A RECONNAISSANCE OF THE CORINNA-PIEMAN HEADS AREA—GEOMORPHOLOGY

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(With 4 Text Figures and 2 Plates)

(*Communicated by K. D. Nicolls*)

INTRODUCTION

The area with which this paper is concerned largely comprises a plateau of mature, moderately low relief, the level of which gradually falls to the west, and which terminates on the seaward side in a steep scarp slope. At the foot of this scarp is situated a small and much dissected bench and slightly below this again is a coastal zone, consisting mainly of rocky headlands and sandy bay-head beaches but also, in places, containing dunes and alluvial flats. Traversing and draining part of the area is the Pieman River which, quite apart from being the largest river of the area under consideration is one of the major water courses of Tasmania.

The area surveyed is indicated in figure 1, a location map of the area, and this report is the result of a brief period of field work during which traverses were made of typical sections of country, and examination made of the various geomorphological units as determined by previous photo-interpretation of aerial photographs. The units have been mapped upon aerial photographs but there is a certain amount of ground survey information available (Nicolls, K. D. and Taylor, R. personal communication), and full use has been made of this.

Much of this paper is occupied with the features displayed within the actual survey area, but there are several pertinent and relevant phenomena to be observed just outside this limited area and these are cited as evidence where suitable and necessary.

GENERAL GEOMORPHOLOGY

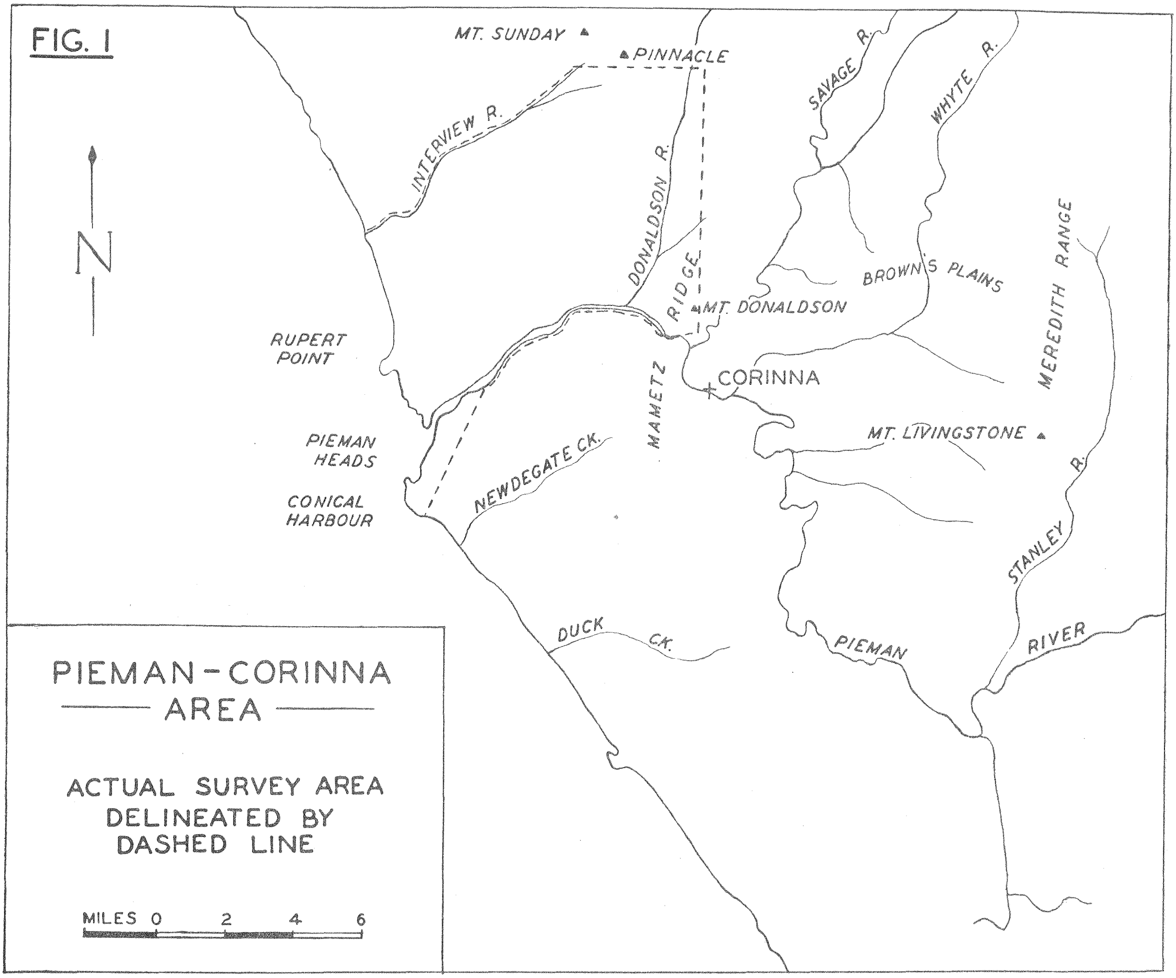
The Pieman-Corinna area has been subdivided into three geomorphological units, a plateau, bench, and coastline, each of which transgresses geological boundaries; and the two major stratigraphic units the Pre-Cambrian metamorphics (comprising quartzites, conglomerates, phyllites, and hornfels) and the granite, which intrudes the metamorphics, both appear in each of the major geomorphological units. Erosion surfaces are clearly of importance in this area, whilst structural control of relief is of secondary significance, a factor which renders the area all the more interesting. The plateau is an undulating or gently rolling surface extending from approximately 250 to 900 feet above mean sea-level; protruding above the general level of the plateau are various residual remnants such as Mt. Sunday, Mt. Norfolk (2600 feet), Mt. Hadmar (2500 feet) and Mt. Vero (2300 feet), and to the east, at a height of some 900-1000 feet, the plateau gives way to the rugged high peaks of the Meredith Range.

Deeply incised in the plateau is the Pieman River which flows in a gorge, the sides of which become less precipitous towards the sea. The river is exceptionally deep, being of the order of 90 feet in its lower reaches, and at Hell's Gates the channel has never been bottomed despite a sounding of 130 feet. The deep channel continues for some 12 miles upstream from Corinna and here there are rapids in the vicinity of which the river quickly shallows to four or five feet; but above the rapids the trench-like form of the channel is maintained. A tidal effect is felt at least as far upstream as Corinna where the range is of the order of two feet. However, the river is unnavigable because of a recently formed wave-constructed bar at its mouth. (In the latter part of the last century steamers did penetrate a considerable distance up the Pieman and in one of the tributaries of the river the wreck of one such ship remains.)

The general course of the Pieman within the area considered herein is east-north-east to west-south-west, and in its lower reaches, at least, the channel follows the strike of the metamorphics for considerable stretches. On the whole the river widens gradually towards the mouth, but there is a considerable constriction at Hell's Gates where the river crosses resistant quartzite strata which cause the channel to narrow to less than 100 yards. Just to the east of Hell's Gates is a well-formed intrenched meander in which the absence of a pronounced slip-off slope is noticeable.

Compared with the Pieman all other streams of the area are minor; they follow the regional slope of the area and flow from east-north-east to west-south-west giving a good parallel drainage pattern, though in detail structural effects (e.g., angular patterns) are discernible.

The general physiography is illustrated in fig. 2, a much generalised block diagram of the area, and in fig. 3 cross sections, of which the locations are indicated in fig. 4, are presented. Various aspects of the geomorphology of the area are illustrated by photographs included at the end of this paper.



GEOMORPHOLOGICAL UNITS

These are indicated in fig. 4 and it will be noted that some reliance has been placed upon map notes to show the occurrence of some of the smaller units.

1. The Plateau

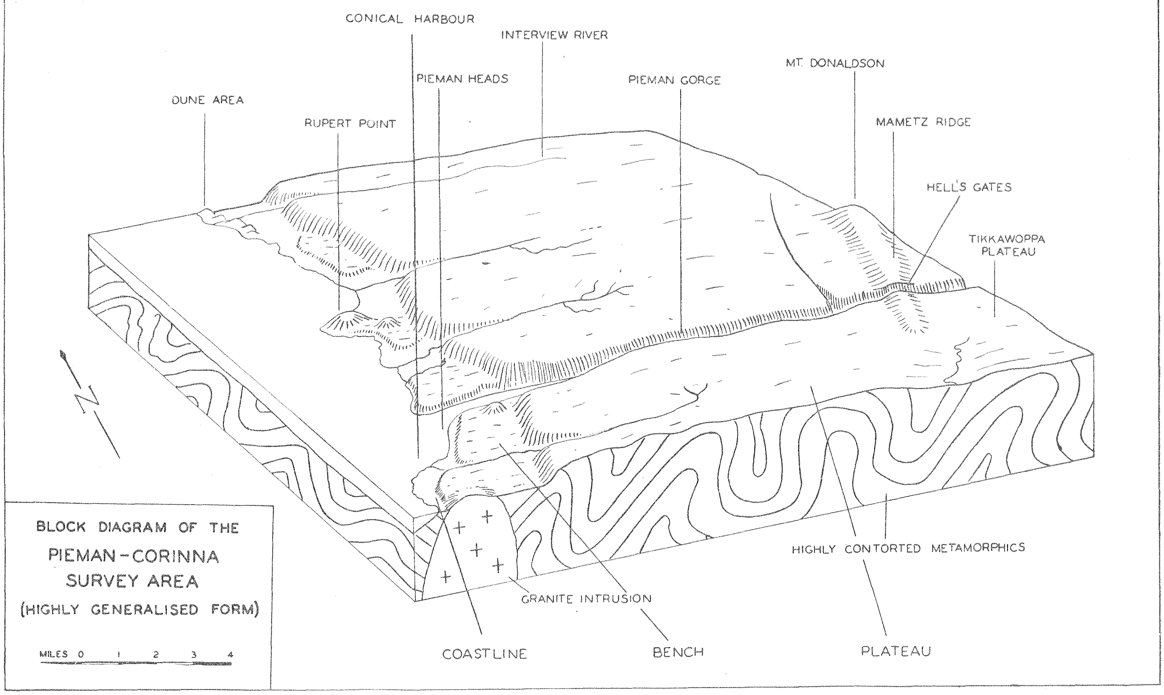
(A) This low rolling area has only a moderately low amplitude of relief and extends from 250 feet above present sea-level near the coast to over 900 feet inland where it is known as the Tikkawoppa Plateau. Over the greater part of its area the plateau is developed upon metamorphic rocks.

Away from the coast the valleys are shallow and marshy but nearer the scarp the streams have been incised and the valleys are deep. A general east-north-east—west-south-west parallel pattern predominates, but areas of angular pattern following joints in the metamorphics and granite are not uncommon, and in granite areas a rectangular pattern is occasionally evolved. The intensity of the drainage lines is not great except where a close structural control has been exerted.

Because of the heavy rainfall received by the area and the impermeable nature of the quartzites and other metamorphics which form the country rock, all but the steepest slopes are marshy and support only a button-grass vegetation; the well-drained sides of the incised stream valleys carry a dense scrub and tall timber vegetation as do also a large number of parallel ridges which trend north-north-east—south-south-west; these ridges are basic dykes intruded in the metamorphics, possibly along joint or strike lines. (See section on Geology.)

The surface of the plateau is scattered with well-rounded or ovoid white quartzitic pebbles averaging two inches, but attaining eight inches, in diameter. In addition to those exposed, the pebbles are often found abundantly beneath the soil surface. (See

FIG. 2



BLOCK DIAGRAM OF THE PIEMAN-CORINNA SURVEY AREA (HIGHLY GENERALISED FORM)

section on Soils.) The pebbles are relatively few in number near the coastward or lower end of the plateau, but at an elevation of about 400 feet they occur in profusion, especially on small narrow benches or platforms which are cut in hill slopes and which as far as the eye can judge occur at a constant level. These benches, being pebble strewn, are considered to be terraces, which (see later) are thought possibly to be former beach terraces, and in the remainder of this paper they are referred to as such. Along the Waratah Highway, a few miles north-east of Corinna, these rounded quartzitic pebbles are well exposed and in places attain thicknesses of five or six feet. Frequently the pebbles have filled irregularities resembling potholes in the underlying metamorphics and at certain places the pebble layers can be seen intercalated with peaty soils—two peats between three gravel beds. It is important to mention that these phenomena—interbedded pebbles and peat, and pebble-filled potholes—do occur and have been observed on stream divides: this factor is significant in considering the origin of the pebbles, which will be discussed later.

The general low relief of the plateau is broken by Mt. Donaldson which attains a height in excess of 1400 feet and which rises abruptly from the plateau; the Mametz Ridge is a south-south-west continuation of the mountain and is caused by the same resistant quartzite strata which give rise to Hell's Gates.

On its coastal side the plateau terminates in a steep scarp some 180 feet high in which rock outcrops are common; in granite areas great tors and rectangular blocks are striking features. In the north the scarp is impinged upon by the shifting sand dunes of the coastline, and in the south the granite intrusion of Conical Harbour forms a resistant mass so that the plateau, with only a slight amount of dissection and truncation is there preserved and reaches the sea.

(B) The general form of the plateau is that of a late-mature surface, i.e., one of low, broadly undulating relief, and since uplifted. Whether or not the feature should be termed a peneplain depends largely on which authority one chooses to follow: if one relies for instance upon Wooldridge and Morgan (1937) then the plateau is not a peneplain (because only a very few miles inland the surface of low relief gives way to the rugged Meredith Ranges) but is a partial peneplain or a "strath" in the connotation of several writers of whom Shaffer (1946) may be given as a recent example. A strath is a plain of erosion of limited areal extent developed during an epicycle of erosion.

If, on the other hand, one prefers the viewpoint of Johnson (1919) for example, then it is quite valid to regard and term the plateau surface, limited in area as it is, as a peneplain which has been uplifted. The present writer does not consider the area of the plateau surface to be sufficiently great to warrant the term peneplain, though it is not thought necessary that a surface of low relief should extend over a whole continent or island before the term is utilised. For example, the "downs" area of north-west Queensland [See Twidale, C. R. Forthcoming reports on the "Geomorphology of the Leichhardt-Gilbert Area" (N.W. Queensland).] is considered to be a peneplain for it does extend over many thousands of square miles, yet to either side upland areas occur.

Since the plateau surface is not considered to be that of an uplifted peneplain it follows that the residual remnants such as Mt. Donaldson, Mt. Sunday and Mt. Norfolk cannot, by definition, be termed monadnocks, though it is to be emphasised that they are essentially of a similar residual nature.

Furthermore, as is mentioned above, the plateau surface should not be attributed to a cycle of erosion but to an epicycle, or a cycle which has been interrupted before completion was attained. The intrenched meander with no slip-off slopes located on the Pieman and referred to earlier was possibly inherited from the surface of low relief associated with this epicycle.

The widespread distribution of the pebbles on the plateau surface indicates that they were deposited during or after the erosion of the surface; the occurrence of the pebbles on divide and in valley depression alike suggests that they are not fluviatile in origin for streams could not attain such a wide spread of pebbles in an area of low rolling relief. However, E. S. Hills (personal communication) has directed to the attention of the writer Victorian examples of rounded gravel with which is associated alluvial gold, widely spread over rise crests and local divides, and whose fluviatile origin is beyond doubt. Also, J. N. Jennings (personal communication) has pointed out that statistical evidence concerning the degree of roundness and size composition of the quartz pebbles would be required before any more definite opinion could be given as to the origin of the gravels. A. Spry (personal communication) suggests that the higher level gravels of the Brown's Plains area are of definite non-marine origin, whereas the lower level gravels situated nearer to the present coast may conceivably be of marine origin; and K. D. Nicolls (personal communication) who has had the benefit of a further examination of the gravels of the Brown's Plains area is also of the opinion that they are of non-marine origin. There appear to be four possibilities: viz., that the gravels are of (1) marine, (2) fluviatile (3) fluvioglacial or (4) glacial (sub-glacial or englacial) origin. The present writer would favour the first or third possibility, but in the absence of palaeontological evidence no positive conclusion can be reached.

The 400 foot level, with its well-defined terraces, which are interpreted as beach terraces, appears well represented, and though palaeontological evidence is again desirable, may be accepted at this stage. If there were a period of higher sea-level than at present, then, during this period of submergence of the land, material was doubtless carried down the sub-marine slope and deposited in irregularities on the surface and indeed covered much of the former land surface with a veneer of debris. Such a postulate might well explain the pedology of the plateau area.

There is no evidence to indicate that the suggested relative changes of sea-level were accompanied by any deformation of the land and it is not unreasonable to conceive that the changes

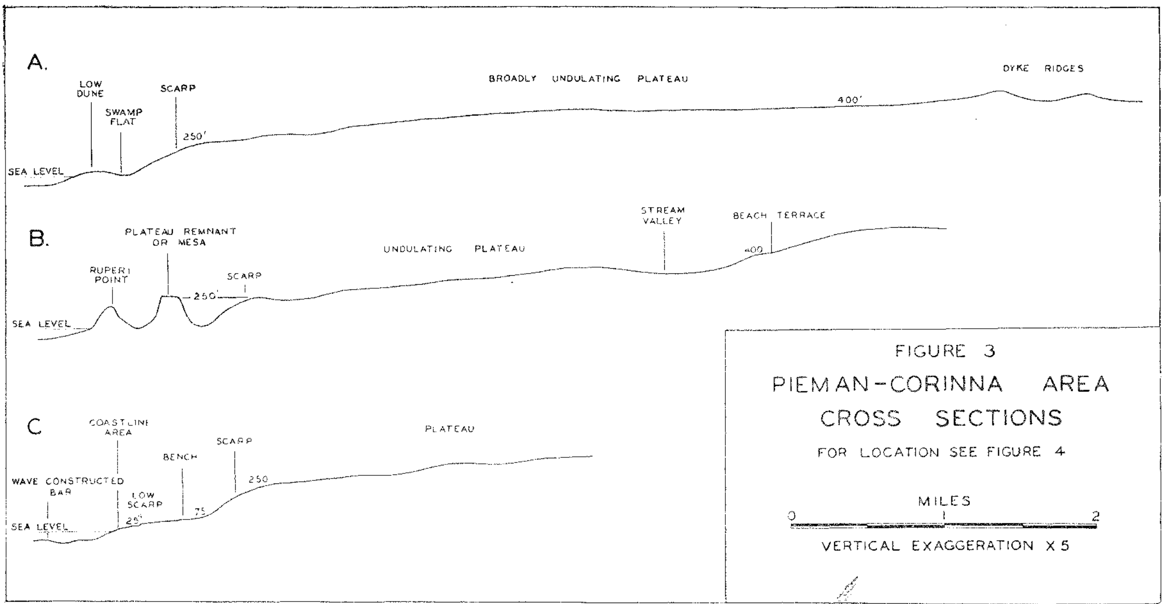


FIGURE 3
PIEMAN-CORINNA AREA
CROSS SECTIONS
FOR LOCATION SEE FIGURE 4

VERTICAL EXAGGERATION X 5

were eustatic in nature. It may seem unlikely that sea-level should formerly have attained such heights above its present level but benches related to movements of a eustatic nature which occur up to 650 feet above present sea-level were implicated in the writings of Wooldridge and Linton (1939), Sparks (1949), Brown (1950) and Balchin (1952) regarding Pliocene or Pleistocene* sea-levels in Southern England, and in those of Coleman and Ferrar (1954) concerning similar features in the North Boulonnais of France. It is certain that verification by fossiliferous evidence is required before any assertions can be made either in Western Tasmania or elsewhere, but "coastal or estuarine gravel-terrace at from 100 to 150 feet . . . in various parts of Tasmania" are noted by David and Browne (1950, p. 600), and the definite possibility of eustatism should be borne in mind, for writing of the detailed work in East Kent and

* The precise dating of the levels is in some doubt at present, but the general tendency in England appears to be to extend the Pleistocene at the expense of the Pliocene; see for example King and Oakley (1949), Baden-Powell (1950), Zeuner (1950) and Boswell (1952).

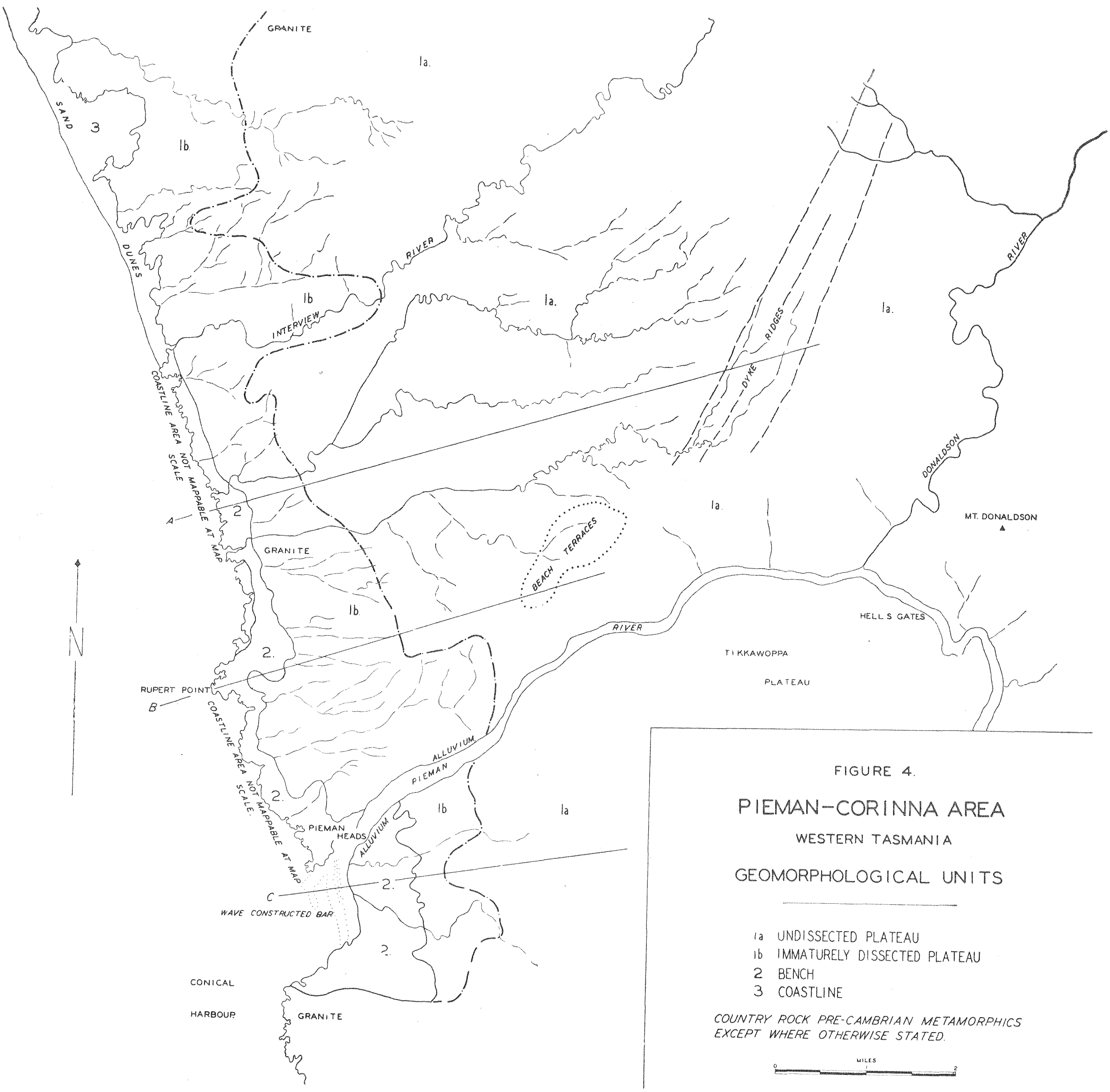


FIGURE 4.

PIEMAN–CORINNA AREA

WESTERN TASMANIA

GEOMORPHOLOGICAL UNITS

1a UNDISSECTED PLATEAU
1b IMMATURELY DISSECTED PLATEAU
2 BENCH
3 COASTLINE

COUNTRY ROCK PRE-CAMBRIAN METAMORPHICS EXCEPT WHERE OTHERWISE STATED.

MILES 0 2

South East England as a whole, Coleman and Ferrar (*op. cit.*, p. 67) state: "Here the agreement between various workers is sufficiently great for general acceptance of the eustatic hypothesis". If eustatic features are present in Southern England then they should be present in other parts of the world, and their presence in Australia is not beyond the bounds of possibility.

2. The Bench (See figs. 2 and 4)

(A) Ranging in height between 25 and 70 feet above sea-level the bench is well preserved around the Pieman mouth where it is an undulating area drained by marshy streams. Elsewhere the bench has been extensively dissected and reduced to an area of very low relief; only small residual areas remain, and where granite outcrops, typical low whalebacks occur. Coastal dunes some 30 feet high have impeded drainage and caused the lower lying areas to be converted into swamps. Streams eating back into the terrace have given rise to deep valleys in marked contrast with the shallow marshy valleys of the terrace proper, and the junction of the two valley stages is frequently marked by falls or rapids which may be regarded as nick-points.

The bench area occurs as a purely coastal phenomenon, and does not penetrate up the river valleys for any distance. The streams of the bench have eaten back into the plateau and where the profiles of these more active streams join those sluggish streams of the plateau there is a marked break of slope. Isolated remnants of the plateau remain as mesas and hills within the bench area.

As has been previously mentioned, the plateau, for structural reasons, reaches the coast in the south of the area; in the north the bench is covered by coastal dunes some 200 feet in height which have encroached inland as far as the plateau scarp. These features are shown in figure 3.

(B) Because of its essentially coastal distribution and its constantly narrow width it is difficult to conceive of the bench originating in a way other than by the action of waves eating into the seaward edge of the plateau. In other words it is regarded as being essentially a marine bench which has suffered uplift and dissection by streams. Despite searches at likely places, no geological evidence for the marine origin of the beach has been found.

It is postulated that the carving of the bench followed a lowering of the sea, or rise of the land, of some 180 feet, when the surface of low relief became a plateau. Subsequently, sea-level fell further by some 45 feet, and it was during and after this emergence of the land that the uplifted bench was dissected.

3. Coastline

This unit forms a narrow zone at the coastal periphery of the area surveyed and for the most part comprises rocky headlands and bay-head beaches, the beaches being composed to some extent of material derived from the wearing back of the headlands. Below the beach and to seaward of the headlands a low-level marine bench (as opposed to the high-level one which has been dissected) carved in solid rock is frequently observable.

Off-shore stacks are not infrequent and structural effects are well displayed; strike lines have been well-exploited by wave action and small dolomitic exposures are characteristically fluted. Coastal granite gives rise to spectacular tors and rectangular blocks. On the south side of the Pieman mouth and also in very narrow zones up the river, are small areas of flat and marshy alluvium, and along the coast in the north of the area is an extensive area of drifting dunes, the dunes being over 200 feet high in places and continuing for many miles up the coast. Dune formation on the coast has caused impedance of drainage on the dissected terrace areas behind the dunes and swamps have developed.

GEOMORPHOLOGICAL HISTORY

From correlation of the evolution of each of the major geomorphological units, the following sequence of events for the whole area can be deduced:—

1. The reduction of the area to one of low relief: a mature stage of the fluvial cycle of erosion was attained, with some remnants of circumdenudation left.

2. Marine incursion to the present 400 foot level during which the beach-terraces were formed.

3. The recession continued until there was a further and quite long pause at the present 70 foot level: marine planation of plateau edge occurred, forming a marine bench and cliff.

4. Further fall in sea-level, during which the marine bench was relatively raised and dissected: dunes formed on the coast, drainage was impeded, and swamps formed.

This sequence seems to be fairly well substantiated but only tentative suggestions can be made as to the dating and explanation of the events. In attempting this dating, evidence from other areas as well as the data from the Pieman area will have to be considered.

Dealing with local facts first, the plateau in the Brown's Plains area is overlain by basalt. Clearly the surface must pre-date the basalt but the age of the basalt is not known. Local opinion (Hills and Carey, 1949) considers all the basalts as being no older than Pliocene, and while there may be Pleistocene eruptions there is no evidence for them; later opinion (David and Browne *op. cit.,*) regards the basalts of the Wynyard-Waratah area to be of Pliocene age, and those of the Waratah area to be Eocene. Spry (personal communication) considers the basalts to be of approximate Miocene age and this opinion is here accepted as a basis on which to work: should later studies demand a change in the age estimate, then the ages of the physiographic events which date from the extrusions can be revised accordingly.

Turning to broader considerations, there is first the widely distributed and well recognized Cretaceo-Tertiary erosion surface which acts as a convenient time marker in many parts of Australia. Another, but less definite time marker is a Miocene period of disturbance during which, in the opinion of some, Tasmania became separated from the Mainland by the formation of a rift valley which the Bass Strait now occupies, and when the west coast of Tasmania was formed by north-south faulting. However, Professor E. S. Hills (personal communication) points out that Victorian geologists have long been of the opinion that the Bass Strait is a much more ancient feature, and that it has been, throughout Tertiary time at least, a major earth feature. In view of this, no weight should be attached to this possible time marker, though the west coast can still be a fault coast of Miocene age.

There is also the problem of a marine incursion to the present 400 foot level: in Europe and recently in Western Australia (Clarke and Phillipps 1953), benches thought to be of marine origin have been related to late Tertiary and Pleistocene oscillations of sea-level and in Europe to isostatic depressions due to ice sheets.

Thus there is a framework into which the events discernible in the Pieman-Corinna area can be fitted.

In the first place the plateau must pre-date the basalts and thus is probably of pre-Miocene age. It is not considered that the plateau comes within the range of the Cretaceo-Tertiary planation for it is firmly considered that the surface of this age is one of the higher levels of Central Tasmania and not this small surface which can only be attributed to an epicycle of erosion which followed the interruption of the main early Tertiary cycle. This consideration precludes a pre-Eocene age of the surface and one is left with a pre-Miocene age for it. Such an age would comply quite well with the concept that the west coast of Tasmania is a Miocene fault coast—the epicycle of erosion fits into late Miocene-early Pliocene times and was interrupted in the late Pliocene by the extrusion of basalts and later by extensive oscillations of sea-levels. Thus if a Miocene-Pliocene age is postulated for the plateau surface the later marine incursion, during which the 400 foot terraces were developed, becomes a Pleistocene event.

There followed further falls in sea level during which the plateau was dissected, the lower bench was formed, and the present coastline developed. This constant, though discontinuous, fall in sea-level recalls the staircase of benches described by Brown (*op. cit.*) from Cardiganshire in Central Wales: these features he considers to be related to a pulsatory negative movement of sea-level (*Ibid.*, p. 65).

The features and events are tabulated in Table I, and the following evolutionary story can be unfolded.

During early Tertiary times, much of Tasmania was reduced to a peneplain which, after suffering relative uplift, perhaps accompanied by faulting on the west coast, was subjected to peripheral dissection and planation. On the west coast of the island, a small plain of low rolling relief, above which protruded remnants of circumdenudation was formed; on this plain consequent streams developed and some of the latter, including the Pieman, developed meandering courses. The plain was backed on the inland side by rough and rugged mountains such as the Meredith Range.

Then followed a rise in sea-level up to the present 400 foot level (the then 150 foot level) when small beach terraces were formed. Further recession occurred and there was a considerable pause at the present 70 foot level during which the edge of the plain suffered marine planation. This stage of sea-level must have been of considerable duration for a marine bench of some width was formed.

Gradual uplift of the land caused the emergence of the marine bench which was subjected to subaerial denudation. However, dune formation on the coast caused the impedence of drainage and swamp formation. There followed further emergence and the formation of another, smaller, marine bench.

CONCLUSIONS

The foregoing is a record of a brief reconnaissance survey of a small area of north-west Tasmania and, as always, several problems and relationships remain to be solved. For example, the relationship of the plateau of the Pieman-Corinna Area with the Henty peneplain of the Queenstown area should be examined, and a correlation attempted between the 25-70 foot terrace and terraces in other parts of Tasmania, for instance old shore lines at 20 and 50-60 feet in the north-west of Tasmania and near Hobart (David and Browne 1950, p. 600, Spry, personal communication). The role, if any, of warping in the present physiography should be investigated and the nature and ages of the several features described in the previous pages should be determined if this is possible.

The Pieman-Corinna Area is a fine example of a landscape in which major features are due to past denudational events and processes rather than to structure. It is of considerable interest, and is significant in that the units discernible there extend to north, south and east, and thus the descriptions and suggested genesis of the units may be of value for future work.

ACKNOWLEDGEMENTS

This work was carried out in conjunction with the Victorian Branch of the Boy Scouts' Association during their camp at Corinna in January, 1954.

TABLE I

PERIOD	AGE	MOVEMENTS OF BASE-LEVEL	PHYSIOGRAPHIC HISTORY
	EOCENE		Planation of upper surface(s) of Tasmania.
	OLIGOCENE		(Tertiary faulting of west coast of Tasmania.)
TERTIARY			Dissection and planation of upper surface, with formation of high level plateau in Pieman-Corinna Area.
	MIOCENE		(Basalt extrusion in Waratah area.)
	PLIOCENE-PLEISTOCENE		(?) High-level beach formation and marine deposition.
		Rise in sea-level to 400 foot level	Beach formation.
		Fall in sea-level to 70 foot level.	Marine planation of edge of plateau; bench formed.
QUATERNARY		Further fall in sea-level.	Dissection of terrace, and formation of lower marine bench.
			Dunes built; subsequent swamp formation.
	RECENT		

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EXPLANATION OF PLATES

PLATE I

No. 1.—Coastline: extensive wave erosion along possible strike fault in highly inclined Pre-Cambrian metasediments.

No. 2.—Wave-cut terrace with scarp and plateau to right. At Pieman Heads.

No. 3.—Massive quartzites exposed in coastline. North of Conical Harbour.

No. 4.—Coastline: wave erosion along strike of relatively unresistant strata. North of Rupert Point.

No. 5.—Marine terrace from top of plateau residual; low residual hill in right middleground. South side of Pieman Heads.

No. 6.—Rectangular granite blocks in plateau scarp, north of Rupert Point.

No. 7.—Marine terrace, with plateau above. Residual mountain standing above plateau in far distance.

No. 8.—Plateau residuals standing above level of marine terrace at Rupert Point.

PLATE II

No. 1.—Gorge of Pieman River.

No. 2.—Gorge of Pieman River. Plateau seen in background.

No. 3.—Landslide on side of Gorge of Pieman River.

No. 4.—"Button-grass plains." Plateau top, with Mt. Donaldson, monadnock-like residual, on skyline.

No. 5.—Mesa-like plateau remnants at Rupert Point.

No. 6.—"Button-grass plains" on top of plateau.

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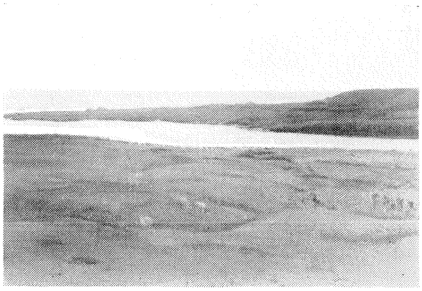

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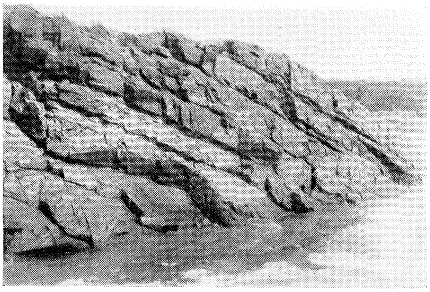

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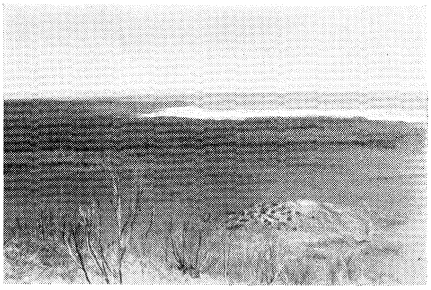

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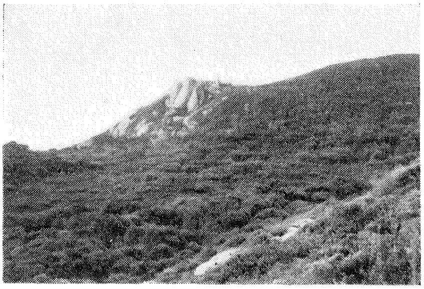

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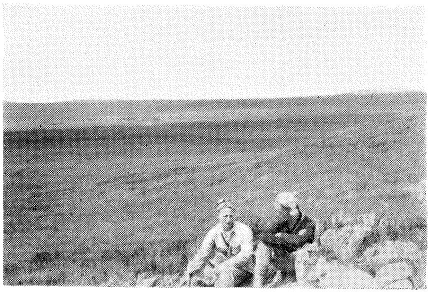

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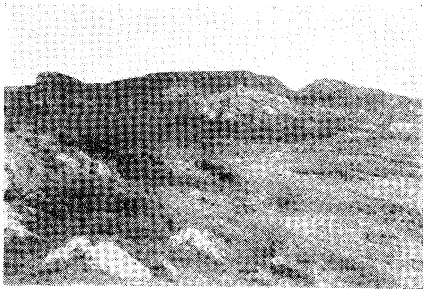

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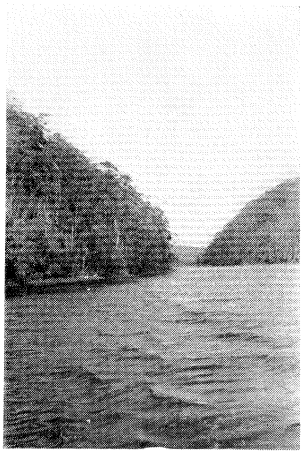

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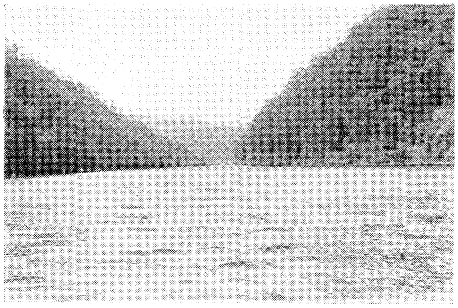

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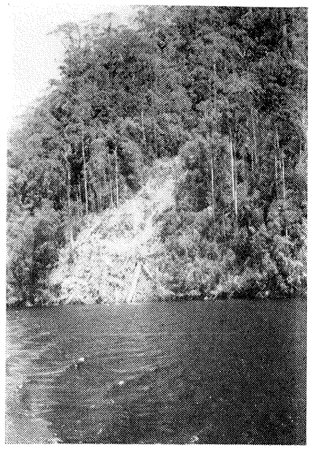

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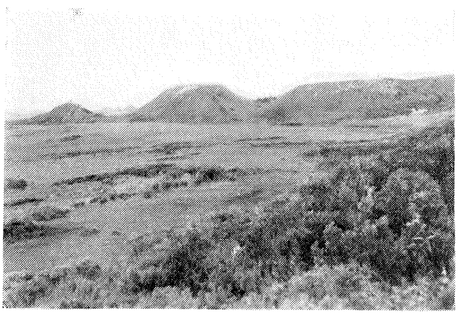

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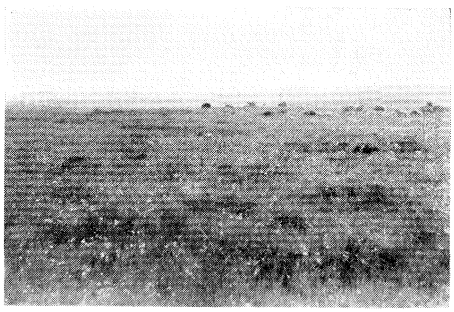

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