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by
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DEPARTMENT OF GEOLOGY

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THE GEOLOGY OF THE SLACKS CREEK AREA, SOUTHEAST QUEENSLAND

ABSTRACT. The stratigraphic sequence in the Slacks Creek area consists of low-grade metamorphics of the Lower Palaeozoic Neranleigh-Fernvale "Group", Triassic sediments of the Tingalpa and Moorooka Formations, minor sediments and volcanics of possible Tertiary age, Tertiary soils, and Quaternary sediments and soils. The Neranleigh-Fernvale "Group" is composed of metaquartzite, greywacke, and minor phyllite; the Tingalpa Formation of partly calcareous shales and sandstones; the Moorooka Formation of conglomerate, shale and sandstone. Volcanic mud balls at the base of the Tingalpa Formation may indicate equivalence of the base of this formation in the Slacks Creek area to the Brisbane Tuff. Megafossils from the Tingalpa and Moorooka Formations have a Lower Mesozoic aspect. Palynological evidence obtained suggests an Upper Triassic age for the Tingalpa and Moorooka Formations. The Tingalpa Formation unconformably overlies the Neranleigh-Fernvale "Group" and is succeeded unconformably by the Moorooka Formation which is in turn overlain unconformably by Cainozoic sediments. Earth movements involving slight displacements of the Palaeozoic basement blocks apparently occurred during the Triassic. Geomorphology in the area is strongly controlled by the joint pattern; the effects of relative hardness of rock types, attitude of beds, changes in climate, and relative changes in sea level are also evident.

INTRODUCTION

The area at Slacks Creek mapped by the author covers 9 square miles, and is situated east of the Pacific Highway, approximately 11 miles SSE. of Brisbane (see Fig. 1).

Field mapping was accomplished by closed pace and compass traverses with the aid of aerial photographs. All grid references refer to Military Sheet No. 193, Beenleigh, 1 mile series, second edition. Pettijohn's classification (1957) is used for sedimentary rocks. Sizes are expressed according to the Wentworth grade scale. A typical measured section of each rock unit within the area has been selected for reference purposes. The rocks and fossils collected are housed and catalogued in the Department of Geology and Mineralogy, University of Queensland.

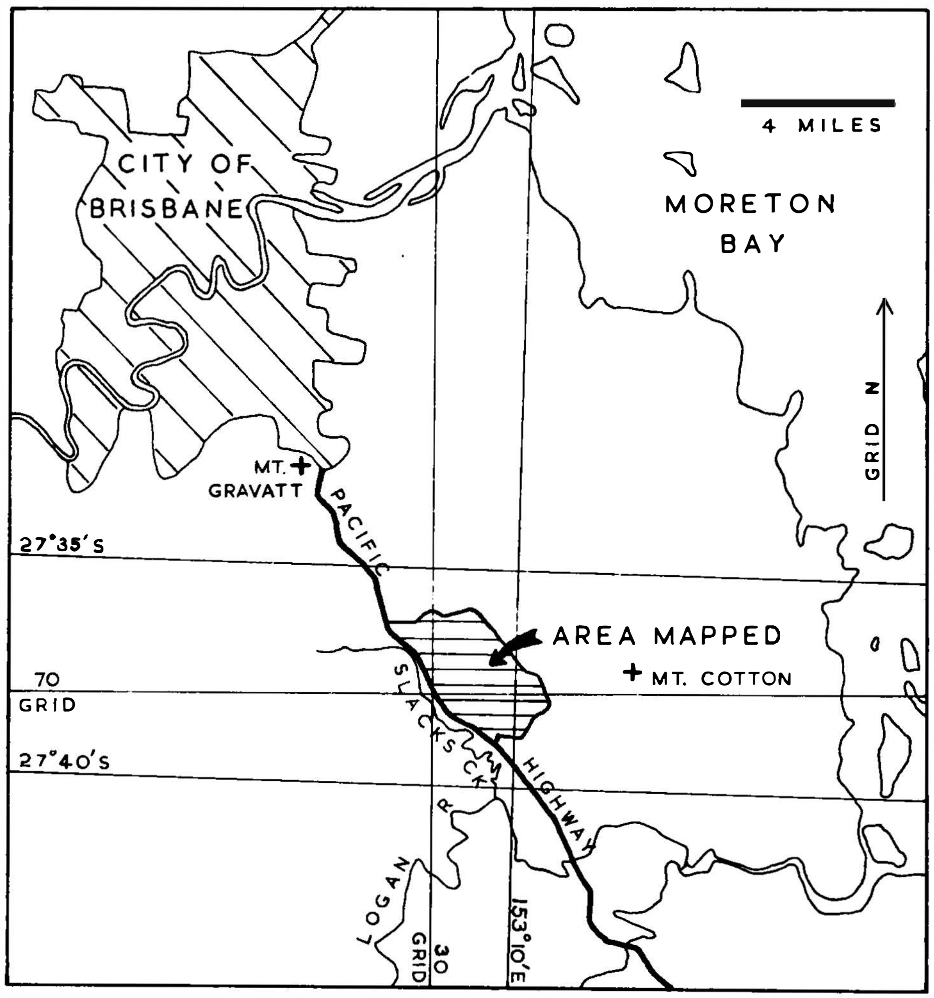

FIG. 1.—Locality map

The present paper is based upon the author's B.Sc. Honours thesis (Gould, 1965) which was submitted to the Department of Geology and Mineralogy, University of Queensland.

PREVIOUS GEOLOGICAL INVESTIGATIONS

Geological maps covering at least part of the area have been prepared by Rands (1889), Jack & Etheridge (1892), Marks (1910), Walkom (1918), Denmead (1928), Higginson (1946), Hill (1953), Hill & Tweedale (1955), McTaggart (1957), and McElroy (1963). Except for Higginson (1946), the foregoing maps have not changed since the interpretation given by Marks (1910). A detailed geological map was given by Gould (1965, map No. 2).

The first geological reports of the area by Rands (1887, 1889) concerned mainly the results of prospecting for coal and gold. Marks (1910) gave a fairly comprehensive geological report, also with an emphasis on the search for coal and gold. Denmead (1928) presented a detailed account of the Brisbane Schists, which included the rocks of the "Neranleigh Series" at Slacks Creek. Higginson (1946) postulated that all the Mesozoic sediments in the area belong to the Ipswich (not Bundamba) "Series". Belford (1950) gave a comprehensive account of the "Neranleigh Series" between the Logan River and the Queensland-New South Wales border. McTaggart (1957) referred briefly to the present area. Contributors to Hill & Denmead (1960) reviewed the information known at that time. McElroy (1963) discussed the geology of the Clarence-Moreton Basin (extending from northeastern New South Wales into southeastern Queensland). Houston (1965*a*) proposed new and redefined names for the stratigraphy of the Greater Brisbane area; these are applicable at Slacks Creek. On palynological grounds de Jersey & Hamilton (1965*a*, *b*) correlated the Tingalpa and Moorooka Formations of Houston (1965*a*) with the Middle or Upper Triassic Ipswich Coal Measures.

Soil types have been described by Bryan (1939), Beckmann (1953, 1959), and Hubble (1961).

Varying aspects of the geomorphology of the area were treated by Marks (1910, 1933), Denmead (1928), Süssmilch (1933), Belford (1950), and Beckmann (1953, 1959).

A more detailed account of the subject of this paper was given by Gould (1965).

GEOMORPHOLOGY

Geomorphology in the area is strongly controlled by joint patterns, attitude of beds, and relative resistance to weathering of the various rock types. Other influential factors included changes in sea level and climate.

The Palaeozoic and Mesozoic rocks have a predominant NW.-SE. and NE.-SW. joint pattern (see Figs. 3, 4, 6, and Geological History), which controls the drainage. The trend of stream valleys, ridges, cliffs, and escarpments is identical with that of the major joint directions.

Slopes in the hard Palaeozoic rocks are controlled by steep, SW. dipping, NW.-SE. joint planes, and the relative resistance of the rock type. Hard Palaeozoic metaquartzites outcrop in fairly straight NW.-SE. lines, forming hills up to 500 feet high. This factor augments the major joint direction to produce a marked NW.-SE. topographic trend.

On the almost flat-lying Mesozoic sedimentary rocks, sandstone and conglomerate form the higher points as well as the escarpments and cliff lines. The sandstone and conglomerate weather out in blocks bounded by joint planes, and the scarps retreat with approximately constant slopes.

Geological boundaries have little geomorphological significance, apart from the formation of an escarpment by the basal conglomerate of the Moorooka Formation (discussed above). Only minor streams follow the irregular and steeply dipping boundary between the Palaeozoic and Mesozoic rocks.

The main watershed in the area extends in a more or less NW.-SE. direction from Oakey Hill (Be 356698) to Stegemann's Hill (Be 302730). Streams to the north flow NE. into Tingalpa Creek; those to the south and west flow into Slacks Creek, thence SE. into the Logan River. The lower courses of the stream valleys have been partly filled with alluvium. Streams to the south and west of the main watershed have incised channels; these are not evident in streams flowing to the north. The tributaries of Slacks Creek in the southern part of the area have well developed terraces as well as the present flood plains. The lower terraces may correlate with the Waterford Terrace of Beckmann (1959).

The Red Earth Residuals (Bryan, 1939) cover much of the area, mainly capping ridges and small plateaux at elevations of 100–450 feet. It has been suggested that the surface of the Red Earth Residuals was a peneplain (Bryan, 1939; Beckmann, 1959; see also Marks, 1933, and Süssmilch, 1933). These residual soils are probably the product of a past climate that was more conducive to lateritization than the present one (Bryan, 1939; Beckmann, 1959; see also section on Red Earth Residuals).

Both the surface of the Red Earth Residuals and the stream terraces are possibly connected with relative changes of sea level in the Cainozoic (see Beckmann, 1959, pp. 3, 47; Bryan, 1939, p. 29).

STRATIGRAPHY

General statement

The stratigraphic succession in the area is as follows:

Alluvium DISCONFORMITY Peat DISCONFORMITY Alluvium / Podzolic soils		QUATERNARY
Lateritic red earth and lateritic podzolic soil	Red Earth Residuals	TERTIARY
Basalt	Possible equivalent of Corinda Formation	
Poorly consolidated conglomerate and boulder bed	Possible equivalent of Darra Formation	
UNCONFORMITY		
Massive and cross-bedded sandstone with minor conglomerate Shales Massive conglomerate with sandstone and minor shale lenses	Moorooka Formation	MESOZOIC, TRIASSIC
UNCONFORMITY		
Shales, siltstones, and sandstones (calcareous in part) Partly calcareous and carbonaceous shales, siltstones, sandstones, with minor conglomerate and coal Tuffaceous (mud balls) and sandy sericitic shale with conglomerate	Tingalpa Formation	
UNCONFORMITY		
Feldspathic greywacke (metamorphosed) and metaquartzite	Neranleigh-Fernvale "Group"	LOWER PALAEOZOIC

Note that the relationship between the Neranleigh-Fernvale "Group" metaquartzite and greywacke is not known; and that the basalt occurs only in conjunction with the Tingalpa Formation and may unconformably overlie it.

Neranleigh-Fernvale "Group"

The term group is placed in inverted commas because this unit's definition (Bryan & Jones, 1950) does not accord with the Australian Code of Stratigraphic Nomenclature, articles 23, 24, and 39.

Derivation of name

"Neranleigh" was derived from the village of Neranwood and the town of Beenleigh; both are situated south of the present area (see Bryan & Jones, 1950; Belford, 1950; Denmead, 1928, p. 73). "Fernvale" was derived from the town of the same name in the Brisbane Valley (Bryan & Jones, 1950).

Location (see Fig. 2)

The "Group" outcrops along the southeast and east of the area from Be 344675 to Be 355694 to Be 337719. The actual boundary with the Mesozoic sediments to the west is irregular; it is approximately represented on Marks's map (1910).

Lithology

The outcropping rocks consist of metaquartzite and feldspathic greywacke (metamorphosed) with associated finer-grained and/or sheared equivalents of the greywacke. The greywacke-metaquartzite relationship proved indeterminate.

The metaquartzite consists predominantly of quartz, with some sericite and minor chlorite. A very fine-grained, black, opaque substance (possibly graphite and/or haematite) is also present. The rock contains numerous megascopic and microscopic quartz veins. The sericite, ?graphite, and chlorite appear to have been formed from the original matrix of the rock.

Red loams (krasnozems) and/or lateritic kraznozems, grading into red earths, are associated with all metaquartzite outcrops in the area (see Denmead, 1928, p. 73; Bryan & Jones, 1963, p. 19).

The metamorphosed feldspathic greywacke is a strongly jointed, hard, green to dark grey, massive rock consisting of quartz (40 per cent), potash feldspar (15 per cent), plagioclase feldspar An_{25-30} (5 per cent), chlorite ($<$ 5 per cent), large flakes of muscovite ($<$ 1 per cent), calcite ($<$ 1 per cent), with a matrix of sericite and silt-sized quartz (40 per cent). The potash feldspar consists of well-cleaved orthoclase, microcline, and perthite. Secondary quartz has filled veins during metamorphism.

Comparisons of chemical analyses of greywacke from the Neranleigh-Fernvale "Group" were given by Denmead (1928), Belford (1950), Bryan & Jones (1954, and in Hill & Denmead, 1960, p. 132), and Green (1964). Green noted that its composition was close to that of an adamellite.

Minor amounts of phyllite are associated with the greywacke and metaquartzite. These are finer-grained and/or sheared equivalents of the greywacke containing abundant sericite (40 per cent) with a few remnant grains of quartz and feldspar.

Grade of metamorphism

Although the rocks are arenaceous, their matrices were argillaceous and have undergone greater changes during metamorphism (see Moorhouse, 1959, p. 440). Minerals formed include quartz, sericite (muscovite), and chlorite. This mineral assemblage, together with the texture and structure of the rocks, suggests that the metamorphic grade was very low. The minerals belong to the pelitic assemblage of the quartz-albite-muscovite-chlorite subfacies in the greenschist facies (Turner, 1958).

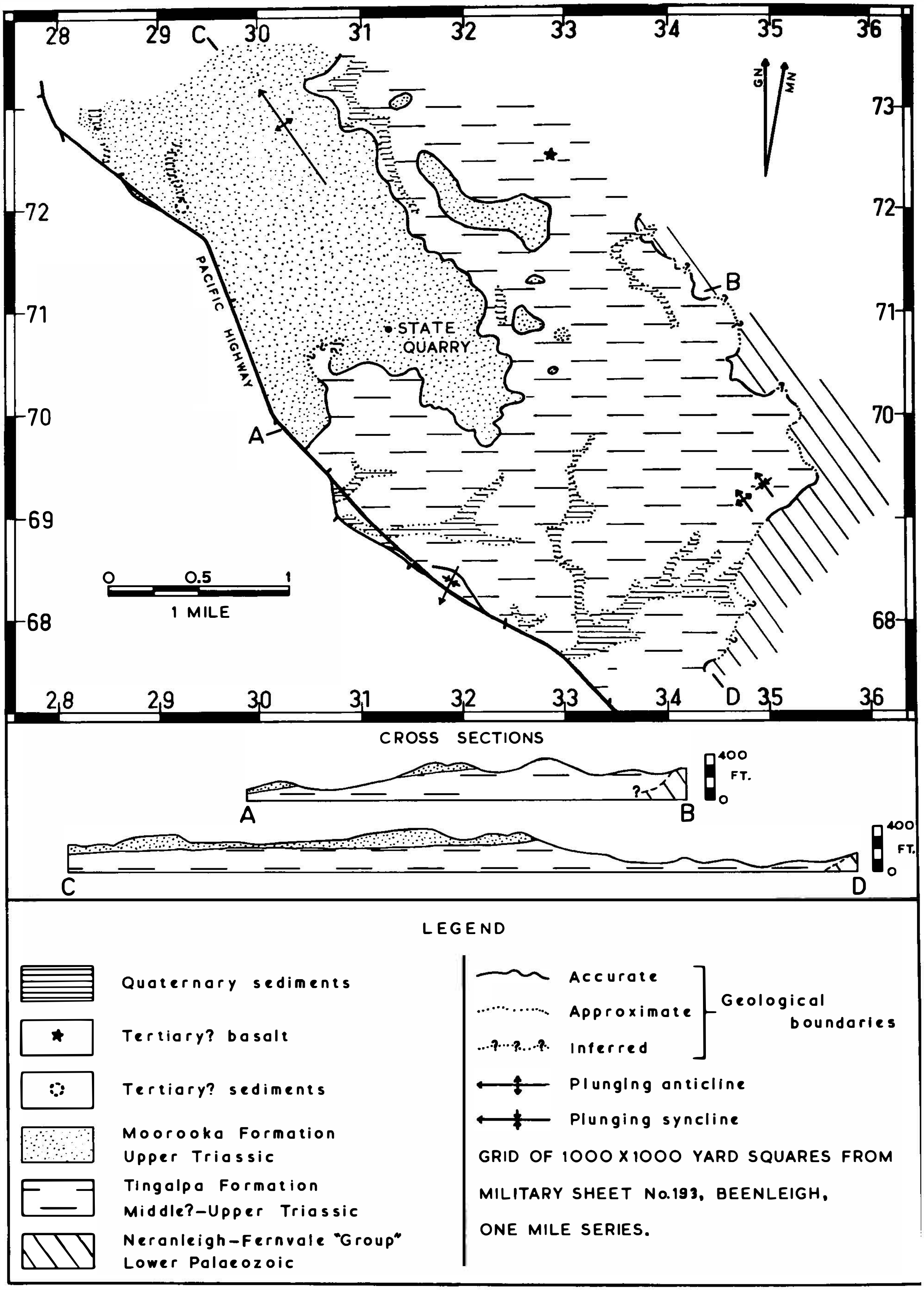

FIG. 2.—Geological interpretation map of the Slacks Creek area

Reference sections

Greywacke: In the Creek from Be 350690 to Be 355694
Metaquartzite: *Ca.* Be 346705 to Be 350705

Thickness

Greywacke: 3,000$\pm$ feet
Metaquartzite: 500–1,000$\pm$ feet
(Only approximate and assuming dip steeper than 60°.)

A prospect shaft and drill hole were put down on the eastern side of Daisy Hill at Be 331708 in 1935. The section passed through was (H. Gerns, pers. comm.):

In shaft
0–90 feet. Sandstone and shale
In bore
90–200 feet. Sandstone and shale
200–566 feet. Diorite and shale (? = greywacke* and phyllite)
566–705 feet. Quartzite and slate
Bottom of hole.

Structure

Structure of the Neranleigh-Fernvale "Group" in the area is dominated by the NW.-SE. trend of outcrops and joints. The unit forms part of the South Coast Structural High (Hill in Hill & Denmead, 1960, pp. 3, 13–14).

Metaquartzite outcrops show consistent NW.-SE. alignment despite variations in topography, thus probably indicating a steep dip. Major joints, especially in the massive greywacke, dip steeply SW. to WSW. A minor direction of jointing is in a NE.–SW. to ENE.–WSW. direction (see Fig. 3). Zones of brecciation and shearing are common in the metaquartzite and greywacke respectively.

Joints dip to the west and parallel the possible strike of the metaquartzite. However no bedding was observed, so relation between joint and bedding planes,

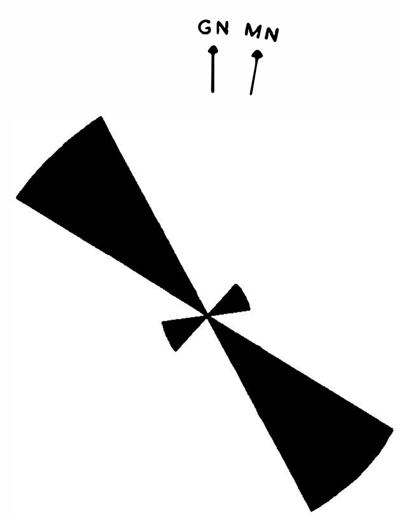

FIG. 3.—Analysis of strike of joint planes, Neranleigh-Fernvale "Group" (simplified; 8 readings from greywacke).

*The green feldspathic greywacke may have been interpreted as a diorite. The section probably does not represent a total section of the greywacke.

and hence structure, could not be determined. Denmead (1928, Fig. 2) tentatively interpreted that the area was part of the eastern limb of a NNW.-SSE. trending syncline. This would indicate that the metaquartzite was stratigraphically below the greywacke. Belford's (1950) stratigraphic column showed the metaquartzite of the area (associated with those of Mount Cotton and Mount Gravatt) correlated with the contorted metaquartzite to the south. The latter was shown as overlying the greywacke.

The boundary between the Neranleigh-Fernvale "Group" and the Mesozoic sediments is highly irregular and usually steeply dipping. Some small inliers of the Neranleigh-Fernvale "Group" may occur (see Marks, 1910; Denmead, 1928; Higginson, 1946).

Age

The age is given by most recent authors as possibly Silurian (see Denmead, 1928, and in Hill & Denmead, 1960, p. 137; Belford, 1950).

Relationships

The unit forms the Palaeozoic basement in the area, being unconformably overlain by Mesozoic sediments.

Tingalpa Formation

Derivation of name

Suburb of Tingalpa, City of Brisbane (Houston, 1965*a*).

Location (see Fig. 2)

The formation outcrops in an approximately meridional strip, 1–2 miles wide. It is underlain on the east by the Neranleigh-Fernvale "Group" and overlain on the west by the Moorooka Formation. Marks (1910) showed the "Bundanba Sandstone" (*sic*), now the Moorooka Formation (Houston, 1965*a*), overlapping the Neranleigh-Fernvale "Group" in the area. The sandstones involved in this "overlap" do not belong to the Moorooka Formation, but are calcareous, intercalated with shales, and continuous along strike with the "Ipswich Coal Measures" (Tingalpa Formation) to the north and south.

Lithology

Natural outcrops consist mainly of sandstones; siltstones, shales (in part tuffaceous and/or carbonaceous), and conglomerate also occur. Many areas are covered with lateritic red earth and/or limonitic concretions. Artificial outcrops (road cuttings, etc.) expose shales, siltstones, fine to coarse sandstones, and minor coal. The lithological succession is illustrated in Figure 6.

Shales containing scattered pebbles and cobbles of metaquartzite, abundant carbonaceous (plant) material, and small (up to 1 cm), spheroidal mud balls outcrop at Be 339717, Be 351701, and Be 352695, overlying the Neranleigh-Fernvale "Group". The mud balls are similar to those described by Richards & Bryan (1927) from the Brisbane Tuff overlying the Neranleigh-Fernvale "Group" at Castra, 4 miles to the north of the present area. The mud balls are larger and more abundant at Be 339717 than at Be 351701 and Be 352695. From the plates and descriptions in Richards & Bryan (1927), the mud balls were even larger and more abundant at Castra than at any of the localities in the Slacks Creek area. It is interesting to note that the further the outcrop from Castra (in a southerly direction) the smaller and less abundant the mud balls become.

Some of the basal strata of the formation appear to pinch out against the Neranleigh-Fernvale "Group" abutment to the east, as the lower sandstone overlaps Palaeozoic rocks at some localities, e.g. Be 337719, Be 343712 (see Fig. 6).

The exposed sandstones of the formation are predominantly medium-to very coarse-grained lithic greywackes; some approach feldspathic greywackes. Grains consist of quartz, metaquartzite, chert, potash feldspar, plagioclase feldspar An_{25-30}, biotite, muscovite, calcite, organic material, kaolinite, and lithic fragments. The matrix is composed of sericite, clay minerals, silt-sized quartz, and limonite. Minor bands of conglomerate are associated with the sandstones.

The sandstones and shales are commonly calcareous, especially when fresh.

Reference section

In Slacks Creek State Forest from the contact with the Neranleigh-Fernvale "Group" at Be 339717 to the road at Be 337716 and then along the road to the base of the gravel at Be 329718. The part of the section from Be 337716 to the creek at Be 335716, where portion of the lithology is repeated due to structure and topography, is omitted. The lithological sequence is illustrated in Figure 6.

Thickness

Thickness of the reference section is approximately 200 feet. Rands (1889) stated that a bore in the State Forest passed through 350 feet of "Ipswich beds" before being abandoned in "Schists". The extra thickness may indicate some abutment against the Neranleigh-Fernvale "Group" to the east. A shaft and drill hole put down by H. Gerns at Be 331708 penetrated 200 feet of sandstone and shale above the underlying basement (see p. 121).

Structure

The formation dips away from the Neranleigh-Fernvale "Group", which it unconformably overlies on the east and southeast of the area. No large-scale faulting has taken place along the irregular Neranleigh-Fernvale—Tingalpa Formation boundary, but upwarping of the Neranleigh-Fernvale "Group" has caused minor adjustments. Dips adjacent to the boundary range up to 25°. Maximum dips

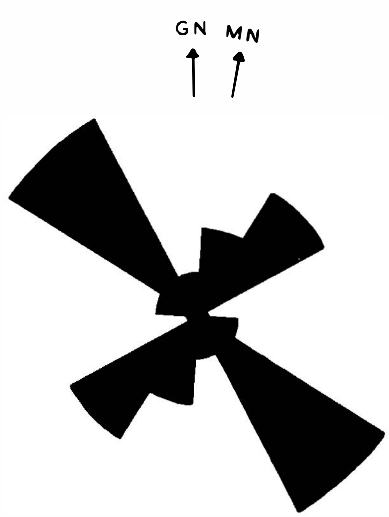

FIG. 4.—Analysis of strike of joint planes, Tingalpa Formation (56 readings)

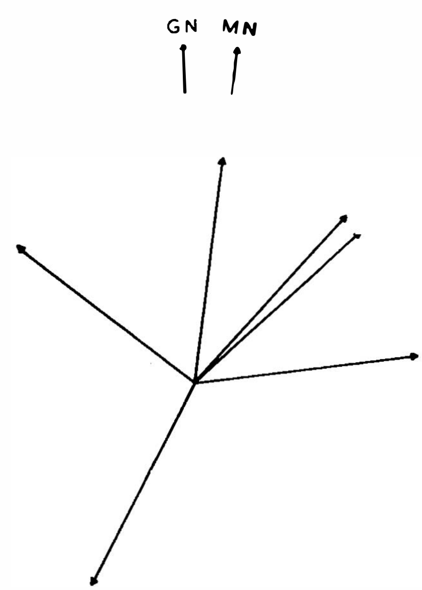

FIG. 5.—Cross-bed dip azimuths, Tingalpa Formation (6 readings as shown)

of up to 40° occur in the road cuttings at Be 306696. Dips are mostly gentle and to the SW., W., or NW. However, some easterly dips result from small-scale folding and minor faulting (both normal and reverse). Thus the structural pattern is one of major dip components to the west alternating with minor dip components to the east. There is a syncline between Be 352694 and Be 348692 and an anticline between Be 348692 and Be 346691; the axes of these structures plunge to the NW. There is also a synclinal structure between Be 320683 and Be 315686 and an anticlinal structure between Be 315686 and Be 305696; the axes of the anticline and syncline appear to trend NE.-SW. with the syncline plunging to the SW.

The joint pattern in the unit is similar to that in the Neranleigh-Fernvale "Group". There is a dominant NW.-SE. and a prominent NE.-SW. direction of strike of joints (see Fig. 4).

The sandstones rarely exhibit cross-bedding; current directions are plotted on Figure 5, but data are too few to be conclusive as to the predominant current directions.

Invertebrate palaeontology (see Appendix for taxonomic description and discussion)

The unionoid bivalve, ?*Unio eyrensis* Etheridge, Jr., 1892*a*, occurs at Be 342693, Be 343695, Be 344697, Be 343701, and Be 332716–Be 333716. These occurrences appear to represent two, or possibly three, closely spaced horizons midway in the stratigraphic sequence of the Tingalpa Formation.

Palaeobotany

a. Megafossils:

Plant megafossils and their localities are listed below.

(1) Shailer's coal mine mullock heap, 40–60 feet above the base of the formation (Be 349692).

Xylopteris elongata (Carruthers) Frenguelli, 1943
Unidentified plant remains

(2) Road cutting on Pacific Highway (Be 315686).

(i) In material excavated from cutting during its construction but not located *in situ:*

Doratophyllum tenison-woodsi (Etheridge) Jones & de Jersey, 1947

(ii) In cutting:

Unidentified, possibly equisetalean remains

(3) Slip face of land slip east of the elbow in Daisy Hill Road, approximately 30 feet below the top of the formation (Be 327701).

Dicroidium odontopteroides (Morris) Gothan, 1912
Doratophyllum tenison-woodsi (Etheridge) Jones & de Jersey, 1947
Pteruchus johnstoni (Feistmantel) Townrow, 1962
Xylopteris elongata (Carruthers) Frenguelli, 1943

(4) Slip face of land slip east of Daisy Hill Road, approximately 15–20 feet below the top of the formation (Be 329705).

?*Dicroidium odontopteroides* (Morris) Gothan, 1912
Doratophyllum tenison-woodsi (Etheridge) Jones & de Jersey, 1947
Xylopteris elongata (Carruthers) Frenguelli, 1943

(5) Road cutting on N.-S. road in State Forest, just below the top of the formation (Be 329717).

Doratophyllum tenison-woodsi (Etheridge) Jones & de Jersey, 1947
Unidentified plant remains

(6) In addition unidentified plant remains were found at Be 339716, Be 351702, Be 320683, Be 324685, and Be 331708.

b. Microfossils:

Plant microfossils and their localities are listed below.

(1) Shailer's coal mine mullock heap (Be 349692). Stratigraphic position is approximately 40–60 feet above the base of the formation.

(i) Shale and sandstone sample; spores and pollen grains numerous but not well preserved.

Alisporites spp.
A. australis de Jersey, 1962
A. parvus de Jersey, 1962
Apiculatisporis sp.
Baculatisporites sp.
?*Cadargasporites reticulatus* de Jersey & Paten, 1964
Converrucosisporites cameroni (de Jersey) Playford & Dettmann, 1965
Cycadopites granulatus (de Jersey) de Jersey, 1964
C. nitidus (Balme) de Jersey, 1964
Duplexisporites gyratus Playford & Dettmann, 1965
Guthoerlisporites cancellosus Playford and Dettmann, 1965
Osmundacidites wellmanii Couper, 1953
Platysaccus queenslandi de Jersey, 1962

(ii) Coal and coaly shale sample; spores and pollen grains numerous but not well preserved.

Alisporites australis de Jersey, 1962
Apiculatisporis sp.
Converrucosisporites sp.
C. cameroni (de Jersey) Playford & Dettmann, 1965
Cycadopites granulatus (de Jersey) de Jersey, 1964
C. nitidus (Balme) de Jersey, 1964
Dictyophyllidites mortoni (de Jersey) Playford & Dettmann, 1965
Guthoerlisporites cancellosus Playford & Dettmann, 1965
Polypodiisporites ipsviciensis (de Jersey) Playford & Dettmann, 1965
Tuberculatosporites aberdarensis de Jersey, 1964

(2) Prospect pit mullock heap (Be 331708). Stratigraphic position is approximately 60–100 feet below the top of the formation.
Carbonaceous sandstone sample; spores and pollen grains not well preserved.

Alisporites sp.
A. australis de Jersey, 1962
A. parvus de Jersey, 1962
Converrucosisporites cameroni (de Jersey) Playford & Dettmann, 1965
Cycadopites granulatus (de Jersey) de Jersey, 1964
Duplexisporites gyratus Playford & Dettmann, 1965
Granulatisporites minor de Jersey, 1962
Guthoerlisporites cancellosus Playford & Dettmann, 1965
Osmundacidites parvus de Jersey, 1962
O. wellmanii Couper, 1953
Punctatisporites sp.
Vitreisporites subtilis (de Jersey) de Jersey, 1962

Note that the distance below the "top of the Tingalpa Formation", referred to in the localities above, is the approximate stratigraphic height below the nearest outcrop of the basal conglomerate of the Moorooka Formation. As there is an unconformity between the Tingalpa Formation and the Moorooka Formation (see p. 129), the datum referred to (i.e. the top of the Tingalpa Formation) is not exactly equivalent in each case.

Age and correlation

Houston (1965*a*) considered that the unit within the Brisbane area is possibly equivalent to the Tivoli Formation (Allen & Staines, 1959) of the Ipswich Coal Measures. The age given was Middle to Upper Triassic. This age was substantiated, on palynological evidence, by de Jersey & Hamilton (1965*a*, *b*).

The basal part of the sequence containing the mud balls may be a time equivalent of the Brisbane Tuff (for two views on the stratigraphical position of the mud balls within the Brisbane Tuff see Richards & Bryan, 1934, and Higginson, 1946). Unfortunately no spores or pollen grains were obtained from the shales containing the mud balls.

Spores and pollen grains from the formation have a Middle to Upper Triassic aspect. The species *Guthoerlisporites cancellosus* and *Tuberculatosporites aberdarensis* are present in the samples from the abandoned coal mine at Be 349692, an horizon near the base of the formation; *G. cancellosus* is present in the assemblage obtained from the prospect pit at Be 331708, an horizon near the top of the formation. The range of *G. cancellosus* is given as Upper Triassic in Hill, Playford, & Woods (1965) while that of *T. aberdarensis* is given as Upper Triassic to Lower Jurassic. *G. cancellosus* has, however, been found to range throughout the Triassic System in Tasmania (Playford, 1965). Thus the age of the formation, above and including the horizon of the coal mine, is probably Upper Triassic. The presence of ?*Unio eyrensis,* which also occurs in the Rhaetic to Liassic Leigh Creek Coal Measures (Ludbrook, 1961; Playford & Dettmann, 1965) and in the Upper Triassic Blackstone Formation of the Ipswich Coal Measures (Etheridge, Jr., 1892*a*; McMichael, 1957; Allen & Staines, 1959; Hill, Playford, & Woods, 1965), may also suggest an Upper Triassic age.

Relationships

The formation unconformably overlies the Neranleigh-Fernvale "Group" and is followed unconformably by the Moorooka Formation.

Moorooka Formation

Derivation of name

Suburb of Moorooka, City of Brisbane (Houston, 1965*a*).

Location (see Fig. 2)

The formation outcrops in the west and northwest of the area from Be 305697 to Be 308735, with some outliers capping ridges over the Tingalpa Formation to the east. This formation was previously mapped as the Bundamba Sandstone (see p. 122).

Lithology

The lithological succession is illustrated in Figure 7. The sequence consists of conglomerate followed by shales and then massive and cross-bedded sandstones.

The conglomerate is a predominantly oligomictic orthoconglomerate consisting of well-rounded pebbles (with some cobbles) of metaquartzite and quartz; pebbles of jasper, chert, chalcedony, and kaolinite are also present. The average size of the pebbles is 1·5–4 cm. The sandy matrix of the conglomerate consists of quartz, metaquartzite, chert, micas, and clay minerals. Sandstone lenses contained in the conglomerate are medium- to coarse-grained lithic greywackes but differ from greywackes of the underlying Tingalpa Formation in being non-calcareous and virtually non-feldspathic. The conglomerate contains some fossil wood.

Kaolinite (identified by X-ray powder photograph No. 1515, Department of Geology and Mineralogy, University of Queensland) occurs in silt- to pebble-sized particles throughout the conglomerates and sandstones of the Moorooka and Tingalpa Formations. Although the kaolinite is very soft, it has the same roundness and sphericity as the accompanying harder particles; it may have weathered from a feldspar or feldspathic rock during lateritization (see Moorhouse, 1959, p. 93; Krumbein & Sloss, 1963, pp. 194–95).

The conglomerate is followed by shales and siltstones containing abundant plant fossils. The best exposure is in the Slacks Creek State Quarry (Be 313708)

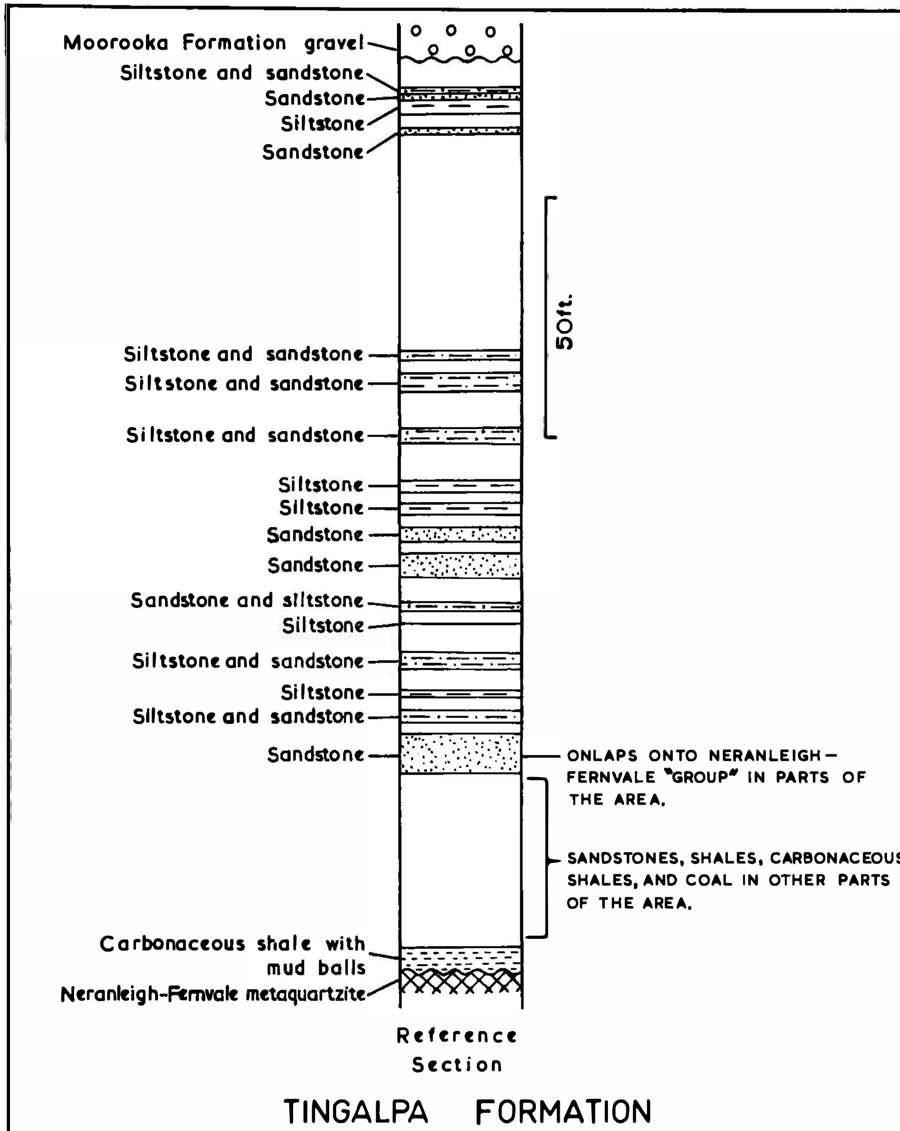

FIG. 6.—Lithological succession of reference section, Tingalpa Formation

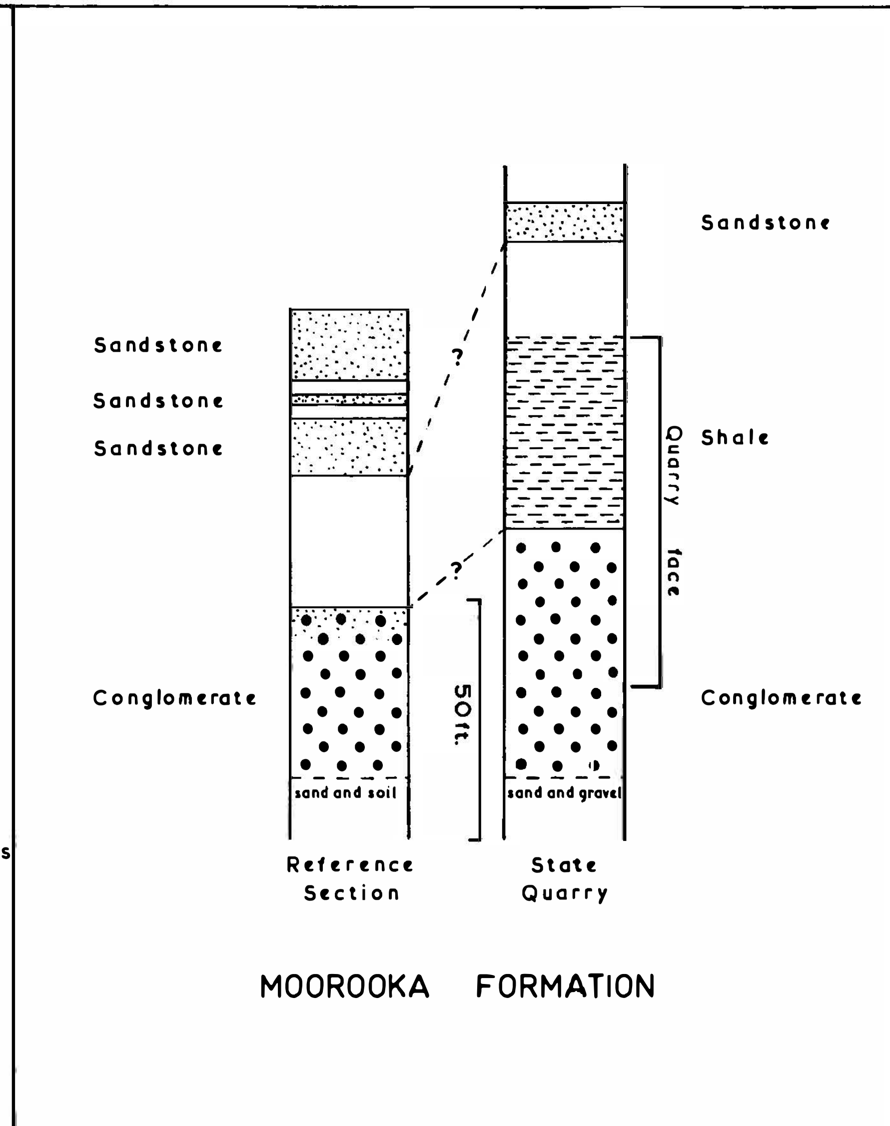

FIG. 7.—Lithological succession, Moorooka Formation

where 40 feet of shales and partly carbonaceous shales overlie the conglomerate. In other areas lacking shale outcrops, the vertical distance between the top of the conglomerate and the lowest sandstone bed is 15–25 feet.

The shales are succeeded by medium- to very coarse-grained protoquartzites and some subgreywackes, with minor granule and pebble conglomerates. A few finer, thin-bedded, more micaceous sandstones (lithic greywackes) are interbedded with the coarser, more mature members. The sandstones may be vertically continuous but outcrop in a maximum of six layers forming small cliffs and escarpments.

Reference section

From the watercourse at Be 324706 to the top of the ridge at Be 322703. The lithological sequence is shown in Figure 7. A more complete section of the lower part is exposed from the creek north and below the Slacks Creek State Quarry at Be 312709, through the quarry at Be 313708, to the top of the ridge (Be 313708) above the quarry (see Fig. 7).

Thickness

Thickness of the reference section is 100–110 feet. Maximum thickness in area is probably 150–170 feet.

Structure

The formation generally dips at 5°–10° to the SW., W., or NW. Its flat-lying nature tends to prevent any accurate measurement of dips, but these may be estimated from relation of outcrops to topography. Joints are well displayed in the conglomerate, shale, and sandstone. The joint pattern (see Fig. 8) is remarkably similar to those of the Tingalpa Formation and the Neranleigh-Fernvale "Group" (see Figs. 3,.4).

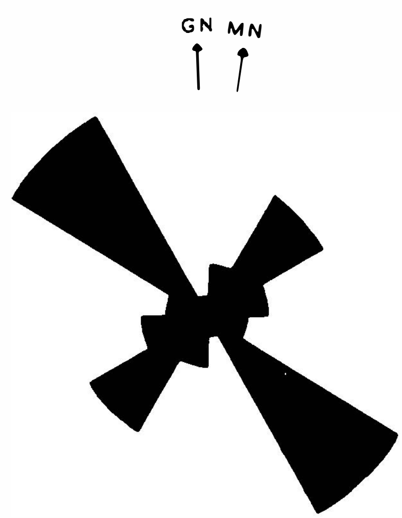

FIG. 8.—Analysis of strike of joint planes, Moorooka Formation (58 readings)

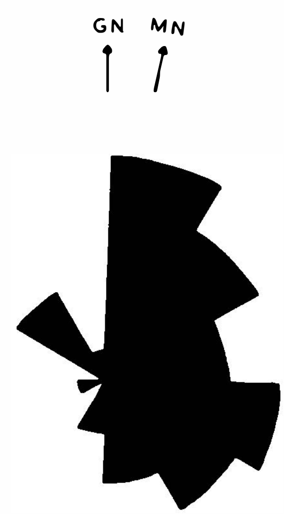

FIG. 9.—Cross-bed dip azimuths, Moorooka Formation (46 readings)

In the north of the area, the sandstone and conglomerate are folded into a gentle anticline which plunges slightly to the NW. from Be 304727 (see Fig. 2). McTaggart (1957) called this the Priestdale Anticline.

The sandstones of the formation are commonly cross-bedded; an analysis of cross-bed dip azimuths is given in Figure 9. The directions of current flow range from north through east to southeast.

From the relationships between outcrops of the Moorooka and Tingalpa Formations, and topography, it appears that the Moorooka Formation was deposited unconformably on the Tingalpa Formation on a slightly uneven surface. The Tingalpa Formation has undergone much small-scale faulting and folding while the Moorooka Formation is unaffected. The overall angle of unconformity is variable but never large.

Palaeobotany

a. Megafossils:

Plant megafossils and their localities are listed below.

(1) Sandstone and shale lens in floor of cave in basal conglomerate (Be 319713).

Schizoneura sp.
Unidentifiable plant remains

(2) Slacks Creek State Quarry, from lower 15 feet of shale above the basal conglomerate of the formation (Be 313708).

?*Chiropteris* sp.*
Cladophlebis australis (Morris) Seward, 1904
Cladophlebis sp.
?*Dicroidiopsis* spp.*
Dicroidium odontopteroides (Morris) Gothan, 1912*
D. feistmanteli (Johnston) Gothan, 1912*
D. superbum (Shirley) Townrow, 1957
Doratophyllum tenison-woodsi (Etheridge, Jr.) Jones & de Jersey, 1947*
Ginkgoites ginkgoides (Shirley) Florin, 1936
"*Johnstonia*" *dentata* Walkom, 1925
Linguifolium denmeadi Jones & de Jersey, 1947
Neocalamites cf. *hoerensis* (Schimper) Halle, 1908
Pteruchus johnstoni (Feistmantel) Townrow, 1962
P. simmondsi (Shirley) Thomas, 1933
Taeniopteris sp.*
"*Thinnfeldia*" *talbragarensis* Walkom, 1921*
Xylopteris elongata (Carruthers) Frenguelli, 1943*
X. spinifolia (Carruthers) Frenguelli, 1943
Yabeiella mareyesciaca (Geinitz) Oishi, 1931
Fruiting bodies (indet.)

(3) Indeterminate plant remains were obtained from Be 306717.

b. Microfossils:

Plant microfossils and their locality are listed below.

Slacks Creek State Quarry (Be 313708). Sample from 6 inches above the basal conglomerate, approximately 50–60 feet above the base of the formation. Shale sample; spores and pollen grains abundant but not well preserved.

Alisporites spp. ⎤
A. australis de Jersey, 1962 ⎥ *
A. parvus de Jersey, 1962 ⎦
Anapiculatisporites sp.
Baculatisporites sp.
Calamospora sp.
Converrucosisporites spp.
?*Converrucosisporites* spp.
Cycadopites granulatus (de Jersey) de Jersey, 1964
C. nitidus (Balme) de Jersey, 1964*
Dictyophyllidites mortoni (de Jersey) Playford & Dettmann, 1965

*indicates dominant elements in the flora.

Duplexisporites gyratus Playford & Dettmann, 1965
Lycopodiumsporites antiquus de Jersey, 1964
Platysaccus queenslandi de Jersey, 1962
Punctatosporites sp.
?*Punctatosporites walkomi* de Jersey, 1962
Stereisporites tenuis (de Jersey) de Jersey, 1964
Vitreisporites sp.
V. subtilis (de Jersey) de Jersey, 1962

Age and correlation

Houston (1965*a*) stated that the Moorooka Formation in the Brisbane area is a possible correlative of the Cooneana Formation of the Ipswich Coal Measures (Allen & Staines, 1959). The age given by de Jersey & Hamilton (1965*a*, *b*), on palynological evidence, was Middle to Upper Triassic.

The assemblage of spores and pollen grains from the shales of the Slacks Creek State Quarry has a Middle to Upper Triassic aspect. The presence of *Lycopodiumsporites antiquus,* which is restricted to the Upper Triassic (Hill, Playford, & Woods, 1965), indicates that the formation may be Upper Triassic in age. The Moorooka formation cannot be older than the underlying Tingalpa Formation, which, on palynological evidence, probably ranges into Upper Triassic. Absence of *Classopollis* indicates that the unit does not belong to the Jurassic System (de Jersey, 1964; Playford & Dettmann, 1965). The author thus assigns an Upper Triassic age to the Moorooka Formation. On the information available the author could not decide if the formation is an equivalent of the Bundamba Group or of the Ipswich Coal Measures (see Higginson, 1946; Bryan & Jones, in Hill & Denmead, 1960, p. 268; Houston, 1965*a*).

Relationships

The unit unconformably overlies the Tingalpa Formation and is the uppermost unit of the lithological sequence in most parts of the area. It is unconformably overlain by poorly consolidated sediments of possible Tertiary age (at Be 293721; see below) and Quaternary alluvium.

Possible Tertiary sediment

Location

In banks and bed of creek at *ca.* Be 293721.

Lithology

Poorly consolidated conglomerate; the constituent pebbles, cobbles, and boulders consist of sandstone and conglomerate from the Moorooka Formation and Neranleigh-Fernvale metaquartzite. The metaquartzite was possibly reworked from the conglomerate of the Moorooka Formation as the deposit presently lies in a topographic position which could not receive sediment directly from a Neranleigh-Fernvale source. Sand-sized material and clay form the incoherent matrix. The deposit shows some effects of lateritization.

Typical section

In the lower part of creek bank from Be 293720 to Be 294721.

Thickness

Two to three feet.

Structure

Almost level, lying unconformably on the Moorooka Formation and overlain by alluvium and peat.

Age and correlation

A Tertiary age is deduced from the presence of lateritization effects (see section on Red Earth Residuals) and the unconsolidated nature of the sediment. Its stratigraphic position and lithology are similar to the Darra Formation (Houston, 1965*a*), but the deposit may be a Pleistocene alluvium.

It should be noted that a Tertiary gravel mentioned by McTaggart (1957) on Daisy Hill Road (at Be 326702) is actually an outcrop of the basal conglomerate of the Moorooka Formation.

Relationships

Unconformably overlies the Moorooka Formation; followed, probably nonconformably, by alluvium, peat, and further alluvium.

Possible Tertiary basalt

Location

Isolated exposure on hilltop (Be 329725) in Slacks Creek State Forest. Outcrops as scree or boulders.

Lithology

Weathered basaltic material, strongly affected by lateritization, consisting of a fine meshwork of feldspar crystals, frequently coated with limonite. Many small, equidimensional cavities in the material are filled with a limonitic network. These cavities may have been originally filled with olivine, the network representing the haematite which is often associated with olivine crystals (see Moorhouse, 1959, pp. 85–6). Except for the feldspar crystal meshwork and the possible presence of olivine, there is no conclusive indication that the rock was a basalt. However the texture of the constituents is similar to that of olivine basalt except that the femic minerals have been removed. The identification as a basalt was kindly verified by Dr. N. C. Stevens (Department of Geology and Mineralogy, University of Queensland).

Structure

The presence of vesicles suggests that the basalt was a flow.

Age and correlation

The basalt is lateritized, hence pre-Quaternary in age (see Red Earth Residuals).

The basalt may be:

(1) a flow of Triassic age interbedded with the sediments of the Tingalpa Formation;
(2) an intrusion into the Tingalpa Formation;
(3) a flow unconformably overlying the Tingalpa Formation.

The presence of vesicles, and the fact that the unit only outcrops at one level on top of a hill with no extension along the strike of the underlying formation, suggest that the third possibility is the most likely one.

The flow may be related to the Tertiary basalts in the Sunnybank-Eight Mile Plains or Redland Bay areas; possibly an equivalent of the Corinda Formation (Houston, 1965*a*). At present it is topographically higher (by at least 100–200 feet) than these other basalts.

Red Earth Residuals

Derivation of name

"Red Earth" was derived from the dominant soil colour and type; "Residuals" was derived from the independent, although now dissected, physiographic surface on which the soils occur (Bryan, 1939).

Location

Mainly capping ridges and small plateaux at elevations of 100–450 feet; forms an undulating surface with an average height of 250–350 feet.

Description (Soil classification used is that of Stephens (1962))

Consists of lateritic red earth and lateritic podzolic soil. The structure, composition, and genesis have been well discussed and illustrated by Bryan (1939) and Stephens (1962). A lateritic krasnozem and/or a red loam (krasnozem) grading to a red earth is associated with the metaquartzite of the Neranleigh-Fernvale "Group" in the area (see Denmead, 1928, p. 73; Beckmann, 1959, p. 48; Bryan & Jones, 1963, p. 19). The best development is on the slopes of Oakey Hill (Be 356699). The height of Oakey Hill (500 feet) suggests that the surface of the Red Earth Residuals grades upwards into the older, higher surface of Mount Cotton (see Bryan, 1939; Beckmann, 1959, p. 29, Pls. 4, 5).

The lateritic podzolic soil forms only from sandstones and has large (up to 3 cm diameter), sandy, limonitic, spherical nodules. The lateritic red earth forms mainly from shales and siltstones and has small, irregularly-shaped, shiny nodules of limonite and haematite. Sometimes these nodules are inconspicuous and the soil then appears to be a red earth or a krasnozem.

Reference section

From the Table Top (Be 317710) along Springwood Road to the junction with Dennis Road (Be 308718) and then to the crest of the ridge along Dennis Road at Be 307718. The section from Table Top (Be 317710) to the junction of Dennis Road and Springwood Road (Be 308718) represents variations caused by podzolization and truncation as illustrated by Bryan (1939, Pl. 3, Fig. 1).

Thickness

Maximum thickness of exposed profile in cutting at Be 307718 is 7 feet.

Age

The age stated by most authors is Upper Tertiary (Connah & Hubble, in Hill & Denmead, 1960, pp. 375–77). Stephens (1962) gave the age as probably Pliocene.

Relationships

The lateritic red earth is developed on the Neranleigh-Fernvale "Group", the Tingalpa Formation, the Moorooka Formation, and the basalt. The lateritic podzolic soil occurs only over the Moorooka Formation.

Quaternary sediments

All soils in the area have been affected to some degree by podzolization during the Quaternary.

Stream valleys and watercourses contain various quantities of alluvium. Some alluvium forms river terraces, probably of Pleistocene age (Beckmann, 1953, 1959). More recent alluvium has followed to form flood plains and unconsolidated stream deposits.

At Be 293721 a layer of peat at least 4 feet thick overlies, and is surrounded by, older alluvium. The peat is made up of black organic matter with some sand and clay. Organic matter which is not altered to peat appears to belong to large, fibrous, reed-like members of the Cyperaceae.

GEOLOGICAL HISTORY

Geological history of the "Neranleigh Series" was discussed by Denmead (1928, and in Hill & Denmead, 1960, pp. 136–37) and Belford (1950). Higginson (1946) considered in some detail the geological history of the Mesozoic sediments in the Brisbane area.

The source material for the Neranleigh-Fernvale "Group" sediments was probably a medium- to coarse-grained igneous or metamorphic rock with a composition similar to that of an adamellite. Boulders of adamellite occur in conglomerate beds to the south (see Green, 1964; Belford, 1950). The environment of deposition of the greywacke was possibly in shallow water in a rapidly sinking geosyncline (Belford, 1950). A cold climate may have prevented any large-scale chemical weathering (Denmead, 1928; Belford, 1950). The massive metaquartzites in the area investigated resemble those which Bryan & Jones (1963) considered to be originally bedded cherts. However, as the quartz grains are similar in size to those of the greywacke, the metaquartzite may have been derived from a quartzose sand.

The sediments were subjected to low grade dynamic metamorphism with an inferred compressive couple acting in a NE.-SW. direction (Belford, 1950). This resulted in folding and uplifting of the "Group". Uplift may have occurred at a later stage to the folding (Belford, 1950). The "Group" weathered to present an irregular surface by the beginning of Mesozoic time (Marks, 1910; Higginson, 1946). The more resistant metaquartzite peaks could be regarded as monadnocks in this landscape (Beckmann, 1959).

Mesozoic sedimentation started, possibly in the Middle Triassic, with shales containing abundant carbonaceous material (plant remains) and volcanic mud balls. The environment in which the mud balls formed has been discussed by Richards & Bryan (1927, 1934) and Faber (1964). The complete Mesozoic sequence in the area was deposited under lacustrine and fluviatile conditions. Plant remains are abundant and ?*Unio eyrensis* has only been found elsewhere associated with freshwater deposits. The sandstones and conglomerates all show cross-bedding and some channel structures. The currents flowed in a northerly to easterly direction (Figs. 5, 9). The presence of scattered pebbles in sandy layers indicates that flow was sometimes in the upper regime (Fahnestock & Haushild, 1962).

Most of the detrital material was derived from rocks of the Neranleigh-Fernvale "Group". The quartz, metaquartzite, feldspars, micas, jasper, and chert are all similar to those described from the Neranleigh-Fernvale "Group" by Belford (1950) and in the present paper. Some of the material in the Triassic sediments (e.g. kaolinite) may have been reworked tuffaceous or volcanic material (possibly associated with the Brisbane Tuff). Chalcedony pebbles of the Moorooka Formation's basal conglomerate may have come from the Triassic volcanics which occur to the south (see Green, 1964; McElroy, 1963; Pearce, 1964).

The Triassic sandstones increase in maturity towards the top of the succession. Those of the Tingalpa Formation are predominantly greywackes, while those of the Moorooka Formation range from greywackes, associated with the basal conglomerate, to protoquartzites higher in the sequence. Probably the sediments were initially poured into valleys and depressions on the Neranleigh-Fernvale "Group" and then as the site of deposition became filled more reworking took place.

Earth movements affecting Triassic sediments were slight. After the deposition of the Tingalpa Formation there was apparently some movement causing uplift and minor folding and faulting, followed by erosion of the sediments. The Moorooka Formation was then laid down on the resultant slightly uneven surface. The joint patterns of the Neranleigh-Fernvale "Group", Tingalpa Formation, and Moorooka Formation are very similar (see Figs. 3, 4, and 8). It thus seems probable that, although there are unconformities separating the Neranleigh-Fernvale "Group" from the Tingalpa Formation and the Tingalpa Formation from the Moorooka Formation, the same pattern of forces was acting, continuously or intermittently, during the Triassic. The directions of movement are not certainly known. It is likely that there was a complex series of vertical movements. The sediments all dip away from the Neranleigh-Fernvale "Group" boundary and minor adjustments have taken place in the Triassic sediments at, or near, this boundary. It would appear that the result of the movements was one of relative uplift of the Neranleigh-Fernvale block, dragging the Triassic sediments with it. That the joint patterns of the Mesozoic sediments are similar to those of the Neranleigh-Fernvale "Group" is because the only method of applying forces to the Triassic sediments was through the surrounding and underlying Palaeozoic basement. The forces would naturally tend to be resolved into the already established planes of weakness in this basement; i.e. the Mesozoic earth movements were of Saxonian type, being caused by adjustments in the underlying Neranleigh-Fernvale "Group".

There is no record of post-Moorooka Mesozoic sedimentation.

The basalt at Be 329725 is at present 100–200 feet higher than basalts of adjacent areas (see p. 131). This leaves two alternatives for a possible source. One is that basalt from Mount Tamborine (see Hill & Tweedale, 1955; Green, 1964) flowed northward to the present area across where the Logan River now flows out to sea. This probably did not occur as the Logan River valley in this region is fairly mature (see Beckmann, 1953, 1959). Also there are higher areas between Be 329725 and the Logan River which are not capped by basalt. The other alternative is that down-faulting of areas of basalt to the NE. or NW. has occurred. Houston (1965*b*) has shown that the basalt at Ormiston (to NE. of present area) has been down thrown by 600–900 feet. The original elevation of the Ormiston basalt would have been much higher than the basalt at Be 329725. The eruptive centre of the basalt is, however, unknown.

During the Upper Tertiary the area was partly peneplained and lateritization produced the Red Earth Residuals under conditions more humid and tropical than those at present (Bryan, 1939; Stephens, 1962).

A very detailed account of the Pleistocene and Recent history of the area was given by Beckmann (1959).

ECONOMIC GEOLOGY

Mining for gold has been carried out spasmodically in the Neranleigh-Fernvale "Group", but, except for the now abandoned opencut at Kingston, no payable quantities of gold were obtained (see Rands, 1887, 1889; Ball, 1933; Hall, 1953).

Coal mining has been attempted in the Tingalpa Formation with little success (see Rands, 1887, 1889; Marks, 1910). The abandoned coal mine at Be 349692, known as Shailer's coal mine, was opened up again in 1946 but no workable coal was found (G. Shailer, pers. comm.). Many prospect pits and at least three bores have been put down into the Tingalpa Formation but without any indication of commercial coal. One bore was mentioned by Rands (1889); the other two were put down in 1935 by H. Gerns (pers. comm.).

Gravel is quarried or scraped from the basal conglomerate of the Moorooka Formation. Large reserves of well-rounded gravel, 1·5–4 cm in diameter, are present in the area. Closeness to a main road and to the City of Brisbane probably assures its future use. The Neranleigh-Fernvale metaquartzite, especially when brecciated (e.g. at Be 343712), could be used for road metal.

The red earths and lateritic red earths are used for growing small crops and bananas. The sandier soils are less fertile but support some citrus orchards. Peat from the deposit at Be 293721 could be used for horticultural purposes.

Natural springs or soaks occur where the topography exposes the sandstone and basal conglomerate of the Moorooka Formation to the west of the ridge from Stegemann's Hill (Be 302730) to Be 322703. The sandstones of the Tingalpa and Moorooka Formations dip westwards beneath the area, but shales of the Tingalpa Formation contain the best supplies of underground water (R. E. Clay, well borer, pers. comm.).

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APPENDIX

Invertebrate palaeontology

Phylum	MOLLUSCA
Class	BIVALVIA Linnaeus, 1758
Subclass	PALAEOHETERODONTA Newell, 1965
Order	UNIONOIDA Stoliczka, 1871 (As Unionacea)
Superfamily	UNIONACEAE Fleming, 1828
Family	UNIONIDAE Fleming, 1828
Genus	UNIO Philipsson, 1788

Type species

Mya pictorum Linnaeus, 1758 (Opinion 495, International Commission on Zoological Nomenclature, 1957). Lectotype selected by Gray in 1847 (Op. 495, I.C.Z.N.).

Diagnosis

Shell thick, oval, or elongated, with a thin periostracum. Surface smooth, tuberculate, striated, or folded; interior nacreous. Umbones more or less anterior, often corroded. Ligament external, opisthodetic, elongated. In the right valve, one or two thick, irregular teeth in front of the umbo, and a long lamellar posterior tooth; in the left valve, two thick, irregular teeth near the umbo, and two long lamellar posterior lateral teeth. Anterior adductor impression very deep, the posterior shallow; pedal muscle scar below and behind anterior adductor. Pallial line simple. (After Woods, 1961, p. 258.)

Range of genus

Geographic: Mainly Northern Hemisphere, doubtfully world-wide (Davies, 1935).

Stratigraphic: Definite stratigraphic range is from Jurassic to Recent (Hudson, 1963, p. 333; Cox, 1960, p. 81). In a wider sense the genus ranges from the Triassic to Recent (Zittel, 1900, p. 377; Woods, 1961, p. 258).

Remarks

The ecology of the genus *Unio* has been discussed by Hudson (1963, p. 333). Discussion on nomenclature and selection of type species is given in Opinion 495 of the International Commission on Zoological Nomenclature (1957).

The writer considers that the generic assignment of the Slacks Creek specimens is uncertain; hence taxonomic discussion will follow description of the specimens.

?UNIO EYRENSIS Etheridge, Jr., 1892*a*

Pl. I (Figs. 1–8), Fig. 10*a*–*g*.

Unio eyrensis Etheridge, Jr., 1892*a*, p. 11, Pl. 3, Figs. 1–3.
Unio eyrensis Etheridge, Jr., 1892*b*, p. 389, Pl. 28.
Prohyria eyrensis (Etheridge, Jr.) McMichael, 1957, p. 228, Pl. 13, Figs. 8, 11, 12. (*Non* Figs. 9, 10.)
Unio eyrensis Etheridge, Jr.; Ludbrook, 1961, p. 141, Pl. 1, Figs. 1–6, Pl. 2, Fig. 5.
Unio eyrensis Etheridge, Jr.; Hill, Playford, & Woods, 1965, p. t.26, Pl. T13, Fig. 1*a*, *b*.

Type specimens

Holotype: Adelaide University Department of Geology, Tate Collection, T1347 (Ludbrook, 1961). Figured by Etheridge, Jr. (1892*a*, Pl. 3, Figs. 1–3) and Ludbrook (1961, Pl. 1, Figs. 2–4; latex moulds of holotype Pl. 1, Figs. 5, 6).

Paratype: Australian Museum, Tate Collection, F9081 (Ludbrook, 1961). Figured by McMichael (1957, Pl. 13, Fig. 8).

Locality of types

Black Hills, Leigh Creek, South Australia (See Ludbrook, 1961, p. 142); age Rhaetic to Liassic (Playford & Dettmann, 1965).

Diagnosis

A large solid fairly broad *Unio*, heavily sculptured with flattened concentric ridges, hinge with two triangular pseudocardinals and one long posterior lateral in the right valve, one triangular pseudocardinal and two long posterior laterals in the left valve. Anterior adductor impression deep, bounded by a buttress. Broad low subumbonal-ventral ridge on the interior. (Ludbrook, 1961, p. 141.)

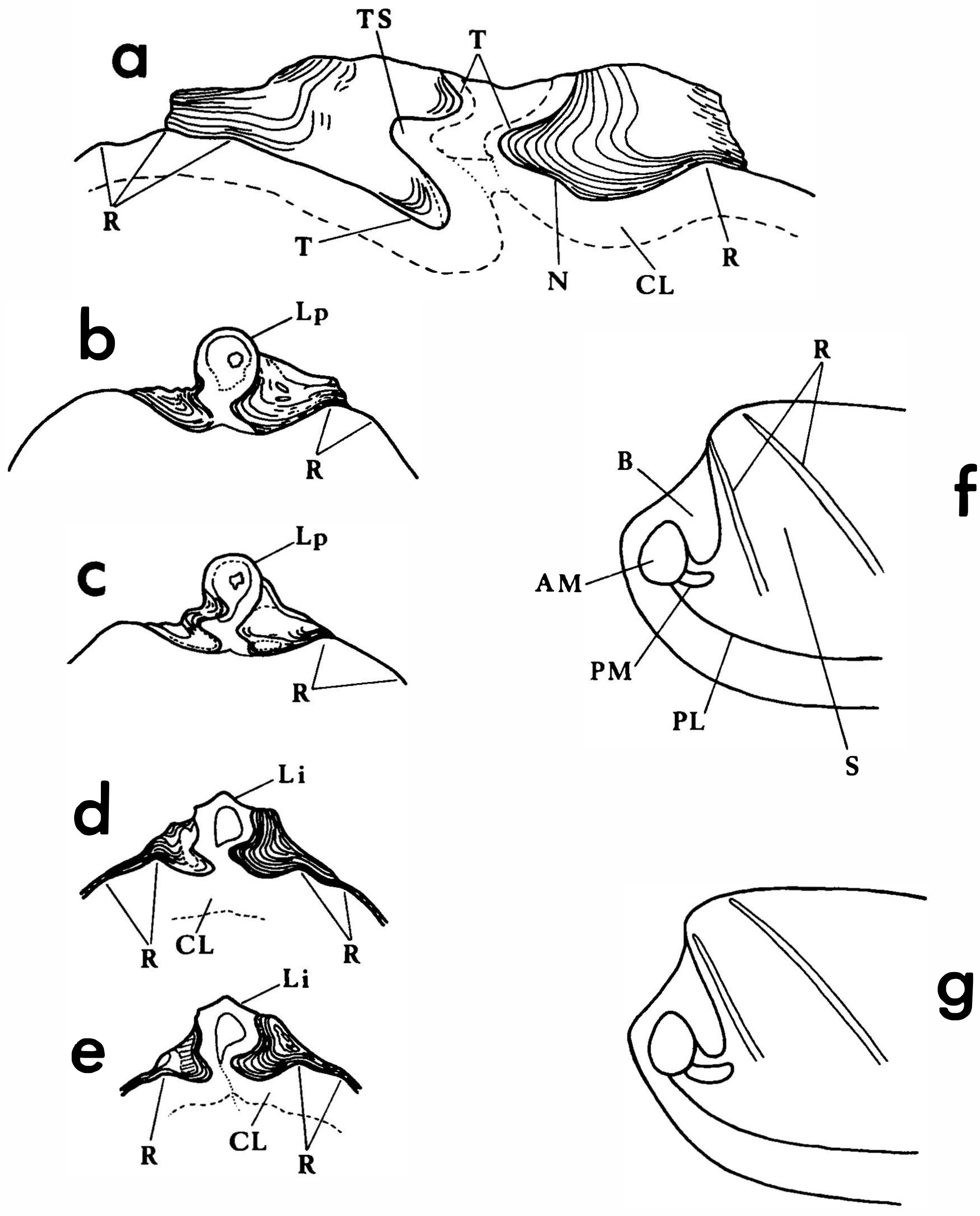

FIG. 10.—?*Unio eyrensis* Etheridge, Jr.

a, x3·25. Transverse section of hinge towards posterior of shell; valves open, viewed from posterior end of shell. UQF48197.

b–e, x2. Sections of hinge and opisthodetic ligament, viewed from posterior; from *b*, anterior to *e*, posterior; *c* and *e* seen in reverse. UQF48178.

f–g, x1. Simplified line drawings of anterior part of internal moulds of left valve.

T, posterior lateral teeth; TS, tooth socket; N, notch; R, radiating ridges on the internal mould caused by trough-shaped depressions in the interior of the shell; CL, concretionary limonite; Lp, prominent part of external ligament; Li, inconspicuous part of external ligament; B, depression in internal mould caused by buttress; AM, anterior adductor muscle scar; PM, anterior pedal muscle scar; PL, pallial line; S, subumbonal-ventral sulcus on internal mould.

Range of species

Geographic: Leigh Creek area, South Australia; Bundamba and Slacks Creek areas, southeast Queensland.

Stratigraphic: Upper Triassic to Lower Jurassic. (Tingalpa Formation, Queensland, Blackstone Formation, Queensland, and base of Leigh Creek Coal Measures, South Australia.)

Description

Descriptions of other specimens were given by Etheridge, Jr. (1892*a*, pp. 11–12, Pl. 3, Figs. 1–3, and 1892*b*, p. 389, Pl. 28, Fig. 1); McMichael (1957, pp. 228–29, Pl. 13, Figs. 8, 11, 12); and Ludbrook (1961, pp. 141–44, Pl. 1, Figs. 1–6, Pl. 2, Fig. 5).

Features noted on Slacks Creek specimens additional to the description given by Ludbrook (1961, pp. 141–42):

A slightly concave dorsal-posterior slope gives some shells a more or less winged appearance (see Pl. 1 [Fig. 1]). An elliptical to subquadrate gape, sometimes with an associated posterior carina, is variably developed at the rear of the shell and is shared equally by both valves. The posterior carina and the more pronounced development of the gape is due to compression of the shell. The gape is not always present; it may be an artifact due to the loss of the posterior tip of the shell.

A moderately large and wide lunule extends from the umbones to, or almost to, the anterior point of the shell. The anterior margin is excavated below the umbones at the position of the lunule. The escutcheon is long and narrow, being as long as the ligament.

A large, elongate, external ligament extends posteriorly from just behind the beak. The ligament gradually thickens posteriorly for one-third to one-half its length and abruptly tapers to continue inconspicuously, being partly surrounded by the shell. Transverse growth lines are clearly distinguishable on the prominent external part of the ligament (see Pl. I [Figs. 3, 6] and Fig. 10*b*–*e*).

The existing shell surfaces are covered with fine concentric growth lines. Shell material, now replaced with limonite, was 0·1–0·8 cm thick. The beak is smooth and the rest of the shell ornament varies from smooth to irregular concentric ridges and thick striations. Ridges, when present, are more or less flattened (see Pl. I [Fig. 4]). The ornament of the specimens may be affected to some degree by amount of decortication; but there seems to be a distinct variation from smooth to ornamented shells.

The pedal protractor scar is subrectangular to somewhat kidney-shaped (sublunate), slightly depressed, and continuous or contiguous with the lower part of the anterior adductor scar. It is situated around the ventral end of the buttress just to the rear of the anterior adductor scar (see Fig. 10*f*–*g*).

No definite information on cardinal teeth could be obtained. Two posterior lateral teeth are present in the left valve, the lower one being the larger. A single posterior lateral tooth in the right valve fits in between the two in the left valve, having a slight notch on the underside to accommodate the lower tooth of the left valve (see Fig. 10*a*–*e*).

The internal shape of the shell below the nymphs, including the posterior laterals, produces a broad, shallow, depressed area, posterior to the umbones along the dorsal side of the internal mould (see Pl. I [Fig. 5]).

Four to six, shallow, slightly curving, trough-shaped depressions radiate from the umbonal region in the interior of the shell, dying out at about two-thirds of the distance to the margin. One depression is just to the posterior of the buttress, another runs diagonally towards the posterior-ventral margin and the others are nearer and approximately parallel to the area below the nymphs. The last mentioned are more closely spaced and may be formed by the branching of one (or two) initial groove(s) to the posterior of the umbonal region. The depressions show as ridges on the internal mould (see Pl. I [Figs. 5, 7] and Fig. 10). The area in the shell between the two anterior depressions forms a broad, low, sometimes inconspicuous, subumbonal-ventral ridge; this produces a corresponding sulcus on the internal mould.

Size ranges (39 specimens)

Length 3·2–8·3 cm.
Height 2·5–4·7 cm.
Thickness 2·6–4·6 cm.

Summary of proportions

Height : Length	1:2 to 2:3
Thickness : Height	3:4 to 1:1
Point of maximum inflation : Length (from anterior)	1:3
Point of maximum height : Length (from anterior)	1:7 to 1:3
Umbone distance : Length (from anterior)	1:7 to 1:5

Material

Most of the Slacks Creek specimens are limonitic internal moulds; some have parts of the shell and ligament variously preserved by limonitic replacement. The posterior end of the shells is generally incomplete.

Localities

All specimens figured in this paper were collected from the Slacks Creek State Forest and occurred in sediments of the Upper Triassic Tingalpa Formation. A list of localities is given on p. 124.

Remarks

The specimens from Slacks Creek appear to be virtually the same as those described by Etheridge, Jr. (1892*a*, *b*), McMichael (1957), and Ludbrook (1961).

The Slacks Creek specimens agree closely with the descriptions and figures of the holotype and paratype, with the exception that no information on cardinal teeth could be obtained from the present writer's specimens. Also no mention of the fairly large lunule was definitely made in any description cited above, but the anterior margin is excavated below the umbones in all the previously figured specimens.

The original Bundamba specimens of Etheridge, Jr. (1892*b*, Geological Survey of Queensland F229 and F2450) are identical with those from the Slacks area. The position of the lunule in the Bundamba specimens is, however, hidden by the matrix. Ludbrook (1961, pp. 143–44) stated that the Bundamba specimens are the same as those from Leigh Creek, except for the lack of the strong concentric ribbing on the shell, and are at least congeneric. This ribbing is not present on the holotype or paratype, which are internal moulds, but is described from a more complete specimen collected later (1945) from the same general locality and figured by Ludbrook (1961, Pl. 1, Fig. 1). Except for growth lines, the Slacks Creek specimens are externally smooth or show flattened concentric ribbing (see Pl. I [Figs. 4, 7]). The ribbing is not as pronounced or as uniform as that of the Leigh Creek specimen (Ludbrook, 1961, Pl. 1, Fig. 1). The degree of ornamentation could be altered by loss of some, if not all, of the outer layers of the shell.

Thus the writer considers that the Slacks Creek specimens are referable to the species *eyrensis*.

The species is assigned to the genus *Unio* with reservations. The present specimens differ from the description of *Unio* s.l. (Woods, 1961) in that the arrangement of cardinal teeth given by Ludbrook (1961, p. 141) for the holotype is opposite to the usual disposition of cardinal teeth in *Unio*. The arrangement of the anterior adductor scar and the pedal protractor scar in ?*U. eyrensis* is unionoid. From the list of characters given by Mongin (1961, p. 341) the species is separated from *Unio* s.s. on account of the large, thick shell, excavation of the anterior margin below the umbones, presence of an interdentum, and lack of umbonal ornament.

The species has many features in common with *Margaritifera* Schumacher, 1816, but differs in having the opposite arrangement of cardinal teeth and vertical striations on the muscle scars (see Etheridge, Jr., 1892*a*; Mongin, 1961). The internal features of the shell shown by Mongin (1961, Pl. 17) may be analogous to the depressions and ridges of ?*U. eyrensis*. ?*U. eyrensis* might belong to *Margaritifera,* but no adequate description of the shell of this genus or its type, *Mya margaritifera* Linnaeus, could be located by the author.

Except for the cardinal teeth, about which no information could be obtained from the Slacks Creek specimens, ?*U. eyrensis* has many characters in common with *Unio* s.l. (which includes both *Unio* s.s. (e.g. Hudson, 1963) and *Margaritifera*).

The genus *Prohyria* McMichael, 1957 was based on *Unio johnstoni* Etheridge, Jr., 1881, and included *Unio eyrensis*. Ludbrook (1961, p. 143, 144), rejected the use of this genus for *U. eyrensis,* claiming that the two species appear to be unrelated. From the descriptions and figures of *U. johnstoni* in Etheridge, Jr. (1881, pp. 20–23, Figs. 1, 2) and McMichael (1957, pp. 227–28, Pl. 13, Figs. 6, 7) the characters common to *U. johnstoni* and ?*U. eyrensis* are general shape, straight hinge line, and possibly also the buttress behind the anterior adductor scar (see McMichael, 1957, Pl. 13, Fig. 7). ?*U. eyrensis* fits the generic description of *Prohyria* (McMichael, 1957, p. 227), but Ludbrook (1961) did not regard the characters used to define *Prohyria* as entirely satisfactory. A study of more completely preserved specimens of *U. johnstoni* may prove it is congeneric with ?*U. eyrensis,* thus placing the two species *johnstoni* and *eyrensis* in the genus *Prohyria.*

The Slacks Creek specimens differ from species of *Tihkia* Sahni & Tewari, 1958, by lack of definite information on cardinal teeth, the deep impression of the anterior adductor scar, the pedal muscle scar, the presence of a buttress, the radiating depressions on the internal surface of the shell, the conspicuous subumbonal-ventral sulcus on the internal mould, the length of the anterior margin, and the size of the lunule.

EXPLANATION OF PLATE I

The specimens were photographed by the Photographic Section, University of Queensland, and are here reproduced X $1\frac{1}{8}$.

?*Unio eyrensis* Etheridge, Jr.

FIG. 1.—Lateral view of right valve, part internal mould and part external; shows posterior wing, ligament, excavation of margin below umbones, and depression caused by buttress. UQF48195.

FIG. 2.—Anterior view of same specimen as Fig. 1; shows lunule and ligament. UQF48195.

FIG. 3.—Dorsal view of same specimen as Fig. 1; shows ligament and possible posterior gape; note prominent anterior section of ligament with transverse growth lines. UQF48195.

FIG. 4.—Shows most of shell surface of right valve. UQF48202.

FIG. 5.—Dorsal view of incomplete internal mould with some replaced shell material at anterior. UQF48177.

FIG. 6.—Dorsal—right valve view of incomplete specimen showing ligament. UQF48186.

FIG. 7.—Anterior view showing partly infilled lunule, low radiating ridges each side of subumbonal-ventral sulcus, and incomplete shell surface on left valve (on right of figure). UQF48201.

FIG. 8.—Lateral view of left valve of internal mould. UQF48184.

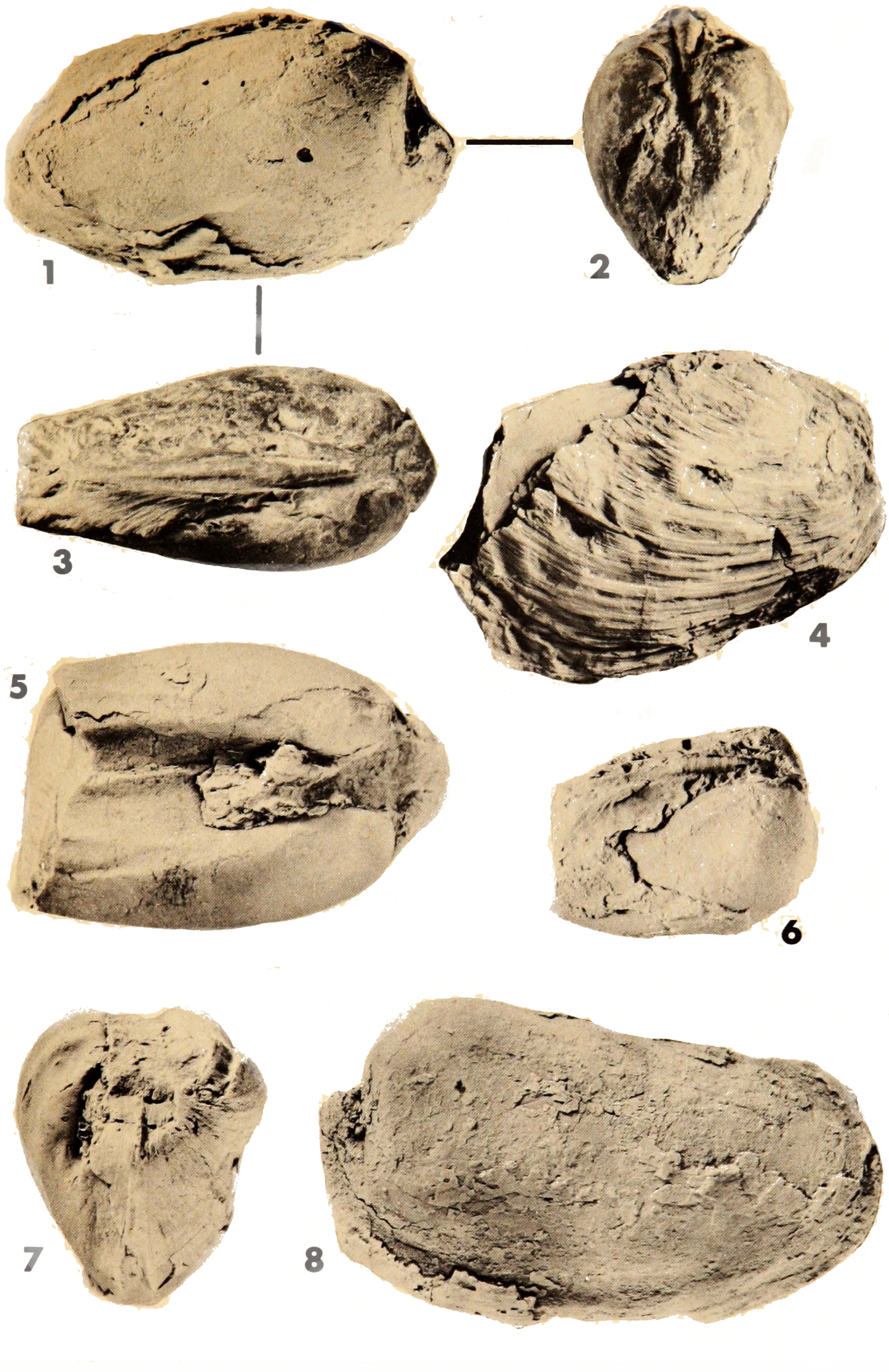

PLATE I

Family position

Only three of the six families of the superfamily Unionaceae Fleming, 1828, need to be considered (see Newell, 1965, and Op. 495, I.C.Z.N.). These are:

Family Unionidae Fleming, 1828

Family Margaritiferidae Haas, 1940

Family Mutelidae Gray, 1847

?*U. eyrensis* can be placed in the family Unionidae (see Zittel, 1900, p. 377). However a minor point of difference is that ?*U. eyrensis* has a smooth beak, while the description of the family stated "beaks usually sculptured".

The genus will fit in the family Margaritiferidae (Margaritanidae of some authors: see Hannibal, 1912, p. 119; Davies, 1935, p. 135; Op. 495, I.C.Z.N.). The genus may also be placed in this family by comparison with *Margaritifera*.

From the descriptions given by Zittel (1900, p. 378) and Davies (1935, p. 135), the family Mutelidae is characterized by "lack of pseudocardinals and laterals" or if dentiferous "a more or less taxodont hinge". This excludes ?*U. eyrensis*. McMichael (1957) included *Prohyria eyrensis* in the subfamily Velesunioninae. McMichael & Hiscock (1958) placed the subfamily Velesunioninae in the family Mutelidae. Their description of the family (p. 386) did not mention a taxodont hinge line and would include ?*U. eyrensis*.

In conclusion, and for convenience, the writer places the genus in the family Unionidae.