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THE GEOLOGY OF THE RICHMOND-SORELL AREA

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(With three text figures.)

ABSTRACT

Permian mudstones and sandstones crop out over much of the Richmond area; Triassic sandstones, shales, and coal measures occur east of Richmond and in the Sorell area. Faulting of Permian and Triassic strata and injection of dolerite, possibly as sheets, broke up the area.

Lakes formed in fault-angle troughs produced by Tertiary faulting; deposits in them occur between Richmond and Sorell. Faults of Jurassic and Tertiary age trending north and west of north control topography and stream direction. The Richmond Graben is Jurassic, pre-dolerite in age: Tertiary movement occurred along earlier lines of weakness.

INTRODUCTION

The area under consideration comprises two ten-thousand yard squares, which have been designated the Richmond and Sorell squares, because these are the largest townships in those squares.

Roads linking Hobart, Richmond, Sorell, Orielton and Brighton give easy access.

The high land levels are covered by an open sclerophyll forest with a low understory of shrubs. The lowlands are, in the main, grasslands which are used for grazing and cultivation. The highlands support sheep, whilst in the vicinity of Richmond, Sorell and Orielton dairy cattle occupy the richer pastures.

Rock exposure, except on the shores of Pittwater and in creeks and rivers, is poor; some difficulty was thus experienced in determining boundary positions of some stratigraphic units. Mapping was carried out by walking the outcrop and plotting rock boundaries on aerial photographs. Together with this several magnetic-variation traverses were made to determine the form of some isolated areas of dolerite north of Richmond.

A basemap was constructed on a scale of 20 chains to one inch using the slotted template method; the geology was plotted onto this from the aerial photographs. Grid references in the text are given in the same manner as used by the Army.

PREVIOUS LITERATURE

Previous notes on various aspects of the geology of the Richmond-Sorell area have been published by Johnston (1888), Nye (1922), Hills *et al.* (1922), Edwards (1939) and Lewis (1946). More recently Moore (1965) has commented on part of the Richmond Square.

ACKNOWLEDGEMENTS

Thanks are due to the staff of the Geology Department, University of Tasmania for their help and encouragement during the fieldwork, compilation of the map and preparation of this paper. Mr. M. R. Banks identified many of the Permian fossils and constructively criticised the manuscript.

PHYSIOGRAPHY

The physiography of the Richmond-Sorell area has been controlled by Tertiary faulting, secondarily by rock distribution.

In the south, east, and north-east of the area the hills are rounded, with an average altitude of about 600 feet and a maximum of 1786 feet at Grass Tree Hill. To the north-west the hills are angular, steep-sided, and frequently fringed by talus slopes. Dolerite caps many of the hills, and the valleys are eroded into softer Triassic sediments.

Tertiary faults, striking approximately north-west and downfaulted to the east, have controlled stream directions. In common with other parts of Tasmania, Tertiary faulting is of the tilted block type. The troughs so produced were, in some cases dammed, thus producing freshwater lakes. Three major physiographic features, the Duck-Hole Creek, the Coal River, and the Orielton Rivulet valleys are all sites of one or more Tertiary lakes. The sea obscures the southern limits of these valleys but the northern and upper limits of the lake sediments indicate a single lake in this area.

Davies (1959) defined the Llanherne and Milford levels just south of the area; his observations can be extrapolated along the shores of Pittwater. In spite of these two levels indicating emergence, the coastline is one of submergence.

In its lower reaches, the Coal River has filled the valley with sediment and formed a delta at the coast.

STRATIGRAPHY

PERMIAN SYSTEM

Malbina Siltstone and Sandstone

This formation is exposed at three points on Belbin Rivulet (230305) and at a locality one mile west southwest of "Strathayr". The rocks of the Malbina Siltstone and Sandstone are poorly exposed at Belbin Creek; about 20 ft. crop out above the dolerite and the top 15 ft. of the formation below the Risdon Sandstone can be observed. The total thickness of the unit here would be about 100 ft.

Lithologically this unit consists of a pale brown, fine-grained matrix containing angular quartzite fragments up to four centimetres in diameter, with occasional larger erratics. Bedding is 12 to 18 inches thick.

Fossils, normally uncommon in this unit, form a coquinite immediately below the Ferntree Group. The observed fauna comprises *Strophalosia*, spiriferids and fenestellids. Banks and Read (1962) give a thickness of 300 feet for this formation in the type area and an Upper Artinskian or Kungurian age. In the Richmond square correlates of Member "E" of the type area are present; the uppermost part of member "D" may also be present.

FERNTREE GROUP

Risdon Sandstone

The Risdon Sandstone is the basal unit of the Ferntree Group, it conformably overlies Malbina Siltstone and Sandstone and is overlain by Ferntree Mudstone. The unit is a well-sorted, soft, yellow-brown sandstone containing subangular quartzite fragments, muscovite mica, graphite and occasional small pebbles. The thickness varies from 15 to 20 ft. Typically the Risdon Sandstone forms a narrow bench and small cliff more or less following the contours. Two small faults with throws of 30 feet or so have caused this unit to recur in three outcrops in Belbin Rivulet at (235350).

Ferntree Mudstone

Outcrops of Ferntree Mudstone occur over large areas of the Richmond square. At (248305) Risdon Sandstone conformably underlies this unit which is itself overlain by Cygnet Coal Measures at (227328). It is a buff, very fine-grained, compact mudstone containing a few isolated angular pebbles of quartzite, slate and granite. At (325303) on Shark Point several bands of conglomerate about one foot thick are exposed and patches of angular boulders also occur there.

Fossils are not common in the Ferntree Mudstone. However, *Stutchburia costata* (Morris), *Cleobis grandis* Dana, *Pachydomus* and *Terrakea* cf. *fragile* may be found 100 to 150 feet below the Triassic at (342323). Worm tracks, fossil wood, *Stenopora* and spiriferids are part of the fauna at Shark Point.

Cygnet Coal Measures

Only one outcrop of Cygnet Coal Measure is known in the area. It is exposed in a small roadside ditch at (228328). A maximum of 4 feet of laminated carbonaceous siltstone is exposed here.

TRIASSIC SYSTEM

Ross Sandstone

The base of the Ross Sandstone is marked by a pink, pebbly sandstone, the matrix of which is a fine-grained sand of quartz, feldspar and muscovite, carrying pebbles up to 40 mm. in diameter. Sorting is poor and cement almost absent in this unit. This basal bed may be observed at (228328) and (285370).

The bulk of the Ross Sandstone comprises sandstone and shale. The formation exceeds 400 feet in thickness. Because the shale weathers more rapidly than the sandstone, outcrops of it are obscured by surface rubble. The sandstones are strongly cross-bedded, showing that bottom currents were from the west, which is consistent with current directions at other localities. Occasional slump structures of the type recorded by McDougall (1959, p. 70), are found in the cliffs at Midway Point. "Clay-pellet" conglomerates are frequent at Midway Point and on Butchers Hill. The pellets comprise oval discs of pink to white mudstone, apparently with a preferred orientation, set in a fine-grained sandstone matrix.

Knocklofty Sandstone and Shale.

Those rocks which are correlated with Knocklofty Sandstone and Shale, outcrop at (363223) in Duck Hole Creek on the Richmond square. Strongly chloritic sandstones, micaceous shales containing plant fossils, clean white sandstones, and clays, occur in the creek bed. One of the clay beds contains numerous worm tubes 5-10 mm. long and 3-5 mm. in diameter filled with the overlying sediment. Outcrops also interpreted as this unit occur at Sheoak Hill and in the roadway at (379825). Quaternary gravels on the western edge of Sorell square apparently conceal the Knocklofty Sandstone and Shale, as several creeks in the area have cut through the veneer of gravel into a sequence of sandstone and shale similar to this unit.

Lithic Arenites

Overlying the Knocklofty Formation is the so-called "Feldspathic Sandstone". Only one exposure, 200 yards downstream from the weir on the Coal River at Richmond, is known. A bore sunk by the Department of Mines in 1922 at the above locality revealed the presence of at least 500 feet of clays, sands, coal, and shales, belonging to this formation. A cliff face in this locality exposes coal seams a foot or more in thickness.

Tertiary System

Tertiary sediments occur along the southern boundary of both Richmond and Sorell squares, with deposits extending north of Richmond in the valleys. Pale grey clays and sands are exposed in cliffs along the Coal River under the Catholic Church at Richmond, on the coast of Pittwater near Penna, and 1½ miles south-east of Gunns Sugar Loaf.

Angiosperm leaf impressions were found east of Shark Point and 1½ miles south-east of Sheoak Hill close to the Richmond-Sorell road.

The clay deposits, as exposed near Shark Point and Penna are at least 15 feet thick. When wet these clays, particularly the white and pale grey strata, are plastic. The clay was apparently derived from the dolerite by weathering in the catchment area of streams feeding into the lakes.

IGNEOUS ROCKS

Jurassic System

In the Richmond-Sorell area dolerite crops out as slightly transgressive sheets except at Shark Point where two small dykes occur. In general the

dolerite is a fine to medium-grained rock of uniform texture and of grey-blue colour when fresh. In thick sheets, such as north of Grass Tree Hill and north of Sorell, the rock is distinctly pegmatitic away from the edges of the mass. Extremely fine-grained dolerite occurs at contacts with country rock and the sedimentary rocks are hornfelsed. The intensity and extent of thermal metamorphism is small and McDougall (1959, p. 64) has suggested that this may be due to a lack of fluids and low thermal conductivity of the country rock.

An outcrop of fine-grained dolerite in a small excavation in basal Triassic sandstone, at the base of Butchers Hill near the northern end, may be an offshoot dyke from the main intrusion. As the Coal River Fault is several hundred yards to the east, this outcrop is not laterally connected with the dolerite sheet south-east of Richmond.

Tertiary System

Basalt flows occurred at Sorell, Gunns Sugar Loaf, Richmond, Penna, Midway Point and Orielton. Phenocrysts of olivine indicate an olivine saturated magma, as is common in the lower reaches of the Derwent Valley. Opaline silica, chalcedony, and zeolitic amygdules are frequently associated with the basalt.

Near the summit of Gunns Sugar Loaf is an outcrop of basalt about 20 yards across and completely surrounded by dolerite; it contains small xenoliths of dolerite and grey clay-rich fragments of Triassic (?) sediments. It is suggested that the basalt is a plug as no Triassic rocks occur above the outcrop but they do crop out some 400 feet down the hill.

South of Sorell in a river bank pahoe-hoe lava indicates a basalt flow; large polygonal cooling columns 15 feet high and 10 feet across were formed from one flow of basalt. Occurrences of basalt in the Orielton-Penna-Sorell valley indicate that the valley floor was flooded with basalt. Several lava flows crop out below the Catholic church at Richmond where they overlie lake sediments and are overlain by gravels. A chalcedonic structure reminiscent of a tree-trunk penetrates three feet into the base of the basalt there.

Outcrops of basalt north and west of Orielton are about 200 feet above sea-level thus indicating a source or sources topographically above this, presumably north of the Sorell Square.

STRUCTURE

Faulting

Faults of Jurassic and Tertiary age occur in the Richmond-Sorell area (Fig. 1). Some of the Jurassic faults also exhibit Tertiary movement.

Jurassic Faults

The Bagdad Fault of McDougall (1959) continues, as suggested by him, along the Back Tea Tree Valley. At a point half a mile south of Bourbon Homestead (220377) the fault becomes manifest and continues in a south-easterly direction parallel to the Back Tea Tree Road. At (240348) the fault is obscured by a dolerite mass, the easterly contact of which is steep and may be the fault plane. Hastie (unpublished Honours thesis 1961) has found evidence for the continuation of this fault south of the Richmond square into the Lindisfarne square. Near Bourbon this fault has a throw of approximately 700 feet. The fault is pre-dolerite or contemporaneous with the dolerite.

The Coal River Valley is the topographic expression of a pair of parallel faults of Jurassic age. The graben was initiated prior to the injection of dolerite when the "Feldspathic" Sandstone was faulted down to the lower levels of the Ross Sandstone. A single sheet of dolerite was injected. Subsequent movement along the western fault, here named the Coal River Fault, occurred in Tertiary times and gave rise to Butchers Hill as it is now known. Jurassic movement along the western fault was of the order of 1200-1300 feet, and Tertiary movement 300-400 feet. The eastern limit of the graben, here called the Richmond Graben, is a fault whose position and throw are not accurately known owing to a core of dolerite and scant sediments. The graben does not appear to be more than one mile wide at Richmond and is less than this to the south.

The Richmond Fault (Lewis 1946) does not appear to be as long as he indicated; from the dolerite at (238342) it extends in a south-westerly direction up into the Triassic sediments. Because this fault does not continue either into or past the dolerite it must be regarded as pre-dolerite. Two deep, steep-sided gullies meet at (230337); the southern branch is cut along a fault of only a few feet throw, whilst the northern branch appears to be eroded along an extension of the Richmond Fault. If this latter gully is along a fault the throw is such as not to affect the surface geology noticeably.

Two faults near Dulcot and several small faults between Shark Point and Penna are also of Jurassic age.

Tertiary Faults

A fault in the Duck Hole Creek Valley, here named the Cold Blow Fault, is of Tertiary age with an estimated throw down to the east of more than 1000 feet. Its estimated position is 300 yards west of the southern end of Butchers Hill and running parallel to the western edge of it. From its topographic expression the Cold Blow Fault continues north of the Richmond square.

The Coal River Fault has already been mentioned as having Tertiary movement.

In the Grass Tree Valley a system of two subparallel faults—the Shellstone Fault to the west, the Strathayr Fault (new name) to the east—form the limits of the Grass Tree Valley Graben. Throws of the faults of this graben are more than 450 feet and more than 690 feet respectively. The East Risdon (south of Richmond square)-Richmond road cuts the Shellstone Fault at four points, so that Permian and Triassic sediments alternate along the road cuttings.

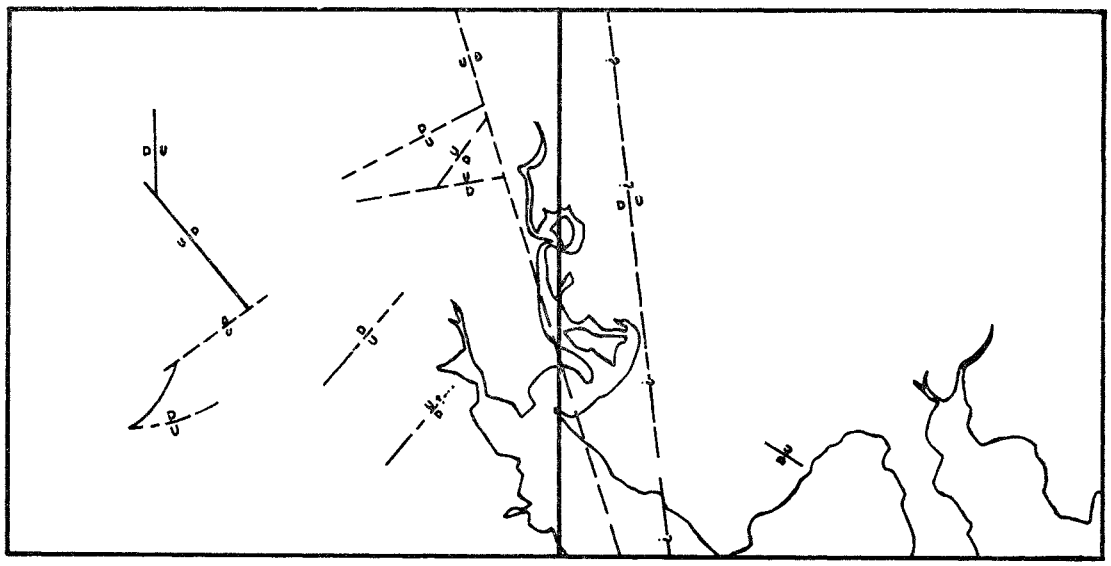

fig. 1a. JURASSIC FAULT SYSTEM

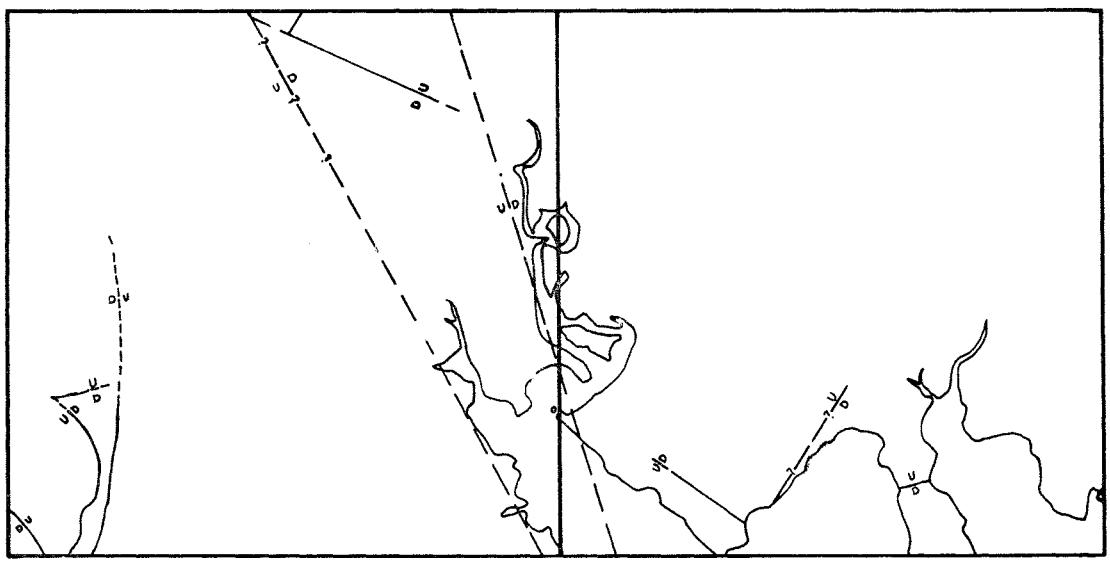

fig. 1b TERTIARY FAULT SYSTEM

Structure of the Dolerite

Jurassic dolerite, in this area, has transgressively intruded Permian and Triassic sediments and because of its greater resistance prominent features of present-day topography are invariably capped by it. Two small dykes outcrop at Shark Point, but elsewhere the dolerite occurs as a sill. However, where the top and bottom contacts of a sill have been observed both may be flat lying or one may be steeply inclined. Structural interpretations of the dolerite have been presented by Carey (1958, p. 134).

Extensive sills of dolerite occur at Grass Tree Hill, Mt. Lord, Sheoak Hill and north of Sorell.

The intrusion between (236350) and the southern boundary of Richmond square has a steep eastern contact with a flat-dipping contact on the western or uppermost side.

Two superimposed dolerite sills separated by about 30 feet of sediment occur one mile north-west of Richmond. The upper contact of the lower sill is chilled and the overlying sediments baked, and the higher intrusion has its lower contact chilled. Although a small fault cuts across the southern end of the outcrop there is no evidence for a fault between the outcrops of dolerite.

References.

Banks, M. R. and Hale, G. E. A., 1957.—A Type Section of the Permian System in the Hobart Area. *Pap. Roy. Soc. Tasm.*, 91, pp. 41-64.

————————and Read, D. E., 1962.—The Malbina Siltstone and Sandstone. *Pap. Roy. Soc. Tasm.*, 96, pp. 19-32.

———————— 1962, in Gill, E. D., 1962.—Cainozoic in "Geology of Tasmania", *J. Geol. Soc. Aust.*, 9, pt. 2. pp. 241-243.

Carey, S. W., 1958.—A New Technique for the Analysis of the structure of the Tasmanian Dolerite, pp. 130-169, in *Dolerite Symposium*, Univ. Tasm.

Davies, J. L., 1959.—Sea-Level Changes and Shoreline Development in South-Eastern Tasmania. *Pap. Roy. Soc. Tasm.*, 95, pp. 35-40.

Edwards, A. B., 1939.—The Age and Physiographical Relationships of some Cainozoic Basalt in Central and Eastern Tasmania. *Pap. Roy. Soc. Tasm.* (1939), pp. 175-200.

Hastie, L., 1961.—Unpublished Honours Thesis, *University of Tasmania.*

Hills, C. L., Reid, A. M., Nye, P. B., Keid, H. G. W., and Reid, W. D., 1922.—The Coal Resources of Tasmania. *Miner. Resour. Tasm.*, 7.

Johnston, R. M., 1888.—*Geology of Tasmania.* Govt. Printer, Hobart.

Lewis, A. N., 1946.—*Geology of the Hobart District.* Mercury, Hobart.

McDougall, I., 1959.—The Geology of the Pontville-Dromedary Area, Tasmania. *Pap. Roy. Soc. Tasm.*, 93, pp. 59-70.

Moore, W. R., 1965.—Geology of the Risdon Vale Area. *Tas. Dept. Mines Tech. Rept.*, 9, pp. 77-88.

Nye, P. B., 1922.—The Underground Water Resources of the Jericho-Richmond-Bridgewater Area. *Underg. Wat. Resour. Pap. Tasm.*, 2.

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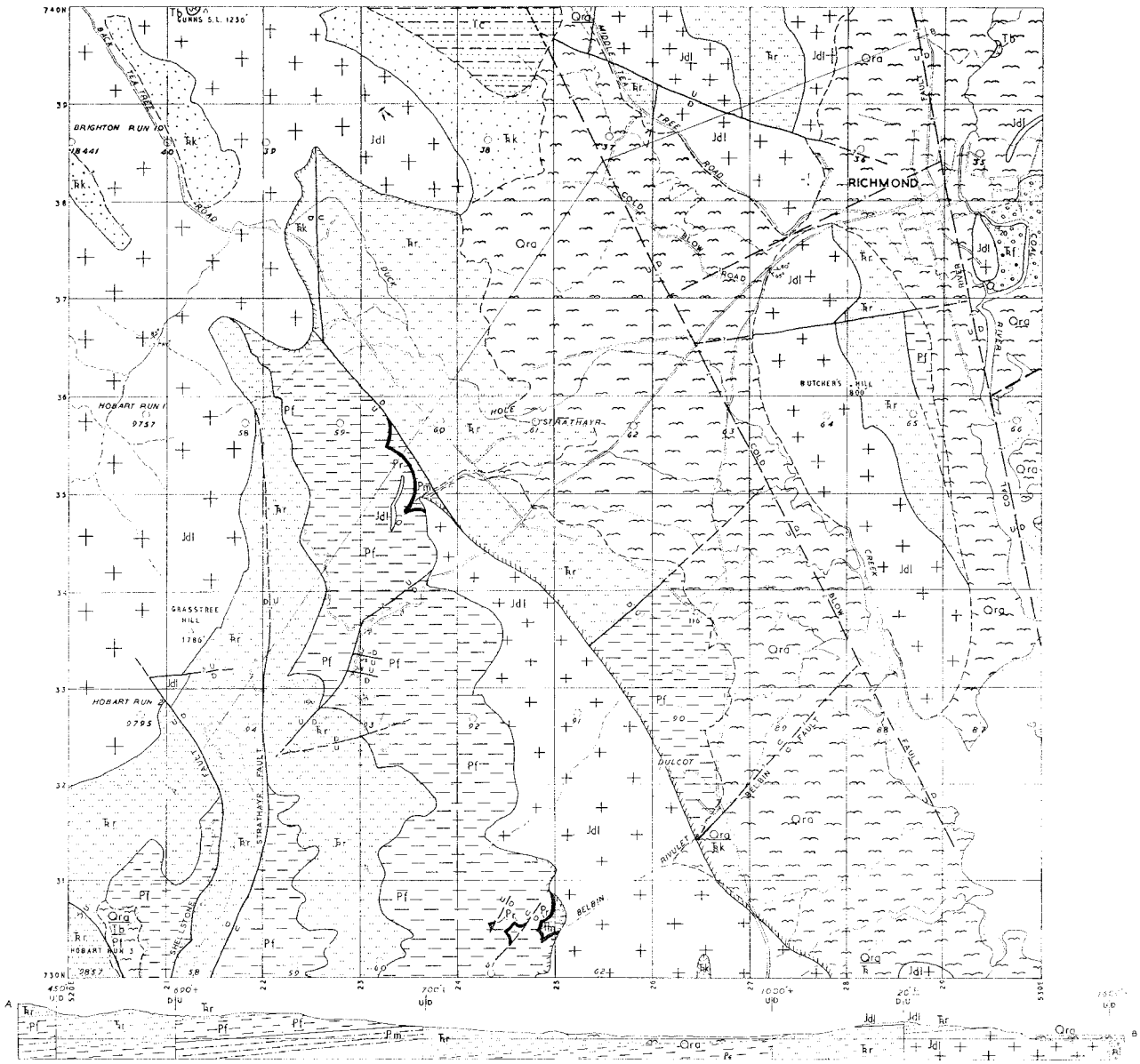
RICHMOND

5273



LEGEND

Compilation from Aerial Photographs
Trigonometric Station Control by courtesy of the Department of Lands and Surveys, Hobart, and the Australian Army Survey Service.
Origin of co-ordinates 400,000 yds. West and 1,800,000 yds South of True Origin of Zone 7 of the International Grid.

- FAULT WITH DOWNTHROWN SIDE INDICATED
- FAULT CONCEALED
- FAULT INFERRED
- FORMATION BOUNDARY
- FORMATION BOUNDARY POSITION APPROXIMATE

Dolerite Boundaries
- CONCORDANT BOUNDARY
- DISCORDANT INTRUSIVE BOUNDARIES

- VERTICAL JOINTS
- STRIKE AND DIP OF JOINTS
- STRIKE AND DIP OF STRATA
- ROAD
- VEHICULAR TRACK

Quaternary System
RECENT SERIES
- Qra ALLUVIUM

Tertiary System
- Tc CLAYS AND SANDS

Triassic System
- Rf FELDSPATHIC SANDSTONE
- Rk KNOCKLOFTY FORMATION
- Rr ROSS SANDSTONE

Permian System
- Pf FERNTREE MUDSTONE
- Pr RISDON SANDSTONE
- Pm MALBINA SILTSTONE AND SANDSTONE

IGNEOUS ROCKS
Tertiary System
- Tb BASALT

Jurassic System
- Jdl DOLERITE

KEY MAP SHOWING MAGNETIC DECLINATIONS 1957
SECULAR VARIATION 7' PER ANNUM

MAPPED AND COMPILED BY C.G.GATEHOUSE 1960

SCALE
0 1 2 3 4 5000 10000 FEET
0 2 MILES

FIG. 2

GEOLOGY OF TASMANIA

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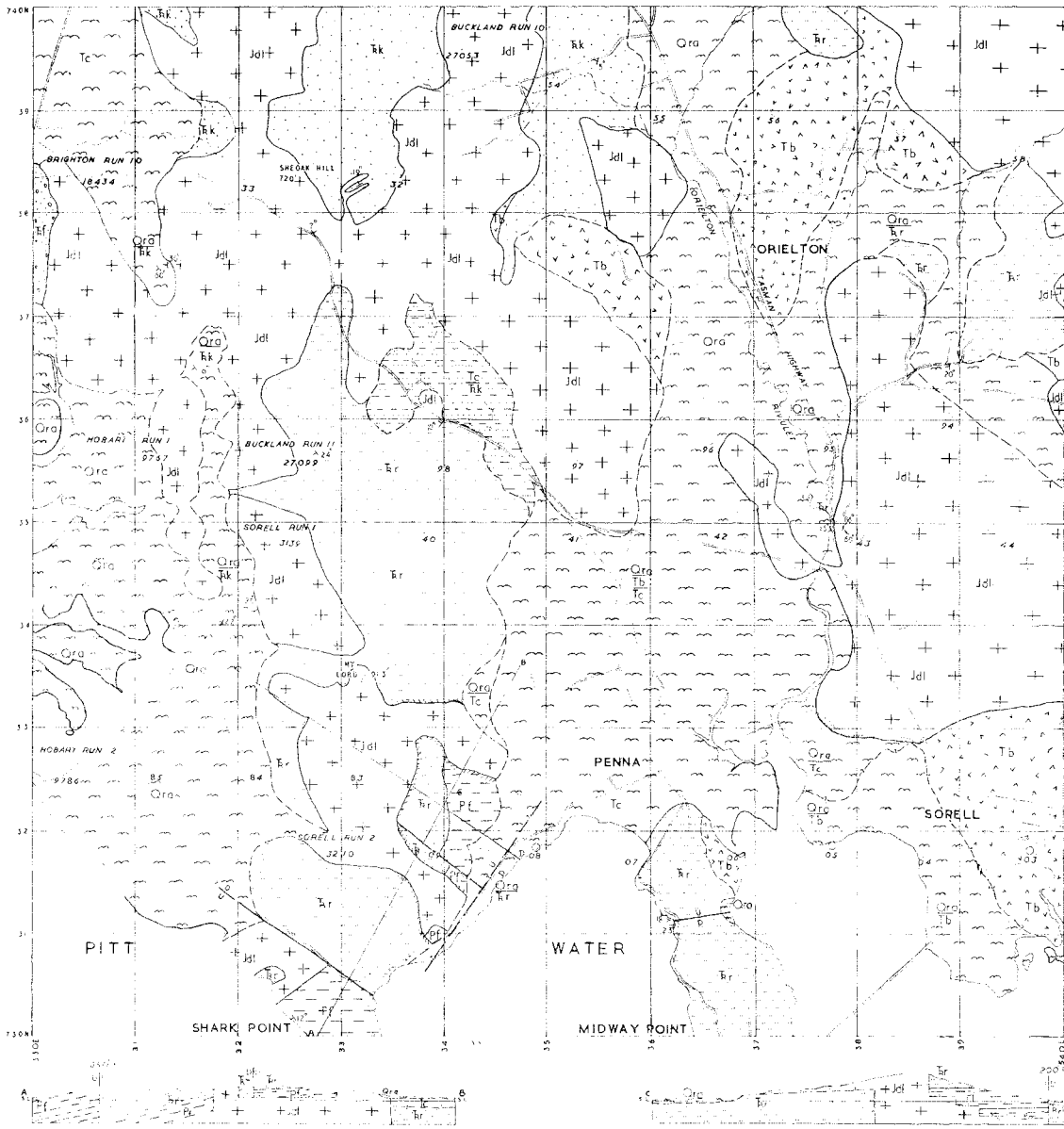
SORELL

5373



LEGEND

- FAULT WITH DOWNTHROWN SIDE INDICATED
- FAULT CONCEALED
- FAULT INFERRED
- FORMATION BOUNDARY
- FORMATION BOUNDARY POSITION APPROXIMATE

Dolerite Boundaries
- CONCORDANT BOUNDARY
- DISCORDANT INTRUSIVE BOUNDARIES

- VERTICAL JOINTS
- STRIKE AND DIP OF JOINTS
- STRIKE AND DIP OF STRATA
- ROAD
- VEHICULAR TRACK
- FOSSIL LOCALITIES

Quaternary System
RECENT SERIES
- Qra — ALLUVIUM

Tertiary System
- Tc — CLAYS AND SANDS

Triassic System
- Trf — FELDSPATHIC SANDSTONE
- Trk — KNOCKLOFTY FORMATION
- Tr — ROSS SANDSTONE

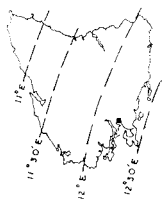
Permian System
- Pf — FERNTREE MUDSTONE

IGNEOUS ROCKS
Tertiary System
- Tb — BASALT

Jurassic System
- Jdl — DOLERITE

Compilation from Aerial Photographs Trigonometric Station Control by courtesy of the Department of Lands and Surveys, Hobart, and the Australian Army Survey Service. Origin of coordinates 400,000 yds. West and 1,800,000 yds. South of True Origin of Zone 7 of the International Grid.

KEY MAP SHOWING MAGNETIC DECLINATIONS 1957. SECULAR VARIATION 7' PER ANNUM.



MAPPED AND COMPILED BY C.G.GATEHOUSE 1960

SCALE
0 1 2 3 4 5,000 2 MILES 10,000 FEET

FIG. 3