put up temporary boards on some of the beaches for the guidance of persons lost or shipwrecked, but proper ones, with mileages and directions to the main track, should be prepared and fixed permanently, as well as paths connecting all beaches on the coast with the track.

IV.—Cockle Creek Plain.

At the mouth of the creek in Rocky Bay is situate the most southerly settlement in the island. A few houses cluster round MacDougall and Co.'s sawmill, which is the sole industry here. At the time of this journey the mill was giving employment to about 20 hands. The mill business at this end of the bay is not in a flourishing state at present.

The plain consists of a strip of sandy land from 300 to 500 yards in width, extending from the head of the marine inlet of Cockle Creek to very nearly the southern coast. Its general level is about 100 feet above the sea, except among the sand-dunes which border the coast-line, where diabase rock and Trias-Jura coal measures form hills covered with drift sand and rising to a height of 400 or 500 feet. The bedrock of the plains is diabase rock, and the surrounding hills are the same; the latter are clothed with indifferent stringy-bark and peppermint timber. Small hills of brown sand are scattered about the plain They bear a superficial resemblance to the gas-mounds which occur on many oilfields, but are manifestly residual

mounds of blown sand. The vegetation on them differs in no way from that of the surrounding plain.

Bare Hill, east of the plain, is a diabase mountain rising to 900 feet above the sea, with a flat top covered with low honeysuckle, peppermint, and fern. Bearings on the surrounding country are obtainable from the summit. Posts for telegraphic signal-station on South-East Cape were put up here during the Russian scare some years ago.

From the low elevation of the plain and the configuration of the country it may be inferred that in recent times a water communication existed between Rocky Bay and South Cape Bay. Among the sandhills behind the coast are five fresh-water lagoons, which remain filled with water even in dry weather. There is some wild duck shooting on these. The soakage escapes to the coast, and forms little streams, which trickle over the cliffs on the beach.

The bay, bounded on the west by South Cape and on the east by South-East Cape, is known as South Cape Bay. There is a distance of 7 miles between these promontories, which present high and steep fronts of diabase rock to the ceaseless breakers of the Southern Ocean. In rough weather the surf is flung in huge masses over 200 feet up the vertical sea-wall, and is heard at Catamaran, 8 miles to the north-east.

A couple of miles south-west of Bare Hill the diabase forms a junction-wall with the Trias-Jura coal measures at 100 feet behind the sea-cliff. The observed line of contact is nearly vertical, and is marked by a fragmental zone of red ochre and hematite bands. The direction of the junction here is north-north-west, and the contiguous coal measures consist of soft shales. The cliff is about 200 feet high, and exposes the edges of numerous alternating thin beds of shale and sandstone, with seamlets of coal, none of it thick enough or good enough to be of importance. At the base of the series, and underlying soft felspathic sandstone, is shale, which forms a beach pavement containing impressions of coal plants (Zeugophyllites), and in one place stones of decayed rock, which with a naked eye inspection can only be described as felspathic porphyry. About 40 of these inclusions were noticed, from 6 inches to a foot in diameter, arranged lineally in the plant-bearing shales and stretching out seawards. The rock of which they are composed is foreign to the locality, and the occurrence does not seem to be repeated, as far

as search could be made. The idea that glacial conditions existed during the deposition of the coal is inadmissible. The only rational explanation of the phenomenon would appear to be that the stones have been released from Permo-Carboniferous glacial till which forms the shoreline at different points west of South Cape. This, however, involves an unconformity between the deposits of the two systems which has not been observed elsewhere in the island.

Pieces of asphaltum have been picked up by the Bolton Brothers on this beach, evidently brought to shore by the westerly drift, with which, however, the beach is not exactly in line. The substance is rare here, and despite careful search no more of it could be found. The cliffs continue westward on the shore for a couple of miles as far as Coal Hill, where the sea-face of sandstone has slipped down from the wall of diabase rock behind it, and caused the collapse and destruction of the old coal tunnel and other work which was done there by the Government in the old days.

The seam used to be called a 4-feet one, but there does not appear to have been anywhere more than a couple of feet of coal, the remainder being black shale and clay. Other seamlets exist, a few inches in thickness. Dr. Joseph Milligan (2) in 1848 described the main seam as follows:—

> "There are several seams of coal; the principal one, called a 4-feet seam, proceeding from beneath upwards, consists of—

	Inches.
Black shale	12
Coal	18
Hard anthracite...	3
Brown clay, soft and plastic	2
Hard anthracite	2
Coal	6
Black shale	8

> "The coal which it yields is highly carbonaceous; much of it has a porous coke-like aspect, and it contains iron pyrites to such an extent that it is disagreeable and inconvenient to breathe the fumes of sulphurous acid gas extricated during its combustion, even when at the distance of some feet from the fire and in the open air. It is, therefore, a coal inadmissible for domestic purposes."

(2) Proceedings Royal Society of Van Diemen's Land, 1849.

A sample taken on the present journey has been assayed in the Geological Survey Laboratory by the Government Assayer (Mr. W. D. Reid), with the following result:—

	Per cent.
Fixed carbon	76·30
Volatile combustible matter	10·07
Ash	10·70
Moisture at 100° C.	2·93
	100·00

The coal evidently has a composition tending towards that of the anthracite class, that is to say, the fixed carbon content is high and the volatile matter low; but even for a semi-anthracite the former would have to exceed 80 per cent., and the latter to be less than 10 per cent. Bands in the coal have a brilliant anthracite lustre; it does not soil the fingers, and does not burn readily. It has probably been anthracitised by proximity to the diabase.

Three or four hundred feet back from the edge of the cliff at Coal Hill Point is an ancient coal shaft, which has been sunk in diabase clay. It is circular, and apparently shallow, and is now full of water. It is said to have been a Government shaft. Four ruined chimneys of Government huts are on the bank to the east. To the people of that day it would be the most natural thing to suppose that by sinking through the diabase rock coal would be reached below. The real explanation is that the coal measure sandstone which fringes the coast forms a wall behind which the diabase passes down to an undetermined depth. This makes shaft-sinking in the diabase utterly futile.

Near Little Island, between Coal Hill Point and the eastern part of the bay, a narrow dyke of diabase with vertical walls some 20 feet in height bars the way to a traveller along the beach, and the island itself is composed of the same rock.

According to the Admiralty chart the depth of the sea off the south coast for many miles out varies between 50 and 80 fathoms. The sea bottom must be regarded as a submerged part of Tasmania: the coal measures are no doubt continued beneath the water.

It may be mentioned here that on the Admiralty chart the term South Cape is applied to the promontory which on the map of Tasmania bears the names of South-East Cape and Whale Head. The South-East Cape of the Tasmanian map is the Three Hillock Point of the Admiralty chart. The Three Hillock Point of the map of Tasmania is situate between South-East Cape and Whale Head.

V.—South Cape Rivulet.

The track after leaving Cockle Creek plain winds about among the sandhills which fringe the coast, till South Cape Rivulet, known locally as Big Creek, is reached. The timber passed through is stringy-bark, with manuka, salvewood, pinkwood, sassafras, pear-tree, &c., with patches of tree-fern, cutting-grass, and grass-tree, also leatherwood. Where solid rock is met with, it is sandstone or shale belonging to the coal measures. When the Coal Hill ridge is crossed, the loose stones of diabase indicate the presence of that rock. The track here has been cut down to the beach, and five minutes' walk from the west end of the latter brings one to the beach at the mouth of South Cape Rivulet. The rivulet or creek opens out on a little sandy beach, in which it cuts a variable channel, according to the rainfall. Further back, where the stream is confined within its proper banks, it is fully 20 feet deep in ordinary weather. It flows in a southerly direction. At its mouth a creek from the west flows into it from the Black Hole Plain: Tyler's track goes west up this creek on its north side. The present track follows the hills to the south of it.

At the mouth of the rivulet trees form a dense forest of celery-top pine, stringy-bark, tallow-wood, sassafras, pinkwood, pear-tree, &c. The stringy-bark trees are old and mostly rotten. The ground is very rocky, and has only a thin covering of soil.

The strata consist of Trias-Jura sandstone of a white, loosely granular variety, consisting of quartz with felspar and a little mica. In places it is very firm and compact. Round the shore-line there has been a good deal of displacement by falls and subsidence, and the bedding is consequently not always normal. On the beach towards Coal Hill the sandstone beds have an easterly dip.

Coal is said to have been found cropping out somewhere up the little creek which flows in from the west.

VI.—Black Hole Plain.

The track to this is a sideling one along the flank of the hills, which on the south bound the valley which descends from the plain to South Cape Rivulet. The plain occupies a low basin, edged on the south with steep rocky cliffs of sandstone and shale abutting on the sea. There is practically no beach, and the cliffs are sheer for 100 feet, so the water's edge is inaccessible. The prevailing rock is dark-grey shale, and the dip easterly. A little creek flows down the hillside, and falls over a precipice into the sea. In the creek-bed small pieces of quartz were observed, together with stones of pebbly grit, evidently derived from Permo-Carboniferous beds, which must be somewhere about here. From the summit of this cliff on the plain a good view was obtained of the white rock called "Piedra Blanca," some 20 miles out at sea to the south-east, and of the tower-like pile of stratified rock near it called "Eddystone." These rise 150 and 200 feet respectively from 70 fathoms of water. Shoal water exists between the two.

The east point of Black Hole Bay is diabase; westerly the shore line is sandstone until the point of South Cape is approached, which is diabase. Mr. Tyler says that at low tide the lowest shelf of rock at the extreme end of the cape is sandstone; over it towers the massive columnar diabase.

Black Hole Plain is covered with grass, heather, and stunted honeysuckles. North of it is Tyler's old track, by the side of a creek fringed with horizontal, tallow-wood, myrtle, and peppermint. The creek flows through shale and grit; it has a rapid current, and is here 8 to 10 feet in width. The track was well chosen through comparatively level country from South Cape Rivulet.

The determination of the age of the shale and sandstone of this stage of the journey is difficult, as no criteria exist by which the Trias-Jura strata can be distinguished with confidence from those of the Permo-Carboniferous, that is, where the latter are not calcareous and glacial phenomena are absent. The junction of the two is apparently somewhere to be found in the locality, but cannot easily be found, as exposures are rare, and no marked want of conformity exists. Provisionally, the beds here will be referred to the Trias-Jura. It will be borne in mind that wherever beds of this period occur there is the possibility of finding coal-seams.

VII.—South Cape Range.

In the latitude of Black Hole the South Cape Range is about 3 miles across from shore to shore. It is a massive double-ridged promontory, one ridge terminating at the point of South Cape proper, and a second one running out at Fluted Point, some 2 miles up the coast on the other side of the cape. The rock on the cape, and up the shore as far as Fluted Point, is diabase, but it does not extend very far inland, being replaced by sandstone. The trigonometrical station is situate about a mile from the shore, and at a height of 1600 feet above sea-level. The track from Black Hole Plain ascends this range through myrtle forest, passing to the north of the trigonometrical station site. At the summit of the ridge are the remains of Fazackerley's old camp, in somewhat open peppermint timber. The same sandstone as prevails to the east is exposed in thick beds on the western brow just before beginning to descend on that side of the hill. The track goes down into a deep valley filled with cutting-grass and small myrtle scrub, through which Hard Luck Creek flows. A saddle exists here, one creek flowing to the north, the other to the south. The hill on the western side of the valley, up which the track is carried, is the Fluted Point ridge, and the tents were pitched on the crest, 1600 feet above sea-level, in a patch of manuka scrub. This was found to be half a chain off Tyler's track. In the dry creek to the west a whitish, bedded, granular sandstone occurs, with included small pebbles of quartz. This has an easterly dip. The indications are that it belongs to the Permo-Carboniferous, but the reference is somewhat uncertain. The forest growth prevents any view of the surrounding country.

A mile or two south-west of this camp the track enters a high treeless and wind-swept plain, where a picturesque panorama of the ocean, with the De Witt and other islands, and of the high coastal mountains, unfolds itself to the gaze. The plain is covered with heath and honeysuckle breast high; at the highest part is an exposure of flat beds of conglomerate, dipping towards the east at an angle not exceeding 6 degrees. The rock contains rounded and angular pebbles of quartz, sometimes flinty-looking, and some organic remains, which may be either crinoids or corals. There can be hardly any doubt that

the beds belong to the Lower Marine series in the Permo-Carboniferous. The height of the plain is about 1500 feet above sea-level. It is referred to in this bulletin as the Flat Rock Plain.

A ridge of diabase rock passes out to the headland west of the plain, and the track crosses this in a steep descent to Shoemaker Bay (Granite Beach). This descent is effected in an hour's walk. The cutting-grass was very thick in this part of the track.

VIII.—Shoemaker Bay (Granite Beach).

Camp was fixed on the east side of Sandstone Creek, about 10 minutes' walk from the sea-beach. The sandstone is a coarse brown variety, consisting of quartz, kaolinic material, mica, and a little specular iron ore. It contains large rounded pebbles of flinty-looking quartz, and is unquestionably Lower Permo-Carboniferous. The creek flows south-west, and the valley is evidently the line of junction with the ridge of diabase mentioned above.

The beach is stony. Many of the stones are diabase; others are granite, derived from the Permo-Carboniferous glacial till, of which good sections occur at both ends of the beach. Towards the east end, where the creek flows out on the shore, the rock is a bluish-grey mudstone conglomerate, containing, *inter alia*, stones of granitic quartz-mica rock, and forming a true glacial till. One of the inclusions is a large boulder of Rocky Boat conglomerate 6 feet long. The east point of the bay consists of columnar diabase, and a little way back this is observed resting on the stratified rock. The cliff descends precipitously into the sea, and is inaccessible, but the relations and contact are plainly visible from a distance. The west point of the bay is said by Mr. Tyler to consist of dark limestone. The beach is about half a mile in length, and at its western end is a fine cliff front of glacial till from 80 to 100 feet high. A few feet above the base of the section 4 feet of thinly-bedded mudstone shale are intercalated. The inclusions in the till are dark carbonaceous shale, granite with a bronzy mica and hard bluish-grey quartz felspar rock; all both rounded and angular. The stones are scattered through the unstratified till promiscuously, like plums in a pudding. The promontory at the west end of the beach is known as the Shoemaker.

IX.—Surprise River Bay.

The track now passes north-west for about 3 miles over the Shoemaker promontory, showing here and there stones of mudstone conglomerate or pebbly mudstone. Deep narrow ravines are crossed; these narrow gullies are quite a feature of the country. They indicate youthfulness and a recent elevation of the land. The Surprise River, about 40 feet wide at its mouth, runs out on the beach at the east end of the bay. The beach is sandy, and high sand-hills, reaching a height of a couple of hundred feet, skirt the coast. The bedrock at the east end of the bay and continuing out to the point is Silurian limestone, which strikes 10 to 20 degrees east of north, and dips at from 50 to 60 degrees to the south-east. The limestone of the east point extends in the form of a low wooded range, sloping gently into the sea at Shoemaker Point. In the rock on the beach are thin slaty beds, which weather out to knife-edges every 5 or 6 inches.

At the west end of the beach strata occur which belong to an older system. From their lithological aspect they appear to be members of the group of strata which are found in Tasmania below the Silurians and resting unconformably on Pre-Cambrian beds. These can only be called provisionally Pre-Silurian or Cambro-Ordovician, though it is still possible that the uppermost members may eventually be assigned to the Silurian. The exposures in this bay are separated from the eastern limestone outcrops by the stretch of sandy beach, which obscures the geology of the intervening space; but in the western corner of the bay high outcrops of rock are seen. These consist first of a white saccharoidal quartzite, then of a hard conglomerate, containing pebbles of quartz, slate, quartzite, and schist, and striking north 20 to 23 degrees east, with a dip to the south-east at angles varying from 50 to 55 degrees. From below these rise conformably the steep arenaceous and argillaceous flagstones of Pretty's Point. These contain in profusion tubular casts and obscure markings, some of which may represent worm trails or burrows, while others are perhaps the impressions of fucoids. Which are really algæ, and which are animal burrows or trails, is utterly impossible to assert from merely external resemblances. The names which have been affixed by palæontologists to similar casts and markings (mainly

from Cambrian beds) do not appear to substantially advance our knowledge of their real nature.

A good-sized piece of asphaltum lying on the sand on this beach was picked up (by Mr. Tyler), but no more of it was found. It was below high-water mark, and had apparently been washed up after the recent storm.

X.—Rocky Plains Bay.

This is a bay about 3 miles north-west of the Surprise and just south of Rocky Harbour. It skirts the seaward edge of Rocky Boat Plains. The track from the Surprise crosses that river at some distance from the coast, and ascends in timbered country to between 400 and 500 feet above sea-level. After passing Pretty's promontory the rock under foot appears to be Lower Marine conglomerate. Finally the plains are reached, across which a small creek winds its way down to the sea to Rocky Plains bay. At the north end of this bay is an occurrence of brown coal, referred to later in this bulletin. At this end of the beach beds of slate strike north-easterly and dip south-easterly; below them is a hard white and pink conglomerate, which runs out towards the point. The shore at the southern end of the beach consists of Permo-Carboniferous glacial till, and this till or conglomerate continues southwards into the southerly division of the bay, in which there is a small flat surface exposure of pyroxene contact rock, barely visible in the sand at one place on the beach. According to Mr. Tyler, a ridge of serpentine exists inland a couple of miles distant, and judging from its position it is possible that it has some connection with this outcrop. The glacial till appears to have been deposited on the denuded surface of this rock. In the till are stones of granite, serpentine, and numerous rather rotten stones of vivid red colours, giving a very characteristic appearance to the cliff sections. Some of these reddish stones are of a rock decomposed to a mixture of serpentine and talc; or, again, others represent an igneous contact-rock showing microscopically a groundmass of dolomite and calcite, full of serpentinised segregation nodules composed of decomposition products, secondary quartz, limonite, chlorite, serpentine, &c. The rock contains primary grains of chromite and magnetite.

XI.—Rocky Boat Harbour.

This is reached in half an hour's walk west over the hill ridge from Rocky Plains Bay. It is, as its name denotes, a small rocky bay about 30 chains across, and filled with rock islets which stretch across in a line from the New River Bluff, which forms the western point of the harbour. Point Vivian is at the extreme end of the eastern promontory. Opposite the former is the island known as the Hen; opposite the latter is the one called the Chicken.

On the stony beach at the head of the harbour are large boulders of reddish-brown and white conglomerate. Steep cliffs of conglomerate and quartzite bound the west side of the bay. On the east side are beds of lithographic stone, which appears to be an integral member of the conglomerate series. These strike north 60 degrees east, and dip to the south-east at an angle of 25 degrees. A reward claim of 97 acres was granted to W. Handy Tyler in 1892 embracing the Point Vivian promontory, and a lease of similar area was taken up north and adjoining. These concessions expired in 1913. A good deal of the value of lithographic stone has disappeared with the introduction of new processes in the printing trade, but the writer is informed that it is still of use, and for certain work is preferred to any other material.

Some varieties of this stone make excellent sharpening hones. It is essentially a fine-grained, siliceous, dolomitic rock. It is very homogeneous in texture, and quite soft enough for the lithographer's purpose. The beds are on the shore of the harbour, and can be worked with ease, as they rise from the edge of the water into elevated ground. The first direction in which prospecting operations should be employed is that of ascertaining whether fair-sized slabs can be obtained without cracks. The sizes for which the demand is said to be greatest are those in the neighbourhood of 2 feet square or 2 by 3 feet, but the introduction of zinc and aluminium plates has affected the market. The ordinary small sizes of 1 foot by 16 or 20 inches will sell at 2d. or 3d. per lb., while larger sizes range between 4d. and 6d. per lb.

A piece of asphaltum was found on the beach last year by Mr. Adams when he was down at the harbour with Mr. Herbert Smith. This was about the size of a billy-can. None was seen during the present visit.

XII.—New River.

This is the most important river on the south coast. Its mouth is about a couple of miles north-west of Rocky Boat Harbour. It rises in the high land, on the other side of which the Craycroft River flows north into the Huon. Its length is perhaps 12 miles, and its course north and south.

A small belt of scrub-covered sandhills separates the river from the Rocky Boat Plains. The scrub affords sheltered spots for camping, but water is scarce. Tyler's track from Rocky Boat Harbour to New River has been used by various parties landing in the harbour, and is easy to follow. It descends to the beach at the river-mouth. The original mouth is now a blind creek at the east end of the beach which loses itself in the sand. There is a bar some distance out from the shore-line, on which the sea breaks at low tide. The sandy beach is 4 miles long. The point at its east end is composed of conglomerate or quartzite, with a north and south strike and westerly dip at angles of 30 and 35 degress.

Silurian limestone on the beach strikes east and west, with a southerly dip. A great unconformity therefore exists here between this limestone and the conglomerate series.

The beach is fringed all the way with sand-dunes from 30 to 100 feet high. At the base of these are thin bands of carbonaceous and ferruginous sand. At the extreme western end quartz conglomerate overlies quartzite, and both strike northerly and dip easterly at an angle of about 15 degrees. These strata belong probably to the Cambro-Ordovician.

Two pieces of asphaltum were picked up on the beach on this occasion: they were lying on the sand, which is only covered by the sea at the time of flood-tides. The bed-rock below the beach sands is most probably limestone, which in its turn no doubt rests on the older conglomerates and quartzite.

XIII.—The Asphaltum Glance and Oil Syndicate.

The New River claims of this syndicate are four extended prospecting areas of 320 acres each. Besides these, 640 acres are held in the neighbourhood of Recherche Bay.

About three years ago some large pieces of asphaltum were found by Messrs. Smith, Adams, and Glover on the New River beach east of the then mouth of the river, about where the present mouth is situate. Mr. Adams also found some on the beach in Rocky Boat Harbour, in August last. One of the pieces at the New River was estimated to weigh nearly a hundredweight. Mr. Hy. Glover states that he has frequently seen large quantities of natural asphaltum lying about on these beaches, including a piece large enough to take two men to lift. Natural asphaltum or bitumen is universally recognised as being the residue of petroleum after the latter has lost its more volatile constituents by evaporation. The syndicate was also informed by its prospectors that they had seen large surfaces of oil floating on the sea in the neighbourhood of the properties. Seams of what appeared to be asphaltum perished by the weather were also reported as occurring *in situ*, both on the sea-coast and 3 miles up the New River. The occurrence of black sand on the beach was correlated with the Taranaki iron sand in New Zealand, and was looked upon as a favourable feature. Some weight was also attached to the existence of limestone, and some hills with rounded tops which occur on the Rocky Boat Plain have been alluded to, presumably with the idea that they may be comparable with the gas-mounds or mud-volcanoes which are a frequent phenomenon on petroleum fields. The above alleged indications encouraged the syndicate to take steps towards testing the district for oil.

Before dealing with the asphaltum discoveries, which constitute the real basis of the enterprise, the various occurrences which have been supposed to have some bearing on the question of the existence of asphaltum or petroleum in the district will be described.

(*a*)—Tertiary Coal in Rocky Plains Bay.

The beach is approached from the Rocky Boat Plain by following the course of a creek which flows through the plain and enters the sea at the bay. Crossing it near its mouth, and following a westerly direction, an exposure of Tertiary strata with a development of brown coal is met with at that end of the beach. The width of the exposure is about 140 feet. There is an outcrop of soft brown shales about 20 feet across at the foot of a cliff of loosely aggregated conglomerate or gravel, apparently belonging to the

same geological period as the shales, as the carbonaceous matter of the latter extends into and permeates the conglomerate. The shales strike north 40 degrees east, and dip to the north-west at angles of 50 to 60 degrees. A little prospecting work has been done by the syndicate, both in the shales and in the conglomerate cliff at the back.

Some disturbance of the strata has evidently taken place since they were laid down, for a little further west similar clays are in a vertical position, and the conglomerate also, though showing no lines of stratification except in one spot, seems to be vertical. A raised beach of quartz gravel overlies all these beds. It is difficult to connect the inclined shales with the vertical strata, except by supposing faulting to have taken place, for they are all evidently one assemblage of beds.

A cut has been put in about 5 feet across the beds, showing seams of brown coal and carbonaceous material throughout its length. The overlying conglomerate is also impregnated with coaly matter, though not so heavily as the shales. The coal is dull-looking, with some small shining layers, which have suggested an asphaltic origin. Its physical properties, however, behaviour when heated, odour, &c., negative the suggestion.

Analyses of it have been made in the Geological Survey laboratory by Mr. W. D. Reid, Government Assayer, with the following results:—

	Per cent.
Fixed carbon...	36·34
Volatile combustible matter ...	42·48
Ash	8·50
Moisture at 100°	12·68
	100·00

The substance evidently belongs to the Tertiary brown coals. No asphaltum fragments have been found on this beach, and no exudations or other signs of oil are observable. If the shales are reservoir rocks, they ought to show signs of the seepage which is generally present somewhere or other where such rocks outcrop.

On the other hand, one may recall that oilfields frequently supply instances where the Tertiaries or Cretaceo-Tertiaries with rapidly alternating beds of carbonaceous material, sands, and clays, are strata favourable for the origination and storage of oil deposits. Such estuarine or

littoral sediments may be looked upon as inviting close examination and tests, provided that the requisite geological conditions coexist. Presupposing the existence of the organic matter which is the source of the oil, there must be porous storage rocks (usually sandstone or limestone) flexed so as to receive the ascending supply of oil, and the whole must, further, have an impervious cover (generally clay or shale), which is apparently essential in preventing the escape of the volatile products, and may even play some part in the process of the formation of the oil itself.

At Rocky Plains Bay there is nothing to show the vertical thickness of these strata, but as they appear to be squeezed in a very narrow front, it is improbable that they are very thick. The Rocky Boat Plains probably consist partly of the Pre-Silurian conglomerate which comes in on the shore west of the coal beds, and partly of the soft Permo-Carboniferous beds which are so well shown along the south-east beach. How far the latter extend inland on the plain could probably be ascertained by a few shallow pits.

The occurrence at the coal outcrop is very suggestive of these beds being the mere land fringe of strata which extend seawards below the water. If this group of strata is to be regarded as a source of oil, it is possible that the process of oil-formation was confined to those beds which are now submarine. It is stated in the literature of the subject that in some oilfields one and the same geological horizon is both lignitic (or coal-bearing) and petroliferous in different parts of the same area where slightly different conditions of sedimentation obtained. Consequently it is not impossible that beds which on the shore are carbonaceous may be petroliferous in their submarine extensions.

Unfortunately the inclination of the carbonaceous beds in Rocky Plains Bay, where not vertical, is towards the land; they thus afford no channel for the reception of oil from strata below the sea. It may be accepted as a general rule that oil beneath the surface rests on the underground water, by which it is forced up through the reservoir rock towards the apices or at least the higher parts of folds in the strata, where it accumulates, or, alternatively, to the outcrop. In the present case the beds have either been fractured at the sea margin, or their anticlinal apex was over where the sea now exists. On the other hand, if they extend below the surface of the plain, a bore-hole there would strike them on their descending course not far from the bottom of the trough, and in a bad position for the chance of oil.

The Silurian and Pre-Silurian strata further west consist of hard, compact rocks from which nothing can be expected. If a fully developed Tertiary series existed, with a succession of sands, clays, lignites, and carbonaceous beds, the whole under a good weight of impermeable rock, it might be anticipated that at one time or other conditions had prevailed which would permit the reduction of the organic material to petroleum. There certainly is a remnant of Tertiary sediments at the Rocky Boat Plains, but to all appearance the area is very limited, and the outcrop is backed and hemmed in by older rocks in which the chances of the existence of oil are extremely slight. The structural characters of these Tertiaries are likewise unfavourable, for they dip inland against the older strata, and have themselves been subject to violent faulting. The absence of anticlinal structure from the Tertiaries need perhaps not be taken too seriously, for it is conceivable that the disposition of the beds may still permit the existence of migration and accumulation conditions: for instance, it is possible that false bedding may to some extent take the place of anticlines.

(*b*)—Tertiary Beds at New River.

A small exposure of what from the description is evidently Tertiary coaly matter occurs some 3 miles up the New River, but can only be visited by boat. It is included in one of the areas held by the syndicate. The beach at the mouth of the New River is nearly 4 miles long, and is skirted by sand-dunes, at the base of which there appears to be a thin layer of loosely coherent sand with its grains held together by dark carbonaceous material. All these sands belong to the Recent period. The foundation rock of the coast, judging from the outcrops at the east end of the beach, is here Silurian limestone, which has no doubt been deeply eaten into by the river in the course of ages. It is possible that below the dunes and the beach sand the excavated limestone floor is covered by sediments of Tertiary age. To ascertain by drilling whether this is the case will be a part of the work which the syndicate has set itself to carry out. The bore should be put down some distance back from the beach, and about half-way between the river-mouth and the high land to the west.

(*c*)—Geological Age of Petroliferous Beds.

Is the age of the coal beds at the Rocky Boat Plains such as encourages hopes of the discovery of oil? This is

a question which the promoters of the search have no doubt put to themselves. The answer in the first place is that geological age has no decisive bearing on the problem. From the occurrences of oil-bearing strata in different parts of the world, it is clear that the oil-forming processes are independent of the age of the rocks in which they take place, for the known oil rocks vary in age from Ordovician to Tertiary. The Ordovician Trenton limestone of the North American continent furnishes an illustration of the existence of petroleum in strata of a high antiquity. On the other hand, the oilfields of Roumania, Baku, Burmah, Dutch East Indies, &c., are of Tertiary age (in some instances associated with brown coal and lignites; in other cases with beds in which animal remains are abundant). In the Taranaki gas and oil field in New Zealand the productive strata are also Tertiary.

The obvious conclusion is, therefore, that no horizon in the geological sequence of stratified rocks can be excluded. But though age is not a factor, physical characters are of importance, and these, again, must be accompanied by the structural conditions requisite for the accumulation and conservation of oil. Having regard to the general nature of Tasmanian Tertiary strata, with their rapid alternations of sands and clays and carbonaceous deposits, the writer would be disposed to first seek sites in the island for drilling where the lacustrine and estuarine Tertiaries are strongly developed and the other conditions are present. Thus the beds on the edge of the Rocky Boat Plain are not fundamentally excluded by reason of their age; in fact, from this point of view they may be said to have a *prima facie* claim for examination, though the collateral conditions are not quite encouraging.

The drilling necessary for testing would be on the shore of the bay at the base of the coal cliff and above high-water mark. Another bore could be put down on the plain itself and not much above sea-level. If the beds are found to rest on the glacial till of the Permo-Carboniferous, boring should be continued until the drill enters the Cambro-Ordovician conglomerate and quartzite, in which the chances of the existence of oil are slender.

It must be understood that these bores will be purely exploratory and speculative. The geological data which are available do not warrant any positive prediction of their results, but the necessary drilling is almost certain to be on a very limited scale.

(*d*)—Hills on Rocky Boat Plains.

Gas or mud volcanoes emitting water and mud under gas pressure are known phenomena of petroleum fields, and oil is often struck when holes are drilled near these vents. Such mounds furnish very valuable evidence as to the existence of oil.

Some hills at the back of Rocky Boat Plain, rising about 100 feet above the level of the plain, have been thought to give some indication of this nature. They were examined on this occasion, but nothing abnormal could be observed in connection with them. They are covered with button-grass, and here and there support a few stunted peppermint shrubs. The top soil consists of a couple of feet of turf resting on quartz and quartzite gravel, which can be followed down for a couple of feet without any change. The hills on the western side of the plains have probably a conglomerate bedrock; on the eastern side, a bedrock of glacial till, which perhaps also fills the central portion of the plains. It is not likely that the Tertiary beds on the beach extend far back into the plain. I had opportunities of inspecting this plain both in fine and wet weather, but could not detect any signs of oil.

(*e*)—Black Sand in Rocky Plains Bay.

There are several small runs of a black iron sand on the beach in the bay east of the mouth of Rocky Plains Creek, and the occurrence has been mentioned as being in some way indicative of petroleum. The surface streamlets of sand are more abundant after heavy rains; the grains of iron ore are obviously released from material washed out of the loose till which forms the cliffs on the shore of the bay. The parent rock which was their source was found to be the serpentinised rock of the majority of the red stones contained in the glacial deposit, and which form such a distinctive feature of the latter.

A sample of the sand has been examined in the Geological Survey laboratory by Mr. W. D. Reid, Government Assayer, who reports that it consists of chromite and magnetite. This composition indicates a derivation from the serpentinised rock just mentioned.

The Taranaki iron sand, which is composed of magnetite and ilmenite and contains no chromium, has been referred to in connection with this occurrence, but the correlation is illusory.

Black sand has also been cited by prospectors as existing in quantity up the New River, but any reference to it as a petroligenic feature is unintelligible.

(*f*)—Alleged Surface Films of Oil on Sea.

Smooth, glassy looking patches on the sea opposite the mouth of the New River have been cited by some observers as being due to a surface film of oil on the water. Oil films on the sea and on the surface of streams are familiar phenomena in oil districts, so that if the existence of such films could be established here, there is no doubt that the evidence would be of importance. Several smooth patches of water were pointed out to the writer by Mr. Herbert Smith when at the New River, but the interpretation of them which ascribes them to oil seems unconvincing, as samples of the water have not been obtained. They appeared to be in motion, and to be more abundant in the vicinity of the mouth of the river than in other parts of the bay.

There are various ways of accounting for these smooth streaks and patches, *e.g.*, the presence of masses of seaweed, imperfect admixture of fresh water with salt sea-water near the mouth of a stream, or uneven atmospheric pressure on different areas of the ocean surface. But until the examination of the water itself has revealed the presence of oil, the formation of an opinion is premature, and the phenomenon cannot be properly appealed to as an indication of petroleum seepage. With a southerly wind the odour of petroleum ought to be perceptible on shore with all these patches floating about in the bay.

In view of the possibility of the seepage of oil from submarine beds, the promoters may be strongly advised to take steps to examine the alleged films *in situ* by means of a boat, and collect samples for testing.

(*g*)—Limestone at New River.

There is a disposition on the part of the promoters of the search for petroleum on this coast to view the Silurian limestone as a possible source. This view is probably due to the influence of American opinion with regard to the storage of oil in the somewhat porous and dolomitised Trenton limestone of that continent. American authors consider that the oil in that limestone was derived from animal remains originally contained in the rock. E. H. Cunningham Craig, on the other hand, argues in his suggestive book on "Oil-Finding" that the limestone is simply a reservoir rock into which the oil has ascended, and in which it is stored owing to the cavernous structure of the rock. He calls attention to the difficulty of supposing that the soft parts of animals are preserved in buried sediments on a scale sufficient to account for the huge quan-

tities of petroleum which oil rocks yield. Following out this line of reasoning, Mr. Craig in enumerating the indications which suggest the presence of petroleum says:

> "The occurrence of marine limestone is, generally speaking, a bad sign, though many prolific fields have a limestone as their reservoir rock. An entirely marine series without intercalations with littoral or estuarine beds is to be avoided."

However, in various parts of the world limestones contain petroleum supplies, and it is also believed that sandstone reservoir rocks have in some cases received their store of oil from the limestone which underlies them.

Thus the conditions in the Alberta oilfield, in Canada, are that the Lower Cretaceous Dakota sandstone, a porous rock, is the storage medium of gas and petroleum products, and it is believed by the Geological Survey that the source is in the underlying petroliferous Devonian limestone.

The oil rock at the famous Spindletop, in Texas (Recent to Tertiary), is a dolomite of great porosity, which appears to rest on gypsum and a considerable thickness of salt. It is surmised by C. W. Hayes and W. Kennedy that the oil is probably derived, in part at least, from the action of decomposing organic matter, both animal and vegetable, but chiefly the latter, upon gypsum.(3)

The Trenton limestone (Ordovician) in Ohio is a most important source of oil, but it is principally where it is magnesian and porous that it forms such an excellent container. However, in Texas ordinary limestones are also quoted as being oil-bearing. The Trenton is often highly fossiliferous.

The whole question is a controversial one; nevertheless, the fact that these limestones are oil-bearing has to be explained and accounted for by that large body of geologists who hold that petroleum has nearly always originated from vegetable matter. The formation of oil from the remains of marine plants and animals has been strongly advocated on the supposition that by the action of bacteria the tissues of the animals and plants entombed in the sediments on the sea-floor are reduced to a condition favourable for their conversion into petroleum; and this is held to explain the alleged origin of oil in certain limestones. There are still great differences of opinion among the writers on the subject.

The Silurian limestone at the New River is compact, non-magnesian, and is inclined to be somewhat argillaceous

(3) Oil Fields of the Texas-Louisiana Gulf Coastal Plain: U.S. Geol. Survey Bulletin No. 212, p. 140.

in places. It shows in the outcrops neither seepages of oil nor any traces of bitumen. The limestone of this age and series has been drilled or otherwise worked in different parts of the island, viz., at Beaconsfield, Railton, Mt. Claude, the Don, Zeehan, Queenstown, &c., but signs of bitumen or oil have never been detected in it. In any case, there is no reason for regarding the New River limestone as having any bearing on the question of the derivation of the pieces of asphaltum picked up on the New River beach.

XIV. — Asphaltum, the Substance which is Guiding the Present Search for Petroleum.

The mineral substance which has been found on the beaches is a jet-black asphaltum, occurring in pieces varying in weight from an ounce or two to nearly a hundredweight. The fragments have no constant shape: they are sometimes rounded, water-worn chunks, and frequently possess a flattened, cake-like form. In the larger pieces desiccation cracks tend to develop, which eventually cause the lumps which they traverse to break into two or more fragments. The beach sand lodges in the superficial cracks, but the substance itself is singularly pure. It is sometimes quite plastic, and can be drawn out by hand; other specimens are hard. In some samples (presumably the freshest or freshly broken) a strong odour, resembling that of naphtha, is emitted; in others this is fainter or imperceptible.

The mineral has the brilliant lustre of pitch, and when hard has a conchoidal or subconchoidal fracture.

A specimen from the New River was examined in the Geological Survey laboratory by Mr. W. D. Reid, Government Assayer, who reports as follows:—

> "The asphaltum readily dissolved in carbon bisulphide and benzine. It was insoluble in alcohol and hydro-chloric acid. It was acted on to a slight extent by hot sulphuric acid. It burned with a smoky flame, and gave off an odour similar to that given by kerosene. Its specific gravity was found to be 1·0313.
>
> "The following are determinations made of the specific gravities of other Tasmanian samples:—
>
> | | |
> |---|---|
> | Asphaltum from Port Davy... ... ... | 1·0349 |
> | Ditto from Rocky Boat Harbour... | 1·0429 |
> | Ditto from Surprise River beach ... | 1·0426 |
> | Ditto from north of Point Hibbs ... | 1·0459 " |

Mr. W. F. Ward, Government Analyst, reports the average density of the sea water as 1·030, so that substances of the above gravities would not float in stationary sea-water, but there is no doubt that the more plastic varieties would do so. The specimens collected from Surprise and New River beaches sank slowly when immersed in motionless sea-water. In course of drying, the substance no doubt loses some of its buoyancy. Fresh exudations would unquestionably float and be carried along by ocean currents.

Asphaltum is a product of petroleum, sometimes by oxidation, sometimes by simple evaporation of the lighter constituents: as such, its occurrence is of course evidence of the existence of petroleum at the time of its formation.

XV.—General Remarks on Indications of Oil.

So little is known by prospectors in this country concerning the indications of oil and its mode of occurrence that some general remarks on the subject may be acceptable. Beyond vague ideas that fossiliferous limestone and sandstone and coal beds are favourable guiding signs, uncertain notions prevail as to where search should be prosecuted. The only strong opinion which may be said to dominate the searchers at present is that they ought to prospect somewhere in the vicinity of the discoveries of asphaltum.

In the writer's opinion this conclusion rests on an insecure basis, for there is every reason to suppose that the fragments of asphaltum which have been found are found in positions governed by ocean currents, and that the beds whence they have been derived may easily be a hundred miles out at sea. It would seem indeed that the latter must be at such a distance as permits the distribution of the substance along the shores of South Australia and Western Australia.

According to Mr. Howchin (see his " Further Notes on the Geology of Kangaroo Island " : Trans. Roy. Soc. South Australia, 1903) loose pieces of this pitch-like substance were found at several points on the south coast of Kangaroo Island as far back as 1844. It occurs there usually in the form of more or less flat cakes, up to 3 or 4 inches in thickness, or in small broken fragments—generally near high-water mark, though small pieces are stated to have been picked up amongst the sand hills to about a mile from the

coast. Mr. L. K. Ward has examined the same material from the West Australian coast.

Mr. T. B. Moore, the well-known explorer, informs the writer that as far back as 1876 he discovered the first bitumen on the West Coast of Tasmania, along the beaches north and south of Sandy Cape. It was in small isolated pieces, some being very soft. In later years he picked up pieces at the mouth of the Mainwaring River and on the coast-line in the vicinity of Point Hibbs. Over 20 years ago he discovered small lumps of the material (not numerous) near Farm Cove, in Macquarie Harbour. Mr. Moore states that there is a large quantity of fossil resin in the Tertiary lignite beds on the shore of Macquarie Harbour. The sizes of the pieces of resin vary from quite small particles to masses a foot long by half a foot wide. During a visit to Farm Cove the writer ascertained the mode of occurrence of this resin; it is referred to later in this bulletin.

Pieces of asphaltum have been found on Hummock Island and Cape Barren Island, in the Straits (occasionally in some quantity), on the beach near Wynyard (according to the late W. F. Petterd, but in view of the Preolenna kerosene shale, this perhaps needs verification), on the west coast of King Island; on the beach between Albina and Point Hibbs; on the beaches north of Port Davey; in Port Davey; and then proceeding eastwards along the south coast, in a bay east of Cox Bight (probably Louisa Bay); on the beach at the mouth of the New River; in Rocky Boat Harbour; on Surprise River beach; and on the beach in South Cape Bay.

The occurrences on the south coast have been mentioned earlier in the present bulletin. The Point Hibbs discoveries have been described by Mr. Loftus Hills in Geological Survey Bulletin No. 18 ("Geological Reconnaissance of the Country between Cape Sorell and Point Hibbs.") He states that the most plentiful occurrence is on that portion of the beach opposite the 8 and 9 mile pegs, although fragments occur all along the coast, varying in size from 3 feet long by 2 feet wide down to small fragments a few inches in diameter.

The existence of the substance in Port Davey was known 20 years ago. Mr. P. Hutchings, of Cockle Creek, has presented to the Geological Survey a piece picked up by him there about that time. But it has been found recently in Port Davey at the mouth of Deep Creek in considerable quantity, about a quarter of a ton having been brought to Hobart for inspection.

The number of places where it has been found and their respective situations, as well as the positions of occurrence at high-water mark, suggest strongly that ocean currents have been powerful agents in its wide distribution.

Consequently prospectors in exploring beds along the coast have to seek further indications than are afforded by these pieces of asphaltum.

It is noteworthy that indications do not invariably obtrude themselves even on important oilfields. Some oil reservoirs have been discovered quite accidentally while boring for water, and have given no sign of their existence until tapped unexpectedly. In other fields no sign of oil has been detected until the surface soil has been stripped. It has been observed that in arid regions vegetation is affected and the surface of an oilfield is bare and barren, though this feature must be partly due to the aridity of the climate, for where there is an abundant rainfall vegetable growth is not affected in this way.

The escape of inflammable gas with the odour of petroleum is a widely spread indication on oilfields. Sulphuretted hydrogen and sulphurous waters are common occurrences. In diagnosing these gas emanations, care must be taken not to mistake escapes due to the decay of superficial organic deposits for genuine emissions of deep-seated origin.

Gas-mounds or mud-volcanoes are very common in oil districts. Gas pressure from below and in the presence of water results in the escape of the gas and the formation of conical mud-mounds which are very distinctive objects in the landscape.

Films of oil on the surface of the sea or streams are important indications. Mr. E. de Courcy Clarke, in his "Bulletin on the Geology of the New Plymouth Subdivision" (New Zealand Geol. Survey, No. 14) makes mention of large patches of films of oil floating on the sea near New Plymouth and at the mouth of the Waitara River. He says that near the breakwater at New Plymouth on calm days the sea is often covered for a considerable distance with a film of oil, and that the dredge at work inside the breakwater brings up a sufficient quantity of oil mixed with the debris to preserve the machinery from rust. He ascribes this film to seepages of oil on the sea-bottom.

Iridescent films on fresh water, however, have given rise over and over again to much erroneous opinion, the scum of oxide of iron resulting from the oxidation of ferrous carbonate or from the decomposition of organic matter being times without number mistaken for oil. If oil is

present, it will generally betray itself by its odour, or it can often be burned in an improvised lamp with a wick, but in all cases of doubt a sample should be taken for analysis.

It is not yet established beyond doubt that salt is genetically related to petroleum occurrences, though it is certain that the waters associated with them are saline, and salt plains and deposits of rock salt are frequent features of oil-fields.

Bituminous sandstones and limestones are often found to outcrop as the upper parts of beds which were once oil-bearing, but in which the more volatile constituents of the oil have been lost by evaporation.

Lastly, asphaltum is an indication which cannot be neglected. This may be an oxidation product of petroleum seepages, the lighter elements having disappeared and a viscous or hard asphalt having been left. In this way it may occur as flows from scattered vents, and become mixed with organic and inorganic impurities. Another mode of occurrence is that of veins of pure hard bitumen.

XVI.—Ocean Currents.

If the substance, the occurrences of which are now being reviewed, has been brought to its present resting places by oceanic currents, the trend of the latter may be expected to explain its distribution, even if it is inadequate to reveal its source.

It is singular that with great marine highways of commerce surrounding Tasmania, the available information with respect to the trend of the sea currents round its coasts should be so contradictory. The only point on which there seems to be general agreement is that there is an eastward flow through Bass Straits.

In the Australia Directory published by the Hydrographic Office, Admiralty, it is stated that on the west coast of Tasmania the current generally sets to the northward, particularly during the prevalence of south-west and southerly winds.

In the pilot chart of the Indian Ocean published by the United States Hydrographic Office the trend of the current along the west coast of Tasmania is marked as going south, while the current from the south-west is indicated as impinging on the south coast.

Inquiry at the Marine Board Office in Hobart elicited a statement by Captain MacArthur, the Harbourmaster, to the effect that on the west coast the current flows south in summer and north in winter.

On the other hand, Mr. W. Hake, the Harbourmaster at Strahan, states that his experience is that the set of the current along the west coast of Tasmania is towards the south. A few years ago he picked up a bottle thrown overboard in the vicinity of King George's Sound from one of the liners, and from the message which it contained it was just 12 months coming to the shore about a mile north of the entrance of Macquarie Harbour.

At present, therefore, it does not appear that any useful conclusion can be drawn from our knowledge of the trend of the ocean currents in the neighbourhood of the coasts.

XVII.—Probable Source of the Asphaltum on the South Coast.

A serious question which those who are interested in oil-finding on the south coast will inevitably put to themselves is, where is the place of origin of the asphaltum? Whence did these pieces come which have been found on the beach of South Cape Bay, on Surprise River beach, at Rocky Boat Harbour, and on the New River beach? Are they indigenous to their respective beaches? Have they been washed down to the beaches from beds existing inland? And if they have been washed up by the sea, have they been derived from submarine beds close to the shore and within the range of breakers and tidal action, or have they been released from beds further out on the continental shelf and brought within the sphere of tidal action by the ocean currents? Or, again, have they come from far to the west, where Kerguelen Island rises from the ocean with its seams of coal and fossiliferous Tertiaries? Such questions must suggest themselves, and no dogmatic reply can be given to them. It may be assumed with tolerable certainty that the beaches on which the fragments are found are not their birthplaces. The identity of nature of the various specimens forces upon one the conviction that they have emanated from one and the same stratigraphical series. Hence the pieces found at South Cape Bay resting on Tiras-Jura strata, those at the Surprise

River resting on either Silurian limestone or Pre-Silurian conglomerate and quartzite, those at Rocky Boat Harbour on Pre-Silurian conglomerate, and at the New River on the limestone and conglomerate were not actually derived from these beds respectively, but had a common origin.

The beds inland behind these beaches are not such as to encourage search for the parent veins. They are of Trias-Jura, Permo-Carboniferous, Silurian, and Pre-Silurian age. The only exposure of Tertiary strata is a restricted outcrop on the Rocky Plains beach, where, moreover, no asphaltum has been found, and a reported small outcrop of brown coal a few miles up the New River.

No pieces have ever been found inland or up the stream, though it must be added that a thorough search would involve considerable difficulty. However, if pieces were being brought down by the creeks and rivers, they might be expected to be more plentiful on the beaches. On the contrary, they may be said to be rather rare. Only three specimens were found on the present journey, though the beaches were thoroughly and repeatedly searched.

Some of the asphaltum is slightly plastic. That found near Point Hibbs is sometimes distinctly so in the interior of the pieces. Some of that from Port Davey is so plastic that it can be readily stretched. The plasticity diminishes with exposure, excepting under the burning rays of the sun. This property and the diminishing odour of naphtha given off by the substance suggest that the parent beds are not at an excessive distance. By this is meant that they are not separated from Tasmania by thousands of miles of ocean. On the other hand the comparative rarity of specimens indicates that the beds of origin are not close in to shore, where every tide or storm would bring in fresh pieces. The probability is that they are out somewhere on the continental shelf to the west or south-west of Tasmania.

The most likely strata, in the writer's opinion, would be the submarine extensions of the Tertiary beds which here and there fringe the coast-line of western Tasmania, *e.g.*, near Cape Grim, Strahan, in Macquarie Harbour, and apparently in Port Davey. It is true that no indications of asphaltum or oil have been observed in the shore or inland beds of this age, although they have been drilled or sunk into or otherwise penetrated in different parts of the island. It may, however, very well be that the entirely different conditions to which their submarine equivalents have been subjected have been favourable for the process of oil-formation.

XVIII.—Geological Structure of Oilfield.

There are certain well-known structural and stratigraphical conditions which seem to be favourable for the development of oil basins, and it may be as well briefly to review these, and see whether it can be considered that they exist on the south coast of Tasmania.

The storage, or reservoir rock, as it is called, is formed by the strata which contain the supply of oil. Its texture is porous so as to contain the fluid in the interspaces between the constituent grains of the rock, or in small cavities in the substance of the rock itself. Hence the reservoir rock is usually either a sandstone or a dolomitised limestone.

The view nearly universally accepted is that the most generally favourable structural conditions are those where folding is present. It is held that with the folding of the strata the contained water, oil, and gas separate in accordance with their respective densities, the gas occupying the highest position in the anticlines, the oil below the crests and the water (if any) in the troughs of the synclines. The theory is not of universal application, but is so commonly supported by the facts of occurrence that the first structural features which an oilseeker looks for on an untried field are the anticlines and synclines, for if accumulations of oil exist, they will always be found to possess a distinct relation to the structural phenomena.

The sequence of events in an oil area appears to be as follows:—

First the organic material, whether animal or vegetable, contained in the beds of origin passed through its usual stages of decay and putrefaction, and then under the pressure of its cover underwent under ill-understood conditions the process of distillation. The resulting oil ascended gradually into overlying porous strata, which thenceforth constituted the great reservoirs of supply. A higher impervious covering rock prevented its escape. With folding of the strata the gas and oil rose along the inclined bedding-planes as far as permitted by the conditions in each case. Here they accumulated, ready to be tapped by the drill.

The supply of oil, a reservoir rock of sufficient porosity, and an impervious covering rock are the three absolute essentials for an oilfield. The anticlinal structure, while highly favourable for the concentration of oil, though it

obtains perhaps in the majority of instances, is not an absolutely essential condition. The geological key to every mode of accumulation has not yet been found, but as far as data are accessible, the fundamental relations are found to be constant.

On the south coast of Tasmania, proceeding from east to west, a continual easterly dip is observable (whether east of north or east of south). This dip is practically continuous through the whole thickness of the Trias-Jura and Permo-Carboniferous systems from South Cape Bay to Flat Rock Plain. At South Cape Bay the Trias-Jura coal measures are at sea-level; consequently, in travelling west, potentially petroligenic beds are left behind, and the outcrops of older and less favourable strata continuously emerge to view.

No folding of these Mesozoic and Upper Palæozoic strata has taken place; whatever dynamic disturbances exist are due to block-faulting. The beds are tilted, not folded; still gentle undulations may, and no doubt do, exist. Nowhere in the island have signs of oil been detected in the Trias-Jura beds, and the Permo-Carboniferous coal-seams appear to be absent from this part of the country.

The only beds of Tertiary age which were seen by the writer are those on the Rocky Plains beach on the Asphaltum Glance and Oil Syndicate's ground, and should be tested by that syndicate. There is also the possibility of more fully developed Tertiaries being concealed beneath the sands at the mouth of the New River, where an exploratory bore might be put down either in front of or behind the sand-dunes.

During any petroligenic phase the strata of origin must admittedly have been under pressure, and consequently at the depth from surface involving the requisite weight. In Tasmania the Tertiary beds seem to have attained in places a thickness of nearly 1000 feet (*e.g.*, in the Launceston Tertiary basin, and this depth might suffice for oil-formation if the necessary conditions coexist. At Belmont, near Longford, a bore went down 894 feet without reaching the bottom of the series, and one at Carr Villa descended to 500 feet. Near Coal Head, Macquarie Harbour, Tertiary beds have been bored into for 300 feet. At the Coal Head tunnel lumps of fossil resin occur in the bed above the coal-seam (in this connection it may be mentioned that Mr. Howchin, in describing the occurrences on Kangaroo Island, states that pieces of fossil resin are found there associated with the asphaltum in such a way as sug-

gests that both substances have been transported from a common source).

In Tasmania the Trias-Jura measures may, of course, be regarded as potential oil sources, though the large amount of work done in them in connection with the coal industry contra-indicate the existence of an oil phase.

The saltpans near Ross in the Triassic or Upper Permo-Carboniferous strata are suggestive of the possibility of the existence of petroleum, as the waters associated with oil are almost always saline, and salt lakes and salt deposits occur in many oil regions. The exact connection of these occurrences with oil-formation, however, is still unsettled, and for the present all that can be said with certainty is that, while salt is a constant associate of petroleum, the occurrence of the former is not an invariable indication of the latter. The saline sands of the Midlands may be merely the result of the dry continental conditions and salt lakes of the period.

The Permo-Carboniferous calcareous mudstones, limestone, sandstone, conglomerate, and coal measures are also possible strata of origin, though free oil or asphaltic indications have not been observed in them. The marine formations in this system are perhaps less favourable than the beds which are estuarine or littoral. The sapropelic coals at Preolenna and Barn Bluff and the tasmanite shale of the Mersey may be made to yield oil by distillation.

The next older system obtaining is the Silurian, in which limestone is abundant, as at Beaconsfield, Mole Creek, River Mersey, River Forth, River Don, River Gordon, Zeehan, Queenstown, Ida Bay, New River, &c. This limestone in different parts of the island has been, and in places perhaps still is, under the weight of the overlying Permo-Carboniferous and younger strata. It is fossiliferous, but not abundantly; it is non-magnesian, and generally of compact and dense texture. Where it outcrops, or where it has been quarried and tunnelled into, it has never been observed to be petroliferous. These are unfavourable signes. Where the sequence is fully developed it succeeds the Cambro-Ordovician pipestem sandstone, and always with some degree of unconformability of dip, occasionally also strongly unconformable in strike. The dolomitic beds in the Pre-Cambrian are the only calcareous strata of moment earlier than the Silurian, and the probability of petroliferous beds existing in the ancient systems is slight.

On the whole, therefore, despite the various occurrences of asphaltum on the beaches, the outlook for the discovery of petroleum in Tasmania is not encouraging. There are possibilities, however, and these would appear to lie principally in the beds belonging to the Tertiary series. The saliferous beds of the Midlands need investigating before an estimate of their indications can be formed.

XIX.—Concluding Remarks.

The only beds seen along the part of the south coast visited this journey which can be said to belong to a series favourable for oil are the Tertiaries on the sea edge of Rocky Boat Plains, on the ground taken up by the Asphaltum Glance and Oil Syndicate. These should be tested by that syndicate. There is also the possibility of more fully developed Tertiaries being concealed beneath the sands at the mouth of the New River, where an exploratory bore might also be put down.

The conclusions drawn as a result of the visit are as follows:—

(1) The pieces of asphaltum which have been picked up were stranded by the sea on the beaches where they are now found, and are most probably derived from submarine beds lying at no very great distance from the west or south-west shore of Tasmania.

(2) In seeking asphaltum or oil on the south coast, the most favourable strata are those of Tertiary age.

(3) The Tertiaries on the coast, however, are remnants of insufficient extent to warrant much hope of good results from the quest. There is, moreover, reason to believe that they have been detached from their submarine extensions by faulting, and the structural and stratigraphical features are unfavourable.

The writer is unable to trace any relation between the fragments of asphaltum found at Rocky Boat Harbour or New River and these Tertiary outcrops, but as the latter are on the syndicate's property, the question can be easily settled by means of a few bores. At the same time, the geological data do not afford much support for expectations.

It should be observed that the recent discoveries of asphaltum at Port Davey are not dealt with in this bulletin, as that district was not visited. It is arranged that an official inspection shall be made in the spring, and the results will appear in a future publication.

Apart from oil prospects, the country to the north of the Rocky Boat Plains should be searched by the prospector for economic minerals, especially along the line of serpentine rock. There appears to be a ridge of serpentine a few miles back from the coast, which probably has some relation to the same rock reported lately by the Port Davey prospectors as existing north of the Arthur Range. Further north, at the head of the Florentine River, serpentine was also observed by the writer in 1909 on the Gordon Track: a belt 3 chains wide was crossed by the track just where the latter passes into the great horizontal and myrtle forest of the south end of the Sawback Range. There is also a further outcrop north of the Gordon River on the west side of the Denison Range. These isolated outcrops have no doubt some real connection with one another, and probably indicate some concealed granite mass. In some cases they are inaccessible, and in most instances difficult to prospect, but some possibility of ore occurrences certainly exists.

The only other mineral likely to be within reach of the new track from Recherche is coal. The continuation of the South Cape Bay seams may be sought along the course of the Black Hole Creek, which flows into the South Cape Bay Rivulet near the mouth of the latter; and if these are found in that country where the diabase rock appears to be absent, the coal may prove better in quality than that of the seams on the coast-line.

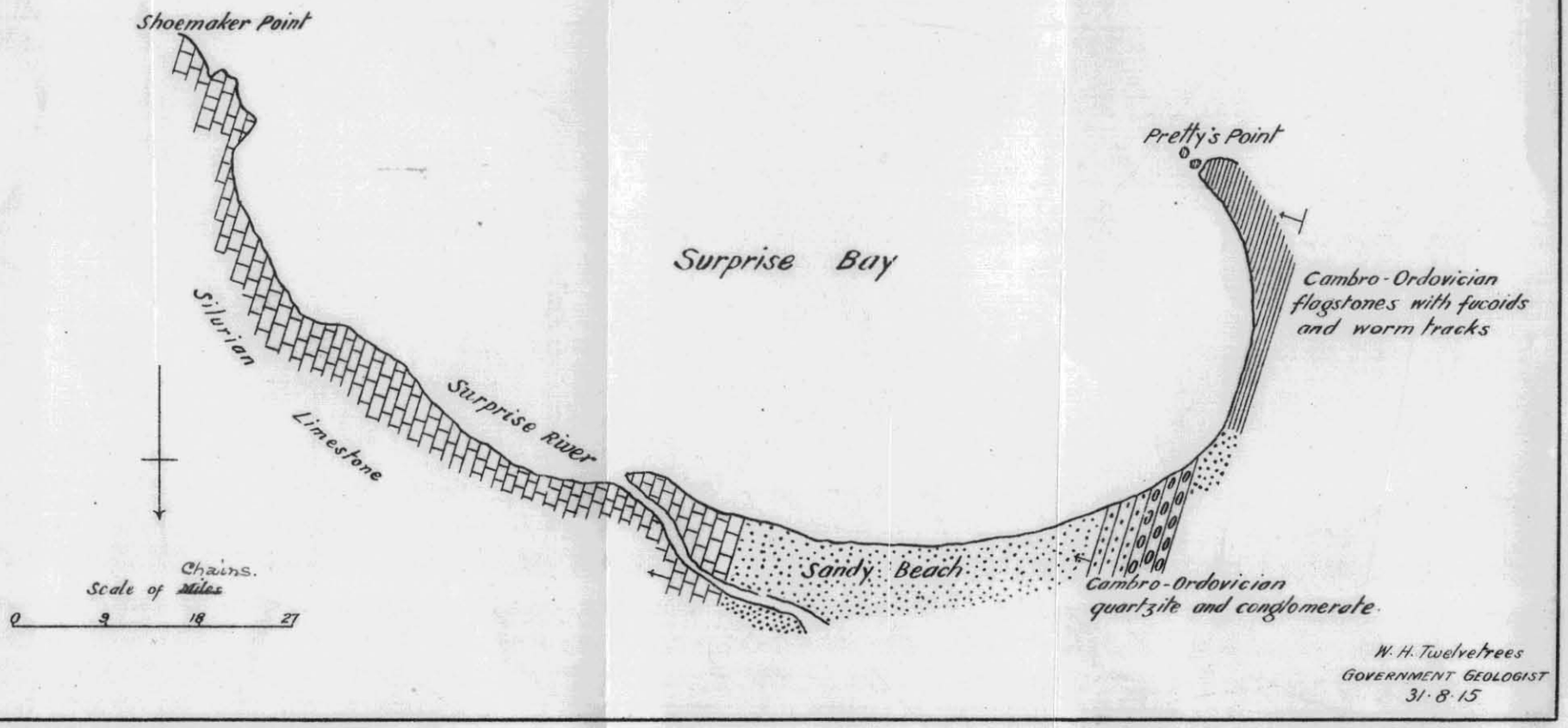
The new route, besides giving a line of communication all along the coast, will, when continued, open up the unexplored country between New River and Port Davey. This is a mineral country belt, the possibilities of which have not yet been tested, in consequence of its rough character and inaccessible situation. While natural conditions must in the main remain unchanged, a way in and out will be provided for the indefatigable brotherhood of prospectors, who are always ready to search and prove the unknown when it is at all practicable to do so. The country north and north-east of Cox Bight especially invites attention, as it surrounds the outcrop of tin-bearing granite at the south end of Bathurst Range.

W. H. TWELVETREES, Government Geologist.

Launceston, 31st August, 1915.

PLATE II

GEOLOGICAL SKETCH MAP OF SURPRISE BAY



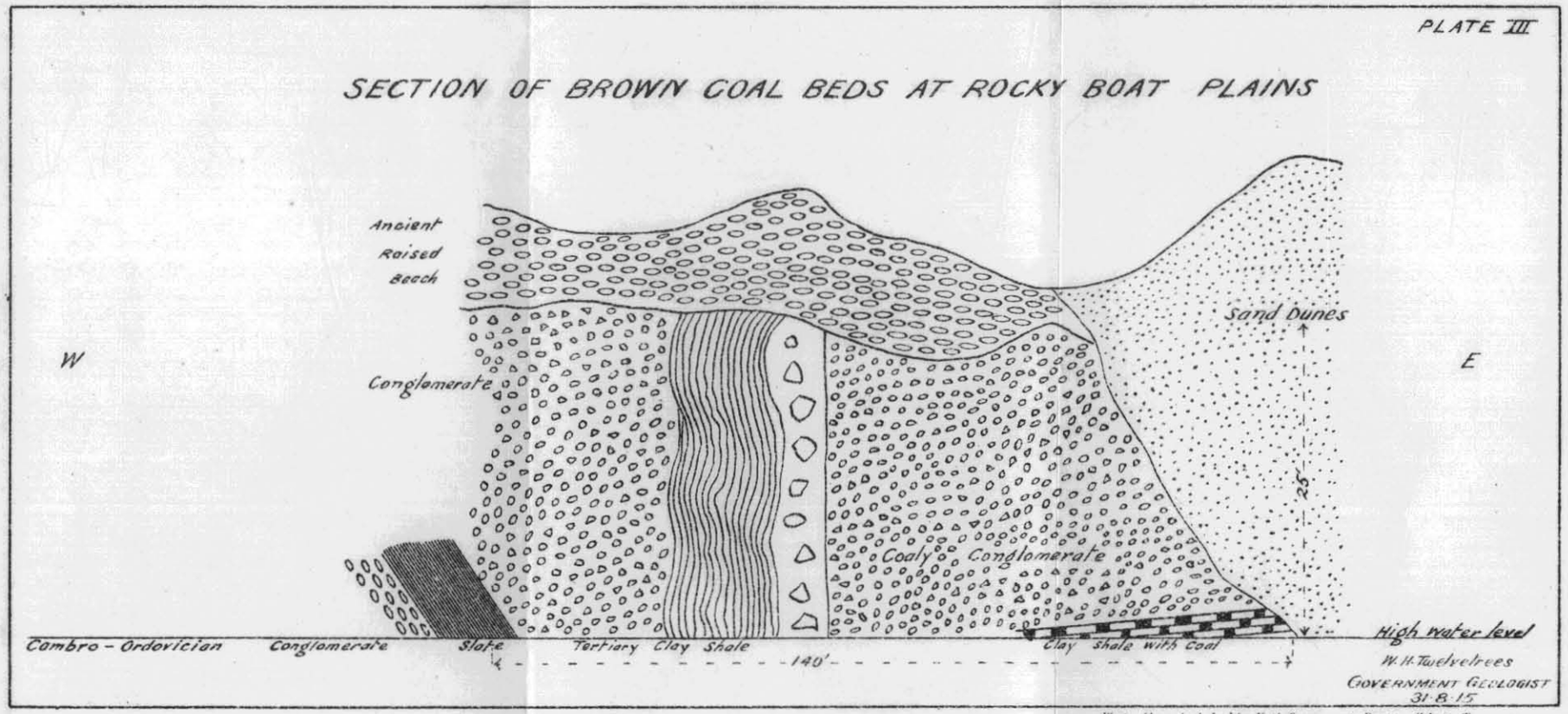
W. H. Twelvetrees
GOVERNMENT GEOLOGIST
31·8·15

Photo Algraphed by John Vail Government Printer Hobart Tasmania

5 cm

PLATE III

SECTION OF BROWN COAL BEDS AT ROCKY BOAT PLAINS



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GOVERNMENT GEOLOGIST
31-8-15

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5 cm

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PLATE IV.

PLAN OF ROCKY BOAT HARBOUR

LANDS AND SURVEYS DEPARTMENT

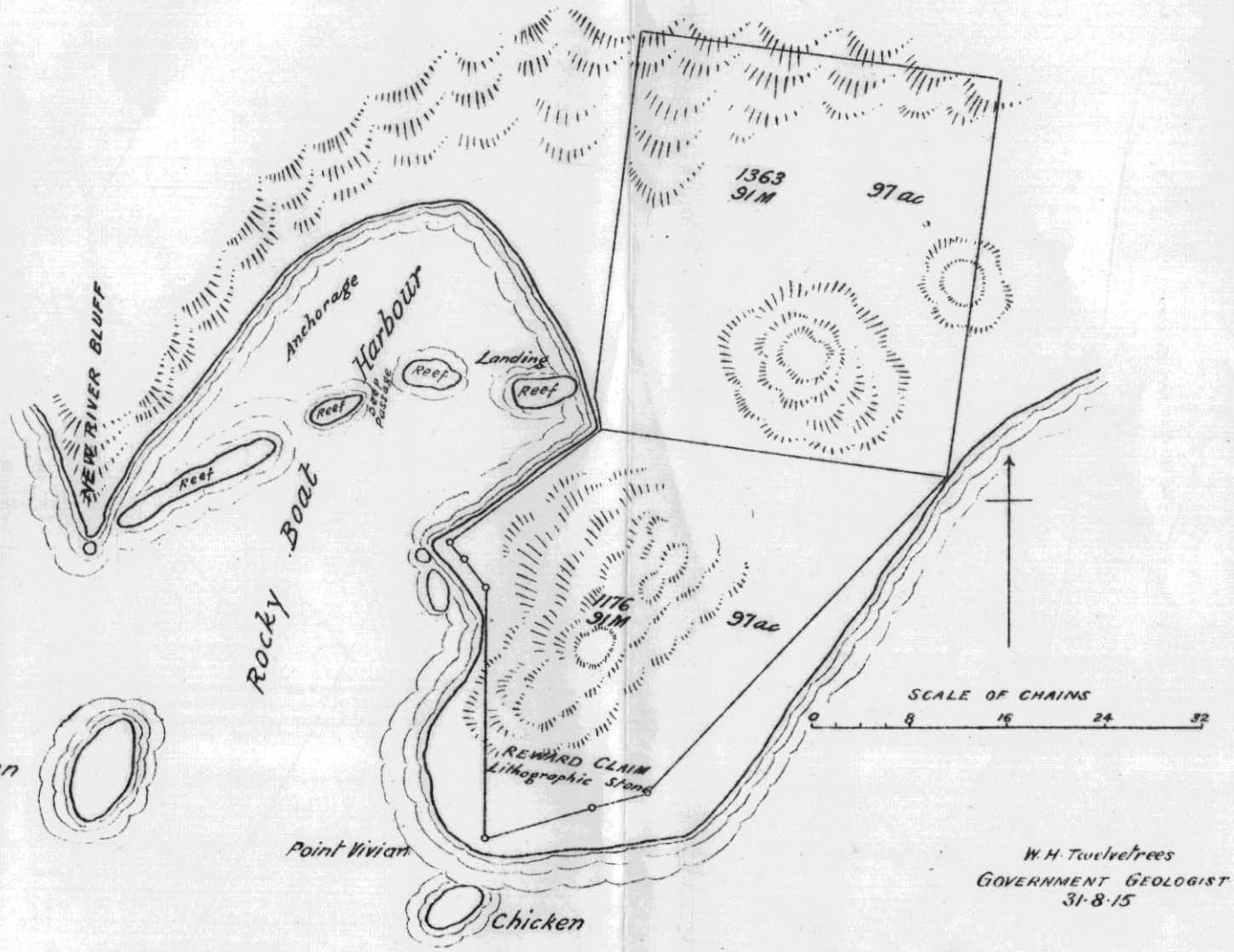

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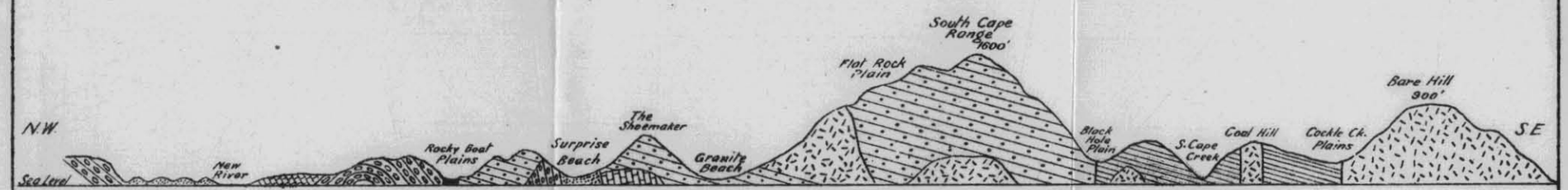
PLATE V

SECTION OF COUNTRY ALONG TRACK FROM RECHERCHE TO NEW RIVER

22 MILES



QUATERNARY ---- Sand

TERTIARY ---- Coaly shales

TRIAS-JURA ---- Sandstone, shale and coal seams

PERMO-CARBONIFEROUS ---- Sandstone, shale and glacial till

SILURIAN ---- Limestone

CAMBRO-ORDOVICIAN ---- Conglomerate, quartzite, etc.

IGNEOUS ROCKS ---- Diabase

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5 cm