REPORT 164

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DEPARTMENT OF MINERALS AND ENERGY
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SUMMARY

The Palaeozoic rocks of the Warwick and Goondiwindi Sheet areas form the northern part of the New England Fold Belt, which consists of generally highly deformed eugeosynclinal sediments ranging in age from Ordovician to Permian, and the Permian to Lower Triassic granitic rocks of the New England Batholith. The fold belt is flanked to the southwest by the mildly deformed Permian-Triassic sequence of the Sydney Basin, and to the northwest, north, and northeast by the undisturbed Mesozoic rocks of the Great Artesian and Clarence-Moreton Basins.

Deposition throughout the Devonian, Carboniferous, and Permian was dominated by intermediate and acid volcanic activity. The sediments, which were all laid down in the sea, consist mainly of volcanic rock fragments; primary volcanic material is abundant in the Devonian and Permian sequences, but forms only a minor part of the Carboniferous succession. Strong angular unconformities exist between the Devonian, Carboniferous, and Permian rocks and probably also within the Permian sequence. These unconformities, the presence of vast quantities of granitic rock, and the prevalence of widespread volcanic activity indicate that the area of the New England Fold Belt was, throughout the Palaeozoic, a highly mobile region within the Tasman Geosynclinal belt, which did not become stabilized until the end of the Permian. It formed a mountainous upland during the Mesozoic. The presence of an upland (New England Arch) in this area during the Carboniferous is discounted.

The oldest rocks in the northern part of the New England Fold Belt belong to the Lower Devonian Silverwood Group. The group is subdivided into three formations which consist of (from the base upwards): 1800 m of fine-grained andesitic tuffs and silicified fine-grained sedimentary rock (Risdon Stud Formation); 1400 m of coarse-grained andesitic pyroclastics and flows with some sedimentary rock, including fossiliferous limestone lenses, mainly near its top (Connolly Volcanics); and 1200 m of olive-green mudstone, chert, lithic sandstone, limestone, and intraformational conglomerate (Rosenthal Creek Formation). Neither the top nor the bottom of the Silverwood Group is exposed, and the thickness of 4400 m must be regarded as a rough estimate. Rich coral faunas in limestones near the top of the Connolly Volcanics and in the Rosenthal Creek Formation indicate a Lower Devonian age for the upper part of the group; the Risdon Stud Formation could at least partly extend into the Silurian.

Carboniferous rocks underlie most of the area west of the granite (Texas Beds), and crop out in a narrow inlier in Permian rocks east of the batholith north of Drake (Emu Creek Formation) and around Mount Barney near the axis of the Clarence-Moreton Basin (Mount Barney Beds). The Texas Beds are a sequence of flysch-like regularly interbedded volcanolithic sandstone and mudstone with minor chert jasper, intraformational conglomerate, intermediate volcanics, and limestone containing Visean corals. The Texas Beds are intensely deformed and their thickness is not known, although it is thought to be great. They probably unconformably overlie the Silverwood Group. The Emu Creek Formation, comprising at least 1500 m of lithic sandstone, siltstone, and some conglomerate, and the Mount Barney Beds, which consist of at least 2100 m of feldspathic sandstone, shale, and minor conglomerate, are Upper Carboniferous. They are the oldest rocks exposed in the Drake region and at Mount Barney, and their relationship with the Lower Carboniferous Texas Beds is not known.

The Permian rocks in the northern part of the New England Fold Belt are mainly confined to small outliers, inliers, and fault blocks; one large area of outcrop is east of the New England Batholith in the Drake-Rivertree region. In the Silverwood area south of Warwick, the Permian strata are confined to largely fault-bounded blocks within the Lower Devonian Silverwood Group. The sequence, which consists of conglomerate, sandstone, siltstone, pebbly sandstone and siltstone, and acid volcanic rocks has yielded abundant marine macrofossils belonging to Faunas 2, 3A, and 4 of Dickins et al. (1964). The small Permian outliers in the western part of the area are at Alum Rock, Pikedale, Terrica, Glenlyon, and Silver Spur and comprise conglomerate, pebbly sandstone, and siltstone, with minor volcanic rocks. Fossils belonging to Fauna 2 were collected from most of these outliers. The Permian sequence between Drake and Rivertree, which is at least 3300 m thick, is subdivided into four units (from the base upwards): 2400 m of conglomerate, mudstone, and lithic sandstone (Paddys Flat Formation); 300 m of mudstone (Razorback Creek Mudstone); 450 m of coarse-grained pyroclastic rocks and flows with some sediments (Drake Volcanics); and 150 m of mudstone (Gilgurry Mudstone). The sequence has yielded fossils belonging to Faunas 2 and 4. The Permian succession unconformably overlies the Carboniferous and Lower Devonian rocks; the unconformity is well exposed in the Drake region, northwest of Silver Spur, near Terrica and Alum Rock homesteads, and in the Silverwood area south of Oaklands homestead.

INTRODUCTION

The Palaeozoic rocks of the Goondiwindi and Warwick Sheet areas on the border of Queensland and New South Wales were mapped from June to November 1968 and during April and June 1969 by F. Olgers and P. G. Flood. A. D. Robertson examined the plutonic rocks of the Queensland portion of the New England Batholith. The Mesozoic rocks of the Warwick and Goondiwindi Sheet areas were mapped during 1968 by Exon, Reiser, Casey, & Brunker (1969), and Mond (in prep.).

Air-photographs at a scale of approximately 1:85 000 taken by Adastra Airways Pty Ltd in 1963 were used. Photographs at a scale of approximately 1:30 000 are also available. Geological information was plotted on compilation sheets at 1:75 000 scale prepared by the Royal Australian Survey Corps.

The climate is subtropical. The mean annual rainfall ranges from 1000 mm in the east to about 600 mm in the west, more than half of which falls in the six months from September to February. Tabulam, Wallangarra, and Texas have average annual rainfalls of 980, 750, and 670 mm respectively. The mean maximum temperature varies from 14°-16°C in midwinter to 27°-30°C in midsummer. Frosts occur in the granite belt (surface elevation between 900 and 1200 m), and usually the first frost occurs in early April and the last in late October. Snow falls occasionally in the Stanthorpe-Wallangarra area.

The granite belt, in the centre of the area, is a long-established fruit-growing district. Clearing is continually increasing the area under cultivation, and trials of grape cultivation are proving successful.

Fig. 1. General view of the rugged country east of the granite belt looking northeast from the Boorook-Rivertree track, 12 km south of Rivertree. The hills and ridges in the foreground and middle distance consist of the Permian Drake Volcanics and the peaks and ranges on the horizon are part of the Main Range consisting of Tertiary volcanics.

The area west of the granite belt is mainly devoted to sheep grazing. Large areas have been cleared of timber, but most pastures are natural on account of the unfavourable soils. All properties rely on surface water.

In the region east of the granite belt rainfall is high, and the rich volcanic soils support dense rain forests, which are the basis of the local timber industry. Cattle are grazed also.

The alluvial flats of the Condamine and Dumaresq Rivers and Macintyre Brook are the sites of extensive cultivation for forage, grain crops, and tobacco. The proposed Border Rivers Development Scheme of the Water Conservation and Irrigation Commission of New South Wales will give impetus to the already established tobacco industry of the Texas-Yetman area, and the Coolmunda Dam, on Macintyre Brook 16 km east of Inglewood, should be capable of supplying ample water for irrigation purposes to the area west of Inglewood.

Previous Investigations

The earliest geological work in the area was done by Richards & Bryan (1923, 1924) in the Silverwood area south of Warwick, and by Andrews (1908) and Voisey (1936, 1939) in the Drake region of New South Wales. Wade (1941) and Lucas (1959, 1960) mapped most of the Palaeozoic rocks west of the granite. The nomenclature used by the earlier workers has been set out in Figure 14.

Physiography

The Palaeozoic rocks give rise to country ranging from gently undulating hills to extremely rugged mountainous terrain. The area cannot readily be subdivided into distinctive physiographical units, and geological units are not characterized by diagnostic physiographic features. This is particularly so in the rugged east, where Permian sediments, including soft mudstone and hard volcanic rocks, Carboniferous strata, and granite cannot be distinguished on the air-photographs. Relief in this eastern region is in places at least 600 m (Figs 1 & 2).

The central part of the area, 50 to 55 km wide and coinciding largely with the outcrop of the New England Batholith, is referred to as the granite belt and is part of the Great Dividing Range. A notable feature of the landscape is its general maturity, but in places it is interrupted by rugged granite tors, which are most conspicuous in the National Park east of Ballandean. Along the western margin of the granite belt, the country falls away gradually and the contact with the adjacent sediments is rarely marked. To the east, however, the country falls abruptly away and the margin is deeply dissected by tributaries of the Cataract, Maryland, and Boonoo Boonoo Rivers.

The sedimentary rocks to the north and west of the granite belt are steeply dipping, and resistant beds of jasper and massive sandstone produce prominent strike ridges; they give way southward to gently undulating and hilly country, except in the vicinity of Sundown homestead, where the Dumaresq River is entrenched in a prominent gorge up to 300 m deep. The low-lying, gently undulating country about Pikedale, Terrica, and Glenlyon homesteads and near Silver Spur is related to the soft, thin-bedded Permian sediments.

The Dumaresq-Macintyre, Condamine, and Clarence River systems rise in the region. The divides between these systems are formed by the Great Dividing and Herries Ranges.

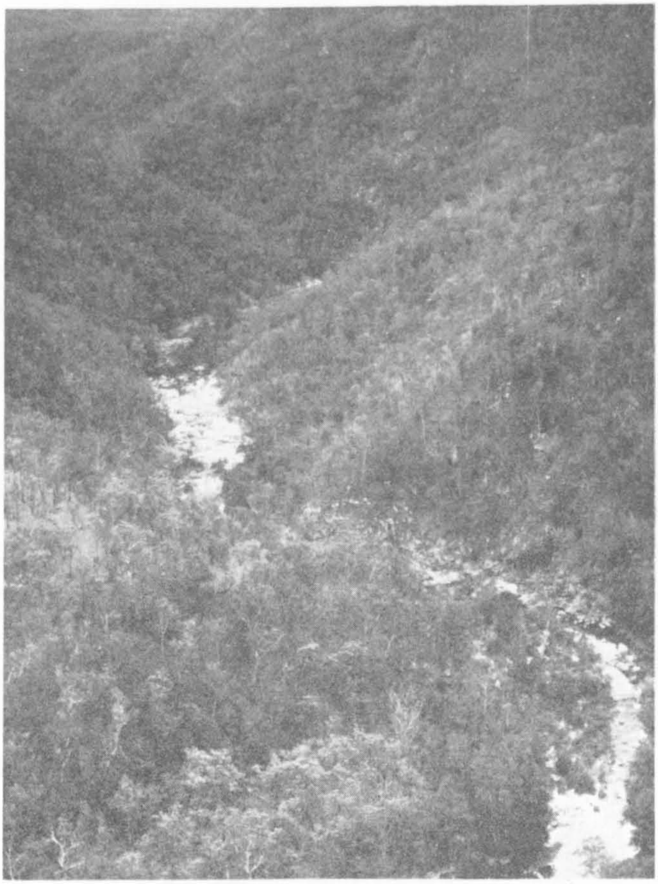


Fig. 2. View from Red Rock looking north along the Cataract River. Relief in this deeply dissected area is at least 300 metres.

REGIONAL GEOLOGY

Only the Palaeozoic rocks of the northern part of the New England Fold Belt (Packham, 1969, p. 1) were mapped in detail (Fig. 3), and one reconnaissance trip was made through the Palaeozoic rocks bordering the Clarence-Moreton Basin in northeastern New South Wales and southeastern Queensland; however, the regional geology of the entire central east coast is briefly discussed in this chapter to outline the geological setting of the area mapped. The detailed Palaeozoic stratigraphy of the Warwick and Goondiwindi Sheet areas is dealt with separately (pp. 23-56).

The northern part of the New England Fold Belt (Fig. 3) consists of generally highly deformed volcanic and sedimentary rocks ranging in age from Lower Palaeozoic to Permian, and the Lower Permian to Lower Triassic granites of the New England Batholith. It is bordered to the northeast, north, and northwest by the Mesozoic rocks of the Clarence-Moreton and Great Artesian Basins, to the southwest and south by the Permian-Triassic rocks of the Sydney Basin, and to the east is the Pacific Ocean. The New England Fold belt is almost connected

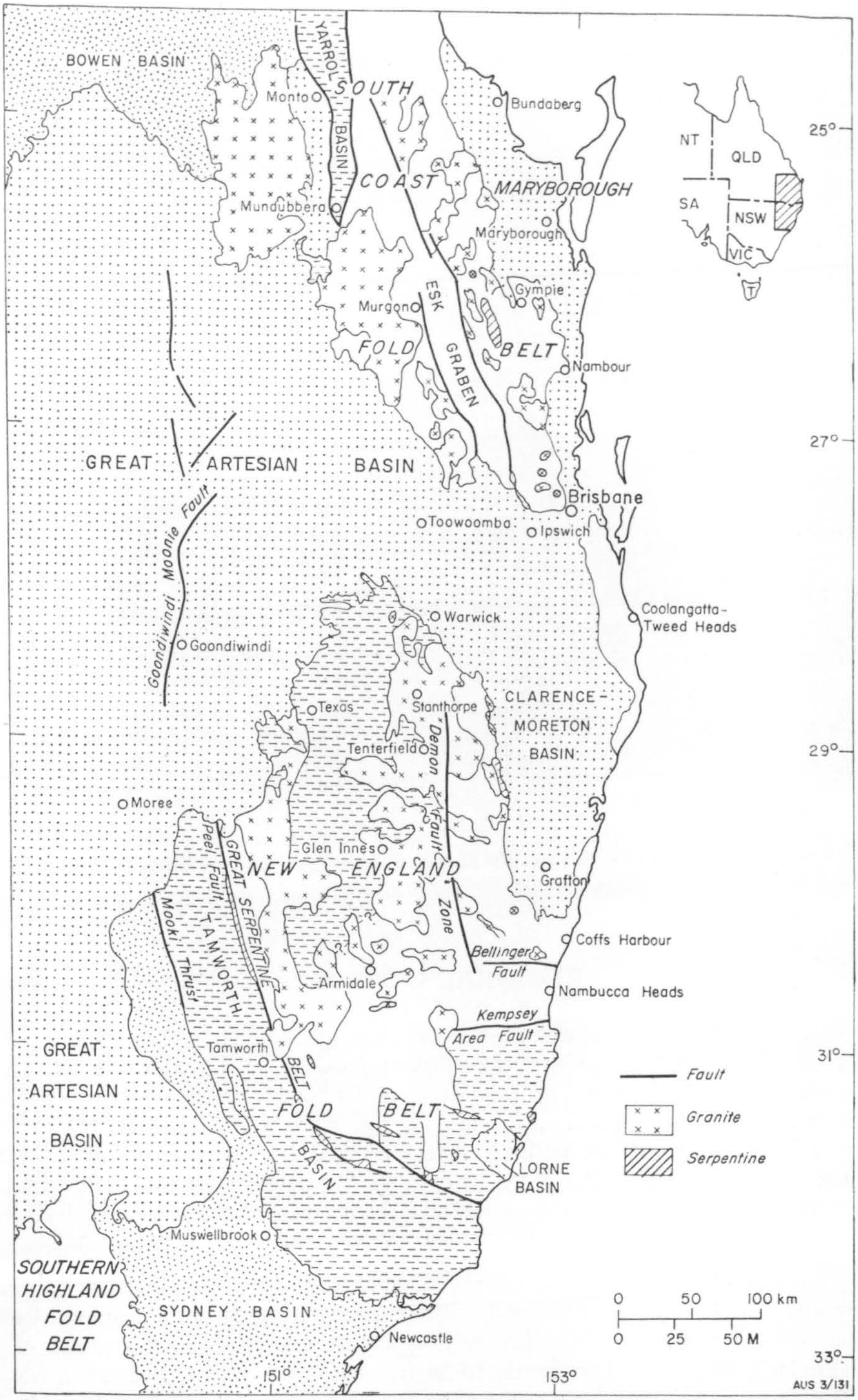


Fig. 3. Structural elements, northeast New South Wales and southeast Queensland.

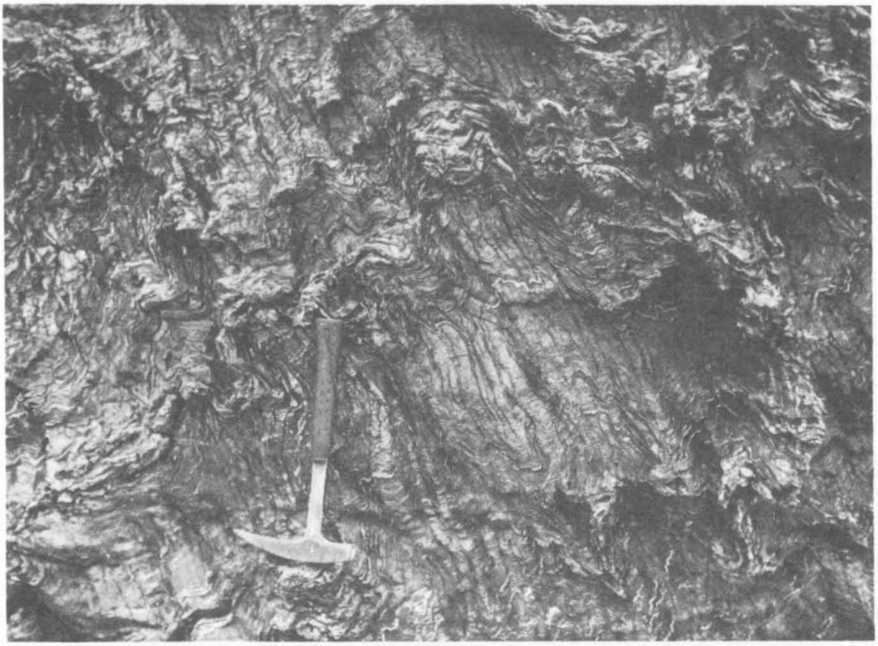


Fig. 4. Highly contorted Nambucca Beds at Nambucca consisting of laminae of mica schist and milky quartz. The quartz bands, which were formed by metamorphic differentiation, lie along first-order cleavage planes. They were contorted by strain-slip cleavage and small-scale crumpling between individual cleavage surfaces during a second period of deformation.

with the South Coast Fold Belt* (Fig. 3) by a narrow belt of Palaeozoic rocks along the New South Wales north coast and Queensland south coast. In the Brisbane area, the Palaeozoic rocks are overlapped by Mesozoic strata which form the connexion between the Mesozoic Maryborough Basin, which lies along the eastern margin of the South Coast Fold Belt, and the Clarence-Moreton Basin.

Lower Palaeozoic

The oldest rocks in the region are the Rocksberg Greenstones and Bunya Phyllite (Bryan & Jones, 1950) northwest of Brisbane, the Nambucca Beds (Voisey, 1934) on the New South Wales north coast, and the Gladstone Group (Kirkegaard, Murray, & Shaw, 1970) which crops out along the eastern margin of the Yarrol Basin. The *Rocksberg Greenstones* are the oldest; they are metamorphosed basic volcanics, possibly olivine basalts and related rocks (Mathews, 1954), which are conformably overlain by and interfinger with the fine-grained phyllitic rocks of the Bunya Phyllite. The *Bunya Phyllite* is lithologically similar to the *Nambucca Beds;* they both consist of alternating micaceous and quartzitic bands with innumerable parallel bands of milky quartz which were formed by metamorphic differentiation and are situated along the original cleavage planes. This can be observed in outcrops in which the quartz bands are widely spaced and the relic bedding, at a very acute angle to the bands, has been preserved. The

* The area north-northwest of Brisbane, largely made up of Palaeozoic rocks but also including some deformed Mesozoic strata (Kin Kin Phyllite), bounded to the east, south, and west by the undeformed Mesozoic sediments of the Maryborough, Clarence-Moreton and Great Artesian Basins. The South Coast Fold Belt covers nearly the same area as Hill's (1951) South Coastal Structural High.

intense deformation of the rocks is due to buckling and movement upon a system of strain-slip cleavage developed during a later tectonic event (Figs 4 & 5). The Nambucca Beds are correlated with the Bunya Phyllite because of close tectonic, metamorphic, and lithological similarities. The *Gladstone Group,* which crops out along the entire eastern margin of the Yarrol Basin as far south as Mundubbera, consists of quartzose sandstone, mudstone, chert, and limestone. The rocks are intensely deformed and have been subjected to two periods of regional deformation; three events have been recognized locally (Kirkegaard et al., op. cit.). The most striking feature these Lower Palaeozoic rocks have in common that distinguishes them from the Devonian and younger Palaeozoic rocks of the region is the abundance of quartz. The quartz content of sandstones of the Gladstone Group is on the average about 70 percent, whereas 5-10 percent quartz is the maximum observed in the Devonian and younger sediments (Fig. 10).

The age of the Lower Palaeozoic rocks will not be known until fossils are found; they are thought to be Ordovician or Silurian and to have been laid down in the Tasman Geosynclinal belt before the Bowning Orogeny, when the region was mobilized and eugeosynclinal sedimentation with a very high volcanic and volcanolithic content commenced. Most of the eastern region, where the Lower Palaeozoic rocks crop out, did not become stabilized until the end of the Palaeozoic and continued to receive eugeosynclinal deposits. The oldest known fossils in the entire region are Ordovician; they were collected from the Trelawney Beds (Philip, 1966) and from the lower part of the sequence of rocks mapped as 'Tamworth Group' (Packham, 1969, p. 231) and occurring in small fault blocks near the Peel Fault 15 km southeast of Tamworth.

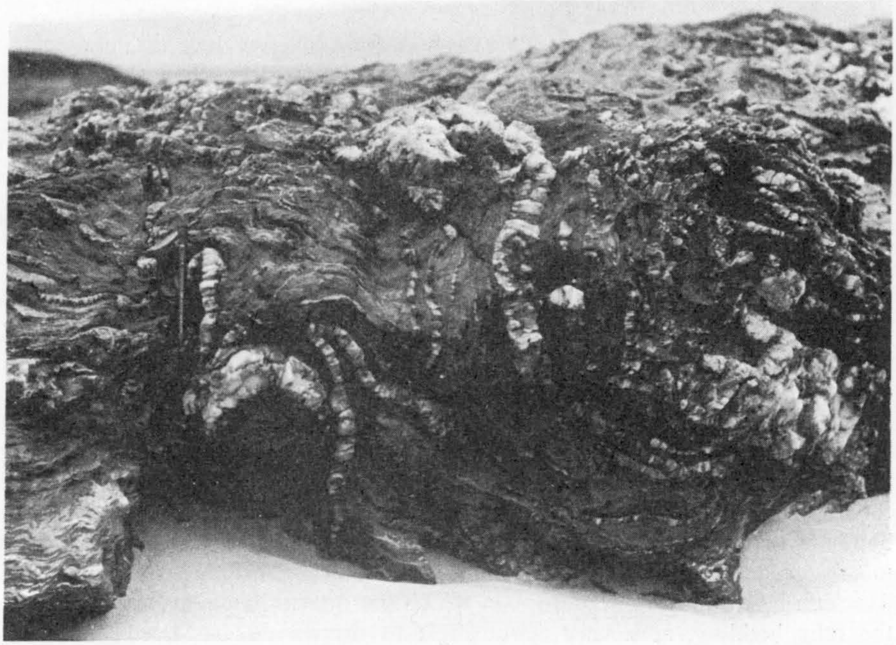


Fig. 5. As above; showing the great variation in thickness of the quartz bands from a trace to several centimetres. It is in outcrops as the one shown, in which the quartz bands are widely spaced, that the relic bedding, at an angle to the quartz bands, can be observed. This is not visible in the photograph. (Scale is a pencil, 15 cm long).

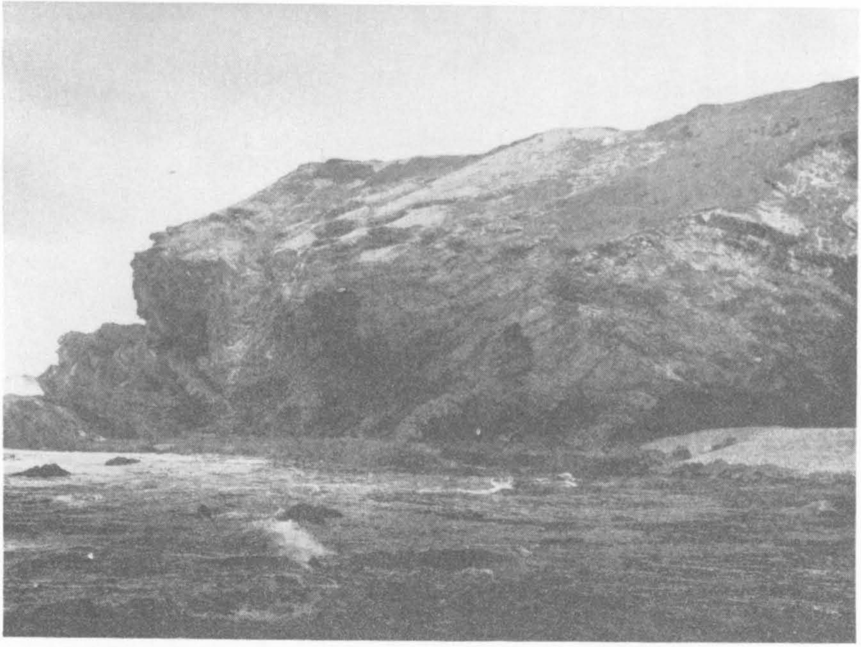


Fig. 6. Gently folded interbedded Palaeozoic sediments, Brooms Head, 32 km southeast of Maclean.

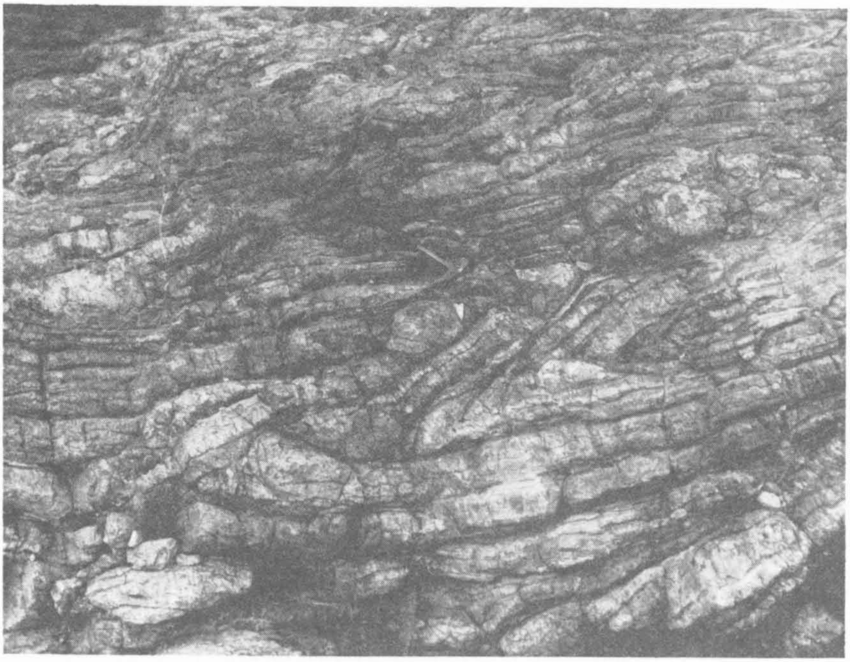


Fig. 7. Red Rock headland, 16 km north of Woolgoolga.

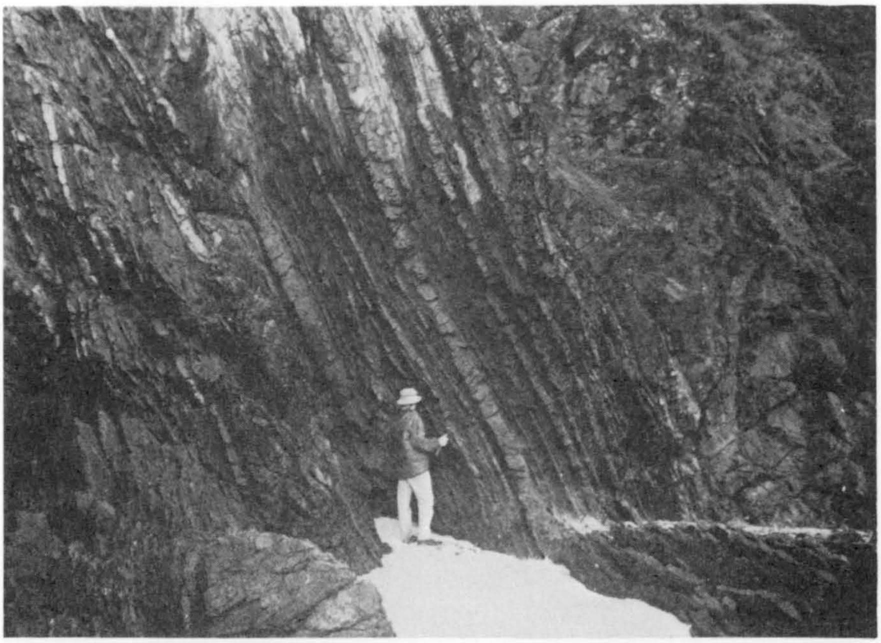


Fig. 8. Palaeozoic interbedded sandstone-siltstone sequence, Cape Byron, Byron Bay.

Fig. 9. View looking north along the valley of Rosenthal Creek. The hills in the middle distance and background consist of Devonian and Permian volcanics, and the sediments of the Rosenthal Creek Formation crop out in the valley.

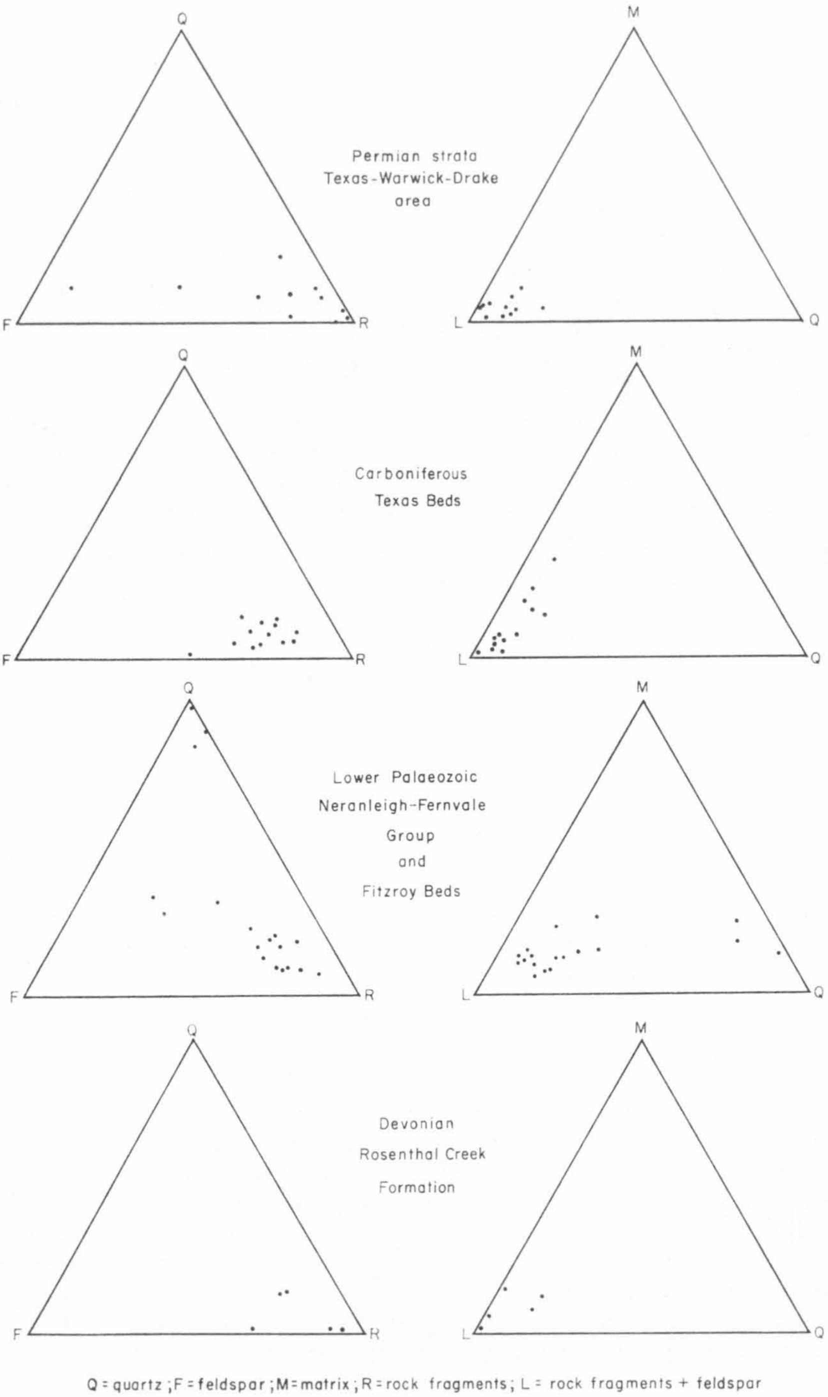


Fig. 10. Composition of some sedimentary rocks in southeast Queensland and northeast New South Wales.

Palaeozoic

Palaeozoic rocks, probably largely of Devonian or Carboniferous age, crop out along the western, southern, and eastern margins of the Clarence-Moreton Basin (Fitzroy Beds; Kenny, 1937) extending northward into the Brisbane area (Neranleigh-Fernvale Group; Bryan & Jones, 1950).

At Jackadgery, 40 km west-northwest of Grafton, the sequence comprises steeply dipping thinly interbedded sandstone and siltstone with several lenses of limestone from which poorly preserved Silurian or Lower Devonian fossils including *Favosites* and *Tryplasma* spp. have been collected (Whiting, 1951). These fossils provide the only clue to the age of the rocks flanking the Clarence-Moreton Basin.

Along the New South Wales coast from Sawtell (6.5 km south of Coffs Harbour) in the south to Tweed Heads in the north, are intermittent outcrops of steeply dipping, tightly and in places isoclinally folded Palaeozoic strata which make up the eastern margin of the Clarence-Moreton Basin. They all consist of well bedded regularly interbedded sandstones and siltstones (Figs 6-8). The sandstones consist largely of volcanic rock fragments and feldspar; quartz is a minor constituent (Fig. 10). They are generally graded, and chips of siltstone are present in places. Slump structures have been noted.

In southeast Queensland, the regularly interbedded sandstone-siltstone sequence gives way to massive sandstone, individual beds of which reach a thickness of 300 m or more and contain siltstone fragments of pebble size or larger. Beds containing well rounded boulders of quartzite and granite up to 1 m in diameter are also present (Denmead *in* Hill & Denmead, 1960, p. 136). Similar boulder beds occur in the Upper Carboniferous Emu Creek Formation and Mount Barney Beds farther west.

The Neranleigh-Fernvale Group, which unconformably overlies the Bunya Phyllite in the Brisbane area, and the Fitzroy Beds, which are faulted against the Nambucca Beds at Nambucca, are lithologically similar to the Devonian and Carboniferous rocks of the northern part of the New England Fold Belt and have been deformed to the same extent, in contrast to the much greater deformation suffered by the Bunya Phyllite and Nambucca Beds. The Palaeozoic rocks are on these lithological and tectonic grounds tentatively correlated with the Devonian and Carboniferous rocks of the northern New England Fold Belt.

Lower and Middle Devonian

The remnants of the Lower and Middle Devonian eugeosyncline in the central part of the Tasman Geosynclinal belt are preserved in the Tamworth Basin (see p. 15) (Tamworth Group; Crook, 1961), in the northern part of the New England Fold Belt south of Warwick (Silverwood Group; Richards & Bryan, 1923), in the basement below the Yarrol Basin (Mount Holly Beds and equivalents; Kirkegaard & Dear, 1968) and in small areas of outcrop in the region of the Anakie Inlier (Dunstable Formation and equivalents; summarized *in* Olgers, 1972). The Palaeozoic rocks in northeastern New South Wales (Fitzroy Beds) and in south-eastern Queensland (Neranleigh-Fernvale Group) either are also part of this sequence or belong to the Upper Devonian to Carboniferous succession.

The miogeosynclinal sequence, which was laid down farther to the west, is preserved in the Adavale Basin in central Queensland and in central and south-eastern New South Wales.

The Lower Devonian *Silverwood Group,* which is about 4400 m thick, has been subdivided into three formations (Fig. 16), which are, from the base upward: 1800 m of fine-grained andesitic tuff and silicified fine-grained sedimentary rocks (Risdon Stud Formation); 1400 m of coarse-grained andesitic pyroclastics and flows with some sedimentary rocks including fossiliferous limestone lenses, mainly near the top (Connolly Volcanics); and 1200 m of mudstone, chert, volcanolithic sandstone, limestone, and intraformational conglomerate (Rosenthal Creek Formation). Rich coral faunas in the limestones near the top of the Connolly Volcanics and in the Rosenthal Creek Formation indicate a Lower Devonian age (Appendix 3).

East of Fernvale, 32 km northwest of Brisbane, are andesitic crystal tuffs which closely resemble the rocks of the lower part of the Silverwood Group. They are adjoined by Permian strata, including tuffs to the west and east, and have tentatively been mapped as part of the Permian sequence (Fig. 13); but they may be Devonian.

The *Tamworth Group* was laid down farther to the southwest. The group, which in the Tamworth-Nundle district has a maximum observed thickness of 2400 m, consists mainly of argillites, lithic sandstone, greywacke, and conglomerate, with several thick richly fossiliferous lenses of biohermal and biostromal limestone. Near the base of the succession is a sequence of volcanic rocks up to 300 m thick. The source area throughout the period of deposition of the Tamworth and Silverwood Groups was dominantly made up of andesitic volcanic rocks, and the sequence was probably largely laid down in a shallow sea.

In the Rockhampton region of central Queensland are extensive areas of Lower and Middle Devonian rocks which are part of the basement to the Upper Devonian to Carboniferous Yarrol Basin sequence; they consist largely of pyroclastic rocks with some flows and sediments including lenses of richly fossiliferous limestone.

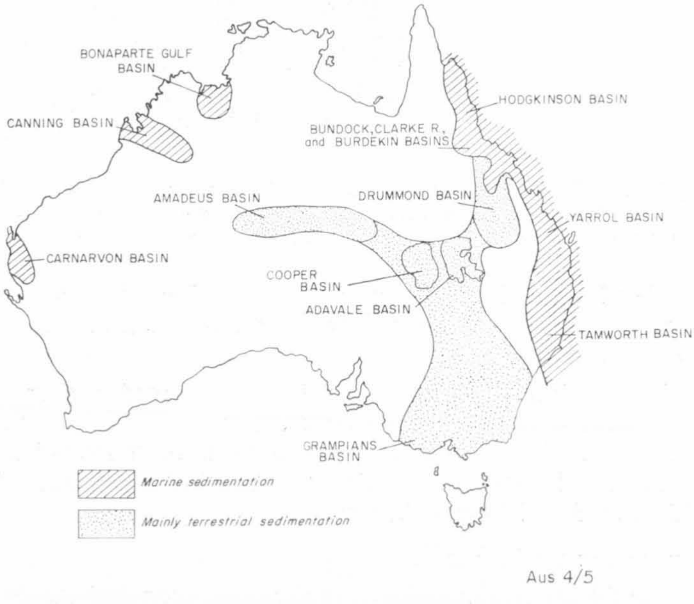


Fig. 11. Upper Devonian-Lower Carboniferous palaeogeography.

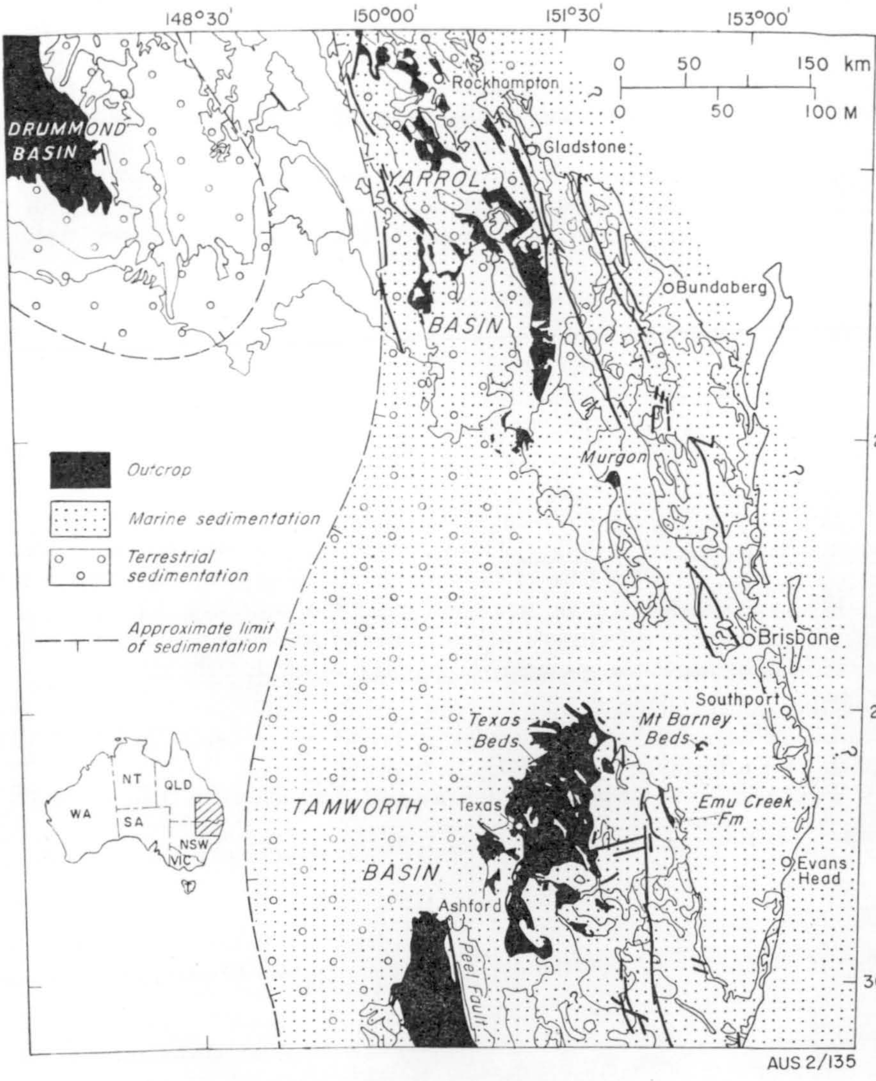


Fig. 12. Distribution of Upper Devonian-Carboniferous rocks, and Upper Devonian-Carboniferous palaeogeography in southeastern Queensland and northeastern New South Wales. (For explanation of outcrop pattern, see Plate 3).

Small isolated areas of outcrop of lower Middle Devonian andesitic volcanics and coralline limestone overlie the Lower Palaeozoic rocks of the Anakie Inlier in central Queensland.

The andesitic volcanic rocks that have been intercepted in a large number of oil exploration wells in the Great Artesian Basin west of the New England Fold Belt have in the past invariably been referred to as the Carboniferous Kuttung 'Series'; but they could partly be equivalent to the andesitic volcanics of the Lower Devonian Silverwood and Tamworth Groups.

Upper Devonian and Carboniferous

The Upper Devonian/Carboniferous palaeogeography and the distribution of Upper Devonian and Carboniferous rocks are shown in Figures 11 and 12. The pattern of deposition was drastically altered in the Middle Devonian by the Tabberabberan Orogeny, which affected most of the region. A geanticline rose in east-central Queensland and central New South Wales, separating a region in the west, which was to receive a great thickness of quartzose terrestrial sediments in the Upper Devonian and Lower Carboniferous, from a dominantly marine region in the east, which continued to receive large quantities of andesitic detritus. The western and eastern regions have in the past been referred to as the Lachlan and New England Geosynclines; but these names are not used here because it is preferred not to nominate parts of the Tasman Geosyncline, during a particular period of time, as geosynclines.

The terrestrial sedimentation in central Queensland has been fully described by Olgers (1972). About 1200 m of dominantly fluviatile sediments, including quartz sandstone, quartz pebble conglomerate, and mudstone were transported into a large intermontane basin, the Drummond Basin, by a north-flowing river system. Brief marine incursions from the north, where the terrestrial sedimentation merged with the marine deposition, may have occurred (Fig. 11). Sedimentation in the western region came to an end in the middle Carboniferous.

The dominantly marine sedimentation in the east took place in a large basin covering the eastern margin of the present-day continent (Fig. 11). Remnants of the sequence crop out in the north (Yarrol Basin) and in the south (Tamworth Trough of Crook, 1961; Tamworth Basin in this Report); the central region is covered by the Mesozoic sediments of the Great Artesian Basin, but probable equivalents of the succession have been recorded in numerous oil exploration wells. The eastern margin of the basin of sedimentation was considered to closely approximate the eastern structural margins of the Yarrol and Tamworth Basins, and the land area to the east has been referred to as the South Coastal Structural High (Hill, 1951), New England High (Brown et al., 1968, p. 156) and New England Arch (Campbell *in* Packham, 1969, p. 259).

The evidence for the existence of the New England Arch was summarized by Campbell (op. cit.): 'In the New England area, Crook (1961b) has shown that the Goonoo Goonoo Mudstone thickens toward the Peel Fault where it is cut off. No undoubted equivalents of these rocks are known to the east . . . but there is a thin sequence at Texas extending down to Ashford, along the eastern side of the Peel Fault line. This together with the strong angular unconformity between the Devonian and Permian in the Stanthorpe region (Lucas, 1960, p. 166), and the absence of Lower Carboniferous rocks at Mount Barney and Drake suggests a broad tectonic land extending from the Stanthorpe-Warwick area well to the south of Uralla . . . It is proposed to call this feature the New England Arch.'

Mapping of the Palaeozoic rocks in the Drake-Warwick-Texas area by the authors has shown that there is no evidence for a 'high' or arch in this region in the Upper Devonian or Carboniferous, and the following comments apply to the evidence set forth by Campbell:

(i) The northern part of the New England Fold Belt consists largely of Upper Devonian(?) to Carboniferous Texas Beds. The thickness of the unit is unknown, but thought to be great; the Goonoo Goonoo Mudstone, which crops out farther to the south, consists of conglomerate, sandstone, greywacke, mudstone, and limestone and is up to 2700 m thick; it could be equivalent to any part of the Texas Beds, and there is no basis for the assumption of easterly thinning toward a 'high'.

(ii) The Upper Devonian(?) to Lower Carboniferous sequence is not present in the Silverwood area south of Warwick, where Permian strata unconformably overlie the Lower Devonian Silverwood Group. It has been established that orogenic movements occurred in the northern part of the New England Fold Belt at the end of the Carboniferous (see p. 17), and that considerable erosion took place before the Permian sediments were laid down. The absence of the Upper Devonian(?) to Carboniferous sequence does not necessarily indicate that the sequence was never laid down in this region and it cannot be concluded that the Silverwood area was part of a 'high'.

(iii) The oldest exposed rocks in the Drake region of New South Wales and around Mount Barney in Queensland are Upper Carboniferous, but it cannot be assumed that the Upper Devonian(?) to Carboniferous sediments were not laid down and are not preserved subsurface.

In addition it may be pointed out that there is no evidence to suggest that any sediments were derived from the east, from the New England Arch; in fact all current measurements indicate a westerly source area (McKelvey & White, 1968). Recent work in the Yarrol Basin has uncovered no evidence to suggest that the area east of the basin was not submerged during the Upper Devonian and Lower Carboniferous (Kirkegaard & Shaw, pers. comm.), and the presence of Carboniferous rocks at Murgon (Fig. 12) on the supposed 'high' supports this view.

There is, therefore, no evidence for an arch or 'high' in this region during the Upper Devonian and Carboniferous, and in our opinion sedimentation took place in a large basin that was 'open' to the east and extended northward to include the Hodgkinson Basin (Fig. 11).

The Tabberabberan orogeny did not significantly change deposition in the eastern region. The supply of andesitic detritus continued, probably from volcanic activity within and to the west of the basin, and the supply of quartz remained very low, indicating that the eastern area was effectively separated from the quartz-rich source area to the west, which supplied the Drummond Basin in Queensland and areas of similar terrestrial sedimentation in western New South Wales during the Upper Devonian and Lower Carboniferous.

Great thicknesses of greywacke, sandstone, conglomerate, and mudstone, with some limestone and primary volcanic material, were laid down in the Yarrol Basin, but local unconformities have been reported from the Tamworth Basin (White, 1964, p. 211).

The *Texas Beds,* a thick sequence of flysch-like regularly interbedded lithic sandstone and mudstone (Figs 25 & 26), with minor chert, jasper, intraformational conglomerate (Fig. 21), intermediate volcanics, and limestone (Fig. 23), crop out in the northern part of the New England Fold Belt and are the northernmost outcrops of the Tamworth Basin (Fig. 12). The sandstones, which are largely made up of angular andesitic volcanic material (Fig. 10), are generally graded. The intraformational conglomerates consist of angular mudstone fragments, up to 30 cm in diameter, set in a poorly sorted lithic sandstone matrix. They are probably slump deposits. The limestones, including massive limestone, limestone breccia, and limestone 'conglomerate', occur in large lenses. They are in most areas underlain by andesitic volcanic rocks, and fragments of the limestone occur in the volcanics and vice versa. The similar occurrence of shallow-water limestone within an apparently deep-water turbidite sequence farther to the south in the Tamworth Basin has been explained by probable local arching to a level at which corals and stromatoporoids could become established and limestone formed (Brown et al., 1968, p. 129). We do not think that it is necessary to invoke local upwarps to provide the shallow-water conditions conducive to reef formation in the Texas-Warwick area. The sediments were probably all laid down in shallow water (but below wave base), and thin submarine volcanic outpourings, up to 60 m thick, provided shallow 'banks' on which the reefs could be built. Reef breccias have been observed, an indication of occasional local emergence.

The Texas Beds were severely deformed at the end of the Carboniferous and again after the Permian; it has not been possible to establish a mappable sequence within them, and it is not known whether local discordances occur.

The limestone lenses have yielded Visean corals (Appendix 2), and shelly fossils, which have tentatively been assigned to the Upper Carboniferous, were collected from a locality 3 km east of Terrica homestead (Fig. 35 & Appendix 5). The age of the beds probably ranges down into the Upper Devonian, but no fossils have been found to substantiate this. There is no evidence in the Texas Beds to suggest non-marine sedimentation at any time.

The relationship between the Texas Beds and the Upper Carboniferous rocks of the Emu Creek Formation and Mount Barney Beds is not known because they are, in outcrop, not in contact. Maxwell (*in* Hill & Denmead, 1960, p. 167) suggests that calc-silicate rocks near the base of the sequence and adjacent to the intrusion at Mount Barney could be altered Visean limestones, but no proof is offered.

The *Emu Creek Formation* consists of at least 1500 m of regularly interbedded lithic and feldspathic sandstone and mudstone with minor coarse-grained polymictic conglomerate, and contains fossils of the *Levipustula levis* Assemblage Zone (see p. 36).

The *Mount Barney Beds,* which comprise feldspathic sandstone, shale, tuff, limestone, and thin beds of conglomerate, and contain Upper Carboniferous marine fossils, are up to 2100 m thick. The sandstone is in places cross-bedded (see p. 37).

Upper Carboniferous fossils have recently been collected from limestone at Murgon (Palmieri, 1969) in the little known belt of Palaeozoic rocks along the western margin of the Esk Graben (Fig. 12). Associated rocks are regularly interbedded lithic sandstone and mudstone.

In summary, it appears that sedimentation in the eastern region took place in a sea which extended to the east probably uninterrupted by large land areas or islands or island arcs. The sedimentary sequence, in both north and south, thickens towards the east, and the sediments were derived from the west from a volcanically active region. Conglomerate, sandstone, mudstone, limestone, chert, and flysch-like regularly interbedded lithic sandstone and mudstone were deposited in shallow and deeper water (below wave base). Reefs formed also, in the areas of apparently deeper water sedimentation, where local upwarp or submarine volcanic outpourings provided the shallow conditions conducive to reef formation. The southern part of the region was tectonically unstable, as evidenced by the abundance of slump deposits, the outpouring of volcanic rocks, and the presence of local angular unconformities. In the late Visean, the sea regressed to the east and terrestrial deposits were laid down along the western margin of the basin. The shallowing of the sea extended well to the east, where the Upper Carboniferous Emu Creek Formation and Mount Barney Beds, including massive conglomerate and cross-bedded sandstone and containing shelly fossils, were laid down.

The easterly regression was due to uplift probably closely related to the uplift and deformation which occurred in the western region (Drummond Basin) at this time (Olgers, 1972).

The Upper Carboniferous terrestrial and marine sedimentation in the eastern region came to an end in the late Carboniferous when the Yarrol Basin sequence, and particularly the eastern part of the Tamworth Basin sequence (Texas Beds, Emu Creek Formation), were severely deformed in the Kanimblan Orogeny. The western part of the Tamworth Basin (west of the Peel Fault) was less affected by the orogeny.

The Carboniferous-Permian boundary in northeastern New South Wales has been variously interpreted as conformable and unconformable; a recent review (Leitch, 1969) of the literature on Permian diastrophism in the region concluded that there is no evidence of orogenic movement at the close of the Carboniferous Period. However, a marked angular unconformity between Carboniferous and Permian strata has been observed by the authors at Alum Rock, Terrica, Silver Spur, Glenmore, and northwest of Tabulam (Figs 32, 33, 35, 37, 38), and Owen & Burton (1954) recognized an unconformity between Lower Carboniferous sediments and the Ashford Coal Measures north of Ashford. The orogeny in the

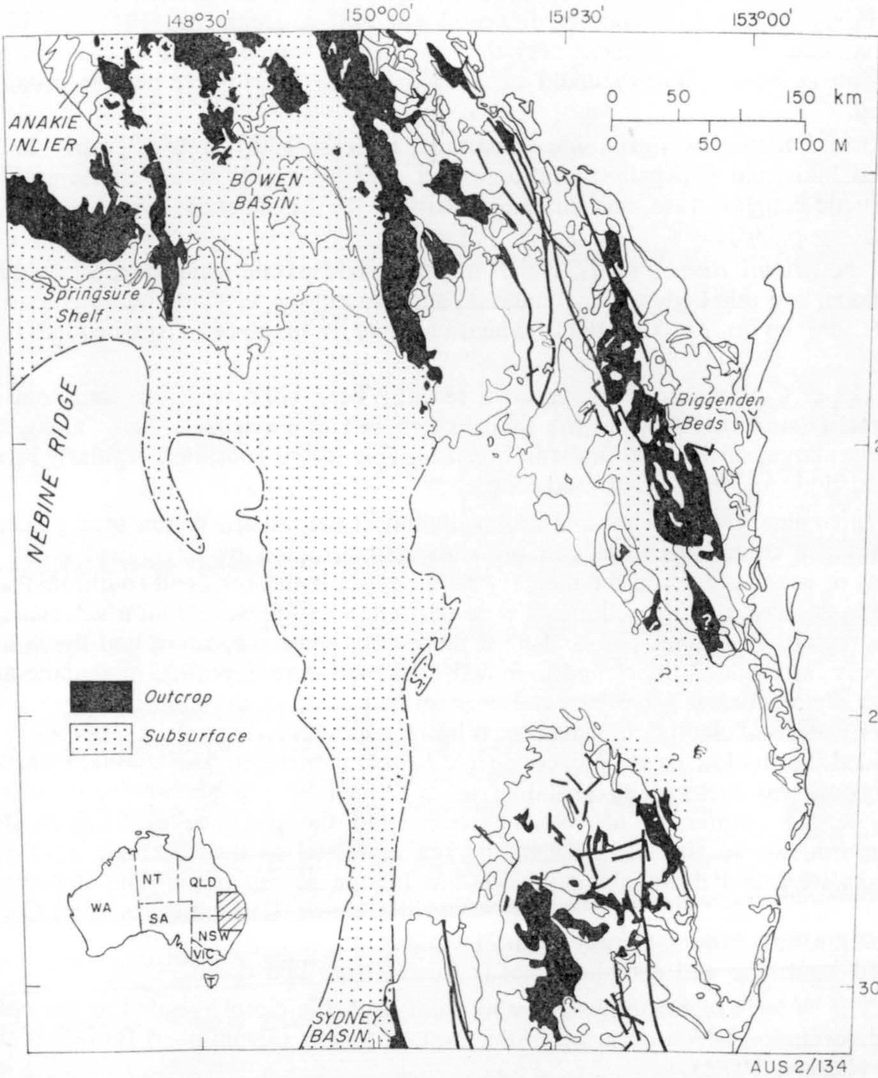


Fig. 13. Distribution of Permian strata in southeastern Queensland and northeastern New South Wales. (For explanation of outcrop pattern, see Plate 3).

eastern region can be dated, within limits, by the age of the faunas occurring above and below the unconformity in the area northwest of Tabulam, where Upper Carboniferous strata (Emu Creek Formation) containing fossils characteristic of the *Levipustula levis* Assemblage Zone (Campbell & Roberts *in* Packham, 1969, p. 262) are unconformably overlain by Lower Permian sediments (Paddys Flat Formation) containing fossils belonging to Fauna 2 of Dickins et al. (1964). The unconformity in the northern part of the New England Fold Belt does not appear to persist far to the west, southwest, or south. Leitch (1969) points out that the Carboniferous-Permian sequence west of the Peel Fault and along the New South Wales Coast from Port Stephens to Kempsey is broadly conformable, but local disconformities have been reported from most areas. The late Carboniferous orogenic event has been recognized as far north as the Yarrol Basin, where a slight angular break occurs between the Carboniferous and Permian successions (Kirkegaard et al., 1970).

Permian

The pattern of Permian sedimentation, set by the Kanimblan Orogeny, differed markedly from that of Devonian-Carboniferous deposition, particularly in Queensland, and it was considerably modified during the Permian by epeirogenic movements. The land separating the Yarrol and Drummond Basins became submerged and the sea transgressed to the west as far as the Anakie Inlier and Nebine Ridge (Bowen Basin) and locally farther west still (Springsure Shelf and Galilee Basin). In the south (Sydney Basin), sedimentation covered roughly the same area as in the Carboniferous.

A summary account of Permian sedimentation in Queensland was given by Dear (1969), who subdivided the region of deposition into an eastern mobile eugeosynclinal zone, the remnants of which crop out in the general area of the Yarrol and Maryborough Basins and extend southward into the Brisbane area and the northern part of the New England Fold Belt, and a western miogeosynclinal zone which crops out in the Bowen and Sydney Basins. Intracratonic deposition took place farther to the west in Queensland in the Galilee and Cooper Basins.

The sediments of the Bowen and Sydney Basins are continuous in the subsurface (Fig. 13); however, Dickins (1968, p. 35) and Runnegar (1970) suggest that the connexion between the basins was in mid-Permian time. The break was probably caused by epeirogenic movements in the western region, and diastrophism, folding the early Permian sediments of the eugeosynclinal zone, in the east. Evidence for the diastrophism is furnished by the angular unconformity between the Rannes Beds and Boomer Formation in the Gogango Range (Malone, Olgers, & Kirkegaard, 1969) and by the break within the Drake Volcanics in the northern part of the New England Fold Belt (Fig. 31).

The Permian sequence that was laid down in the eugeosyncline in southeastern Queensland and northeastern New South Wales is preserved in isolated inliers, outliers, and fault blocks in the northern part of the New England Fold Belt. Most of these areas of outcrop yielded marine macrofossils belonging to Faunas 2, 3A, and 4 of Dickins et al. (1964) (Appendix 1 and pers. comm.). The correlation between the Permian units is shown in Figure 28. The greatest thickness of sedimentary and volcanic rocks is preserved between Rivertree and Drake, where about 3300 m of Permian strata are exposed. The lower 2700 m consist of conglomerate, lithic sandstone, pebbly sandstone, pebbly mudstone, and mudstone (Paddys Flat Formation and Razorback Creek Mudstone). This is followed by

540 m of mainly volcanic rocks (Drake Volcanics) and 150 m of mudstone (Gilgurry Mudstone).

The abundance of volcanic rocks and the emplacement of the various phases of the New England Batholith during the Permian and early Triassic indicate that the region was highly mobile.

The presence of Faunas 2, 3A, and 4 in the Silverwood area south of Warwick, the absence of Fauna 3 in the Drake region, where a possible angular unconformity occurs within the Drake Volcanics between strata containing Faunas 2 and 4, and the angular unconformity between Lower Carboniferous and Permian strata containing Fauna 2 at Alum Rock, Terrica, Silver Spur, and Ashford, and Fauna 4 at Glenmore, support this view and show pronounced differences in sedimentation and intensity of deformation over relatively short distances.

Mesozoic

In the Sydney and Bowen Basins, sedimentation continued uninterrupted into the Triassic, but it is doubtful whether this continuous deposition persisted far to the east, where, in the Maryborough area, the Triassic sequence overlies the Permian succession with possible unconformity (Ellis, 1968, p. 21); the relationship between the sequences in the northern part of the New England Fold Belt is not known because of overlap by Jurassic strata (Pl. 1, cross-sections); however, the unconformable relationship between the Permian and Jurassic rocks near the Condamine River south of Warwick, and the conformability within the Triassic-Jurassic sequence of the Clarence-Moreton Basin to the east, indicate that orogenic movements affected the Permian strata before the Triassic rocks were laid down.

Triassic sediments were laid down in the Bowen-Sydney, Maryborough, and Clarence-Moreton Basins to the east and west of, and between, the South Coast and New England Fold Belts, areas which were uplifted during the Bowning Orogeny and which supplied much of the material deposited in the flanking basins. Volcanism was widespread in the early Triassic. Renewed deformation took place in the Bowen-Sydney and Maryborough Basins at the end of the Triassic, and the Jurassic-Cretaceous succession was laid down unconformably over the older rocks in these areas. The unconformity, which is most pronounced in the Bowen and Maryborough Basins, has not been reported from the Clarence-Moreton Basin.

The bedding trends in the Palaeozoic rocks flanking the Clarence-Moreton Basin everywhere parallel the basin margin, indicating that the formation of the basin was controlled by pre-existing structure.

Summary of regional geology

Early Palaeozoic. Deposition of sediments (Bunya Phyllite and Nambucca Beds) and basic volcanic rocks (Rocksberg Greenstones). Age and environmental conditions unknown.

Lower and Middle Devonian. Eugeosynclinal deposition and widespread volcanism in a large basin covering the eastern part of the present-day continent. Miogeosynclinal deposition farther to the west in the region of the Adavale Basin in central Queensland. Deposition was interrupted by the Tabberabberan Orogeny.

Upper Devonian-Carboniferous. A great thickness of eugeosynclinal volcanolithic sediments was deposited in a large basin along the eastern margin of the present-day continent (Yarrol-Tamworth Basin). Relatively little primary volcanic material was laid down. There is no evidence that a continental area or large islands lay to the east. Sediment was derived from the west, from a land consisting largely of

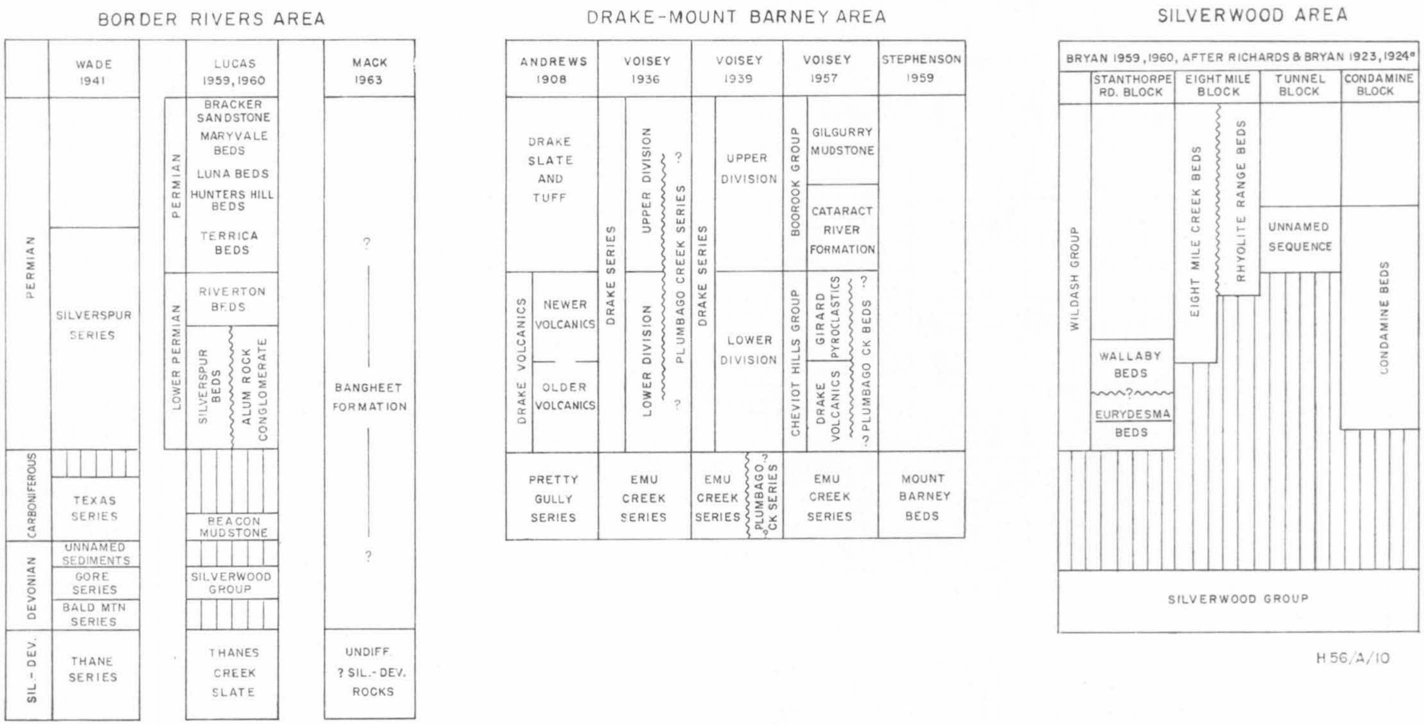


Fig. 14. Summary of previous stratigraphic nomenclature for the northern part of the New England Fold Belt.

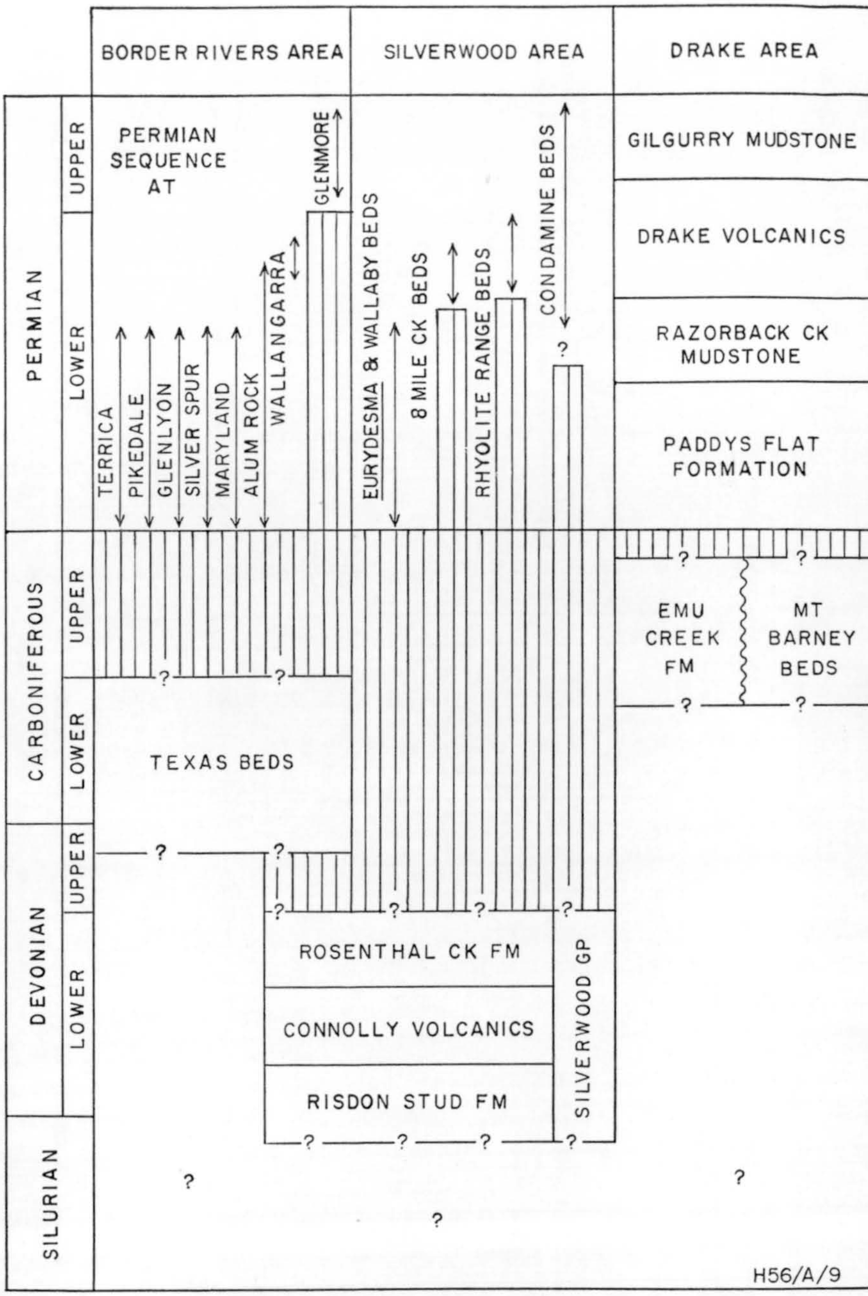


Fig. 15. Correlation chart for units exposed in the northern part of the New England Fold Belt. (For location of Permian outliers, see Fig. 27).

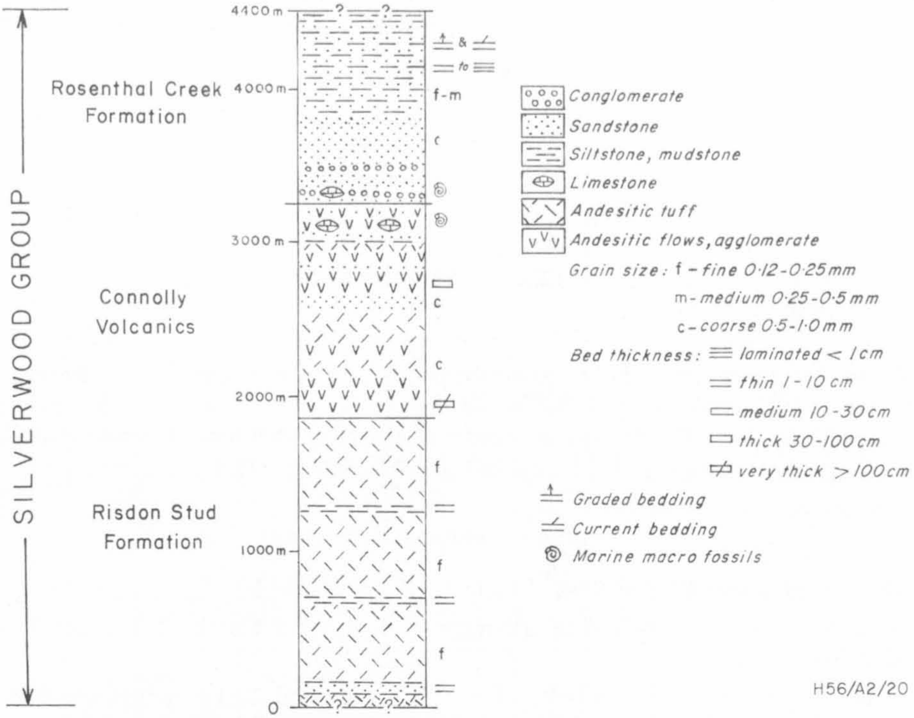


Fig. 16. Diagrammatic stratigraphic column of the Silverwood Group.

volcanic rocks and separating the area of marine sedimentation from the region of terrestrial deposition farther to the west (e.g. Drummond Basin). Sedimentation in the western region came to an end in the middle of the Carboniferous and in the east by orogenic movement at the end of the Carboniferous.

Permian. Eugeosynclinal sedimentation covered a large area. In the south (Sydney Basin) it coincided roughly with the region of Carboniferous deposition, but in the north (Bowen Basin) it was greatly expanded to the west. A great thickness of volcanolithic sediments was laid down and volcanism was widespread. Epeirogenic movements in the middle of the Permian temporarily separated the northern and southern parts of the area. The eastern part of the region was highly mobile, and batholithic granitic intrusives were emplaced in the late Permian and early Triassic.

Mesozoic. In the western area (Sydney-Bowen Basin), sedimentation continued uninterrupted into the Triassic. In the east, deposition came to an end at the close of the Permian when the sequence was folded. The New England and South Coast Fold Belts were uplifted and Triassic sediments were laid down in the flanking basins. Epeirogenic movements occurred at the end of the Triassic, and the Jurassic-Cretaceous succession was laid down in the Great Artesian, Maryborough, and Clarence-Moreton Basins, in most areas unconformably on the Triassic and older rocks. The Mesozoic Clarence-Moreton Basin sequence is apparently conformable.

STRATIGRAPHY

DEVONIAN

The oldest rocks in the area crop out south of Warwick on the northeast margin of the New England Fold Belt. The sequence is Lower Devonian and possibly partly older, and has been mapped as the 'Silverwood Series' (Richards & Bryan, 1923, 1924a) and Silverwood Group (Lucas, 1959). A twofold subdivision into a dominantly volcanic unit at the base followed by a sedimentary sequence was recognized but not mapped out by Richards & Bryan (1924).

The Silverwood Group, which is estimated to be about 4400 m thick, is here subdivided into three formations (from the base upward): Risdon Stud Formation, Connolly Volcanics, and Rosenthal Creek Formation (Fig. 16).

Rich coral faunas in limestone near the top of the Connolly Volcanics and in the Rosenthal Creek Formation indicate a Lower Devonian age for the upper part of the group (Appendix 3); the Risdon Stud Formation could at least partly extend into the Silurian.

The Silverwood Group can be correlated with the Tamworth Group (p. 12) and possible equivalents of the group crop out to the northeast in the Fernvale area west of Brisbane (see p. 13). The Rocksberg Greenstones and Bunya Phyllite, which crop out in a narrow belt northwest of Brisbane, are almost certainly older than any of the rocks exposed in the Silverwood area (p. 7).

Risdon Stud Formation (new name)

Derivation of name: Risdon Stud, 13 km south of Warwick.

Type area: A small east-flowing tributary of Rosenthal Creek, 1 km north of Risdon homestead.

Distribution: A north-trending belt, 1.5 to 3 km wide and 22 km long, from 2 km north-northeast of Dalveen to the New England Highway 5 km south of Warwick (Fig. 17).

Lithology: Mainly silicified very fine-grained pyroclastic and sedimentary rocks. The pyroclastics crop out as structureless masses of cherty rock; they are poorly sorted andesitic crystal-lithic tuffs which are made up of angular clasts of devitrified glass, feldspar, and quartz, set in a groundmass of devitrified glass (feldspar). Shards are present, and veinlets of plagioclase, calcite, and prehnite cut most of the rocks. The thin interbeds of the less common sedimentary rocks, which are also extensively silicified, are generally well preserved. These rocks which are similar to the regularly interbedded siltstone-mudstone sequences of the Rosenthal Creek Formation, except for their greater silicification, are in many places tightly folded. Whether this is due to tectonism or slumping is not known.

Relationships: The Risdon Stud Formation crops out along the western margin of the block of Lower Palaeozoic rocks south of Warwick. To the east the formation is probably conformably overlain by and faulted against the Connolly Volcanics, in the south it is intruded by granite, and near the New England Highway it is unconformably overlain by the Marburg Sandstone. To the west are the Texas Beds, the contact with which is in places marked by a bed of conglomerate containing abundant angular fragments of chert. Above the conglomerate are beds of massive lithic sandstone and a thin sequence of well bedded thinly bedded chert and jasper which have been traced for at least 5 km parallel to the boundary between the units. The presence of the conglomerate, the overall change in lithology, and the pronounced difference in deformation of the rocks on either side of the contact suggest that the Texas Beds unconformably overlie the Risdon Stud Formation. The formation is intruded by feldspar porphyry and diorite dykes.

Thickness: Estimated from the cross-section of Figure 17 to be about 1800 m. It is highly speculative.

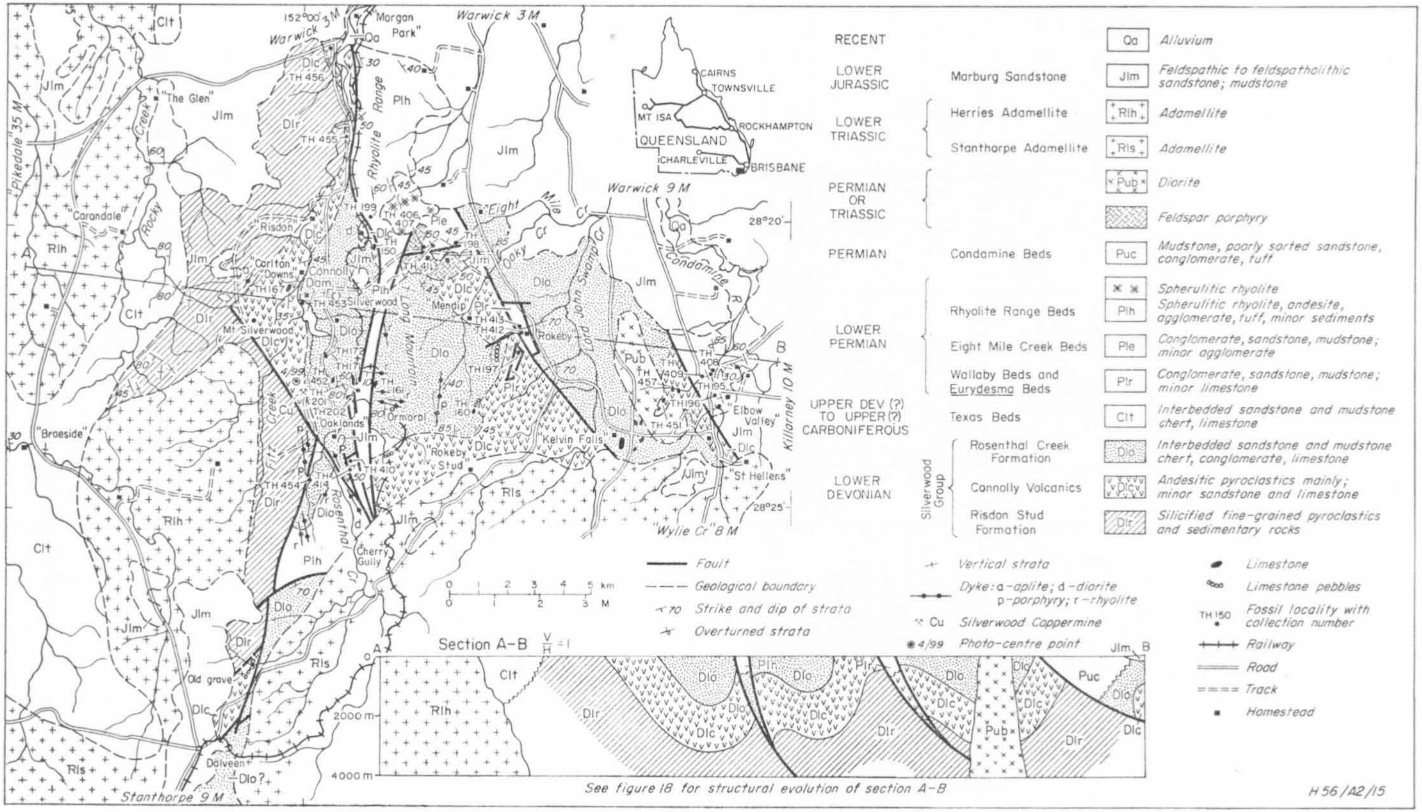


Fig. 17. Geological map of the Silverwood area, Queensland.

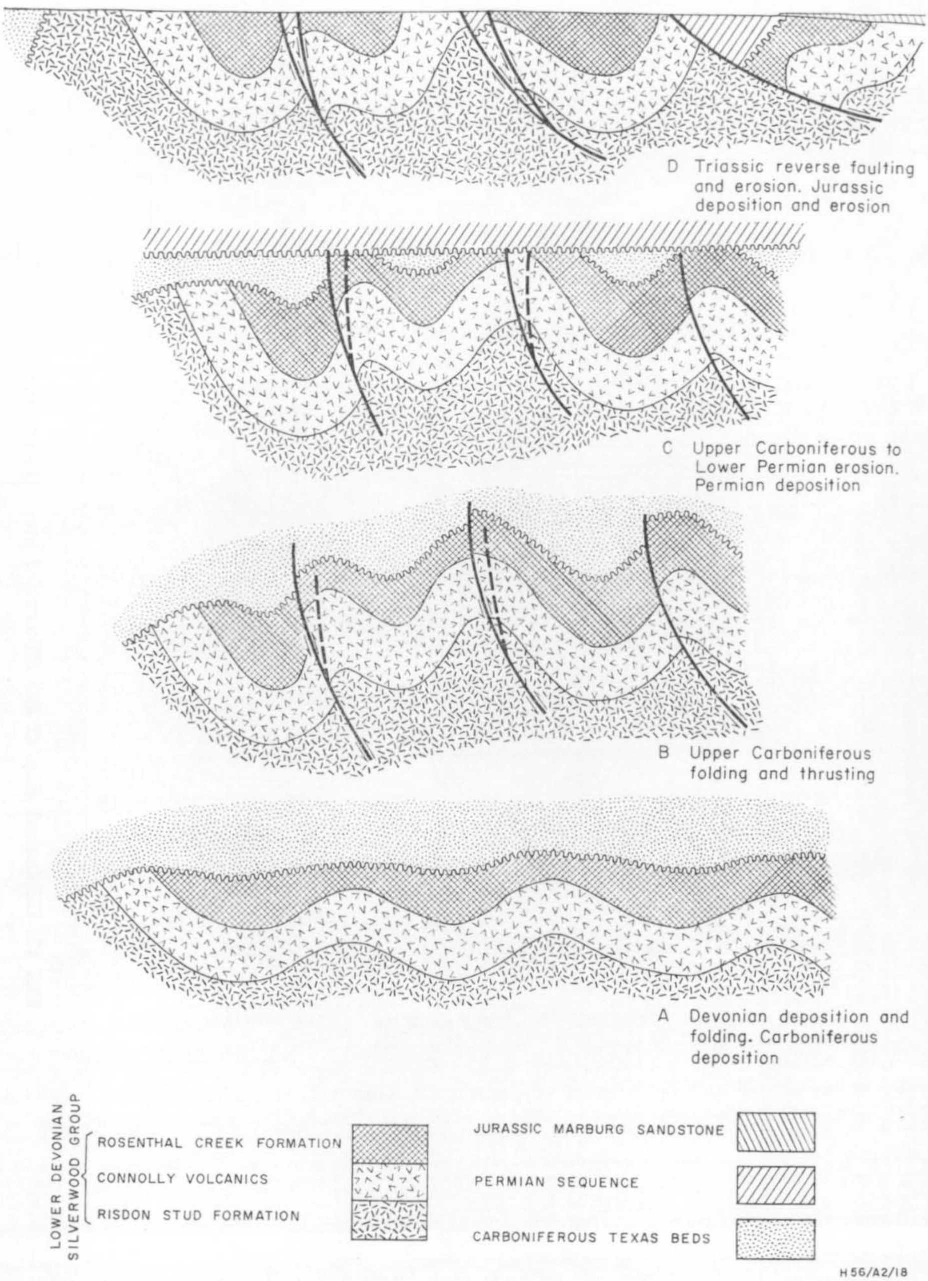


Fig. 18. Structural evolution of the Silverwood area. (For section line, see Fig. 17).

Age: Silurian(?)-Lower Devonian, based on the Lower Devonian faunas in the conformably overlying Connolly Volcanics.

Connolly Volcanics (new name)

Derivation of name: Connolly Dam on Rosenthal Creek 16 km south of Warwick.

Type area: In the east-flowing tributary of Rosenthal Creek which joins it just north of Connolly Dam.

Distribution: The formation, which underlies some of the most rugged country in the area, crops out mainly in two belts, one, up to 1.5 km wide and 16 km long, along Rosenthal Creek from the Silverwood Copper Mine in the south to the New England Highway, and the other, arcuate in shape, from the railway tunnel 3 km north of Cherry Gully siding through Rokeby Stud and Mendip homesteads. Small areas of outcrop are in the Elbow Valley area, 1.5 km north-northeast of Dalveen, and north of Silverwood siding (Fig. 17).

Lithology: The Connolly Volcanics, in contrast to the underlying Risdon Stud Formation, consist mainly of coarse-grained pyroclastic material with some flows and sedimentary rocks. Agglomerate is most common, but volcanic breccia and coarse-grained crystal-lithic tuff are also abundant. Flow-banded and porphyritic andesites are present. Sedimentary interbeds are most common near the top of the formation and limestone lenses are the most conspicuous and important because they contain rich Lower Devonian coral faunas. Locally, also near the top of the formation and in places closely associated with the limestone lenses, is a bed of conglomerate or lithic sandstone containing rounded and subangular fragments of fossiliferous limestone identical with the limestone of the lenses. The most accessible and spectacular outcrop of these 'limestone conglomerates' is 3 km north-northeast of Dalveen at an old grave and in the creek 0.5 km northeast of it. The conglomerate contains odd cobbles of granite and numerous boulders of limestone up to 1 m in diameter. All limestones and the locations at which limestone fragments occur in the volcanic rocks have been indicated in Figure 17. Beds of volcanolithic sandstone are also interbedded with the volcanics in the upper part of the formation.

Relationships: The Connolly Volcanics are probably conformably overlain by the Rosenthal Creek Formation, and faulting has brought them into contact with the Rosenthal Creek Formation and the Permian rocks. The volcanics may be unconformable below Permian strata 1.5 km north-northeast of Mendip homestead (Fig. 17): the contact is not exposed, but conglomeratic sandstone and conglomerate crop out close to the volcanics and dip away from them. North of Cherry Gully Siding the volcanics are intruded by granite, and hornfels, including garnet hornfels, occurs along the margin (Richards & Bryan, 1924, p. 94); they are well exposed in a railway cutting north of Cherry Gully Siding. A diorite stock intrudes the formation east of Rokeby homestead and several diorite dykes were observed, the largest of which crops out in a railway cutting 1.5 km north of Silverwood Siding.

Thickness: Estimated from the cross-section of Figure 17 to be about 1400 m.

Age: The faunas contained by the limestones indicate a Lower Devonian age (Appendix 3).

Rosenthal Creek Formation (new name)

Derivation of name: Rosenthal Creek, which starts in the granite country east of Dalveen and joins the Condamine River at Warwick.

Reference area: Lord John Swamp Creek and areas southwest of Rokeby homestead between Silverwood siding and Connolly Dam (Fig. 17).

Distribution: A discontinuous belt from the vicinity of Risdon homestead in the north to Delmoak homestead on the Maryland River in the south, and two areas, drained by Lord John Swamp and Oaky Creeks, east and west of Rokeby homestead (Fig. 17).

The Rosenthal Creek Formation generally underlies the more gently undulating country in the area of outcrop of the Silverwood Group, but hilly terrain with relief up to 150 m occurs west and southwest of Mendip homestead.

Lithology: The formation consists entirely of sedimentary rocks and presents a marked lithological change from the dominantly volcanic lower part of the Silverwood Group. Primary volcanic detritus is present, but reworked andesitic material, presumably derived from the lower part of the group, is most common.

In the Silverwood/Elbow Valley district, it is apparent that the formation consists of a lower sandy and conglomeratic sequence and an upper finer-grained succession, but no attempt was made to map these subdivisions. The outcrop belt east of Rokeby homestead mainly comprises the upper part of the formation, and the rocks in the narrow outcrop belt from northeast of Dalveen to Delmoak homestead, though severely hornfelsed, probably also largely belong to the upper division. The structure of the Rosenthal Creek Formation is very complicated and it is difficult to determine the stratigraphic position of any one area of outcrop within it.

The only well exposed contact between the Rosenthal Creek Formation and the underlying Connolly Volcanics that is not faulted is north of Rokeby Stud. The sedimentary sequence consists mainly of coarse-grained sandstone with, near the

Fig. 19. Regularly interbedded sandstone-mudstone sequence of the Rosenthal Creek Formation, 1.5 km north of Silverwood siding.

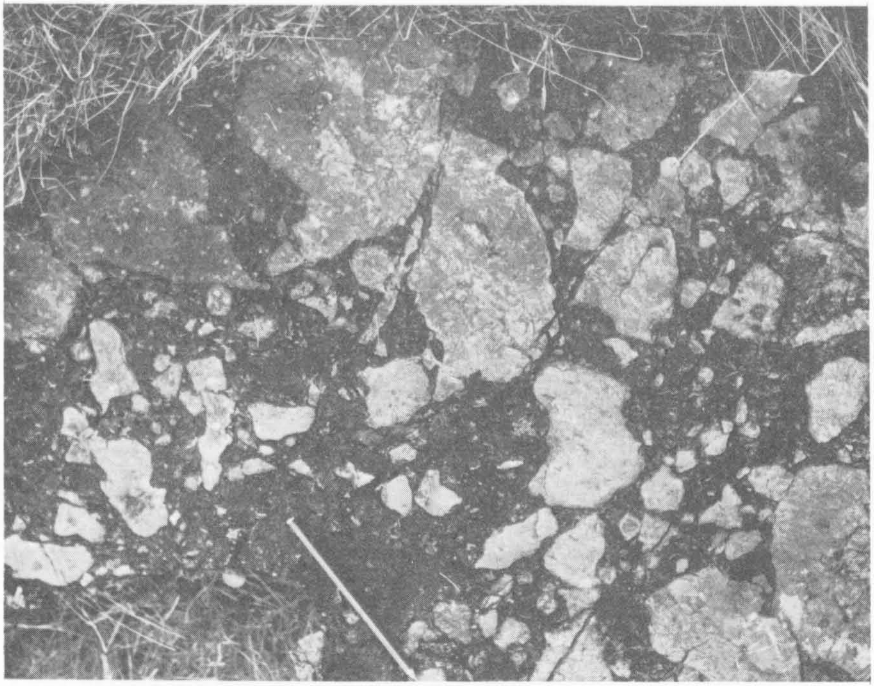


Fig. 20. Lower Devonian limestone conglomerate 1.5 km west of Rokeby homestead; scale is pencil, 17 cm long.

base, a small lens of limestone containing corals, and a thin discontinuous bed of conglomerate that in places contains only angular fragments of limestone up to 60 cm in diameter (Fig. 20) and elsewhere contains well rounded pebbles and cobbles of granodiorite, quartz-feldspar porphyry, and sedimentary rocks including limestone. The sandstone is massive, coarse-grained, and poorly sorted, and is mainly composed of angular fragments of volcanic rocks and feldspar (Fig. 10). The quartz content is variable but generally very low. Fragments of radiolarian chert and tuff and grains of sedimentary rocks have been noted.

Similar coarse-grained rocks, including poorly sorted conglomeratic sandstone containing pebbles and cobbles of limestone and a chert breccia consisting entirely of angular pieces of banded chert, crop out at Connolly Dam; Long Mountain, 1.5 km east of Silverwood siding, is underlain by coarse-grained sandstone and intraformational conglomerate containing chert and siltstone fragments up to 25 cm long. The breccia at Connolly Dam could be a slump breccia. A small lens of fossiliferous limestone 3 km northeast of Oaklands homestead is associated with coarse-grained rocks and is part of the lower portion of the formation.

The upper part of the formation consists mainly of regularly interbedded fine-grained sandstone, siltstone, and mudstone (Fig. 19) with some chert and lenses of limestone. The thickness of the beds within the interbedded sequence, although relatively uniform within any one area, ranges from a fraction of a centimetre in the west to 8 to 10 cm east of Rokeby homestead. The sandstone is finer grained and better sorted than the sandstone of the lower part of the formation, but is very similar in composition. Graded bedding is common; and cross-bedding, in units up to 3 cm thick, and slump structures have been noted in a few places. One kilometre south-southwest of Oaklands homestead is a thick bed of mudstone containing cobbles and blocks of sedimentary rock. The sequence between Oaklands homestead and Connolly Dam is dominantly mudstone. The interbedded rocks are locally silicified into banded and laminated cherts which closely resemble the silicified sedimentary rocks which are in places interbedded with the andesitic tuffs of the Risdon Stud Formation. The upper part of the Rosenthal Creek Formation also includes fossiliferous limestone lenses. Five are in the Elbow Valley area, two are between Oaklands homestead and Connolly Dam just east of the road, and one is 1.5 km south-southwest of Oaklands homestead. Most have been or are being quarried.

The fine-grained mica hornfels which occurs east of Dalveen in the narrow outcrop belt surrounded by granite shows in places good bedding, slump structures, and cross-bedding; it probably belongs to the Rosenthal Creek Formation. Similar hornfels and spotted slate occur near the contact with granite at the head of Lord John Swamp Creek.

Relationships: The formation overlies the Connolly Volcanics probably conformably and is unconformably overlain by Permian and Mesozoic strata. The contact zone with the Connolly Volcanics is best exposed southeast of Rokeby homestead and north of Rokeby Stud. The unconformity between the Rosenthal Creek Formation and the Permian rocks is exposed south of Oaklands homestead, where deformed mudstone is unconformably overlain by poorly sorted pebbly sandstone and conglomerate containing abundant pebbles and fragments of sedimentary rocks. The area is structurally complicated by faulting and the emplacement of numerous acid dykes. The unconformity is locally steeply dipping and dykes have in places been emplaced along it.

The unconformity between the formation and the Mesozoic rocks is well exposed in the southern cutting of the railway tunnel east of Dalveen, where steeply dipping, deeply weathered hornfels is overlain by flat-lying Mesozoic conglomerate containing abundant fragments of hornfels, and poorly sorted quartz sandstone.

A long narrow block of Permian volcanics and sediments (Eight Mile & Tunnel Block) has been downfaulted into the formation east of Oaklands homestead and Silverwood Siding, and two small fault blocks of Permian sediments (Stanthorpe Road Block) are at Rokeby homestead.

The Rosenthal Creek Formation has been intruded by granite in several places and by a small mafic intrusion in the Elbow Valley area. Limestone along the margin of the intrusion has been brecciated and angular fragments of marble are set in a very fine-grained groundmass of igneous rock. Numerous dykes of rhyolite, diorite, and feldspar porphyry intrude the formation. The dykes at Ormoral siding are vertically flow-banded spherulitic rhyolite ranging in width from 30 cm to 1.2 m.

Thickness: The preserved thickness has been estimated from the cross-section of Figure 17 to be about 1200 m.

Age: Lower Devonian, based on coral faunas collected from the limestones near the base of the formation (Appendix 3).

CARBONIFEROUS

Carboniferous rocks make up the bulk of the northwestern part of the New England Fold Belt (Texas Beds); they also occur in a narrow inlier in Permian rocks near the northeastern margin of the fold belt north of Drake (Emu Creek Formation), and crop out 50 km to the east of Warwick around Mount Barney (Mount Barney Beds) (Fig. 12). Carboniferous strata crop out along the entire western and southern margins of the Sydney and Great Artesian Basins. Similar rocks have been encountered in many of the wells drilled in the Surat Basin to the northwest (Kuttung Formation). Carboniferous rocks probably occur in the central and eastern parts of the fold belt, though this has not yet been confirmed by fossils (see pp. 8 & 12).

The northwestern part of the New England Fold Belt was largely mapped by Lucas (1957, 1958, 1959, 1960), who recognized several units ranging in age from Siluro-Devonian to Permian. All previously established fossil locations in the northwest and many additional ones were sampled during the recent survey. All the limestone yielded Lower Carboniferous corals, one questionable Upper Carboniferous fauna was found near Terrica homestead (Appendix 5 and Fig. 35), and numerous Lower Permian faunas were collected in the vicinity of Silver Spur, and near Glenlyon, Terrica, and Alum Rock homesteads.

The formations mapped by Lucas and assigned by him to the Siluro-Devonian, Carboniferous, and Permian mainly represent broad facies changes within a thick and very extensive Carboniferous sedimentary sequence, which, owing to intense deformation, cannot be subdivided. They have been named the *Texas Beds*. Five small outliers of Permian rocks have been recognized within their area of outcrop in the Warwick and Goondiwindi Sheet areas. They are at Silver Spur, and Glenlyon, Terrica, Pikedale, and Alum Rock homesteads, and have been mapped and described in some detail (see pp. 49-52); others may yet be found.

Texas Beds (new name)

Nomenclature: The name, derived from Texas on the State border, has been given to the Lower Carboniferous sequence that makes up the northwestern part of the New England Fold Belt. The name 'Texas Limestones' was informally used by Bryan & Jones (1944) to describe the Lower Carboniferous limestones in the Texas-Limevale area near the border. These limestones are part of the Texas Beds. The area west of the batholith was largely mapped by Lucas (1957, 1958, 1959, 1960), who recognized several units ranging in age from Siluro-Devonian to Permian; his subdivisions have been abandoned.

Distribution: The northwestern part of the New England Fold Belt west and north of the New England Batholith extending southward from Queensland into New South Wales.

Type Area: Branch Creek between the Pikedale to Warwick (via Melva homestead) and Pikedale to Cooinoo roads.

Lithology: Sandstone, mudstone, slate, jasper, chert, intraformational conglomerate, limestone, and andesitic volcanics. The characteristic feature of the sequence is the rhythmic alternation of sandstone and mudstone beds. The relative proportion of sandstone to mudstone varies greatly from one area to another and a section may consist largely of either (or slate). The sandstones in the interbedded sequence are generally graded; in places they show irregular laminations. Flute casts were seen in one area, but current bedding or ripple marks were nowhere observed. The sandstones, which are generally poorly sorted, consist largely of angular volcanic rock fragments (Fig. 10). Angular pieces of black mudstone are not uncommon in the massive sandstones and they are locally abundant enough to form intraformational conglomerate (Fig. 21). Slabs of mudstone up to 30 cm in diameter have been seen. Mudstone fragments rarely occur in the sandstones of the interbedded sequence.

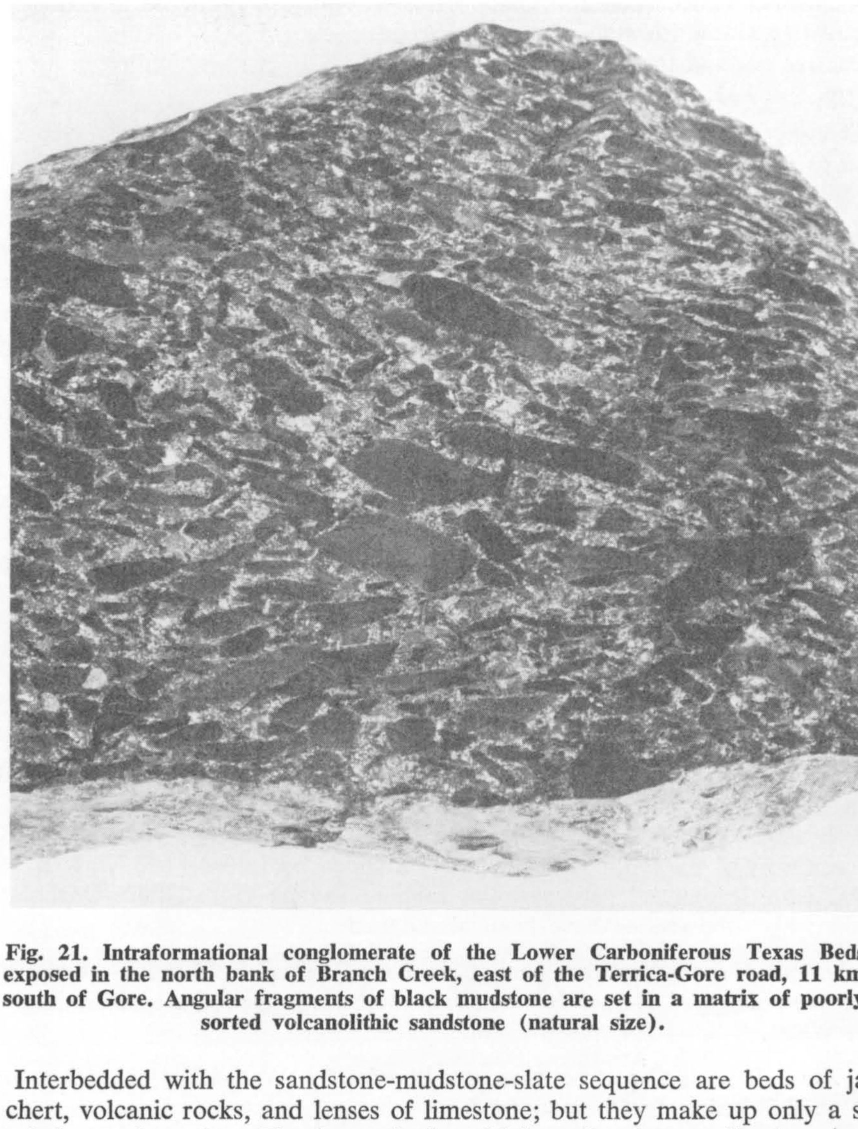


Fig. 21. Intraformational conglomerate of the Lower Carboniferous Texas Beds exposed in the north bank of Branch Creek, east of the Terrica-Gore road, 11 km south of Gore. Angular fragments of black mudstone are set in a matrix of poorly sorted volcanolithic sandstone (natural size).

Interbedded with the sandstone-mudstone-slate sequence are beds of jasper and chert, volcanic rocks, and lenses of limestone; but they make up only a small part of the total section. The jasper beds, which grade along strike into jaspery chert and pale grey-green chert, contain radiolaria. The beds range in thickness from 60 cm to 10 m or more and form most of the higher hills of the region. They are most common in the northern part of the area and the most prominent outcrops are east of Waroo station, in the vicinity of Terrica homestead, and at Mount Gammie. The jaspers are not closely associated with any other particular rock type: they have been found in contact with massive sandstone and volcanic rocks, and interbedded with slate and phyllite and with the regularly interbedded sandstone-mudstone sequence.

The jasper and chert beds can nowhere be traced for more than a few kilometres and are of little use as marker beds.

Limestone, in lenses up to 6 km long and 1 km wide, crops out at several widely scattered localities. The main occurrences are in Pike Creek 1.5 km south

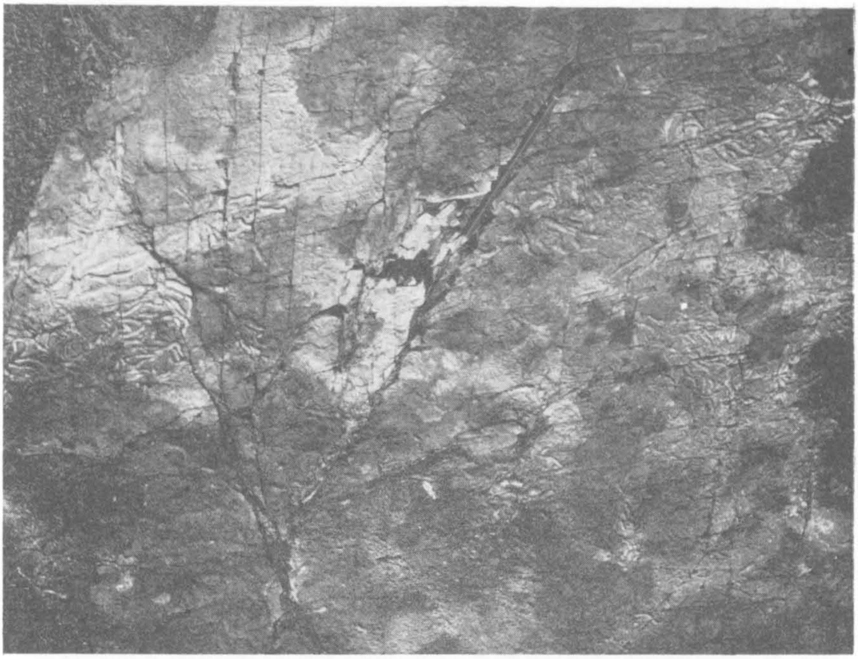


Fig. 22. Bedding plane with numerous worm trails in the Lower Permian Rhyolite Range Beds, railway cutting 5.5 km south of Warwick. Scale is pencil, 17 cm long.

Fig. 23. Massive outcrops of Lower Carboniferous limestone on the north bank of Pike Creek, 6 km south-southwest of Glenlyon homestead.

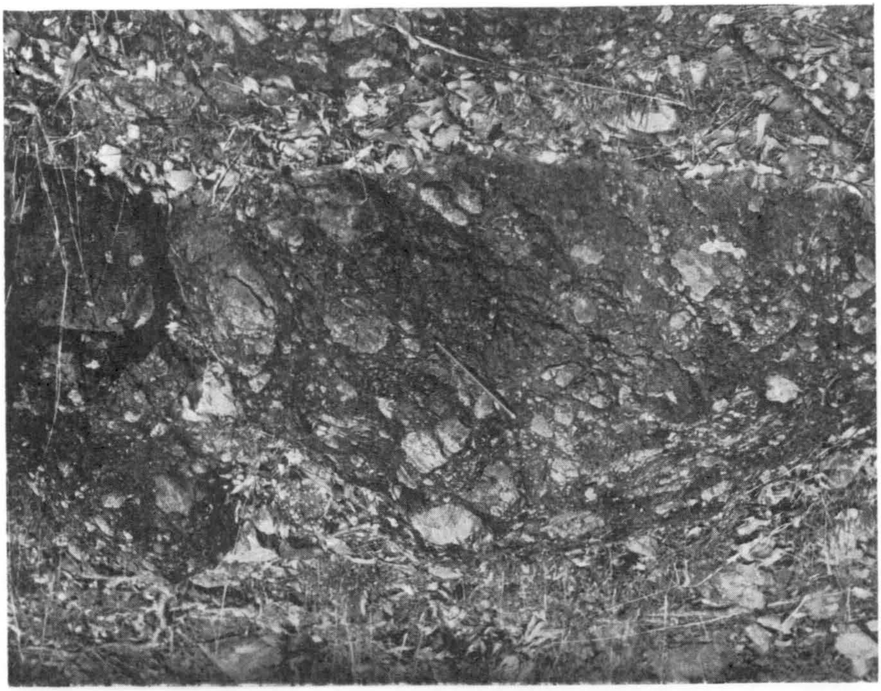


Fig. 24. Limestone conglomerate containing blocks and fragments of limestone up to 30 cm in diameter. Locality as above; scale is pencil, 17 cm long.

Fig. 25. Regularly interbedded volcanolithic sandstone and mudstone of the Texas Beds, Alpin Greek, 3 km south of Silver Spur.

Fig. 26. Interbedded sandstone and mudstone in Alpin Creek. The mudstone is cleaved; some of the sandstone beds show boudinage, others are fractured and disrupted. Scale is pen, 14 cm long.

of Riversdale homestead, and 3.5 km to the northwest, in the Limevale area, at Cement Mills, and at Cooinoo, Barangarook, South Pikedale, and Craigie homesteads. The limestone outcrops in the Inverell Sheet area to the south are shown in Figure 38A. The limestones are massive (Fig. 23) and generally poorly fossiliferous; Visean corals have been collected from most (Appendix 2). Fresh water-washed outcrops in the banks of Pike Creek show that in places the limestone contains abundant coralline and crinoidal material, whole shells and fragmentary shell material. Oolites are in places also abundant. A massive limestone breccia, consisting of angular blocks cemented by calcilutite, constitutes a small part of the limestone lens in Pike Creek. Most of the limestones have been recrystallized, and white and some black marble is being quarried in the Limevale area, and until recently at Cement Mills.

Intermediate volcanics occur sporadically within the Lower Carboniferous sequence. They are mostly closely associated with the limestones which they invariably underlie. Fragments of the volcanics have been observed in the limestone, and 'limestone conglomerate' consisting of angular blocks and fragments of limestone set in a tuffaceous matrix occurs with the limestones at South Pikedale and Craigie homesteads and in Pike Creek (Fig. 24). The volcanics are best exposed near Craigie homestead, where they include porphyritic flows, agglomerate, and rocks which show vague pillow structures.

Structure: The Texas Beds are intensely deformed, and attempts to subdivide the sequence were unsuccessful. Dips are generally steep to vertical and the beds are in many places overturned. Many of the larger creek outcrops show that the rocks are tightly folded and overturned. The sandstones in the interbedded sequence are fractured and boudinage has been observed. In places, the sandstone beds have been completely broken up and the rock resembles a conglomerate consisting of sandstone 'pebbles' set in a cleaved mudstone matrix. The mudstones of the interbedded sequence are generally cleaved (Fig. 26). Slate and phyllite have invariably been formed in areas where the Texas Beds consist largely of fine-grained sediments, and cleavage is not apparent in areas where massive sandstone dominates the succession. The boundaries between the Texas Beds and the isolated areas of Permian outcrop are in many places faulted, and it is suspected that many faults occur within the Lower Carboniferous sequence. Regionally, the Texas Beds have been folded into a large synclinal structure. It is outlined by bedding trends which swing from north-northwest near the New England Batholith, through west and southwest between Gore and Limevale, to south-southeast at Texas and Yetman. A small subsidiary fold occurs on the west flank of the structure in the Silver Spur area, where Permian rocks are infolded with the Carboniferous sequence; this indicates that the Texas Beds were subjected to late or Post- Permian deformation. The mineralization at Silver Spur occurs along the axis of the subsidiary fold.

Relationships: Overlies the Silverwood Group probably unconformably (see p. 24), unconformably overlain by Permian and Mesozoic strata, and intruded by the Permian-Triassic granites of the New England Batholith. The unconformity with the Permian rocks is well exposed at Glenmore homestead (Fig. 38), northwest of Silver Spur (Fig. 37), at Terrica homestead (Fig. 35) and northwest of Alum Rock homestead (Fig. 33).

Age: Lower Carboniferous, possibly extending into the Upper Devonian and Upper Carboniferous. Lower Carboniferous corals have been found in many of the limestone lenses (Appendix 2) and questionable Upper Carboniferous fossils have been collected from the area northeast of Terrica homestead (Appendix 5 & Fig. 35).

Thickness: Unknown, but great.

Emu Creek Formation (new name)

Derivation of name: The Emu Creek Formation was originally named the Emu Creek Series (Voisey, 1936), which was changed to Emu Creek Beds (Voisey *in* McElroy, 1962). The series, as defined by Voisey (1936, 1939), included sediments which are now recognized as being of Permian age and are named the Paddys Flat Formation; they overlie the Emu Creek Formation unconformably.

Reference area: Along the banks of Emu Creek, near Jump-Up Hill, 13 km north-northeast of Drake.

Distribution: A continuous belt 35 km long and up to 5 km wide, trending north-northwest, from 3 km northeast of Lunatic mine, 10 km north-northeast of Drake, to 8 km northeast of Rivertree on the upper Clarence River.

Lithology: Interbedded sequence of fine-grained feldspathic and lithic sandstone, dark grey siltstone, mudstone, and polymictic paraconglomerate containing well rounded clasts of granitic and volcanic rocks.

Relationships: The western boundary is in fault contact with Permian sediments and volcanics; to the east, the formation is unconformably overlain by the Lower Permian Paddys Flat Formation, to the north it is unconformably overlain by the Jurassic Marburg Sandstone, and it is intruded by late Permian or early Triassic granitic bodies.

Thickness: 1500+ m.

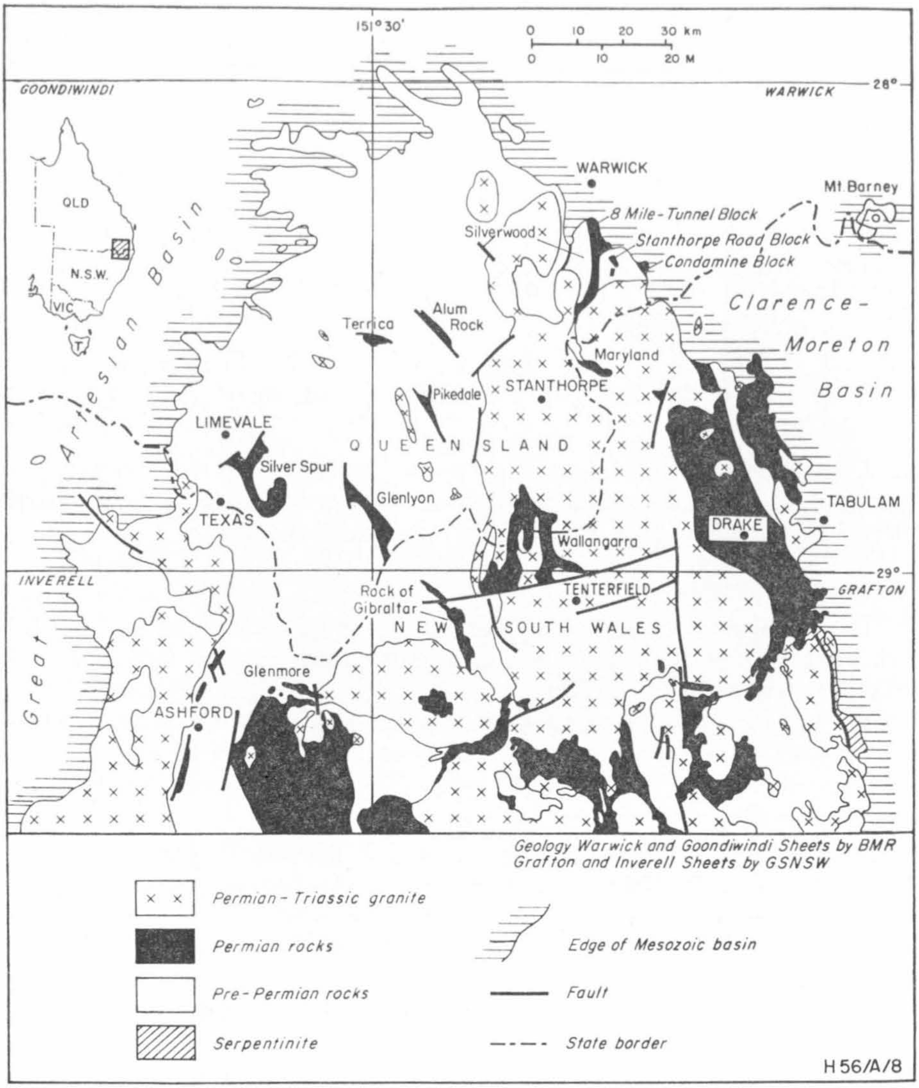


Fig. 27. Permian of the northern part of the New England Fold Belt.

Age: Upper Carboniferous. The formation contains fenestellids, a trilobite, and a rich shelly fauna characteristic of the *Levipustula levis* Assemblage Zone (*of* Campbell & Roberts *in* Packham, 1969, p. 262).

Mount Barney Beds (Stephenson, 1959)

Derivation of name: Mount Barney (1320 m), 50 km southwest of Beaudesert, just north of the state border.

Reference area: The hilly country immediately to the east of the steep peaks of Mount Barney.

Distribution: An area of approximately 16 km^2 immediately surrounding Mount Barney.

Lithology: The sequence begins with 90 to 150 m of calc-silicate rocks (probably limestone metamorphosed by the intrusion of Mount Barney), which are followed by 90 m of lithic and feldspathic sandstone with interbedded rhyolitic and trachytic lava flows and tuffs, and dark, fine-grained siltstone. Spiriferid remains are present. Carbonaceous material occurs in the finer sediments, in which Stephenson (1959) recorded *Lepidodendron.* Succeeding these beds is the main sequence of lithic and feldspathic sandstone, conglomerate, and dark bryozoan and crinoidal mudstone (Appendix 4), which reaches a thickness of about 1800 m. A narrow band of dark mudstone about 600 m above the base contains a *Levipustula* fauna. The conglomerate is persistent throughout the area and consists of well rounded pebbles of trachyte and rhyolite up to 8 cm in diameter. Some of the sandstones are cross-bedded and ripple marked.

Relationships: The sequence has been upthrust through Mesozoic strata by the forceful intrusion of the Tertiary Mount Barney igneous complex.

Thickness: 2100+ m.

Age: Upper Carboniferous. The marine fossils identified from the sediments have been listed by Maxwell (*in* Hill & Denmead, 1960, pp. 167-8) and the material collected by the authors was examined by Wass (Appendix 4).

PERMIAN

The Permian rocks are mainly confined to small outliers, inliers, and fault blocks; one large area of outcrop is east of the New England Batholith in the Drake-Rivertree region (Fig. 27).

The Permian strata in the Silverwood area, which occur in three fault blocks, the Condamine, Stanthorpe Road, and Eight Mile & Tunnel Blocks, were first mapped by Richards & Bryan (1923; 1924), whose nomenclature has been used in this Report (Fig. 14).

Lucas (1957, 1958) mapped the area west of the New England Batholith; he considered large areas to be made up of Permian rocks, but our mapping has shown that the Permian strata are confined to small outliers within the Lower Carboniferous sequence. Five outliers were recognized and mapped, but there may be others.

Correctly, the strata in each outlier should be given a different stratigraphic name; however, this would in the future lead to a multitude of names covering a small area of outcrop of rocks which are of the same age and lithologically indistinguishable. To avoid this, new names have not been introduced for newly mapped areas of Permian outcrop west of the batholith, and the nomenclature used by Lucas (1959, 1960) has not been used in this Report or on the accompanying geological maps.

The Drake region of New South Wales was mapped by Andrews (1908) and Voisey (1936, 1939). In 1957, Voisey proposed a new stratigraphic subdivision and nomenclature for the Permian sequence in the Drake region (Fig. 14), without describing the units or showing their distribution. That nomenclature is only partly used here. The authors subdivided the sequence between Rivertree and Drake into four units (from the base upward): Paddys Flat Formation (new unit), Razorback Creek Mudstone (new unit), Drake Volcanics (Andrews, 1908), and Gilgurry Mudstone (Voisey, 1957).

The Permian rocks at Wallangarra and in the Maryland River northeast of Stanthorpe, which were first recorded by Andrews (1905) and Voisey (1939) respectively, remain unnamed.

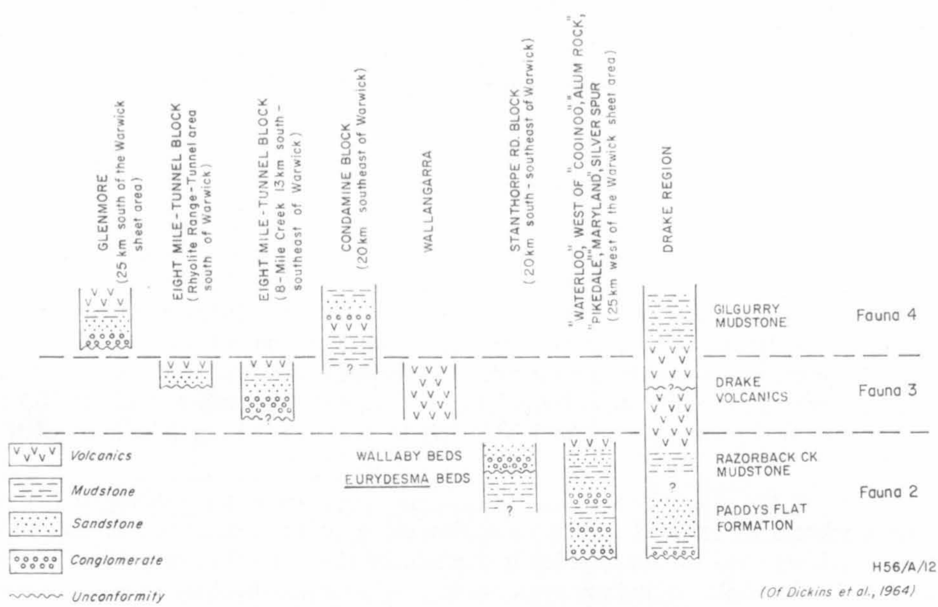


Fig. 28. Permian correlation chart. (Thickness not to scale).

Eight Mile Creek Beds (Richards & Bryan, 1924)

Derivation of name: Eight Mile Creek, 12 km south of Warwick.

Type area: Eight Mile Creek.

Distribution: An area of about 3 km^2 along Eight Mile Creek, 3 km northeast of Silverwood siding (Fig. 17). The outcrop of the lower part of the sequence is generally poor, but the upper part is well exposed in Eight Mile Creek and the small tributaries that join it from the north.

Lithology: The lower 450 m of the unit consists of sedimentary rocks including conglomerate (containing pebbles of chert, silicified sandstone, and volcanic rock), pebbly lithic sandstone, grey very hard well sorted lithic sandstone containing abundant marine fossils, siltstone, and mudstone. The upper part of the sedimentary sequence contains in places abundant Lower Permian marine macrofossils. The *Glossopteris*-bearing shales reported by Richards & Bryan (1924) could not be located. The upper 450 m of the Eight Mile Creek Beds are entirely made up of acid volcanic rocks, including agglomerate, breccia, tuff, and crystal lithic tuff. The volcanics are thought to be equivalent to the volcanic rocks of the Rhyolite Range Beds, from which they are separated by intrusive rocks.

Relationships: The Eight Mile Creek Beds are faulted against the Rosenthal Creek Formation, are in contact with the Connolly Volcanics, are intruded by quartz-feldspar porphyry and spherulitic rhyolite, and are unconformably overlain by the Jurassic Marburg Sandstone. The contact with the Connolly Volcanics is poorly exposed, but the lowermost Permian rocks are conglomerate containing abundant rounded pebbles of Devonian rocks and there is no evidence for faulting; the contact is probably an unconformity.

Thickness: About 900 m.

Age: Lower Permian. The marine fossils belong to Fauna 3A (Appendix 1).

Rhyolite Range Beds (Richards & Bryan, 1924)

Derivation of name: Rhyolite Range, a prominent north-trending ridge which is approximately 5 km long and situated to the east of Rosenthal Creek, about 8 km south of Warwick (Fig. 17).

Reference area: Rhyolite Range and the area directly east of it, opposite the point where the Warwick to Connolly Dam road crosses Rosenthal Creek (Fig. 17).

Distribution: The Rhyolite Range Beds crop out in the Eight Mile & Tunnel Block. Richards & Bryan (1924) mapped the Eight Mile and Tunnel Blocks as separate entities, but recent mapping has shown them to be connected (Fig. 17). The southern boundary of the Tunnel Block, as mapped by Richards & Bryan, no longer exists, because Permian volcanics and sediments extend up to 6 km south and southwest of Oaklands homestead. The Eight Mile & Tunnel Block is about 18 km long and its width varies from 3 km in the south, narrowing to about 500 m in the central connecting area, and widening to 3 km in the northern part of the block.

Lithology: In the reference area, the east-dipping sequence consists of about 120 m (the thickness of exposed sediments varies along strike because of faulting) of lithic sandstone and siltstone, which is overlain by about 1200 m of predominantly acid volcanic rocks including agglomerate, spherulitic rhyolite, quartz-feldspar porphyry, crystal tuff, and minor dacitic to andesitic lavas. The spherulitic rhyolite occurs in massive lenses which may be sills related to the rhyolite dome that intrudes the Permian sequence 2.5 km northeast of Silverwood siding. This is supported by the presence, just north of Ormoral siding, of east-trending flow-banded spherulitic rhyolite dykes which intrude the Rosenthal Creek Formation. A succession similar to that in the reference area is present in the southern part of the Eight Mile & Tunnel Block. About 1.5 km south-southwest of Oaklands homestead gently dipping Permian sediments unconformably overlie steeply dipping sheared siltstones of the Rosenthal Creek Formations. The unconformity is in places faulted or intruded by a quartz-feldspar porphyry dyke. This is the only known locality where the Devonian-Permian unconformity can be demonstrated.

To the northeast and southwest of Rosenthal Creek, about 1 km northeast of Oaklands homestead, more than 300 m of Permian sedimentary rock is exposed. This consists of fine to medium-grained lithic sandstone, pebbly sandstone, calcareous siltstone, and mudstone. Of special interest is the occurrence, both in the railway cutting in the northwestern part of the Eight Mile & Tunnel Block and in this area, of a fine-grained yellow sandstone on whose upper surface are numerous worm trails (Fig. 22). From its stratigraphic position it would appear to be very close to the base of the sequence. These sediments are overlain by about 450 m of acid volcanic rocks, including agglomerate, quartz porphyry, spherulitic rhyolite, and crystal tuff.

Relationships: The Rhyolite Range Beds unconformably overlie the Rosenthal Creek Formation and are faulted against the Silverwood Group, intruded by spherulitic rhyolite and the Stanthorpe Adamellite, and unconformably overlain by the Marburg Sandstone. The correlation with other Permian strata in the region is set out in Figure 28.

Thickness: Sediments about 300 m; volcanics 1200 m. The base and top of the sequence are not exposed.

Age: Lower Permian. The marine fossils belong to Fauna 3A (Appendix 1).

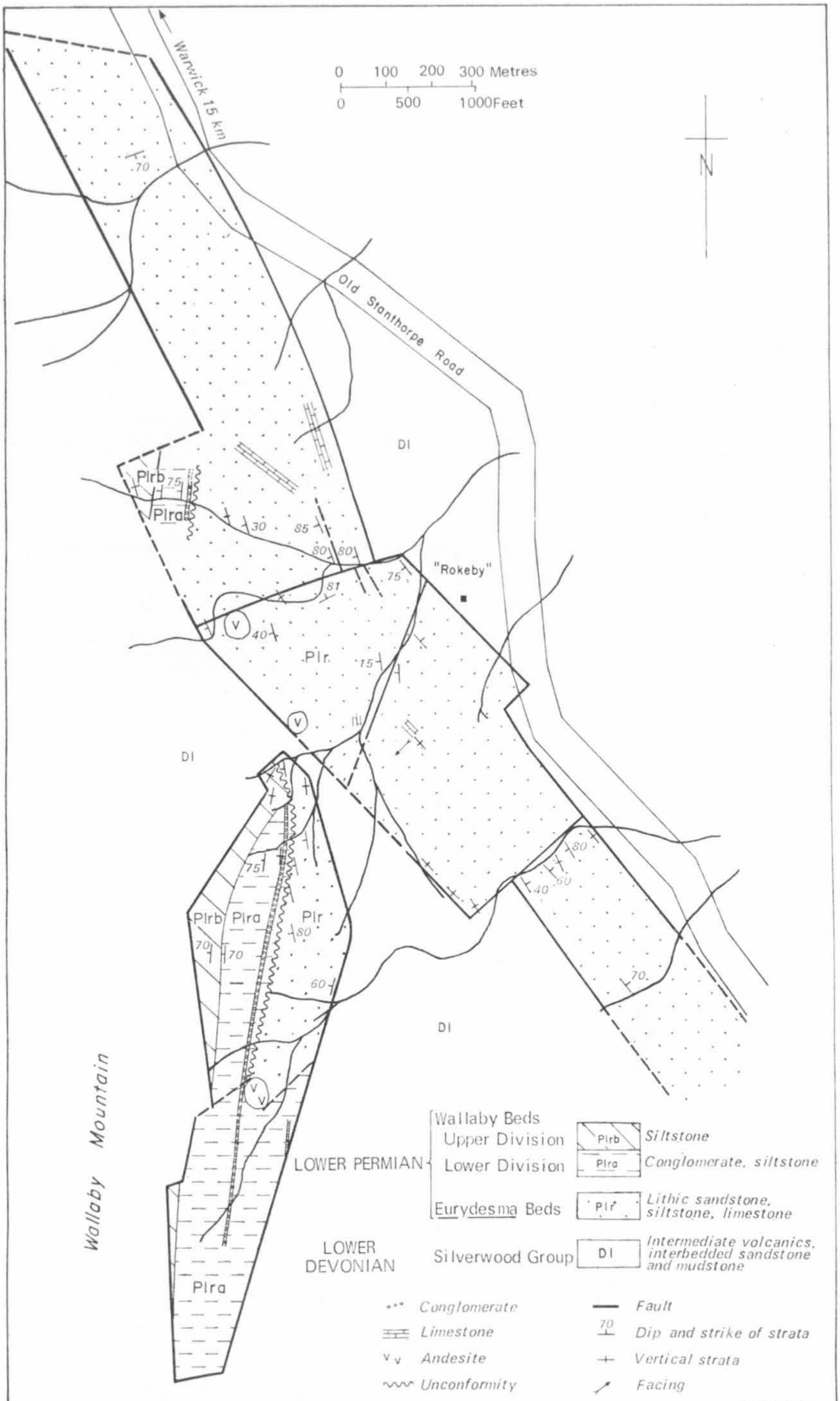


Fig. 29. Stanthorpe Road blocks, Warwick district.

Eurydesma Beds and Wallaby Beds (Richards & Bryan, 1924)

Derivation of name: The names were first used by Richards & Bryan (1924) to describe the sedimentary sequence cropping out in the Stanthorpe Road Block. The name *Eurydesma* Beds is applied to the lower part of the sequence, in which the fossil *Eurydesma* abounds, and the name Wallaby Beds refers to the upper part of the sequence, which crops out on the east slope of Wallaby Mountain, 1.5 km south-southwest of Rokeby homestead (Fig. 29).

Distribution: Richards & Bryan (1924) did not map the twofold subdivision; Armstrong's (1965, 1966) mapping is shown in Figure 29. Because of the limited extent of both units, they are combined on the Warwick 1:250 000 Sheet. Armstrong (1965) was the first to recognize that the Stanthorpe Road Block is two separate blocks. The eastern is about 1.5 km long and less than a kilometre wide, and the smaller western block is 1 km long and one third of a kilometre wide (Fig. 29).

Lithology: The *Eurydesma* Beds consist of conglomerate, fine to medium-grained lithic sandstone, dark calcareous siltstone, and thin-bedded limestone. The Wallaby Beds are divisible into two members of approximately equal thickness; the lower consists of conglomerate, lithic sandstone, and siltstone, and the upper predominantly of ferruginous siltstone.

Relationships: Richards & Bryan (1924) were unable to decide whether the junction between the *Eurydesma* Beds and the Wallaby Beds was an unconformity or a fault. Voisey (1936) suggests that the junction is a fault, but Armstrong (1965, 1966) states that it is more likely to be a small angular unconformity, and we agree. Both sequences are downfaulted against the Connolly Volcanics and Rosenthal Creek Formation. The correlation of the *Eurydesma* and Wallaby Beds with the Permian rocks of the Condamine and Eight Mile & Tunnel Blocks and the other Permian strata in the region is shown in Figure 28.

Thickness: Eurydesma Beds about 200 m and the Wallaby Beds about 150 m. The base and top of the sequence are not exposed.

Age: Lower Permian. The marine fossils belong to Fauna 2 (Dickins, pers. comm.).

Condamine Beds (Richards & Bryan, 1924)

Derivation of name: Condamine River south of Warwick.

Type area: Lucky Valley Creek and Condamine River 21 km south-southeast of Warwick.

Distribution: About 25 km^2 in the type area (Figs 17 & 30).

Lithology: Figure 30 shows the section that was measured along Lucky Valley Creek from the Condamine River to the boundary fault in the west. The lower 330 m of the section consists of dark grey to black slightly calcareous mudstone with some thin beds of fine-grained sandstone. A richly fossiliferous bed occurs near the top of the mudstone sequence (Fig. 30, Loc. TH408). Scattered outcrops east of the Condamine River consist mainly of calcareous mudstone similar to the mudstone of the lower part of the measured section. Corals were observed at several localities.

The mudstone sequence is overlain by two thick beds of rhyolitic crystal-lithic tuff, which are separated by black fossiliferous mudstone and some coarse-grained sandstone and conglomerate. The volcanics are followed by about 300 m of poorly sorted sandstone, pebbly sandstone, and conglomerate. Some of the sandstones

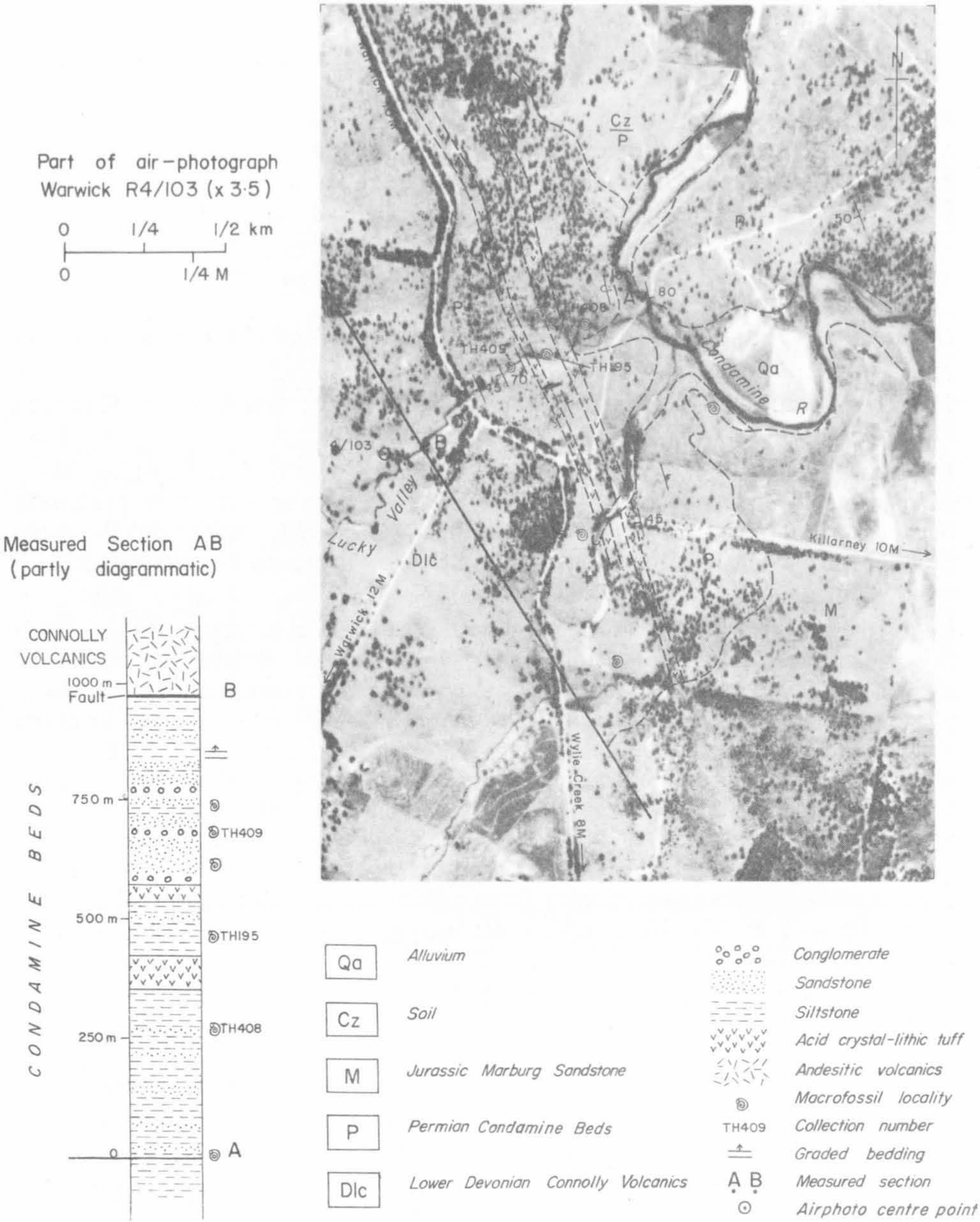


Fig. 30. Condamine block, Warwick district.

contain abundant large angular feldspar fragments, and thin beds of tuff and reworked tuff occur. Fossils occur particularly in the coarser grained rocks.

The upper part of the Condamine Beds consist of about 300 m of unfossiliferous mudstone and fine-grained sandstone which are similar to the fine-grained rocks that make up the lower part of the unit.

Relationships: Faulted against Devonian strata to the west and overlapped from the east by the Jurassic Marburg Sandstone. For correlation with other Permian strata, see Figure 28.

Thickness: The exposed thickness is about 2000 m, assuming that the beds east of the Condamine River dip westerly at an average angle of 50 degrees.

Age: Upper Permian. The marine macrofossils belong to Fauna 4 (Dickins, pers. comm.).

Remarks: Outcrop is generally poor but a good section is exposed along Lucky Valley Creek, which flows across the upper part of the exposed sequence. The beds dip generally to the west at angles ranging from 45° to 70°; at the Condamine River, the sequence is slightly overturned and dips steeply to the east.

Paddys Flat Formation (new name)

Derivation of name: Paddys Flat on the Clarence River, 25 km northwest of Tabulam.

Type area: Exposures along the banks of the Clarence and Cataract Rivers at Paddys Flat.

Distribution: A north-northwest trending belt, 6 km wide and 40 km long, along the Tooloom-Tabulam road. The formation includes the sediments previously referred to the Plumbago Creek Beds (Voisey, 1936, 1939, 1957), and the rocks which were previously included in the Emu Creek Formation but are now known to be younger.

Lithology: The formation is essentially a well bedded sequence of sandstone, mudstone, siltstone, conglomerate, tuff, and minor limestone. In the type area, the sequence consists of a basal conglomerate containing abundant quartz-feldspar porphyry clasts, cherty material, and other sedimentary fragments derived from the underlying Emu Creek Formation. This is followed by mudstone and a well bedded sequence of fine-grained, poorly sorted siltstone and fine-grained sandstone, cross-bedded in places. A prominent massive conglomerate bed crops out near the junction of the Cataract and Clarence Rivers. This is followed by a massive sandstone sequence which is well bedded and cross-bedded, and in which the upper surface of some beds display large asymmetrical ripple marks with wavelengths up to 1 m. Massive conglomerate beds up to 6 m thick are interbedded with the sandstone sequence.

East of the Tabulam-Tooloom Road, the formation consists of conglomerate, sandstone, pebbly sandstone, and mudstone. This part of the sequence is not obviously bedded and the rocks are more deformed because of the proximity of granitic intrusions. One isolated lens of limestone, which was mentioned by Voisey (1936, 1939, 1957) and included by him in the Plumbago Creek Beds, occurs in the formation. The limestone crops out on Plumbago Creek, west of the Pretty Gully Road, about 10 km northwest of Tabulam. Its relationship with the adjacent poorly fossiliferous sediments is not understood, and any trace of fossils in the limestone has been obliterated by recrystallization.

Relationships: Unconformably overlies the Upper Carboniferous Emu Creek Formation and is unconformably overlain by the Jurassic Marburg Sandstone and Tertiary basalt. It is intruded by granites that are probably of late Permian or early Triassic age. The relationships of the Paddys Flat Formation with the Permian sequence farther to the west, from which it is separated by a narrow belt of Upper Carboniferous rocks (Pl. 1), is not exactly known, but the formation is, on stratigraphic grounds, thought to be older than that sequence (Fig. 28 & Pl. 1, cross-section D-E-F).

Thickness: At least 2400 m. Top not exposed.

Age: Lower Permian. The marine fossils belong to Fauna 2 (Dickins, pers. comm.).

Razorback Creek Mudstone (new name)

Derivation of name: Razorback Creek, a north-flowing tributary of the Maryland River, 32 km east of Stanthorpe.

Type area: Razorback Creek and Razorback Ridge east of the creek, 8 km southwest of Rivertree homestead.

Distribution: About 100 km^2 along Razorback Creek and northwest and southeast of Rivertree homestead.

Lithology: Massive olive-green mudstone.

Relationships: The base is not exposed and the relationship with the Paddys Flat Formation, which on stratigraphic grounds is the older, is not known (Fig. 28). The formation grades upwards into the Drake Volcanics; the contact is taken below the first prominent bed of tuff. The eastern margin of the Rivertree outcrop belt is faulted against the Emu Creek Formation. The unit is intruded by granite and basic dykes.

Thickness: About 300 m; base not exposed.

Age: The Razorback Creek Mudstone is unfossiliferous, but since it passes conformably into the Drake Volcanics, it is considered to be Lower Permian.

Drake Volcanics (Andrews, 1908)

Derivation of name: Drake, a small township on the Bruxner Highway between Tenterfield and Tabulam. The name was first used by Andrews (1908, p. 11) for the volcanic sequence that crops out in the Drake district. Voisey (1936, 1939) included part of the volcanic sequence in the Lower Division of his Drake Series (Fig. 14), and in 1957 he introduced a subdivision of the Permian sequence in the Drake region without defining the units (Fig. 14). Voisey's (1957) nomenclature for the volcanic rocks is not used here. The name Drake Volcanics should be used until the boundary between the two units into which the volcanic sequence possibly can be subdivided (p. 46) has been mapped.

Reference area: Road cuttings along the Bruxner Highway, from 10 km east to 6 km west of Drake where the highway descends Newmans Pinch (Pl. 1).

Distribution: An area of about 650 km^2 centred about Drake and extending southward into the Grafton Sheet area.

Lithology: In the north, the Drake Volcanics are essentially a sequence of interbedded grey to greenish-grey acid to intermediate volcanic flows and fine-grained volcanolithic sediments. In the south, the formation consists of a thick sequence of pyroclastic rocks, including dark grey to purplish agglomerate, coarse-grained tuff and crystal-lithic tuff, and volcanic breccia. Some volcanolithic sediments are present and a small lens of limestone, consisting largely of crinoidal material, occurs in a road cutting at Newmans Pinch west of Drake. Only a very small part of the Drake Volcanics in the south is lava.

Although the volcanic sequence has been mentioned by numerous authors (Andrews, 1908; Browne, 1929; Voisey, 1936, 1939; Leitch, 1969; McKelvey & Gutsche, 1969), it has never been examined petrologically in any detail.

Relationships: Conformably overlies the Razorback Creek Mudstone and is conformably overlain by the Gilgurry Mudstone. The boundaries with both units

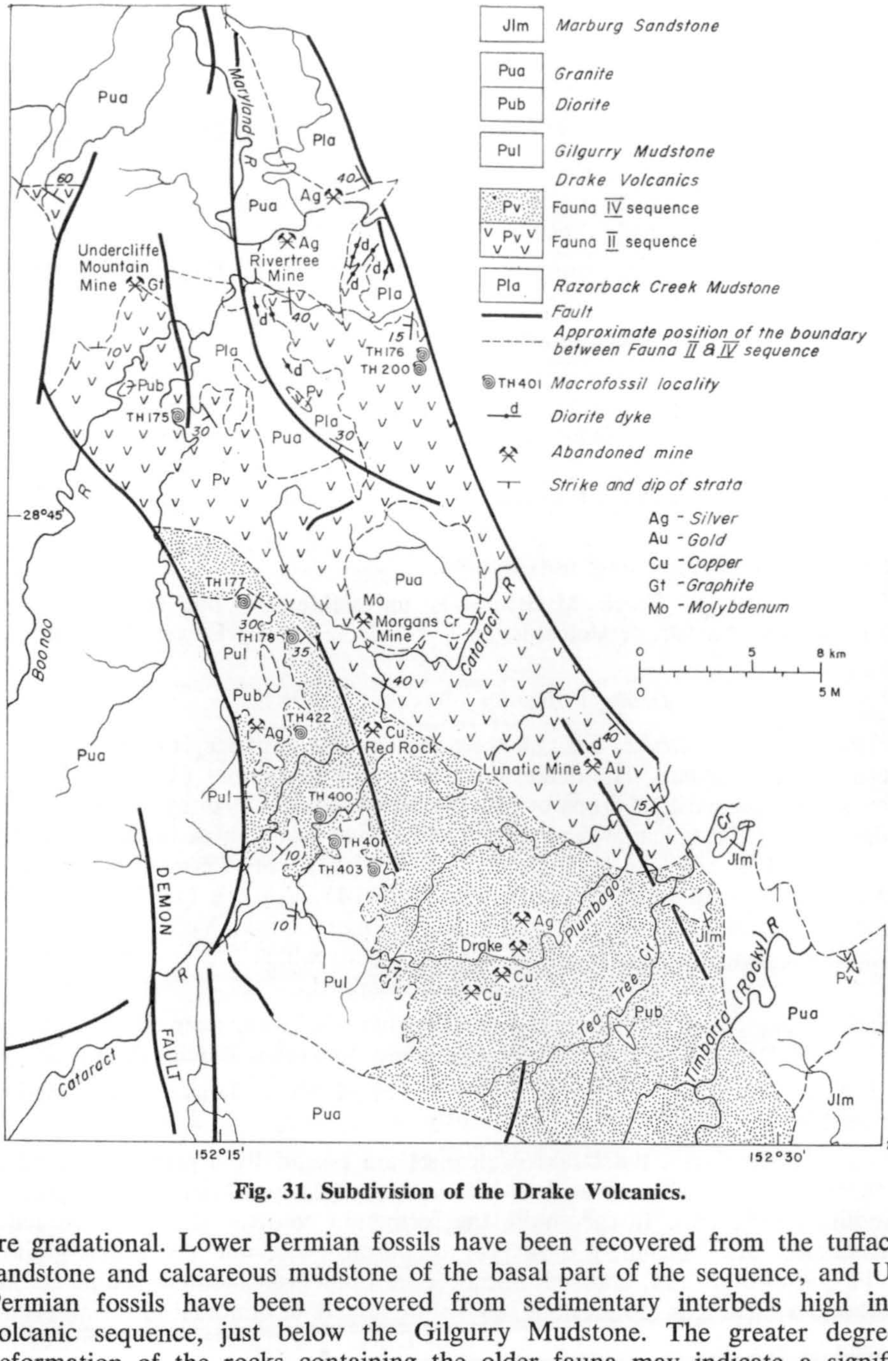


Fig. 31. Subdivision of the Drake Volcanics.

are gradational. Lower Permian fossils have been recovered from the tuffaceous sandstone and calcareous mudstone of the basal part of the sequence, and Upper Permian fossils have been recovered from sedimentary interbeds high in the volcanic sequence, just below the Gilgurry Mudstone. The greater degree of deformation of the rocks containing the older fauna may indicate a significant break within the sequence. No such break could be located in the field, but Figure 31 shows the approximate location of the change from moderately steeply dipping interbedded sediments and volcanics to less disturbed pyroclastics and flows. This subdivision could possibly correspond to Telford's (1971) subdivision of the volcanic sequence near Red Rock into Cheviot Hills Beds (top) and Cataract River Formation (the names were introduced by Voisey in 1957).

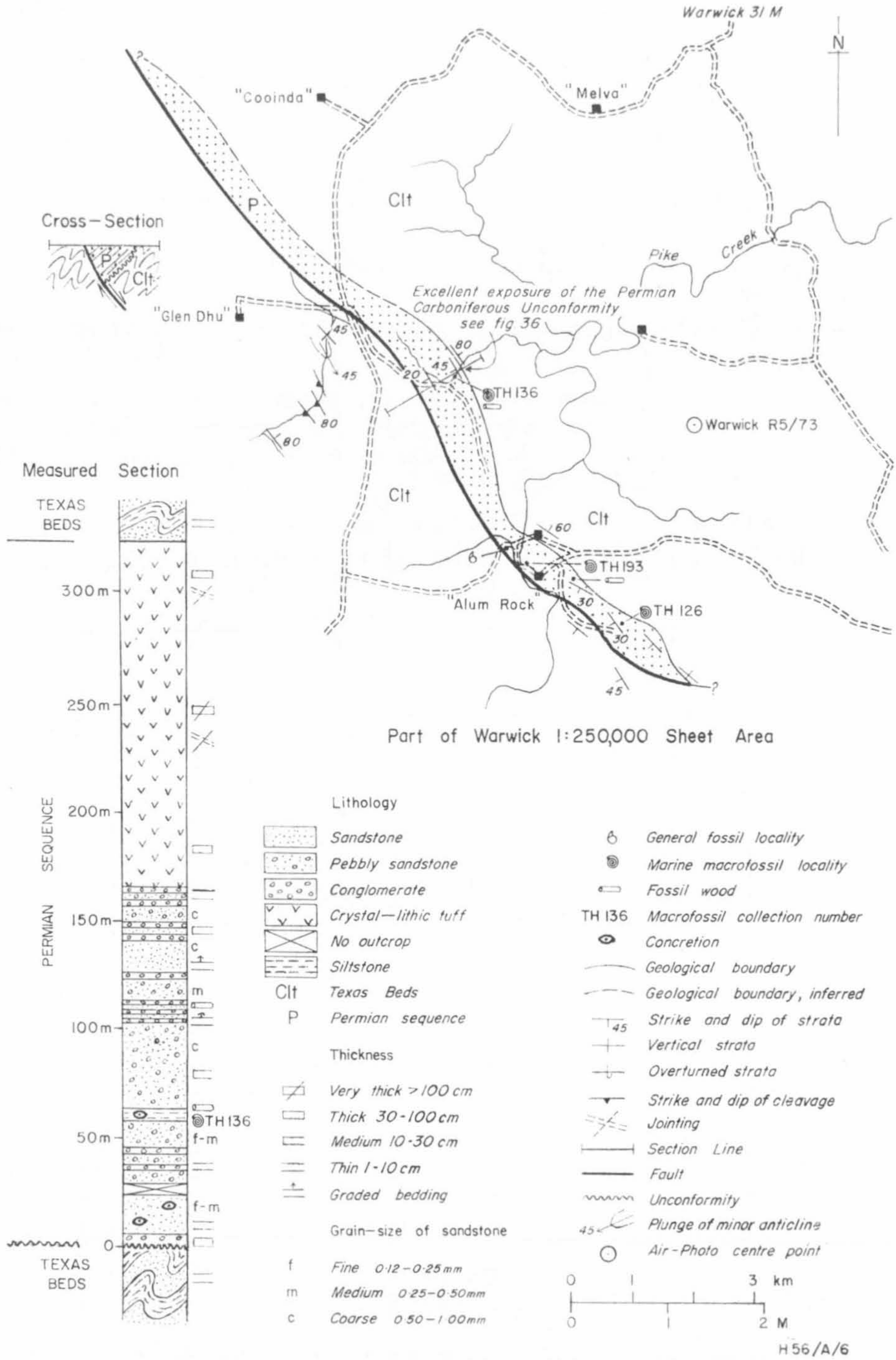


Fig. 32. Permian sequence at Alum Rock homestead.

Thickness: About 450 m.

Age: Lower to Upper Permian. The marine faunas belong to Faunas 2 and 4 (Dickins, pers. comm.).

Gilgurry Mudstone (Voisey, 1957)

Derivation of name: The name, which was introduced without definition by Voisey (1957), was derived from Gilgurry Creek, which heads about 1.5 km north of Boorook homestead, and flows northward into the Boonoo Boonoo River.

Reference area: Road cuttings along the Bruxner Highway for 6 km east of Sandy Hill.

Distribution: An area of approximately 75 km^2 southeast and northeast of Sandy Hill, 13 km west of Drake.

Lithology: Dark grey to green siltstone, siliceous and calcareous mudstone, and minor light brown feldspathic sandstone.

Relationships: The unit conformably overlies the Drake Volcanics. The base is exposed in road cuttings west of Newmans Pinch. The upper part of the sequence has been removed by erosion. In the west and southwest, the formation is faulted against the Stanthorpe Adamellite.

Thickness: 150 m.

Age: Upper Permian. The marine fossils belong to Fauna 4 (Dickins, pers. comm.).

Fig. 33. Carboniferous-Permian unconformity exposed 3 km north-northeast of Alum Rock homestead. Looking south, the west-dipping (30°) Lower Permian basal conglomerate, which is about 3 m thick, rests unconformably on steeply east-dipping sandstone-mudstone-chert interbeds of the Lower Carboniferous Texas Beds.

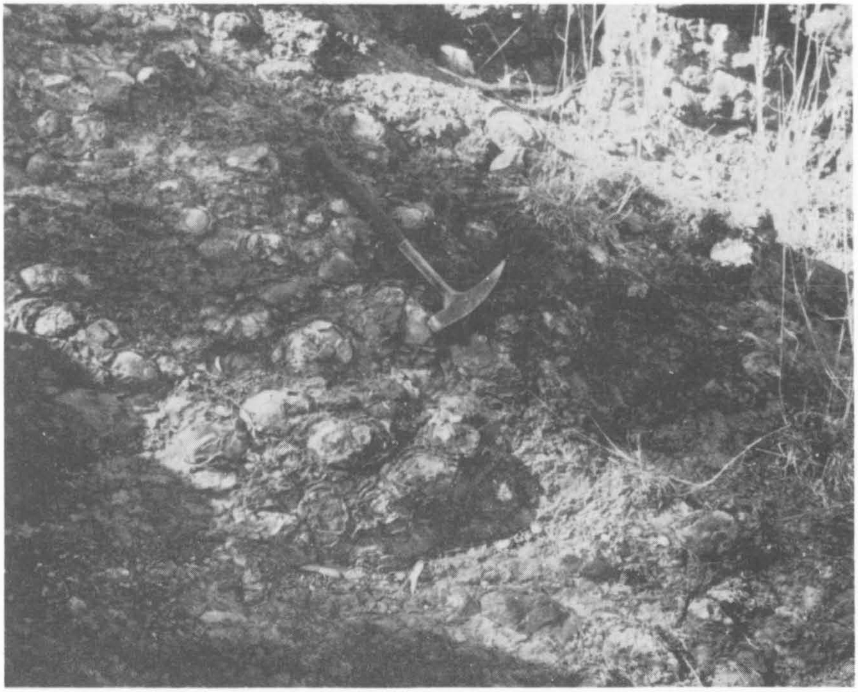


Fig. 34. Concretionary siltstone of the Lower Permian sequence exposed 3 km north-northwest of Alum Rock homestead.

Permian rocks at Alum Rock homestead

Nomenclature: Lucas (1958) first recorded Permian rocks in the vicinity of Alum Rock homestead and referred to them as the Alum Rock Conglomerate. The name is not used here (see p. 38).

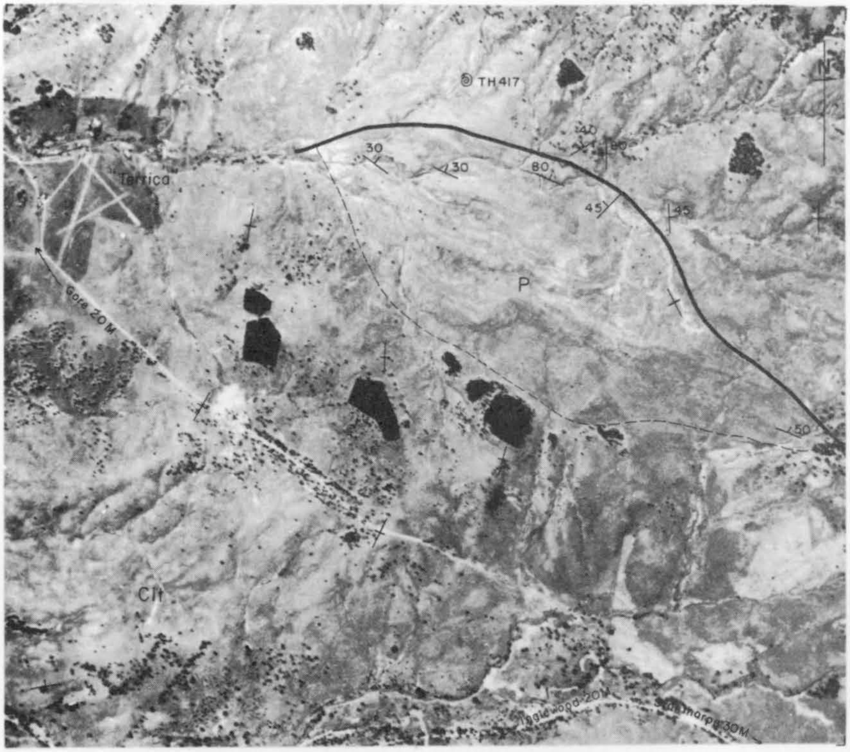
Location: A narrow outlier in Carboniferous rocks at Alum Rock homestead. The extent of the outlier and the relationships with the surrounding rocks were established during the present survey.

Lithology: The lower 165 m of the sequence consists mainly of conglomerate, poorly sorted sandstone, and pebbly sandstone, with only one prominent bed of siltstone about 60 m above the base of the succession (Fig. 32). The conglomerate is thin to thick-bedded, in places graded, and contains pebbles directly derived from the underlying Carboniferous sequence. The sandstone contains abundant rock fragments; it is poorly sorted and pebbly and in places shows graded bedding. The siltstone bed is concretionary (Fig. 34) and contains marine fossils and pieces of fossil wood up to 20 cm long. The upper part of the sequence consists largely of crystal-lithic tuff and reworked tuff with some spherulitic rhyolite (Fig. 32).

Relationships: The Permian rocks unconformably overlie the Carboniferous sequence along the eastern margin of the outcrop belt, and the western margin is entirely faulted. The Permian rocks dip southwesterly at angles progressively decreasing from 45° at the unconformity to 20° near the western margin of the outlier. The unconformity is of high angle and very well exposed in a gully 4 km northwest of Alum Rock homestead (Fig. 33); it can best be reached from the Warwick to Pikedale road (Fig. 32).

Thickness: About 300 m.

Age: Lower Permian. The fossils belong to Fauna 2 (Dickins, pers. comm.).



Part of air-photograph Warwick Run 5 No 67 (x2)

0 1 2 km

0 1 M

P	*Permian strata*	——	*Fault*
Clt	*Lower Carboniferous Texas Beds*	----	*Geological boundary (unconformity)*
⑤	*Macrofossil locality*	┬	*Strike and dip of strata*
TH417	*Collection number*	┼	*Vertical strata*

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Fig. 35. Permian sequence near Terrica homestead.

Permian rocks at Terrica homestead

Nomenclature: The sequence has previously been referred to as the Terrica Beds (Lucas, 1959, 1960), but the name is not used here (see p. 38).

Location: A small outlier 1.5 km east of Terrica homestead on the boundary between the Warwick and Goondiwindi Sheet areas (Fig. 35).

Lithology: The sequence consists of conglomerate containing abundant chert pebbles, poorly sorted lithic sandstone, and pebbly sandstone containing pebbles of chert, sandstone, and volcanic rocks mainly derived from the underlying Texas Beds, and dark grey mudstone.

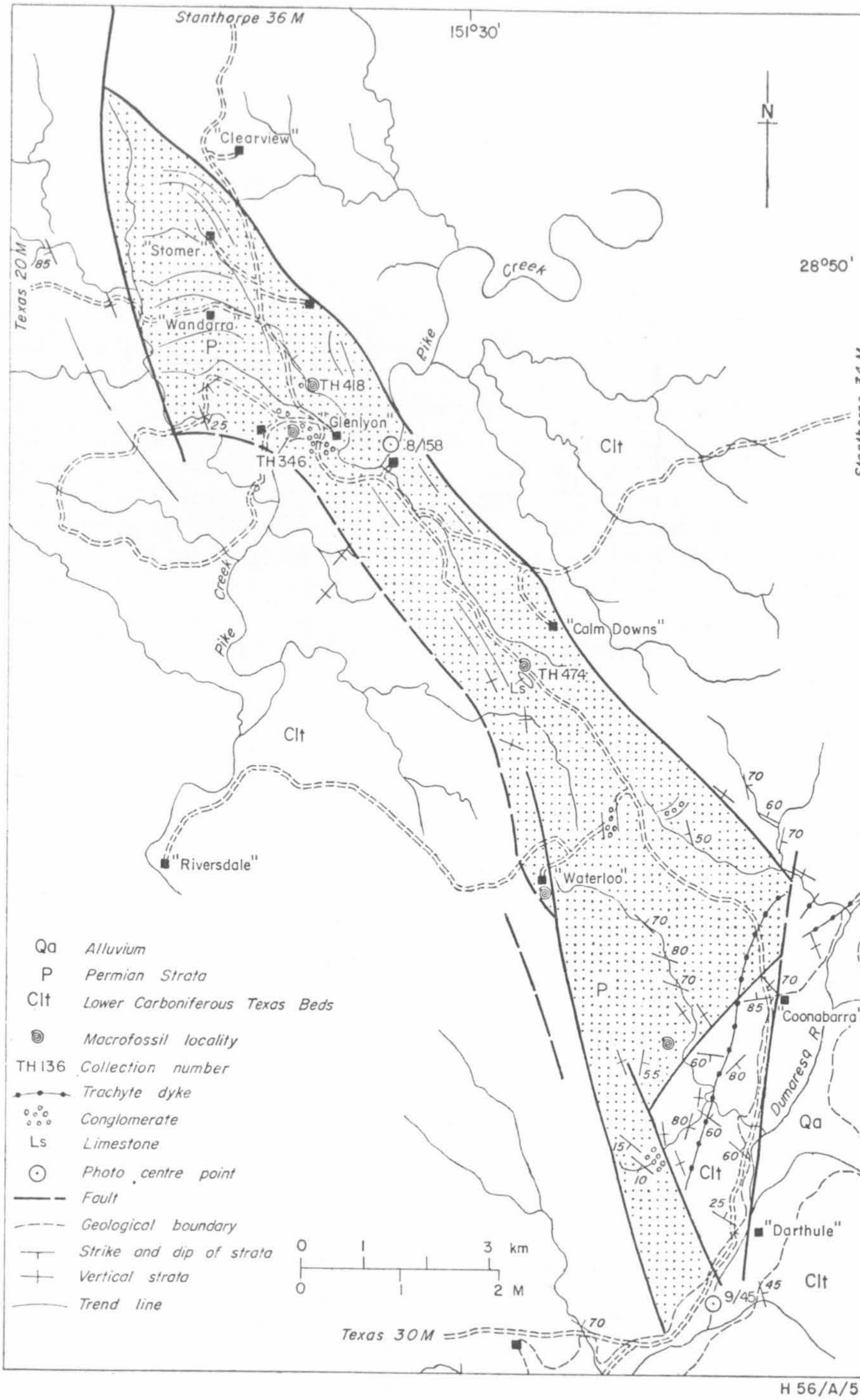


Fig. 36. Permian sequence, Glenlyon area.

Relationships: Unconformable on and faulted against the Lower Carboniferous Texas Beds. The Permian-Carboniferous unconformity can readily be demonstrated in the field. The outcrop in the vicinity of the western contact between the Permian and Lower Carboniferous strata is very poor; the lowermost Permian rocks, which dip at a low angle to the northeast, strike across northeast-trending strike ridges made up of steeply dipping to vertical bands of chert. There is no evidence of faulting or low-angle thrusting.

Thickness: Preserved thickness about 300 m.

Age: Permian. Lucas (1957) reports Permian fossils from the area, but none were found during the present survey.

Permian rocks at Pikedale homestead

Conglomerate, lithic sandstone, mudstone, and acid volcanic rocks occur in a small area near Pikedale homestead. Outcrop is generally poor and the boundaries between these rocks and the typical Lower Carboniferous interbedded sandstone-mudstone sequence surrounding it have not been well established, but are thought to be largely faulted. Identifiable macrofossils have not been found, but fossil wood and crinoid columnals are abundant in poorly sorted conglomerate and conglomeratic sandstone just northeast of the bridge across Pike Creek. The Permian age which has been assigned to the sequence is based on the close similarity between these rocks and the Permian strata preserved in the other small outliers in the region.

Permian rocks at Glenlyon homestead

Lower Permian fossils have been known from the vicinity of Glenlyon homestead in the southeast of the Goondiwindi Sheet area for some time, and Lucas (1960) included the sequence in the Silver Spur Beds. Detailed mapping in the area has shown that the Permian rocks are restricted to a narrow southeast-trending belt from the vicinity of Clearview homestead in the north to the Dumaresq River in the south (Fig. 36). Lower Carboniferous rocks crop out on the south bank of the river, but 3 km to the southeast along the Bruxner Highway are outcrops of conglomerate which are probably Permian, and still farther to the southeast in the valley of the Mole River are extensive outcrops of Permian sediments and also volcanics (Fig. 27). The Glenlyon outlier is probably completely fault-bounded. In the north the rocks generally dip at low angles to the south and southwest and in the south the beds are mainly steeply inclined to vertical. The sequence consists of conglomerate made up of well rounded pebbles and cobbles of silicified sandstone, chert, and volcanic rocks, set in a mudstone or sandstone matrix, lithic sandstone consisting mainly of volcanic rock fragments, pebbly lithic sandstone, pebbly mudstone, and minor poorly fossiliferous limestone. Lower Permian marine fossils belonging to Fauna 2 (Dickins, pers. comm.) were noted at several localities.

Permian rocks at Silver Spur

Nomenclature: The Permian sequence in the Silver Spur area was previously mapped as the Silver Spur Beds (Lucas, 1959, 1960). The name was applied to a large area in the vicinity of Silver Spur, to a northwest-trending belt of country from Red Gate homestead in the north into the valley of the Mole River south of the Rock of Gibraltar (Grafton Sheet), and to two smaller areas of outcrop northwest and southwest of Pikedale homestead (Lucas, 1960). The present survey has revealed that the greater part of these areas mapped as Silver Spur Beds are part of the Lower Carboniferous sequence and that the Permian strata are restricted to very small outliers. The name Silver Spur Beds is not used here (see p. 38).

Location: An irregularly shaped outlier 3 km east of Texas.

Lithology: Conglomerate, sandstone, mudstone, and some thin beds of limestone. The conglomerate consists of well rounded pebbles, cobbles, and boulders of silicified sandstone, chert, and granite. Boulders of granite up to 2 km long have been reported from near Silver Spur (Wade, 1941). The sandstone is poorly sorted and consists largely of volcanic rock fragments with some feldspar and quartz. Pebbles up to 20 cm long have been observed. The mudstone is in places tuffaceous and locally contains numerous small pebbles. Marine macrofossils were found at several localities (Fig. 37).

Relationships: The Permian rocks unconformably overlie the Lower Carboniferous Texas Beds and are faulted against them along the northern margin of the outlier (Fig. 37). The unconformity is best exposed just north of the Limevale to Redgate road, where Permian pebble conglomerate containing few marine macrofossils dips at a low angle to the west and overlies interbedded lithic sandstone and mudstone of the Texas Beds dipping steeply northeast. Outcrop is generally poor, but the unconformity is exposed in shallow washouts on the northeast slopes of a low hill just north of Back Creek (Fig. 37).

Structure: The rocks in the Silver Spur outlier, and particularly those in the southeast, are more intensely deformed than those in the other outliers. Dips are generally steep to vertical, and cleavage is commonly developed in the mudstone and, in the southeastern part of the outlier just northeast of Silver Spur, also in the sandstone and conglomerate. The strike of the Permian strata in the north of the outlier and of the adjoining Lower Carboniferous rocks is north-northwest. An abrupt swing in strike from north-northwest to northeast occurs in both sequences in the Silver Spur area, indicating that the Permian and Lower Carboniferous rocks were together involved in a folding episode.

The Silver Spur Mine lies on the axis of this fold, and the lenticular orebodies, which were formed by replacement of the country rocks, are all confined to the highly jointed and sheared rocks.

Thickness: The preserved thickness is estimated to be about 900 m.

Age: Lower Permian. The marine fossils belong to Fauna 2 (Dickins, pers. comm.).

Permian rocks at Glenmore homestead

Little work was done in the Glenmore area by the authors. The main purpose of the visit to the area was to locate in outcrop the fossiliferous strata, a float of which was collected by Lucas (1958) from a creek just south of Glenmore homestead (Fig. 38B).

Nomenclature: The whole area around Glenmore homestead, including the Lower Carboniferous Texas Beds and Permian sequence, was previously mapped as the Lower Permian Glenmore Beds (Lucas, 1960). The name should be abandoned; it cannot be applied only to the Permian strata because they are contiguous with the Emmaville Volcanics of the Grafton Sheet area to the east.

Relationships: The Permian rocks unconformably overlie the Lower Carboniferous Texas Beds. The unconformity, which had not been recognized previously, is very well exposed 1 km south of the homestead along the northern margin of the

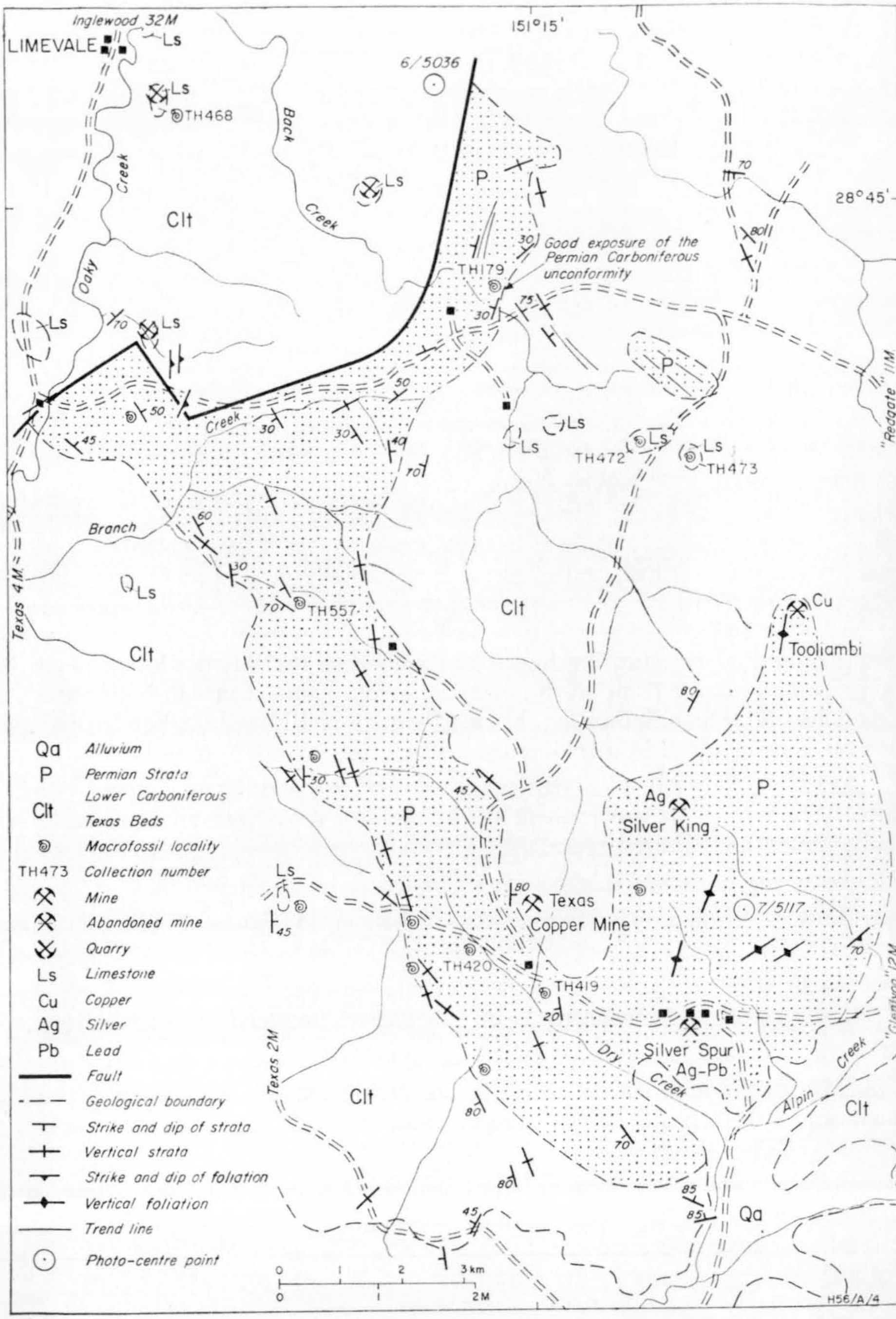
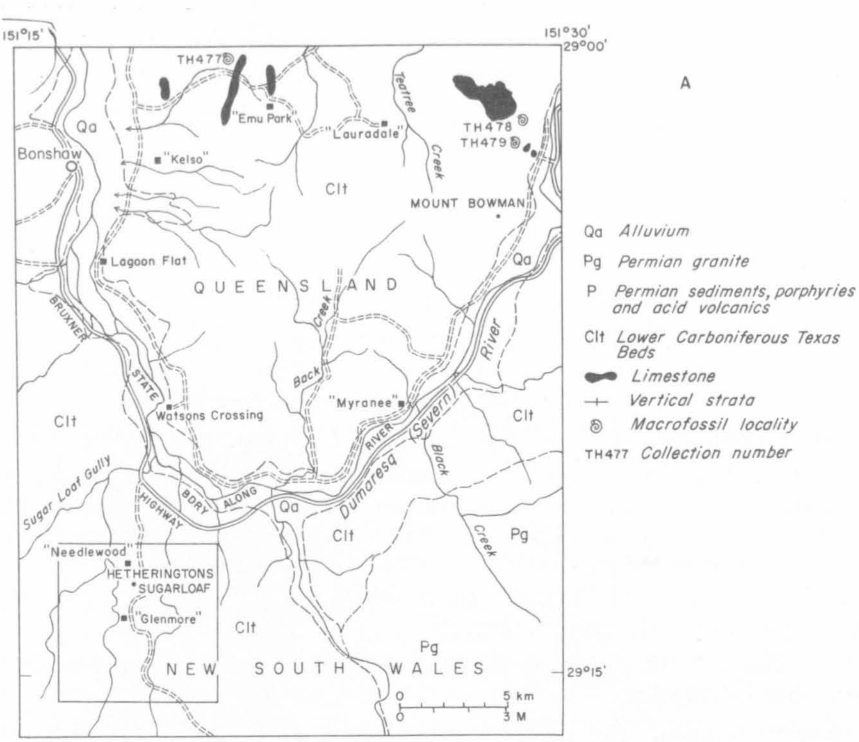
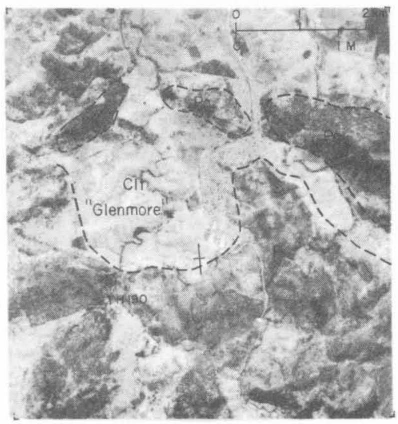


Fig. 37. Permian sequence, Silver Spur area.



A

B



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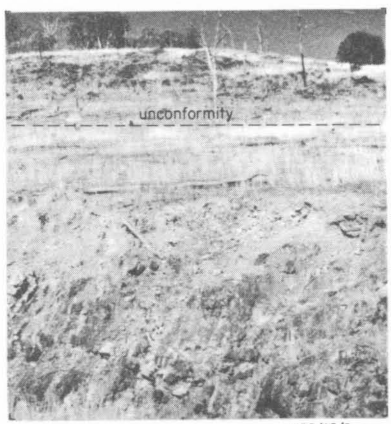

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Fig. 38A. Geological map of the Queensland portion of the Inverell 1:250 000 Sheet.

Fig. 38B. Geology in the vicinity of Glenmore homestead (part of air-photograph Inverell 3/162).

Fig. 38C. Carboniferous-Permian unconformity south of Glenmore homestead.

Permian outcrop belt (Fig. 38C). The Permian rocks at the unconformity are gently dipping, but dips up to 60° were recorded at the fossil locality 0.5 km to the south, the deformation being due to massive quartz-feldspar porphyry dykes which intrude the sequence.

Lithology: The bulk of the Permian sequence consists of very coarse-grained acid pyroclastic material with some interbeds of dark mudstone, one of which contains abundant marine macrofossils. A thin sequence of conglomerate, pebbly lithic sandstone, and mudstone occurs near the base of the succession. The conglomerate contains abundant rounded pebbles of chert, mudstone, and sandstone, all derived from the underlying Texas Beds, and also some fragments and blocks of contemporaneous volcanic rocks.

Age: Upper Permian. The marine fossils belong to Fauna 4 (Dickins, pers. comm.).

Permian rocks in the Maryland River

The Permian rocks were first recorded by Voisey (1939) and later examined by Phillips (1968), who made a detailed study of the phases of the New England Batholith around the township of Liston 16 km east of Stanthorpe.

Location: A small inlier on the Maryland River 11 km northeast of Stanthorpe.

Relationships: The inlier is largely surrounded by younger granite of the New England Batholith; to the north are hornfels and metabasalt which have tentatively been mapped as part of the Lower Devonian Rosenthal Creek Formation (see p. 30). The nature of the contact with the Devonian sediments is not known, but is suspected to be a fault. The Permian strata, which dip steeply to the south, strike at right angles to the Devonian sediments.

Lithology: Tough black slightly carbonaceous fossiliferous siltstone and mudstone, and grey banded rhyolite.

Age: Lower Permian. The marine fossils belong to Fauna 2 (Dickins, pers. comm.).

Permian rocks at Wallangarra

The presence of volcanic rocks at Wallangarra has been mentioned by several authors (Andrews, 1905; Saint-Smith, 1914a; Simmonds, 1958).

Reference area: In road cuttings at Devils Pinch on the New England Highway about 1 km south of Wyberba railway siding, and also south of Wallangarra where the highway crosses the railway.

Distribution: An irregularly shaped area of approximately 50 km^2 to the south, west, and northwest of Wallangarra.

Lithology: The volcanics are mainly rhyolitic and rhyodacitic flows and tuffs. They appear to be structurally complex because of intense jointing, but dips as low as 10° have been observed in bedded tuffs. On the basis of lithological similarity they are correlated with the Drake Volcanics, which crop out about 40 km east of Wallangarra.

Relationships: Intruded by the Stanthorpe Adamellite, and possibly also by the Dundee Adamellite Porphyrite.

Thickness: 300-450 m.

Age: Probably Permian.

INTRUSIVES AND ECONOMIC GEOLOGY

The plutonic rocks of the Warwick and Goondiwindi 1:250 000 Sheet areas constitute the northern part of the New England Batholith. The batholith consists mainly of adamellite, granite, and granodiorite with minor developments of mafic rock. It has intruded Palaeozoic sediments and volcanics and is overlain by unmetamorphosed Mesozoic sediments; radiometric age determinations indicate that the batholith was emplaced during the Permian and Lower Triassic.

A. D. Robertson has provided an account of the intrusives and economic geology of the Queensland portions of the Sheet areas and P. G. Flood a summary account of the intrusive rocks and economic mineral occurrences of the New South Wales portion of the Warwick Sheet. A more comprehensive account of the economic geology is being prepared by the Geological Survey of New South Wales.

The igneous rocks of the northern part of the New England Batholith and the related mineralization have been summarized in Table 1.

INTRUSIVES IN QUEENSLAND

by

A. D. Robertson

In October 1968, the author spent three weeks mapping the various phases of the New England Batholith. One new name, the Herries Adamellite, has been erected. All other phases of the batholith have been described previously by Andrews (1904), Andrews, Mingaye, & Card (1907), Saint-Smith (1911, 1914a), Phillips (1964, 1968), and Wilkinson, Vernon, & Shaw (1964).

Previous literature

The presence of important mineral deposits, especially tin, brought the granites to the attention of Skertchly (1898), Andrews (1901, 1902, 1903, 1904, 1905, 1908), Andrews et al. (1907), Saint-Smith (1911, 1913, 1914a, b, c), and Jensen (1918a and c). More recent geological papers have been by Voisey (1939, 1958), Vernon (1961), Phillips (1964, 1968), Wilkinson, Vernon, & Shaw (1964), Binns (1965, 1966), Binns & Richards (1965), Robertson (1964), and Simmonds (1958).

Dundee Adamellite Porphyrite

Only a small part of the Dundee Adamellite Porphyrite crops out in Queensland; most of it lies in the extreme southern part of the Warwick 1:250 000 Sheet area and to the south of it, in New South Wales. Andrews et al. (1907) assigned the name 'Blue Granite' to this mass and considered it to be an early phase of the New England Batholith. Browne (1929) considered the rock to be a quartz porphyrite. After examining the field relationships, bulk chemistry, and recalculated modes, Wilkinson et al. (1964) designated it an intrusive adamellite. Texturally, it is more akin to a dellenite, owing to rapid cooling after high-level emplacement equivalent to that of the epizone level of Buddington (1959).

Megascopically, the adamellite-porphyrite is a compact, medium to coarse-grained, bluish-grey rock, in some places possessing flow foliation (biotite phenocrysts). Phenocrysts of plagioclase, hornblende, quartz, and biotite, ranging from 1 to 2 mm in length, are present in an aphanitic grey groundmass. Small xenoliths are present in some outcrops, although texture appears to be uniform throughout the mass. The groundmass is composed of xenomorphic-granular quartz and K-rich alkali feldspars with common very fine-grained magnetite. The border phase of the mass tends to exhibit flow structure.

Microscopically, the rock is porphyritic. The average grain size of the phenocrysts (2 mm) is markedly different from that of the groundmass (0.02 mm). Phenocrysts include plagioclase, quartz, biotite, hornblende, clinopyroxene, rare alkali feldspar, and rare orthopyroxene. The quartz-feldspathic groundmass is xenomorphic-granular but becomes crypto- to micro-crystalline fluidal in the border facies. Wilkinson et al. (1964) consider the phenocrysts to show cataclastic effects. Magnetite, sulphides, apatite, and zircon are accessory minerals. Quartz, similar to bipyramidal inverted β-quartz, is locally micro-brecciated. Plagioclase occurs as subhedral laths, glomeroporphyritic aggregates, or brecciated angular fragments, ranging in size from 1.5 x 0.8 mm to 1.0 x 0.5 mm. Biotite is rare in the groundmass. Phenocrysts show mechanical and chemical breakdown, altering to chlorite. Hornblende occurs as euhedral to subhedral phenocrysts, as fractured remnants, and as an alteration product of clinopyroxene. Clinopyroxene (augite) forms glomeroporphyritic aggregates with hornblende, biotite, hypersthene, and opaque minerals. It is usually euhedral to subhedral and extensively fractured. Exsolution is common. Orthopyroxene is rare in the northern part of the intrusion, but has been reported by Wilkinson et al. (1964) in the southern masses as cores to clinopyroxene, hornblende, and biotite. Anhedral magnetite is mainly confined to the groundmass, but may be up to 0.6 mm in diameter. Zircon is an accessory found mainly in the biotite.

The Dundee Adamellite Porphyrite appears as a teardrop-shaped mass intruding volcanics south of Bald Mountain railway siding. The contacts, where seen, are relatively sharp. Radiometric age dating of this mass, using biotite, gave an age of 242 m.y. (= mid Permian) (Harding, 1969).

Wilkinson et al. (1964) considered that the mass is a large-scale hybrid, developed by the mixing of and limited reaction between nearly solid biotite diorite and a low-melting silica-alkali liquid. They consider the hybridization process incomplete owing to comparatively rapid and forceful intrusion to high levels and to solidification following closely upon final emplacement.

Undercliffe Falls Adamellite

The adamellite forms a mass approximately 20 km long with a maximum width of 8 km, lensing to the west-northwest, where it intrudes rhyolite south of Bakers Hill. In the east the adamellite is abruptly terminated by the Demon Fault Shear Zone. The total outcrop area of the Undercliffe Falls Adamellite is about 160 km^2.

The original shape of the adamellite has been modified by the intrusion of the Stanthorpe Adamellite and by faulting along its eastern extremity. On field relations this rock mass can be treated as a unit, although five varieties have been recognized by Phillips (1968):

(1) A normal type, containing pink K-feldspar phenocrysts. This variety forms the largest part of the adamellite.
(2) Adamellite with white K-feldspar phenocrysts.
(3) A medium to fine even-grained adamellite appearing along parts of the margin.
(4) An adamellite intermediate between Types 1 and 3.
(5) A brecciated variety of Type 1.

The most prominent structure in the adamellite is the preferred planar orientation of xenoliths, which is generally east-west. Where the orientation of lenticular xenoliths has been measured along Herding Yard Creek, they dip southwards and the xenoliths closely parallel the contact. Farther away from the contact, towards the middle of the mass, the xenoliths display a haphazard arrangement with variable dips.

Contacts between the adamellite and the country rock appear sharp and, in many cases, transgressive. Phillips (1968) reports that the adamellite at the contact with the country rock southeast of Bakers Hill can be defined as Type 3, grading through Type 4 to Type 1. In the vicinity of Undercliffe Falls adamellite of Type 1 forms a sharp contact with a small remnant of hornfels. There appears to be no marginal variety present and this may be due, in part, to the truncation of the mass by the Demon Fault Shear Zone.

The normal type (Type 1) has pink K-feldspar phenocrysts (11%) set in a grey phaneritic matrix of plagioclase, quartz, K-feldspar, biotite, hornblende, and accessory sphene. The K-feldspar phenocrysts are twinned and range from 30-40 x 15 mm to 15 x 8 mm. Fine-grained black xenoliths, composed of minerals similar to those of the adamellite, are scattered throughout the mass and range from 5 to 30 cm.

Plagioclase (36%-42%) ranges in composition from An25 to An33. It forms subhedral to anhedral grains and also rapakivi-like mantles (An18-An29) around some K-feldspar phenocrysts. Quartz (22%-25%) forms anhedral grains or grain aggregates in the groundmass, but also appears as inclusions in K-feldspar phenocrysts and in myrmekite. Size ranges from 0.3 mm to 3.5 mm. K-feldspar (20%-25%) appears both as subhedral phenocrysts and as anhedral grains in the groundmass. Plagioclase, quartz, hornblende, biotite, and in some cases sphene are present as inclusions in the phenocrysts. Biotite (7%), 0.5 to 2 mm in length, forms distorted subhedral to anhedral laths associated with plagioclase and quartz, or as clusters of biotite, hornblende, and magnetite. Inclusions in the biotite are usually apatite, magnetite, sphene, and zircon. Alteration to chlorite is common (α = pale straw, $\beta = \gamma$ = dark brown to opaque). When chloritization is partly completed, $\beta = \gamma$ = apple green. Hornblende (3-4%) occurs mainly as subhedral crystals, rarely euhedral, twinned, and ranging from less than 1 mm to 8 mm or more in length (α = yellow, β = greenish brown, γ = apple green). Inclusions of magnetite, apatite, zircon, and sphene are common.

Anhedral magnetite (0.1-2 mm) forms the bulk of the opaques (0.3-0.9%); grains of euhedral pyrite have also been noted. Sphene (0.5%) occurs as euhedral crystals, variable in size; maximum length is 3 mm. Granular sphene is associated with the breakdown of biotite. Accessory minerals apatite, epidote, allanite, tourmaline, calcite, kaolin, and zircon together rarely form more than 0.8% of the rock.

Very little mineralization is associated with this adamellite in the Warwick 1:250 000 Sheet area.

Stanthorpe Adamellite

The Stanthorpe Adamellite has the greatest surface exposure of all the granitic types present in the Warwick 1:250 000 Sheet area. Saint-Smith (1911, 1914a) recognized the adamellite's variable texture, but the textural varieties could not be mapped as units. Within the adamellite, xenoliths are rare and where present show random orientation. Some K-feldspar crystals in the more porphyritic phase show crude alignment over very short distances. Andrews et al. (1907) observed marked orientation of long rectangular feldspars at certain localities close to the contacts with the porphyritic adamellite (Undercliffe Falls type). Andrews (1905) recorded intrusion breccias at the contacts between the country rock and the Stanthorpe Adamellite near Undercliffe Falls, and Phillips (*in* Packham, 1969, p. 291) observed, along Herding Yard Creek northwest of Liston, the adamellite intruding basic rock with production of an agmatite.

Blocks of Undercliffe Falls Adamellite are contained in the Stanthorpe Adamellite along Ruby Creek. The Stanthorpe Adamellite cuts across the porphyritic adamellite. Both Andrews and Phillips consider that this relationship is evidence that the Stanthorpe Adamellite is a separate intrusion, and this was confirmed by the present study. The contact between Stanthorpe Adamellite and the country rock along the western margin of the batholith is, in general, sharp and well defined.

Four distinct types of the Stanthorpe Adamellite have been recognized. Phillips (1968) has described three of these types from the Liston-Amosfield area. The following is a summary of his descriptions.

The adamellite from Wilsons Downfall has a preferred orientation defined by subhedral off-white K-feldspar laths (1.3-2.0 mm) occurring with plagioclase (41%), quartz (25%), biotite (8%), hornblende (2%), and sphene (0.2%). The texture is roughly even-grained with a coarse grain size. Rare K-feldspar crystals (3.5-5 cm) give the rock a porphyritic appearance. Locally, these large crystals are mantled by plagioclase. The bulk of the plagioclase crystals (1-6 mm) are subhedral and have an average composition of An23. Quartz (2-3 mm) is anhedral, occurring as granular crystals. K-feldspar (2-6 mm) is subhedral to anhedral and has optical properties that suggest that the mineral is orthoclase. Some grains show the cross-hatch twinning of microcline. Biotite, 1 to 2 mm in length, forms subhedral to anhedral flakes, and is locally altered to chlorite and sphene. Allanite is partly or completely surrounded by biotite (α = pale rusty brown, β = γ = deep red brown to opaque). Hornblende (1-2 mm) occurs as anhedral and subhedral crystals. Pleochroic colours are patchy (α = very pale fawn grey, β = brown-green with grey tint, γ = green). Sphene, apatite, pyrite, and zircon are minor accessories.

The second variety is similar to the 'Stanthorpe granite' of Saint-Smith (1914a). It differs from the porphyritic phase in that there is no obvious preferred orientation of the K-feldspars. The rock is finer grained, the texture is more inequigranular, and there is a lower mafic content. The colour of the K-feldspar is not white. Macroscopically, the second variety has pink K-feldspar, white plagioclase, grey glassy quartz, and is speckled with black biotite flakes. Microscopically, quartz (24%), microperthite (34%), plagioclase (35%), biotite (5%), hornblende (0.7%), and accessories (0.2%) constitute the mineral suite of the rock. Plagioclase (An23) has a similar composition to that of the Wilsons Downfall variety and the K-feldspar is orthoclase.

The coarse-grained Stanthorpe Adamellite (variety 3) forms part of the northern contact with the Undercliffe Falls Adamellite. The rocks are even-grained, hypidiomorphic-granular in texture, with crystals 1-5 mm across. Quartz (36-37%), microperthite (32-33%), plagioclase (27-28%), and biotite (3%) are the dominant minerals. This variety has a higher quartz content than the other two and appears to be similar to the Ruby Creek Granite. Plagioclase ranges in composition from An20-17 in the cores to An12-10 in the margins.

The fourth variety is best developed on the Stanthorpe-Nundubbermere road, 1 km north of Nundubbermere homestead. Between the contact of Stanthorpe Adamellite with metasediments and this fourth variety, an adamellite of the second variety is developed. The second variety grades inwards from the contact into the fourth variety adamellite, which very closely resembles the finer grained edges of the Ruby Creek Granite mass. Megascopically, it is a fine-grained pinkish rock, of relatively even grain size, with hypidiomorphic-granular texture. Phenocrysts of quartz and K-feldspar (3 cm), up to four times the size of the average grainsize of the groundmass, may be present. The phenocrysts of quartz and the quartz in the groundmass are clear and glassy, being similar to quartz in the Ruby Creek Granite along the western margin of the batholith. The fourth variety of adamellite becomes coarser to the north until it grades into the adamellite of the second variety.

Increase in grainsize is also accompanied by an increase in the number of phenocrysts. Within the gradational boundaries of this variety, the soil development is very similar to that developed from the Ruby Creek granite. The soil is sandy and contains a high percentage of quartz. Alluvial deposits of tin have been worked in gullies and creeks heading in ridges composed of this fine-grained adamellite.

On the Queensland side of the border the porphyritic Stanthorpe Adamellite (variety 1) is best developed in the forestry reserve northwest of Amiens, where the adamellite shows strong but local orientation of the phenocrysts. To the east, the porphyritic variety 1 grades through varieties 2 and 3 into variety 4 southeast of Passchendaele Ridge. To the north and east of this ridge, a jumbled assortment of varieties 2, 3, and 4 occurs, and this in turn is intruded by a mass of Ruby Creek Granite near the rabbit-proof fence. The boundary of the Ruby Creek Granite is hidden by soil and has been only approximately defined along its southwestern extremity.

Farther to the east of Passchendaele Ridge, along the Amiens-Passchendaele-Thulimbah road, Stanthorpe Adamellite of the fourth variety grades imperceptibly into second variety. To the south and north of this road, the Ruby Creek Granite intrudes both varieties.

South of Stanthorpe, the second variety is most prominent. In the vicinity of Ballandean homestead, the adamellite becomes porphyritic (variety 1) but contains both white and pink K-feldspar phenocrysts (up to 5 cm long). Occasional rapakivi-type texture occurs. South of Ballandean a small mass of granodiorite is intruded by variety 2. Between Bald Mountain siding and Wallangarra, the adamellite intrudes flat-lying volcanics as a series of dykes. This adamellite is itself intruded by small masses of Ruby Creek Granite and many dykes. Its most prominent structure is a set of north-northeast-trending master joints.

Herries Adamellite

The Herries Adamellite forms a large part of the batholith along its northwestern margin. It is best exposed along the northern edge of the Herries Range, where it forms moderately rugged topography. Along Sandy Creek near Leslie Dam, outcrop is poor and the adamellite appears as a depressed landform surrounded by the more resistant Palaeozoic rocks.

Two variations of the Herries Adamellite have been recognized, one fine and the other coarse-grained, but these cannot be mapped as distinct units as one grades into the other over several hundred metres. In the areas of gradation, outcrop is poor and exposure is reduced by overlying near-horizontal Mesozoic sediments. Few xenoliths are present and there is little or no lineation. Contacts between the adamellite and the surrounding country rocks, where observed, are sharp. Little is known of the relationship between the Herries Adamellite and the Stanthorpe Adamellite as outcrop is poor and soil covers the contact.

The Herries Adamellite north of Dalveen, along the Warwick-Stanthorpe road, is fine-grained, suggesting that the Herries mass may have cooled against the Stanthorpe Adamellite to the south. However, cooling against the country rock could have produced a similar effect. This, coupled with the tendency of the Stanthorpe Adamellite to be finer-grained towards its proposed northern margin in the vicinity of Dalveen, casts some doubt on the suggested mode of emplacement.

The coarse-grained variety which makes up most of the Herries Adamellite is even-grained in texture. Rarely are the larger K-feldspar crystals mantled by plagioclase.

Plagioclase (37%) occurs as 'primary' crystals, as medium to coarse vein perthite, and as grains between larger plagioclase crystals. Small unoriented grains are present in some of the K-feldspars. Most of the plagioclase crystals are strongly zoned, subhedral, and 4 to 6 mm in length, with an average composition of An24 (cores An28, rims An20, locally An15). 'Cloudy' sericite forms much of the alteration products. Clusters of small biotite, hornblende, and magnetite are included within the plagioclase.

K-feldspar (32%) varies from anhedral to subhedral crystals ranging from 0.5 mm to 7 mm. Twinning, where present, is of the Carlsbad type. In some specimens, the K-feldspar shows the cross-matched twinning of microcline.

Quartz (21%) forms anhedral grains up to 4 mm in size and exhibits undulose extinction.

Biotite (5%; α = fawn, $\beta = \gamma$ = dark reddish brown to opaque) occurs mainly as anhedral flakes up to 1.5 mm in length. It is locally altered to sphene and chlorite. Inclusions in the biotite are apatite, zircon, and magnetite. Unlike the biotites of the Stanthorpe granite, allanite does not appear as an inclusion in the biotites of the Herries Adamellite.

Hornblende (4%; α = fawn, β = greyish to reddish brown, γ = apple green) is mainly anhedral, with rare euhedral crystals. The crystals range from 0.2 mm to 3 mm in length. The hornblende forms either as isolated grains or as a cluster of grains associated with biotite, apatite, and quartz.

Accessory minerals (1%) include apatite, zircon, some sphene, and rare allanite.

The coarse-grained variety differs from the finer grained adamellite in that in the latter, the plagioclase is surrounded by coarse perthite and graphic intergrowths of quartz and K-feldspar, and the plagioclase appears to be more strongly zoned.

From just west of Braeside, the Herries Adamellite has been intruded by an extensive dyke swarm, producing a prominent rib of reinforced adamellite which trends north-northeast.

Ruby Creek Granite

The Ruby Creek Granite has its maximum development in an irregularly elongated structure, striking north-northwest astride the State border. Two smaller masses occur, one to the north and the other to the south. To the west and south-west are a number of smaller outcrops. The larger of these western developments are at Red Rock, Mount Jibbinbar, Mount Bullaganang, and near Mount You You. They all have a north-northwest trend similar to that of the granite mass to the east.

Contacts between the granite and the country rock are usually sharp, but diffuse boundaries and highly irregular margins have been observed in small pods of the granite in the area west-northwest of Ballandean. Contacts between the Ruby Creek Granite and other 'granite' masses are sharp. Dyke-like projections from the Ruby Creek Granite into older granites are numerous.

The Ruby Creek Granite is massive, even-grained except at the margins, and has few xenoliths and little or no alignment of the feldspar crystals. Feldspars rarely exceed 2 mm in length. The granite has a prominent north-northeast vertical joint system. Aplite dykes are not common.

Because the margin of the Ruby Creek Granite against the Stanthorpe Adamellite along Herding Yard Creek is fine-grained, both Saint-Smith (1914a) and Phillips (1968) considered that the granite intrudes the adamellite. This appears to be substantiated by the development of fine-grained Ruby Creek Granite against the Stanthorpe Adamellite along the rabbit-proof fence southwest of Dalveen and in the area 8 km west-northwest of Ballandean.

The granite is a homogeneous even-grained medium to coarse-grained rock. Pink K-feldspar, white plagioclase, and glassy quartz are evenly dispersed throughout a granite that is mottled with biotite. Microscopically the granite has an allotriomorphic granular texture, with a few subhedral plagioclase and biotite crystals. Grainsize ranges from 0.5 mm to 2.0 mm with some feldspars to 3.0 mm. Quartz (37%) is anhedral and roughly equidimensional, forming interlocking aggregates. Plagioclase (31%) is present as (1) primary subhedral to anhedral crystals, (2) exsolved phases in perthitic intergrowths with K-feldspar, (3) intergranular albite and myrmekite, (4) rim albite, and (5) inclusions in K-feldspar.

Bulk composition of the plagioclase is An11-12. K-feldspar (30%) develops subhedral and anhedral crystals, whereas biotite (2%) forms ragged subhedral to anhedral flakes (α = fawn, $\beta = \gamma$ = opaque). Zircon and apatite form inclusions in the biotite.

The finer marginal variety is allotriomorphic granular with the appearance of an aplite, although rare phenocrysts (up to 2 mm) of plagioclase and quartz are present. Eight kilometres west of Ballandean, the Ruby Creek Granite intrudes the edge of the Stanthorpe Adamellite. The biotite in the fine-grained variety of the granite has been altered to sericite, and K-feldspar exceeds plagioclase in modal percentage (quartz 41%, K-feldspar 44%, plagioclase 10%, muscovite 5%, and accessories 1%). Away from the contact, the muscovite is replaced by biotite, and the modal composition is quartz 41%, K-feldspar 47%, plagioclase 10%, biotite 1.5% and accessories 0.9%.

Five kilometres south of Nundubbermere homestead, the Ruby Creek Granite has intruded both the Stanthorpe Adamellite and the Carboniferous metasediments. The granite is strongly mineralized and at this point is much more massive, finer grained, and glassy in appearance. Quartz content (49%) is higher than that from the type area (Ruby Creek, N.S.W.) and the granite becomes aplitic. It is cut by numerous quartz and quartz aplite dykes. Many of these dykes and veins are mineral-bearing. The granites at Red Rock, Mount Jibbinbar, and Mount You You are similar, although variations between the fine-grained marginal type and the typical granite have been noted.

Along Sandy Creek between the northern dyke swarm and the Palaeozoic sediments, aplite dykes, Ruby Creek Granite, and the Herries Adamellite phase are exposed in an elongated valley. Because of the apparent predominance of the fine-grained granite over the Herries type, this area has been mapped as Ruby Creek Granite. Farther south in the vicinity of Utopia homestead another low-lying area of very poor outcrop is present. Here the soil is similar to that derived from the weathering of the Ruby Creek Granite, and the area has been mapped accordingly.

Greymare Granodiorite

The Greymare Granodiorite forms the northernmost part of the New England Batholith, in the vicinity of Greymare railway siding. Outcrops are poor, much of the granodiorite being covered by soil and alluvium. The rock is grey, mottled by biotite, and has an even medium-grained hypidiomorphic texture. Quartz and feldspar rarely exceed 2 mm in length. Biotite averages 1 mm in length but exceptional crystals may exceed 5 mm. Megascopically, quartz, plagioclase, K-feldspar, biotite, chlorite, and magnetite are discernible. Microscopically, quartz, plagioclase, K-feldspar, biotite, chlorite, magnetite, and accessory zircon, apatite, sphene, and allanite form the bulk of the minerals. Quartz (anhedral) and plagioclase (subhedral to anhedral) are of approximately equal percentage. The plagioclase (37%) is strongly zoned, the average composition being An31 with cores as calcic as An34 and rims as sodic as An15. Biotite (8%) forms subhedral to anhedral flakes (0.5 mm - 4 mm) which have a tendency to show orientation (α = fawn to light greenish brown, $\beta = \gamma$ = greenish brown to opaque). Alteration of biotite produces granular sphene and chlorite. K-feldspar (15%), 0.1 mm to 3 mm in diameter, occurs as anhedral grains in the groundmass. Zircon, apatite, sphene, and magnetite occur mainly as inclusions in biotite, but magnetite (anhedral) also appears in the groundmass as grains up to 2 mm.

Richards (1918) originally described the material as Greymare Granite, and used the name Greymare Granodiorite in his discussion of the building stones of southeast Queensland.

The Greymare Granodiorite as such is known only from the Greymare railway siding area, where it occupies an area of approximately 55 km^2. To the south of Ballandean, towards Accommodation Creek, a small mass of very weathered granodiorite crops out. The relationship between this mass and that at Greymare is not known. Both are intruded by dykes; the Greymare mass is intruded by the northern extension of the large dyke swarm that extends from Braeside in the south to Greymare in the north.

Dykes

The dykes in the Warwick 1:250 000 Sheet area can be divided into three main groups;

(a) quartz-feldspar porphyry dykes;

(b) rhyolite, trachyte, and dolerite dyke swarms; and

(c) miscellaneous dykes (rhyolite, diorite, aplite, basalt, and trachyte).

The quartz-feldspar porphyry dykes are best developed in the Ballandean-Sundown area, where two large dykes, varying from 1 to 2 km apart, are exposed in outcrop from Ballandean, through Sundown, to the New South Wales border. Farther south another porphyry dyke is exposed, passing through Ballandean township and Ballandean station to the southwest.

Two large dyke swarms have been mapped on the Warwick 1:250 000 Sheet. The southern swarm terminates just south of Accommodation Creek near Lyra and extends in a south-southwesterly direction for 8 km. The width ranges from 1 to 1.5 km. The dykes form the reinforced cores of ridges composed of Stanthorpe Adamellite. Dykes of rhyolite, granophyre, trachyte, and diorite appear to divide, forming an anastomosing pattern similar to that derived from material filling interlaced shear fractures.

The northern swarm is composed of rhyolite, granophyre, trachyte, diorite, aplite, quartz-feldspar porphyry, and rare basaltic dykes. It extends 30 km from Braeside in the south to Greymare in the north-northwest. The width ranges from 1 to 3 km.

Dykes recorded as miscellaneous are those which occur as isolated structures with no great length or width. They include numerous mineralized aplite and quartz-aplite dykes, and occur throughout the New England Batholith.

With the exception of the northern dyke swarm, almost all large dykes have a northeasterly trend which corresponds to the prominent northeast-trending master joint system of the granites. Even within the metasediments, the northeast strike direction of the larger dykes is maintained.

Mode of emplacement of the granites

Phillips (1968) considers that the Undercliffe Falls Adamellite, the Stanthorpe Adamellite, and the Ruby Creek Granite were emplaced as a magma. Evidence cited in favour of magmatic emplacement includes preferred orientation of the xenoliths (Martin, 1953), flow-banding, corroded xenoliths of country rock aligned parallel to a sharp transgressive contact, and a decrease in grainsize of the intrusion at or near the contact (Wilson, 1960).

Local alignment of K-feldspars in the Stanthorpe Adamellite is believed to indicate magmatic conditions, the preferred orientation being due to platy flow structure during magma movement. The variation in grainsize and texture of the Stanthorpe Adamellite suggests different rates of cooling in a large mass of magma, and this, coupled with the finer grainsize towards the contacts, indicates chilling at or near the margins due to rapid heat loss.

The Herries Adamellite tends to be finer-grained towards its margins, but there is at present little evidence to indicate the mode of emplacement. The Greymare Granodiorite and the Ruby Creek Granite also show little evidence of their mode of emplacement. The only visible evidence to suggest that the Ruby Creek Granite was magmatic is the numerous dyke-like masses intruding the older granites, suggesting the granite had the mobility of a magma.

Flow foliation of biotite and the alignment of small xenoliths in the border phase of the Dundee Adamellite porphyrite led Wilkinson et al. (1964) to believe that this hybrid porphyrite developed from a magma which was emplaced at high levels in the Earth's crust.

All the granites in the Warwick 1:250 000 Sheet area show some evidence that their origin was possibly magmatic, and in general it is considered that the 'granites' were emplaced in the upper levels of the Earth's crust, equivalent to the epizone position of Buddington (1959).

Sequence of emplacement

Absolute age determinations have indicated that the Dundee Adamellite Porphyrite was the first to be emplaced (242 m.y. = mid-Permian). It was followed by the Undercliffe Falls Adamellite and the Bungulla Adamellite (225 m.y. = Permian-Triassic). The Bungulla Adamellite, best exposed south of Wallangarra in northern New South Wales, is considered to be equivalent to the Undercliffe Falls Adamellite and to have been emplaced approximately the same time. The Stanthorpe Adamellite, the Herries Adamellite, and the Ruby Creek Granite followed the Undercliffe Falls Adamellite in quick succession. The Ruby Creek Granite (225 m.y. = Permian-Triassic) is considered to be the last major granitic emplacement.

The position of the Greymare Granodiorite in the intrusion sequence is obscure, but a small mass of granodiorite south of Ballandean, which may be equivalent to the Greymare Granodiorite, has been intruded by the Stanthorpe Adamellite.

The last phase of intrusive igneous activity associated with the granites is the emplacement of dykes. Some of the aplitic dykes are synchronous with the Ruby Creek Granite, but the porphyry, rhyolite, rhyodacite, and basic dykes are considered to be younger.

Age of the plutonic rocks and mineralization

Absolute age determinations were carried out by Evernden & Richards (1962) on several granites from the New England Batholith. Using the potassium-argon method, biotite in the Dundee Adamellite Porphyrite (GA236) gave an age of 242 m.y., equivalent to Middle Permian. Biotite (GA224B) and hornblende (GA224A) in the Undercliffe Falls Adamellite gave ages of 225 m.y. and 221 m.y. respectively. Phillips (1968) reports the age of biotite in the Ruby Creek Granite as 225 m.y. The similarity between this age and that for the biotite and hornblende in the Undercliffe Falls Adamellite suggests a relatively small time interval between the intrusion of the Undercliffe Falls mass, the Stanthorpe Adamellite, and the Ruby Creek Granite. The age of these 'granites' is considered to be Permian-Triassic. In the northern part of the intrusive complex, Triassic-Jurassic sediments overlie the granites. From age dating and structural relations, the period of plutonic activity appears to have occurred between the Middle Permian and the Lower Triassic.

Absolute age determinations were carried out by Evernden & Richards (1962) age of 225 m.y. for molybdenite from Carpenters Gully 16 km west-southwest of Ballandean (Harding, 1969). The similarity between the Re-Os age of the molybdenite and the potassium-argon age of the biotite in the Ruby Creek Granite suggests a close relationship between the mineralization and the granitic end-products of the pluton. It is considered that the mineralization along the western edge of the batholith and that in the Silver Spur area can be placed as Permian-Triassic in age. This age agrees with that predicted by Jones (1947) when he equated the mineralization in the Stanthorpe district with that of the Gympie Epoch.

INTRUSIVES IN NEW SOUTH WALES

by

P. G. Flood

Several authors have made reference to the igneous rocks in the New South Wales portion of the Warwick and Goondiwindi Sheet areas. The most recent literature is by Phillips (1968; and *in* Packham, 1969, pp. 290-4), Wilkinson (*in* Packham, 1969, pp. 271-8) and Shaw (*in* Packham, 1969, pp. 285-90).

The following is a brief summary of the previous work; new information about the igneous rocks of the Rivertree and Drake-Tabulam areas is also included.

Dundee Adamellite Porphyrite

The petrology of the Dundee Adamellite Porphyrite has been evaluated by Wilkinson, Vernon, & Shaw (1964), and was briefly mentioned by Wilkinson (*in* Packham, 1969, p. 273) and summarized by Robertson (above p. 59).

Three isolated occurrences have been mapped in the New South Wales portion of the Warwick Sheet area. The largest is an irregularly shaped mass covering an area of approximately 50 km^2 west and southwest of Wallangarra. A smaller area of outcrop is west of Sunnyside railway siding, 16 km south of Wallangarra, and the third mass, covering an area of approximately 20 km^2, crops out along the Bruxner Highway from 16 to 22 km northeast of Tenterfield. All three masses extend southward into the Grafton 1:250 000 Sheet area.

Bungulla Adamellite

The name Bungulla Porphyritic Adamellite was proposed by Shaw (*in* Packham, 1969, pp. 288-9) for a coarse-grained sphene-bearing porphyritic adamellite that is widespread through the northern part of the New England Batholith. The adamellite forms two masses in the southern part of the Warwick Sheet area. One crops out over an area of about 20 km^2 centred on Wallangarra, and the other over an area of about 30 km^2, 13 km northeast of Tenterfield.

The rock is characterized by pink K-feldspar phenocrysts (average size 7.5 cm x 5 cm) which are generally aligned in a northeasterly direction. Xenoliths of dioritic composition are common, and range in size from barely visible spots to large inclusions up to 1 m in diameter.

The thin-section description (taken from Shaw *in* Packham, 1969, p. 289) is as follows: 'The Bungulla Porphyritic Adamellite has phenocrysts of potassium feldspar (Or77Ab22An1) occurring in a coarse hypidiomorphic groundmass of subhedral twinned plagioclase, anhedral microperthite (Or85Ab14An1), shapeless quartz, plates of biotite (β = 1.651), and subordinate amounts of dark green hornblende (β = 1.653) and euhedra of sphene. The microperthite of both phenocrysts and groundmass is twinned on the Carlsbad Law, and in many sections an incipient cross-hatching is present, suggestive of microcline twinning. Plagioclase (An19-35) is present as two generations. The unaltered strongly zoned type appears to have crystallised directly from the melt, while a later generation marked by poikilitic inclusions of hornblende, epidote and/or clinopyroxene, is thought to have been derived from basic xenoliths. It is thought that hybridism has played a significant role in the genesis of this rock.'

Maryland Granite

The name was first used by Saint-Smith (1911) for a relatively small semi-circular biotite granite boss just north of Bakers Hill, 10 km north-northeast of Stanthorpe.

The mass covers an area of about 3 km^2. The rock is a fine to medium-grained greyish blue biotite-rich granite. It has been intruded by the Stanthorpe Adamellite.

Igneous rocks of the Rivertree area (Pua)

A number of different rock types occur in the igneous mass in the Rivertree area, but they have not been differentiated on the geological map (Pl. 1). The mass is faulted against the Stanthorpe Adamellite to the west and intrudes Permian and Carboniferous sediments. The rock types include diorite, granodiorite, adamellite, and biotite-rich granite. Their field relationships have not been investigated, but each probably represents a separate intrusive body.

Granodiorite crops out north of the Clarence River and east of the Maryland River. The rock is medium to fine-grained and contains numerous xenoliths. Diorite crops out southeast of Rivertree, but the extent of the outcrop has not been determined. A small pluton of biotite granite crops out near Rivertree. Fine-grained adamellite and coarse-grained diorite crop out on the Razorback Creek road south of Rivertree, and a small mass of granodiorite occurs 5 km east of Rivertree.

Igneous rocks of the Drake-Tabulam area (Pua)

Three large igneous intrusions crop out in the Drake-Tabulam area. All appear to be of similar composition to the Stanthorpe Adamellite.

The most westerly intrusion is just north of the Cataract River, 16 km north of Drake. It is an adamellite pluton covering an area of approximately 42 km^2, and intrudes the Permian sequence. The adamellite is generally coarse-grained, but has a finer grained aplitic phase. The mafic mineral is biotite, generally altered to chlorite. Near the margins of the mass, the sediments and volcanics of the country rock appear to be granitized. Molybdenite mineralization is associated with the pluton.

The other two bodies of adamellite crop out west and northwest of Tabulam. The large mass in the west is crossed by the Bruxner Highway and occupies an area of approximately 65 km^2. The smaller mass covers an area of about 36 km^2. They intrude the Upper Carboniferous Emu Creek Formation, the Permian Paddys Flat Formation, Razorback Creek Mudstone, and Drake Volcanics, and are overlain by the Lower Jurassic Marburg Sandstone.

Igneous rocks southwest of Texas (Pg)

A large mass of granite and granodiorite, previously referred to as the Ashford Granite (Lucas *in* Hill & Denmead, 1960, p. 233) crops out southwest of Texas. The mass covers an area of approximately 75 km^2 in the Goondiwindi Sheet area and extends southward into the Inverell Sheet area.

Diorite and mafic intrusive rocks (Pub)

Diorite and mafic intrusive rocks (Pub) have been mapped in the Lucky Valley area intruding the Rosenthal Creek Formation, and in the Drake-Rivertree area intruding the Permian sequence. Related dykes occur south of Rivertree homestead. The Lucky Valley intrusion consists largely of plagioclase and actinolite with accessory epidote, chlorite, and iron oxide.

ECONOMIC GEOLOGY — QUEENSLAND

by

A. D. Robertson

Tin has been the main economic mineral won from the Warwick 1:250 000 Sheet area. Although gold was the first mineral to be worked (1863), alluvial tin soon took precedence in 1872. Silver, lead, zinc, copper, arsenic, wolframite, and molybdenite have also been worked from time to time. Coal and limestone have been the most important non-metallic minerals mined. Around the turn of the century, sandstone and granite were quarried for building material, and quarries for brick clay and road metal are still productive.

Alluvial Tin

Tin was first discovered in 1854, by Joe Greer, on the Nundubbermere Run, but the value of the mineral was apparently not recognized. In February 1872, A. Ross had the first specimens of tin ore positively identified, and in April of the same year Messrs Jones and Greenup began work in Paddock Swamp east of Stanthorpe. Between 1872 and 1880, about 30 500 tons of tin concentrate was won. In January 1883, the Stanthorpe Mineral Field was proclaimed. Since 1886, annual production of tin concentrate has rarely exceeded 400 tons and in the last 25 years has exceeded 50 tons on only five occasions.

Stream tin has been worked over an area of about 500 km^2, 35 km in length, along the Severn River and its tributaries. The deposits occupy the present stream channels and swampy flats at the heads of the drainage system. Quart Pot Creek and its tributaries, Sugarloaf Creek and The Broadwater, have contributed much of the field's production. Four Mile, Thirteen Mile, and Kettle Swamp Creeks and Paddock Swamp have also been extensively worked. Hydraulic sluicing and dredging have been applied to most of the available ground, and much of the old ground has been reworked. As a result, the reserves of the field are largely depleted.

The depth of the tin-bearing alluvium averaged about 2 m, but it ranged from a decimetre to as much as 10 m. The composition of the alluvium varies. In places it is composed of granitic detritus; elsewhere, of cemented clays, quartz pebbles, and sand, and in some places with granite boulders. Associated minerals may include ilmenite, rutile, wolframite, monazite, and gold, with widespread cairngorm and topaz. Diamonds, sapphires, zircons, garnets, and spinels have been reported (Skertchly, 1898).

Within the alluvial tin belt, certain areas are known to be relatively free of both ilmenite and wolframite. The area to the north of Stanthorpe, drained by Funkers Gap and Four Mile Creeks and the tributaries of Kettle Swamp Creek, is almost entirely free of ilmenite, whereas that to the east, drained by Sugarloaf Creek and its tributaries, contains notable proportions of 'black sand' in the concentrates. On Block 609, Storm King, the alluvial concentrates held an appreciable percentage of wolframite (Skertchly, 1898). Along the headwaters of Pike Creek, gold is associated with tin-bearing gravels.

The relationship between the Ruby Creek Granite and the tin-bearing alluvium is most striking and it is here accepted that the great concentration of alluvial tin has been derived from widespread and countless disseminations and small veins carrying cassiterite in the Ruby Creek Granite.

Lode Tin

The only known lodes of any consequence occur in the precipitous country 30 km southwest of Stanthorpe, where an intrusive mass of Ruby Creek Granite has been exposed along Red Rock Creek. The lodes are mainly confined to the periphery of the granite, where they occur as many quartz and greisen veins along the contact of the granite and metasediments or intruding the surrounding metasediments.

Small rich concentrations of tin ore were worked to shallow depths in numerous places and are in some places associated with arsenopyrite, chalcopyrite, wolframite, and molybdenite. At Carpenters Gully, a cassiterite zone occurs along the edge of the granite. Nearby, the pegmatites are stanniferous.

In the Sundown area, 3 km farther to the southwest, veins of tin and copper ore traverse the metasediments. These veins were worked intermittently between 1893 and 1925 by open cut and shafts to produce about 270 tons of tin concentrate (Dimmick, 1953, and unpublished records of the Geological Survey of Queensland). The ore occurs as a series of lenses following the master joints, the cassiterite being associated with arsenopyrite, fluorite, siderite, calcite, and chalcopyrite. The largest mine in this area, the Sundown Mine (Dimmick, 1953), was developed to a depth of 74 m before low metal prices and diminishing grade of ore forced it to close. Attempts to resume mining during the mid-1950s were unsuccessful.

Several small and ill defined orebodies have been worked at Kilminster, 10 km northwest of Ballandean railway station. These are also associated with a number of small intrusions of Ruby Creek Granite into metasediments. Numerous stanniferous quartz veins intersect the granite-metamorphic contact and the granite itself, but they have proved to be uneconomic. Minerals associated with the cassiterite are similar to those at Sundown and Red Rock farther to the south.

At the headquarters of Pike Creek, gold commonly accompanies cassiterite, but neither mineral has proved economic. East of Stanthorpe in the headwaters of Sugarloaf and Quart Pot Creeks, 'lode type' cassiterite is mainly restricted to numerous small deposits along greisenized joint planes and quartz veins. No deposits of economic importance have been found, although the area was extensively prospected before 1900.

Gold

Gold was first discovered at Lord John Swamp (Lucky Valley Goldfield) in 1852. In 1863, rich but limited alluvial gold was uncovered on Canal Creek. Following close on the Canal Creek discovery were further finds at Talgai (Darkie's Flat) (1863-64), Thanes Creek (1869), Pikedale (1877), Leyburn (1872), and Palgrave (1897). Canal Creek was an alluvial goldfield only, whereas both alluvial gold and reef gold were won from the Talgai Goldfield. Thanes Creek was primarily an area of reef mining; at Pikedale and Leyburn little or no alluvial gold was won. Little is known about the Palgrave Goldfield.

Lucky Valley Goldfield

No returns for alluvial gold from this field have been recorded. The gold was won from alluvium in the 'valley' and the gullies running into it. At the head of the 'valley' a small hill of metasediments carried leaders of quartz showing free gold. A shaft was sunk on these leaders but was abandoned after 9 tons of ore, yielding 340 g of gold, were recovered.

Canal Creek Goldfield

Gold was discovered by a party of seven Frenchmen working a gully 6 km north of the old Canal Creek Station. Good alluvial ground was worked on the eastern side of Canal Creek up to the base of the dividing range, but nothing of any consequence has been discovered on the western side of the creek. The depth of the alluvium was reported as ranging from 1.5 to 4 m, bottoming on pipe clay. The thickness of the wash varied considerably and it tended to occur as lenses. Archibald (1888) estimated that between 1863 and 1887, 565 kg of gold had been recovered. Although leaders of auriferous quartz were found along the dividing range in metasediments on the eastern extremity of the alluvial deposits, there is no record of any attempts to work these finds.

Talgai Goldfield

The Talgai Goldfield, originally known as Darkie's Flat, has supported both alluvial and reef mining, with spasmodic workings until recent times. Today workings are confined to limited gully-raking and half-hearted attempts at reef mining. The richest alluvial gold was won from Dunns Gully at the head of Gum Flat, 5 km south of Pratten. The alluvium was rich but patchy and ranged in depth from 0.5 to 6 m. The gold was coarse, and many nuggets ranging from 25 to 450 g were unearthed. The largest nugget was discovered on the alluvial fields, weighing 1.5 kg, was found on the Talgai Goldfield.

Traces of tin were commonly associated with the alluvial gold, the cassiterite being most plentiful in the alluvium of Dunns Gully and the gullies leading on to Gum Flat. Skertchly (1898) recorded the find of a tinstone 'nugget' weighing 250 g. No economic deposits of tin have been recorded from this field and little trace of it is seen in the country rocks.

Many reefs have been worked on the Talgai field with varying results. Gold appeared to be patchy and in many cases the stone treated averaged 25 g or less per ton. Several mines exceeded this average, but faulting or small reserves or both prevented development in depth. Jack (1892) recorded that the Queensland reef was thought to be the first gold reef to be worked in Queensland. At a depth of about 21 m, 17 kg of gold were recovered from 4 tons of ore. The main ore-shoot was lost at depth where it was intersected by a quartz reef carrying pyrite.

The reefs in the field range in size from thin stringers to veins 2 m wide. The host rock of the gold is usually quartz that invades the metamorphics. The general strike of the gold-bearing reefs is west to north-northwest and they have a southerly dip. The largest reefs found in the field have been worked along the spur of Mount Gammie North.

Thanes Creek Goldfield

Although the Thanes Creek Goldfield is not contiguous with the Canal Creek Goldfield, it appears to form an extension of the same belt of auriferous country. In contrast to the workings along Canal Creek, no alluvial gold of any consequence has been found, and most of the gold won was derived from reef mining. Lack of suitable crushing and treatment facilities, erratic gold values, and faulting of the ore-shoots appear to have been the main reasons for the decline of the field. No mine has been developed below about 35 m, the average depth being about 18 m.

Pikedale Goldfield

This field is on the southeastern extremity of the 'gold belt' which extends from Leyburn in the north to Pikedale in the south. Gold production was confined to reef mining. Mineralization was found in both quartz 'dykes' and fissure fillings, strongly faulted in part and usually carrying pyrite. Occasionally cassiterite was found associated with the gold in some of the mines. The mines were not very large or very rich and difficulty was encountered with recovery of gold associated with pyrite. No record of production has been found. The country rocks are slate, indurated shale, and greywacke striking north-south and dipping at high angles. Small dioritic lenses have been found along relict bedding planes of the sediments in some of the mines. The strike of the auriferous deposits varies from east to east-northeast and they have a variable dip.

Leyburn Goldfield

No returns of production are available. The gold is found in dark laminated quartz reefs which tend to form lenses striking parallel to the general strike of the country rock and pitching at varying angles to the southeast. Gold has shown erratic distribution within the ore-shoots; the average value per ton of stone treated rarely exceeded 30 g. The country rocks are predominantly pink and purple phyllite, slate, and quartzite which strike approximately north 50° west and dip vertically.

Palgrave Goldfield

Little is known of the history or the workings of this field before 1931, when Denmead (1931) reported on several mines in the vicinity. The country rocks are predominantly greywacke and slate striking a few degrees west of north and dipping to the west. Old miners who know the field have said that the ore was of low grade and the mines small.

Failure of the mines on all the goldfields appears to have been caused by the low average grade of the ore, patchy values, faulting, primitive methods of mining and inadequate equipment, lack of suitable crushing and treatment plants, inability to handle the pyritic ore, high cartage costs, and the discovery of richer goldfields in other parts of Queensland.

Warroo Gold and Copper Mine

The mine is situated on Portion 5, Parish of Warroo, 65 km by road west of Stanthorpe and 30 km east of the Cobba-da-mana railway siding. The lode was discovered in 1906 and the mine worked spasmodically until 1913. Mineralization was exploited to a depth of 60 m and for a length of approximately 90 m along the strike of the lode. Some 2000 tons of ore were treated on the site either by smelting or by cyanidation for an average yield of 10 g of gold per ton.

The mineralization occurs in a series of west-trending indurated shale and interbedded fine-grained quartzite, with steep southerly dip. The lode varies in width from 10 cm to 1 m and appears to be conformable with the strike of the metasediments, although it cannot be considered to be interbedded with the country rock.

Gold values were erratic. Copper mineralization was associated with the gold but appeared to be uneconomic on its own. In 1931 (Denmead, 1932), the mine was reopened for inspection and testing, but activity was short-lived; the gold content of the ore proved not to be economic at that time.

THE GOLDFIELDS IN THE NORTHERN PART OF THE NEW ENGLAND FOLD BELT

Goldfield	*Discovered*	*Proclaimed*	*Area (km^2)*	*Type of Gold*
Lucky Valley	1851	1869	65	alluvial
Talgai	1863	1882	200	reef & alluvial
	redefined	1902		
Canal Creek	1863	1868	55	alluvial
Thanes Creek	1869	1882	45	alluvial
Pikedale	1877	1877	80	reef
Leyburn	1872	1875	21	reef
Palgrave	1897	1897	13	reef

CREEK AND GULLIES THAT HAVE YIELDED GOLD IN THE THANES CREEK/ PRATTEN AREA

Date of Discovery	*Name*
1863-64	Yankee Gully
1864	Slaty Gully
1868	Wilson's Gully, Thanes Creek
1877	Kelly's Gully
1877	Dunn's Gully
1879	3 gullies off Surface Hill
?	Jack's Gully

Copper

Sundown

Copper was first discovered at Sundown, Ballandean district, in 1888, but was not worked until 1898. The mine lies on a branch gully of Sundown Creek, 5 km above its junction with the Severn River and 45 km southwest of Stanthorpe (Ball, 1904b; Reid, 1916). The main mine working is an adit 90 m long, about 15 m above the bottom of the gully and 20 m below the ridge top, with winzes to some 15 m below the adit and a 27 m drive at the bottom. The lode so exposed followed a well defined east-northeasterly joint in silicified slate and according to Ball ranged in width from 0.5 to 2 m. The bulk of the ore mined was found in lenses consisting mainly of arsenopyrite and quartz, with patches of cassiterite. Reid (1916) recorded in the last 35 m of the adit a strong body of sooty chalcopyrite ore up to 1 m wide. Difficulties experienced with water and the lack of capital resulted in intermittent production throughout the mine's history. In 1899, 475 tons of ore yielded 54 tons of copper matte containing 2 kg of silver per ton. Fifty tons of copper matte averaging 2 kg of silver per ton were recovered in 1900. From 1900 to 1915 the mine lay idle. Between 1915 and 1924, about 223 tons of concentrate were produced before the mine closed in 1924 owing to lack of capital. Ball (1904b) reported that the average copper content of the ore was 4.83%.

Silver Spur Mine

Copper produced during the working history of this mine (1893-1926) totalled 1060 tons. See under 'Silver-Lead', p. 77.

Texas Copper Mine

The Texas Copper Mine lies 4 km west of Silver Spur and has been abandoned since 1894 (Ball, 1904b). The country rock is a siliceous clay slate. Several shafts, the deepest being 18 m, were sunk in a siliceous gossan, resulting in the discovery of a few isolated patches of copper ore. No records of production are available.

Silver Crown Silver-Copper Mine

The mine lies 6 km east of Silver Spur. Mineralization occurs in a copper-bearing gossan in clay schist which dips 80° to the south-southeast. The mine was abandoned at a depth of 15 m, where galena and chalcopyrite appeared. Ore produced was reported to assay 150 g to 1.2 kg of silver per ton and 14 percent copper (Ball, 1904b).

Tooliambi Copper Mine

This mine is 7 km north-northeast of the derelict Silver Spur Township; mineralization was discovered in 1918. The main production took place between 1920 and 1922 and surface prospecting was carried out during 1927 and 1928. Mineralization is confined to silty and pebbly mudstone of Permian age and is composed of malachite, azurite, and minor cuprite and chalcocite in a siliceous gangue. Five distinct lodes occur, the majority of which strike northeast and dip steeply to the southeast. Total production to date has been about 80 tons of ore raised, of which 70 tons produced about 8 tons of copper and about 360 kg of silver. Since 1919 official reports have been made on the mine by Ball (1919a, 1920, 1930), Saint-Smith (1923), Shepherd (1934, 1940), Simmonds (1961, 1963), and Sawers (1968).

Commodore Copper Mine

The Commodore Copper Mine is situated near the Warroo Gold Mine, 40 km northeast of Texas. The orebody was discovered in 1905 and was worked at intervals between 1905 and 1912, when the mine was abandoned. The mineralization was exploited to a depth of 35 m and laterally for approximately 85 m. Tenor of the ore varied from 6 to 25 percent copper; gold averaged 25 g per ton.

The orebody varied in width from about 10 cm to 1 m. (Warden's reports for the Stanthorpe Mineral Field for the years 1905 to 1912 inclusive).

'The Ashton' Copper Mine

Mineralization was discovered before 1879 (Cribb, 1944a). Skertchly (1898) places the position of the mine on the junction of Bracker and Treverton Creeks 65 km west of Stanthorpe. Little production has been recorded. The Warden's report of 1898 gives an ore assay of 30 percent copper and about 570 g of silver per ton.

Silverwood Copper Mine

No date is recorded for this discovery but it is thought that the first mine was opened before 1915. The mines are situated on the left bank of Rosenthal Creek 4 km southwest of Silverwood railway station. Mineralization is confined to the vicinity of porphyry dykes cutting silicified and highly epidotized tuffaceous sediments. The porphyry dykes and country rock carry abundant pyrite, whereas chalcopyrite and sphalerite with minor chalcocite are restricted to the contact between the dykes and the country rock, and copper carbonates occur as fracture stainings. Where limestone lenses are present, galena and sphalerite tend to be predominant. Saint-Smith (1924) first reported on these deposits. Since 1966, when new interest was shown in them, open cutting and diamond-drilling at one of them have failed to indicate prospects for other than selective underground mining (Sawers, 1969).

Small copper lodes have been worked in the vicinity of Mineral Hill in the Kilminster area and at the Silver Queen Mine, 11 km west of Ballandean (Ball, 1904b; Cameron, 1908b; Saint-Smith, 1914a; and Robertson, 1964). The deposits were small and the reserves were considered to be insignificant.

Silver-Lead

Pikedale

Mineralization at Pikedale was discovered in 1895 and production commenced in 1896. The mines are situated on the west bank of Woolshed Gully, near Pikedale station 50 km west of Stanthorpe. The lode ranges in width from 0.5 to 2 m and occurs in silicified shales that strike northwest and dip steeply to the northeast. The lode parallels the grain of the country but has been faulted on its northern extremity (Skertchly, 1898). The reef cap consisted of gossan with carbonates of copper and silver, which, at depth, gave way to complex sulphide ores. Mining and smelting were restricted to the years 1896-1897 and 1906-1907 owing to financial and smelting problems.

Since 1907 no work has been carried out on the orebody. During the working periods of the mines, the carbonates were stoped out, leaving the complex sulphide ores. No attempt has ever been made to work the sulphide ore. When Ball (1904b) visited the mines, six shafts had been sunk, the deepest being about 50 m. Production during 1896-1897 was reported by Ball (1904b) as about 760 tons of ore raised for a yield of about 640 kg of silver, 1.4 kg of gold, and 35 tons of copper, with an unspecified high percentage of zinc. During 1906-1907, 435 tons of ore yielded about 13 tons of copper, 135 kg of silver, 11 tons of lead, and 70 tons of zinc (Dep. Min., 1907, 1908; Cameron, 1908a).

Silver Spur Mine

The Silver Spur Mine is 10 km east of Texas and 85 km by road west-southwest of Stanthorpe. The deposit was discovered in 1891 and a small company was formed in 1892. Mining and smelting began in mid-1893 and continued without interruption until November 1913. After a period of idleness, work recommenced in June 1916 and continued until October 1926, when the mine closed; the smelter worked for short periods during 1918 and 1920.

Throughout the period of operation, ore raised and smelted (including fluxes) amounted to about 106 700 tons. Five orebodies were opened to a depth of 150 m. The orebodies occur in beds of dark-grey clay slate which are interbedded with lighter slate, and the ore-shoots are localized by strike faulting and shear fractures (Ball, 1904b). The average strike of the metasediments is north-south and the easterly dip is variable. Diorite dykes intrude the metasediments in the vicinity of Silver Spur. Skertchly (1898), Stokes (1899), Ball (1904b, 1918), and Saint-Smith (1913) have reported on the geology, structure, and potential of this deposit. Prospects for further production have been investigated subsequently by various mining interests, but the mine has not been reopened.

Production figures for the period 1893 to 1920 have been estimated as follows:

Silver	58 618 kg
Gold	150 kg
Lead	1460 tons
Copper	1060 tons
Silver ore shipped to Europe	920 tons
Zinc ore shipped to Europe	700 tons

In 1952, 160 tons of ore was sent overseas as a trial shipment, for a return of 875 g of gold, 265 kg of silver, and about 9 tons of lead.

Silver King Silver-Lead Mine

The mine, 3 km north-northwest of Silver Spur, was opened in 1893. The country rock is a schistose slate containing limestone lenses. The mineralization occurred in a gossan 9 m long and up to 1.5 m wide, partly replacing the country rock. Carbonates of lead and copper formed the bulk of the mineralization but cut out at a depth of 10 m. Recorded production was 30-40 tons of ore yielding 1.4 kg silver per ton and 5 percent lead (Ball, 1904b).

Silver Queen Silver Mine

The Silver Queen Silver Mine is on the right bank of the Severn River 13 km by road west of Ballandean railway station. Mineralization was discovered in 1897, and the mine was first worked in 1899. The deposit consists of impregnations in and replacement of a porphyry dyke by pyrite, galena, chalcopyrite, arsenopyrite, and zinc blende (Bonner, 1952). Five shafts and several pits have been sunk along the line of the mineral zone; the deepest shaft exceeds 30 m. The ill-defined ore pipe is not uniform and the tenor of the ore is variable.

Within the ore pipe, the type of mineral appears to vary from chalcopyrite in the central core to blebs of coarse cubical pyrite on the circumference and in the altered dyke rock. Sphalerite tends to be more abundant at depth at the expense of the other ore minerals. In the upper oxidized zone (surface to 18 metres) chrysocolla, malachite, azurite, and bornite are present.

The mine was worked from 1899 to 1900, 1902 to 1903, and 1905 to 1908. In 1952 the workings were dewatered to a depth of 30 m.

Production (Cameron, 1908b)

1899-1903	40 tons of picked ore carrying 2½ to 4½% copper, 15% lead, and 340 g of silver per ton.
1904	60 tons of ore treated at Aldershot (no details).
1907	5¼ tons of concentrates assaying 2.4% copper, 48% lead, 10% zinc, and 1.7 kg of silver per ton.
1907	(Warden's report) 268 tons of ore crushed locally for a yield of 47 tons of concentrates — no assay recorded.
1908	36 tons of concentrates in 6 parcels, ranging from 21.5 to 39.3% lead, 13 to 14.5% zinc, 0.6 to 27 kg of silver per ton, trace of gold, and 15 to 20% sulphur, were treated at Cockle Creek.

Mrs Allisons Sugarloaf

On the north bank of Sugarloaf Creek near Mount Sugarloaf, east of Stanthorpe, a small quartzose vein carrying galena, pyrite, and chalcopyrite lies along the margin of an altered basic dyke. It was prospected many years ago and is apparently of no economic value (Skertchly, 1898).

Arsenic

With the exception of 2 tons from an undisclosed locality in 1919, the entire arsenic output of Queensland between 1919 and 1927 came from the Jibbinbar and Sundown/Red Rock areas.

Jibbinbar State Arsenic Mine

The largest of the arsenic mines in the Stanthorpe district was the Jibbinbar Mine, 38 km southwest of Stanthorpe. The mineralization appears to have been concentrated in shear zones in granulites marginal to the Ruby Creek Granite. The main lode, striking east-west, averaged 2 m in width and was worked to a depth of 65 m before known reserves were almost exhausted and falling arsenic prices forced the mine and treatment plant to close.

The ore was bunchy and irregular. The main ore mineral was arsenopyrite, accompanied by very small amounts of chalcopyrite, silver, and galena, with scorodite and other arsenates of iron in the oxidized zone.

Marshall's Lode, which adjoins the main lode, carried a low percentage of arsenic except where it intersected the main lode. Another lode (about 1 m wide), 3 km southeast of the mine, was prospected but no production from it has been recorded. This lode consisted of arsenopyrite in a quartz gangue.

From 1919 until 1924, when the mine closed down, the production totalled about 1800 tons of arsenic (McLeod, 1965).

Sundown/Red Rock area

The Sundown group of mines is 23 km by road southwest of Ballandean and 8 km southeast of Mount Jibbinbar. Several lodes have been opened up in strongly metamorphosed sediments and tuffs, with the bulk of the production coming from the 'Tin Lode' and 'Copper Lode' (Dimmick, 1953).

These two lodes appear to be separate and parallel. The ore occurred in shoots, with width varying up to 1 m. Arsenopyrite, chalcopyrite, and cassiterite, together with fluorite, quartz, and calcite, constituted the ore. Mining ceased in 1924 after about 250 tons of arsenic had been recovered.

The Beecroft Mine is half a kilometre southwest of the Sundown workings. The ore is similar to that in the Sundown Mines with the exception that wolframite appeared at depth. Two lenses, each 28 m long and up to 1.5 m wide, were worked before 1928. Output of arsenic from this mine is estimated to be 1170 tons (McLeod, 1965).

Other mines in the area that produced arsenic ore were the Comet Mine and the Orient Mine (formerly called the Planet).

Small arsenic lodes have been discovered in the vicinity of the Severn River 10 km west of Ballandean (Simmonds, 1958; Robertson, 1964). In one instance, an attempt was made to mine the ore, which assayed 28-38% arsenic and 30-60 g of silver per ton (Wall's claim, portion 17V, Nundubbermere). Eight kilometres west-southwest of Gore, on portions 9V and 4V Moynalty, small arsenic lodes are associated with aplite dykes. Arsenic content ranged up to 17%, with silver rarely exceeding 30 g per ton.

Manganese

Many small deposits of manganese have been worked in the Palaeozic sediments in the Warwick, Stanthorpe, and Inglewood districts.

Mount Gammie

The Mount Gammie Mine lies 8 km west-southwest of Pratten and 2½ km east of Thanes Creek. The manganese deposit is on a spur of Mount Gammie, just south of the trigonometrical station on the summit. It was discovered about 1884 and at first the deposit was open cut.

In 1896 a shaft, 4 m deep, was sunk on the southern end of the manganiferous outcrop for a yield of 4 tons of ore. The orebody strikes north-south and has an easterly dip; the surrounding country rocks are sandy clay slates and quartzites, striking a few degrees east of north. The surface ore assayed 48.9% manganese (Ball, 1904a).

The Glen

The Glen Mine is on portion 95V, parish of Rosenthal, 8 km west-southwest of Warwick. The deposit occurs as several small lenses of manganese oxide and silicate in Palaeozoic sediments near their contact with the Herries Adamellite. First mined around 1903, the deposits have been worked spasmodically ever since. No production figures are available and the manganese content of the ore is low. Since 1962 the main interest has been rhodonite.

Mount Devine (ML 241)

The deposit was discovered before 1922. The workings lie just south-southeast of Yuraraba railway siding 80 km from Warwick on the southwestern line. The ore is predominantly psilomelane associated with jasper and schistose slate. One open cut, 2.5 m wide, 3 m deep, and 7 m long, yielded 80 tons of ore to 1923 (Ball, 1923).

Mount Fuller (MLs 209 and 240)

This mine is on portion 21, parish of Bodumba, near Graysholm railway siding 90 km from Warwick. Manganese was discovered and worked in 1918, but the mine was abandoned several months later. The ore lenses (4.5 x 0.5 m), with interlaminated jasperoid, occurred in thin-bedded kaolinized shale striking east-west. One small open cut and two shallow shafts yielded 90 tons of ore with an average assay (Ball, 1923) of:

Manganese	53.5 - 56.59%
Iron	2.64 - 3.0%
Insolubles	5.0 - 11.1%
Ignition loss	10.4%
Phosphorus	0.2%

War Effort Manganese Mine (Mining Claim No. 1074)

The War Effort Manganese Mine is located on portion 85V, parish of Coolmunda, in the Bracker Creek area 22 km east of Inglewood. The manganese ore forms lenses striking northeast conformably with the general strike of the folded kaolinized and jasperized shale (Ball, 1923). Some of the high-grade ore lenses are terminated by joints. The deposits were first worked before 1904 for a yield of 15 tons of ore. During 1904, 4 tons of manganese ore were recorded. In the main deposit, ore was worked at intervals over a length of some 50 m (Ball, 1923) with an average width of 2.5 m (Cribb, 1944b). The average assay of ore won was:

Manganese	56.00%
Iron	2.35%
Insolubles	6.00%
Phosphorus	0.87%

The mine was worked again during 1940, 1941, and 1942, when an estimated 150 tons of ore were won (Cribb, 1944b).

In 1963 the mine was reopened with a view to the production of chemical-grade manganese ore. During 1963, about 150 tons were produced and from January to May 1964 a further 80 tons had been marketed. The ore assayed up to 80.4% MnO_2, 2.6-8.8% silica, and 3.6-6.5% iron.

Manganese has been found in many small uneconomic deposits throughout the area covered by the Palaeozoic rocks. Recorded localities include Braeside, Silverwood, Pratten Goldfield, Dalveen, and west of Texas and Mingoola homestead.

Molybdenite

Molybdenite occurs as an accessory mineral in many of the vein and fissure-type ore deposits that lie within or along the edge of the more acid granites of the New England Batholith. It is rarely concentrated in economic quantities.

The largest deposit occurs at Leis' Molybdenite Mine, Wallangarra, where the mineralized outcrop extends for 150 m and has been mined to a depth of 9 m. The mine is situated in the extreme southwest corner of portion 86, parish of Ballandean, 3 km east-northeast of Wallangarra. The host rocks are the Ruby Creek Granite and numerous aplite dykes. Ball (1919b) reported on the workings. From 1916 to the end of 1919, 203 kg of molybdenite had been won.

Farther to the west-northwest, at Carpenters Gully in the Sundown/Red Rock area, molybdenite in concentrations of less than one percent occurs along the contact between the Ruby Creek Granite and the silicified metasediments. Ball (1919c) considered these deposits to be of the pneumatolytic/contact-metamorphic type. Traces of molybdenite have been recorded from the vicinity of the old Sundown tin mine.

To the west of Ballandean, in the Kilminster area, many small disseminated molybdenite bodies occur in the silicified Ruby Creek Granite. Most of these deposits have proved to be subeconomic. Saint-Smith (1914a), Jensen (1918b), Simmonds (1958), and Robertson (1964) have reported the occurrence of molybdenite in this area. Where the molybdenite occurs in mineralized veins intruding the Ruby Creek Granite in the Kilminster area, it is invariably accompanied by wolframite, tin, and arsenopyrite, and more rarely by chalcopyrite, sphalerite, galena, and magnetite.

Two kilometres southeast of Stanthorpe, molybdenite associated with native bismuth carbonate occurs in a quartz pipe-like structure 12 m in diameter and widening downwards (Jensen, 1917, 1918b). The content of molybdenite is low, averaging from 0.2 to 0.5% MoS_2.

Molybdenite has been reported from portion 80V, parish of Wildash (Jensen, 1918b). It was associated with wolframite in small quartz-aplite veins and greisen 'dyke structures' intruding a small mass of Ruby Creek Granite in the Stanthorpe Adamellite. The deposit proved to be uneconomic.

Wolframite

The main occurrence of wolframite is as an accessory mineral in many of the ore deposits within the granite. It is commonly found in the many mineralized veins crosscutting the Ruby Creek Granite and as a minor constituent in the alluvial tin deposits in many parts of the Stanthorpe Mineral Field. Little mining for wolframite has taken place.

Building Materials

From Greymare railway siding, 'granite' was quarried for the construction of buildings in both Warwick and Brisbane. The marble deposits at Lucky Valley and Limevale have produced a limited tonnage of material; the bulk of current production is being used for terrazzo.

Ironstone

Ironstone crops out 11 km north of the Silver Spur Mine. Three lenticular masses, several metres apart, strike northwest over a distance of 35 m. The greater part of the deposit was reported as being brown limonite with some crystalline magnetite and a little free silica (Ball, 1904c). A sample analysed:

Fe_2O_3 } FeO }	85.22
MnO_2	1.69
Al_2O_3	5.50
SiO_2	4.94
H_2O	2.65
	100.00

The ironstone was used as a flux in the smelters at Silver Spur.

Limestone

Within the Warwick, Gore, and Texas areas, limestone has been quarried from lenticular bodies interbedded with Palaeozoic sediments and metasediments.

Gore

The limestone deposits at Gore, 70 km by rail west of Warwick, occur as lenticular masses interbedded with slate which dips vertically and strikes northwest. The limestone crops out intermittently over a distance of 10 km from near Gore railway station to beyond Macintyre Brook. In the main working 6.5 km south of Gore (Connah, 1958), a light grey limestone has been exposed and proved to a depth of 35 m. Drillholes have indicated that the deposit extends to a depth of more than 60 m. The lens is known to be at least 270 m long by 30 m wide. Cave deposits and joint fillings of clay and detrital material increase the cost of exploitation of the limestone. A sample analysed:

Moisture	trace
Loss on ignition	43.4%
SiO_2	0.4%
Fe_2O_3	0.1%
Al_2O_3	0.1%
CaO	55.9%

Other lenses of limestone southeast of the main quarry, beyond Macintyre Brook, are better situated for quarrying but are farther from the railway.

Limevale

Marble has been quarried for building purposes in portion 28, parish of Silver Spur, 16 km north of Texas. The material has a fine even-grained texture suitable for polishing. The deposits are large and blocks of considerable size can be mined. There is said to be much variation in the colour of stone available in the area.

Silver Spur

Several small belts of limestone are known around Silver Spur and Glenlyon, 20 km to the east-southeast. Parts of these deposits were exploited when the smelters at Silver Spur were operating. At Kilminster, 9 km west of Ballandean, several small lenses have been reported. Close to the granite, these limestones have been altered and garnet and wollastonite developed.

Lucky Valley

Several occurrences of limestone have been reported and worked in Elbow Valley, 11 km southeast of Silverwood railway station. The main deposits occur on Reserve R49, and portions 1200, 1219, 106, and 107, parish of Wildash. The Stanthorpe Adamellite has metamorphosed the limestone to coarse-grained white marble. In Reserve R49, one lens, to a depth of 30 m, has been estimated to contain 2 to 3 million tons of limestone (Connah, 1958). Analysis of marble from portion 106 was given as:

Loss on ignition	43.1%
Insolubles	1.2%
$Fe_2O_3 + Al_2O_3$	0.6%
CaO	54.7%
MgO	0.3%

The marble deposits have been quarried for building, monumental, and terrazzo material.

Silverwood

A number of discontinuous lenses of coralline limestone occur near the railway from Morgan Park to Cherry Gully. Some of these are of considerable size, and large tonnages of limestone have been quarried and burnt for lime from Locks Quarry in portion 508, Rosenthal, and from Grieves Quarry in portion 660.

At Grieves Quarry, the limestone crops out over a length of 270 m with a width of 9 m. Analysis of the limestone from Grieves Quarry has been reported as:

Moisture	0.1%
Loss on ignition	42.6%
SiO_2	0.8%
Fe_2O_3	0.8%
Al_2O_3	0.9%
CaO	54.1%
MgO	0.2%

The following authors have reported on the limestones in the Warwick-Gore-Texas area: Ball (1904c, 1918, 1932, 1945), Dunstan (1913, 1914, 1919), Rands (1887), Richards & Bryan (1924), and Saint-Smith (1914a, 1922).

Gemstones

Gemstones are mainly confined to the stanniferous gravels on the New England Batholith. Rhodonite and agate have been worked in the Warwick area on a semi-commercial scale.

Topaz

Topaz has been found in almost all the alluvial deposits within the 'tin belt' and is abundant in the stanniferous gravels of Spring Creek, Cannon Creek, Quartpot Creek, the head of The Broadwater, Funkers Gap, Bald Rock Creek, Ten-Mile Creek, and Swiper's Gully. The clear variety is the most common, but pale blue, straw yellow, and rare pale green varieties are known. Generally the material is well waterworn although some specimens show well developed crystal faces.

Zircon

Zircon has been recorded from all parts of the New England Batholith. Crystals are generally less than 4 mm in diameter, but several brown specimens up to 1 cm in diameter have been recovered from Spring Creek.

Clear reddish-brown, reddish-yellow, and ice-blue varieties occur.

Beryl

Beryl is a rare constituent of the tin-bearing gravels. Dalcouth Creek has produced the only beryl recorded from alluvial workings. Small green semi-transparent crystals of beryl have been discovered in the old Kilminster mining area, west of Ballandean. These are found in situ, in the outcrop of a small pegmatite dyke. The deposits are too small to be of commercial value.

Sapphire

Sapphires have been recovered from Spring Creek, Kettle Swamp, the Severn River, and to a lesser extent from Sugarloaf Creek, Lode Creek, and the tributaries of Sugarloaf Creek. They rarely exceed 5 mm in length and are well waterworn. Colours vary from green to blue and particoloured. Opaque corundum is plentiful.

Diamonds

Diamonds have been found in Kettle Swamp, Spring Creek, and the head of The Broadwater. In 1873, a diamond-saving machine operated for 8 months on Spring Creek for a total gain of 4 diamonds. The source of the diamonds has never been found: basic dykes have been suggested as a possible source. Skertchly (1898) considered that the diamonds were derived from the greisens, but there is no supporting evidence for this.

Agate

Small quantities of agate have been found in the basalts of the Great Dividing Range, in the alluvium of Emu Creek and the upper part of the Swanfels Valley, and as silicified wood in the Jurassic sandstones near Tannymorel. Small deposits of common opal are known east of Yangan.

Rhodonite

Rhodonite has been worked on portions 95V, 96V, and 3V, parish of Rosenthal, 10 km southwest of Warwick (Ball, 1904a, c). Originally opened as a source of manganese ore, the deposits have been reworked in recent years for rhodonite, to supply the jewellery trade. The quality of the material is variable.

Quartz crystal, Cairngorm, Amethyst

Quartz crystal and cairngorm have been found in all the tin-bearing gravels in the Warwick 1:250 000 Sheet area. Amethyst is rarer and has been recorded from Spring Creek, The Broadwater, and Kettle Swamp only. Rock crystal and cairngorm pebbles 15 cm or more in length are usually associated with schorl tourmaline in the coarser parts of the alluvium. All three varieties have been located at Sundown and Kilminster, while doubly-terminated quartz crystals have been found in weathered pegmatite veins near Ballandean Head station.

Ore Mineralization, Zonation, and Relationship to Rock Types

The ore minerals associated with the granites of the New England Batholith can be classified as either late magmatic (wolframite) or post-magmatic hydrothermal (tin, sulphides, and gold). Of the second type of mineralization, Lawrence (1955) considers there have been two phases of deposition, the first characterized by arsenopyrite, the second by galena and sphalerite. In the Warwick 1:250 000 Sheet area, the post-magmatic hydrothermal stage has been arbitrarily divided into three phases of mineral deposition. The first stage gave rise to arsenopyrite and cassiterite, the second to copper sulphide, galena, and sphalerite, and the third to gold.

Copper, lead, and zinc mineralization is confined mainly to the metasediments in pyrometasomatic zones, caused by the contact of underlying granite with the sedimentary host rock. Lawrence (1955) considers these deposits to be hypothermal whereas Cornelius (1964) suggests that they could be mesothermal. At Sundown, Red Rock, Carpenters Gully (southwest of Ballandean), and Kilminster (west of Ballandean), the cassiterite-arsenic mineralization is restricted to the metamorphics in close proximity to the contact with the granite (Ruby Creek Granite). These areas are considered to be examples of hypogene deposits.

Gold is considered to be of mesothermal origin. The gold is confined chiefly to the Palaeozoic sediments in the northwestern part of the Warwick 1:250 000 Sheet area. In the Pikedale lode west of Amiens, gold and cassiterite are associated and most of the known gold occurrences of economic significance lie northwards from this point along the western side of the batholith.

Cornelius (1964) considers that the dykes were not responsible for the gold mineralization since (a) they carry no appreciable gold themselves, (b) they were emplaced in tension fractures as compared to shear fractures for gold, and (c) the dykes were late magmatic.

Most of the ore minerals classified as post-magmatic hydrothermal have been emplaced along joint and interlacing shear planes and are considered to have been derived from hydrothermal emanations during the final stages of intrusion of the Ruby Creek Granite. Because of this, many of the larger mines are in and around outcrops of this granite where it intrudes the metasediments. Exceptions are the gold deposits and the mines in the vicinity of Silver Spur.

Mineralization in the Warwick 1:250 000 Sheet area shows some evidence of zonation from south to north. Alluvial cassiterite develops its maximum concentration in the vicinity of the Ruby Creek Granite. Arsenic is confined mainly to the Sundown, Red Rock, Kilminster, and Jibbinbar areas and does not extend as economic deposits much farther north than the Stanthorpe-Texas road.

Copper, silver, lead, and zinc occur in a roughly east-west belt from the edge of the granites to Silver Spur near Texas. Gold has its maximum development north of the copper belt and forms an inverted Y-shaped belt oriented northwest-southeast. The edge of the main Mesozoic basin in the north forms the northernmost outcrop boundary of the so-called gold belt. Manganese shows no zonal arrangement as it is scattered throughout the Palaeozoic sediments.

Rock types play an important part in the exploration for various economic minerals. Gold and manganese are confined mainly to the Palaeozoic sediments. Copper, silver, lead, and zinc show similar relationships to that of gold and manganese, but around Sundown, Red Rock, and Kilminster they show a strong relationship to the Ruby Creek Granite. Arsenic, tin, molybdenite, and wolframite show strong affinities with the Ruby Creek Granite.

ECONOMIC GEOLOGY — NEW SOUTH WALES

by

P. G. Flood

The main areas of mineralization are: Wilsons Downfall (tin), Undercliffe Falls (graphite), Morgans Creek (molybdenite), Red Rock (gold, silver, copper, lead, and zinc), Boorook (gold, silver, lead, and zinc), Rivertree (gold, silver, lead, zinc, and copper), and Drake (gold, lead, zinc, and copper). These areas have been discussed by several authors, including Andrews (1901, 1902, 1908), Lawrence (1962), McLeod (1965), Raggatt (1939), and Saint-Smith (1911).

Wilsons Downfall

The cassiterite deposits of the Wilsons Downfall area are continuous with those of the Stanthorpe Tin Field (see p. 71). The alluvial tin deposits are derived from a fine-grained highly acid granite (Ruby Creek Granite; Phillips, 1968), and particularly from pegmatite and aplite dykes and greisen seams related to it. The area has produced more than 17 000 tons of alluvial tin concentrate; data concerning past mining operations can be obtained from the Annual Reports of the Mines Department of New South Wales.

Undercliffe Falls

The Undercliffe Mountain graphite deposits (Andrews, 1902) occur 25 km east of Stanthorpe, and consist of nine small deposits of amorphous graphite, originally carbonaceous shale or coal seams, interbedded with quartz-mica-feldspar hornfels close to the contact with the Stanthorpe Adamellite.

The largest lode is the Plumbago Deposit, with moderately to steeply dipping graphite beds, up to 1 m thick, which have been mined from shafts over a distance of about 375 m. Wynn (1956) records a production figure of about 2750 tons of graphite of average grade about 32 percent.

Morgans Creek

The Morgans Creek molybdenite deposit occurs in the precipitous country between the Cataract River and Morgans Creek, 8 km northeast of the old Boorook mining site. The visible molybdenite mineralization is associated with a small adamellite pluton, but disseminated flakes are concentrated only in very small patches.

Red Rock

The Red Rock Mineral Field is situated in the precipitous country lying between Crooked Creek and the Cataract River, 25 km northwest of Drake. The deposits were discovered in 1886, and from 1887 to 1889 were intensely mined. In 1890 operations were suspended until 1911, when the area was reopened. Mining continued until 1922, when the fall in the price of copper caused the cessation of mining. The mineralization occurs in the Permian Drake Volcanics and consists mainly of sulphides of copper and zinc. Accurate production data are not available.

Boorook

The Boorook Silver Field is situated about the old Boorook township site. In 1872, auriferous reefs were discovered, but they had been worked out by the end of 1873. Other intermittent operations ensued until 1885, when mining was no longer economically feasible. The lodes were associated with porphyry dykes intruded into Permian volcanics and sediments. Silver sulphides are associated with galena, pyrite, sphalerite, and gold. Production figures for the years 1879-1884 indicate that 3200 kg of silver were won.

Rivertree

The Rivertree Silver-Lead-Zinc Field is about 45 km east of Stanthorpe in extremely rugged country around the Maryland and Clarence Rivers. The field was discovered in 1887, but production has been sporadic and small and work was finally suspended in 1925. Pyrite and arsenopyrite are the dominant minerals, and argentiferous galena, sphalerite, and chalcopyrite are also present (Lawrence, 1962). The numerous orebodies are lenticular and occur along shear planes in the granite bodies and along the contacts of the granite and country rock. Detailed production figures are not available.

Drake

The ore deposits of the Drake Field (Andrews, 1908) were first worked in 1878 for gold, which is associated with mixed primary sulphides in small but numerous veins and lodes. The deposits have been followed to depths of 90 m and the gold values were as high as 540 g to the ton in the oxidized zone; but below the water table the percentage of gold dropped and copper became the more important ore mineral. Although this field has been worked spasmodically for many years, production figures are not available.

About 10 km north-northeast of Drake is the Lunatic Gold Field (Jaquet, 1897). Details of this field are not readily available.

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TABLE 1. IGNEOUS ROCKS OF THE NORTHERN PART OF THE NEW ENGLAND BATHOLITH

Age	*Rock Unit and Map Symbol*	*Distribution*	*Lithology*	*Relationships*	*Economic Geology*	*Principal References*
LOWER TRIASSIC	Ruby Creek Granite (Rlr)	Two northwest belts of isolated intrusions: one from Willsons Downfall to Utopia, the other from Wallangarra to Pike Creek homestead and including Red Rock and Mt Jibbinbar. Probably includes masses at and 3 km north of Mt Bullabanang	Massive even-grained medium to coarse granite	Intrudes Stanthorpe Adamellite and Texas Beds. Age: 225 m.y. (Phillips, 1968)	Tin and gemstone-bearing alluvium in Stanthorpe area. Lode tin in Kilminster-Red Rock area west of Ballandean. Associated minerals: arsenopyrite, wolframite, and molybdenite. Leis' molybdenite mine at Wallangarra	Saint-Smith, 1914, Phillips, 1968
	Herries Adamellite (Rlh)	One mass north of Dalveen, another at and south of Leslie Dam	Fine and coarse adamellite	Intrudes the Texas Beds and Silverwood Group. Unconformably overlain by Marburg Sandstone. Relationship to Stanthorpe Adamellite unknown. Intruded by a swarm of aplite dykes	Glen manganese mine (manganese oxide and silicate lenses) in Texas Beds near contact with admellite	This Volume
	Stanthorpe Adamellite (Rls)	Most widespread unit in batholith: about 2500 km^2	Coarse, in places porphyritic, adamellite	Intrudes Devonian, Carboniferous, and Permian volcanics and sediments and Dundee Adamellite Porphyrite, Maryland Granite, and Bungulla and Undercliffe Falls Adamellites	Some alluvial tin workings. Gemstones. Graphite in Permian sequence at Cliff Mountain east of Stanthorpe near contact with adamellite	Saint-Smith, 1911, 1914; Shaw *in* Packham, 1969, p. 289; Phillips, 1968
	Undercliffe Falls Adamellite (Rlu)	Northwest of Undercliffe Falls; another mass 10 km south of Willsons Downfall	Five varieties of adamellite (Phillips, 1968); mainly adamellite with pink K-feldspar phenocrysts	Intruded by Stanthorpe Adamellite. Age: 225 m.y. (Evernden & Richards, 1962, p. 37)		Phillips, 1968, and *in* Packham, 1969, p. 292
	Bungulla Adamellite (Rlb)	Small mass at Wallangarra, and larger along Bruxner Highway extending into Grafton Sheet area	Coarse, sphene-bearing porphyritic adamellite. Phenocrysts large pink K-feldspars	Intrudes volcanics at Wallangarra and Dundee Adamellite Porphyrite. Intruded by Stanthorpe Adamellite		Shaw *in* Packham, 1969, pp. 288-9
UPPER PERMIAN OR LOWER TRIASSIC	(Pg)	Large mass west of Texas extending southward into Inverell Sheet area	Granite, granodiorite	Intrudes Texas Beds. Unconformably overlain by Mesozoic strata. Age unknown		Lucas *in* Hill & Denmead, 1960, p. 233
	(Pua)	Five isolated masses near eastern margin of New England Fold Belt	Adamellite, biotite-rich granite, diorite, granodiorite	Intrudes Carboniferous - Permian sequence; unconformably overlain by Marburg Sandstone	Molybdenite, Morgans Ck mine northeast of Boorook. Silver mines in Rivertree area	
	Maryland Granite (Pum)	One small mass (4 km^2) just east of Maryland homestead	Fine to medium greyish blue biotite-rich granite	Intruded by Stanthorpe Adamellite		Saint-Smith *in* Carne, 1911
	Greymare Granodiorite (Pug)	One mass (55 km^2) at Greymare railway siding, 25 km west of Warwick	Grey medium granodiorite	Intrudes Texas Beds		Richards, 1918
	(Pub)	Four small masses, 18 km south-southeast of Warwick, 3 km northeast of Boorook homestead, 6 km southeast of Undercliffe Falls, and 6 km southeast of Drake	Diorite, mafic rocks (plagioclase, actinolite, epidote, chlorite)	Intrudes Devonian sediments south of Warwick and Permian volcanics and sediments in Drake-Boorook area	Gold in Lucky Valley Creek possibly associated with diorite intrusion	
PERMIAN	(Pur)	Small irregular mass, 13 km south of Warwick	Spherulitic rhyolite and quartz-feldspar porphyry	Intrudes Devonian and Permian rocks in Silverwood area south of Warwick. Possible feeders to Permian volcanic sequence		
LOWER PERMIAN	Dundee Adamellite Porphyrite (Pld)	Irregularly shaped intrusions in Wallangarra area and south of Bruxner Highway, extending into Grafton Sheet area	Blue-grey medium to coarse adamellite porphyrite	Intrudes volcanics at Wallangarra which are probably equivalent to Drake Volvanics. Intruded by Stanthorpe and Bungulla Adamellites. Age: 242 m.y.		Wilkinson et al., 1964

TABLE 2. PALAEOZOIC STRATIGRAPHY OF THE WARWICK AND GOONDIWINDI SHEET AREAS

Age	Rock Unit and Symbol	Thickness (m)	Distribution	Lithology	Palaeontology	Relationships	Environment of deposition
UPPER PERMIAN	Gilgurry Mudstone (Pul)	150	Small area west and northwest of Drake	Grey and green mudstone, minor light brown feldspathic sandstones	Fauna 4	Conformable on Drake Volcanics	Marine
LOWER TO UPPER PERMIAN	Condamine Beds (Puc)	1950+	Condamine Block 15 km southwest of Warwick. Area about 25 km^2	Mainly dark grey slightly calcareous mudstone with 300 m of poorly sorted sandstone, pebbly sandstone, conglomerate, and minor crystal-lithic tuff near top of exposed section	Fauna 4	Faulted against Connolly Volcanics, unconformably overlain by Marburg Sandstone	Marine
	(Pw)	300–450	Irregular area west and south of Wallangarra	Rhyolite and rhyodacitic flows and tuffs		Intruded by Stanthorpe Adamellite and possibly Dundee Adamellite Porphyrite. Probably equivalent to part of Drake Volcanics	
	Drake Volcanics (Pv)	450	North-northwest belt through Drake and Rivertree	North: Interbedded acid and intermediate flows and volcanolithic sediments. South: Mainly pyroclastic rocks including agglomerate, breccia, crystal-lithic tuff. Minor sediments	Fauna 2 in lower part, Fauna 4 in upper, near contact with Gilgurry Mudstone	Conformable between Razorback Creek mudstone and Gilgurry Mudstone. Probable unconformity within volcanic sequence	Terrestrial and marine
LOWER PERMIAN	Rhyolite Range Beds (Plh)	1200	Eight Mile - Tunnel Fault Block, 18 km long and up to 3.5 km wide south of Warwick	About 900 m of acid volcanic rocks over 300 m of conglomerate, lithic sandstone, calcareous siltstone, and mudstone	Fauna 3A	Unconformable on Rosenthal Creek Formation, faulted against Silverwood Group, unconformably overlain by Marburg Sandstone and intruded by spherulitic rhyolite and Stanthorpe Adamellite	Marine and possibly partly terrestrial
	Eight Mile Creek Beds (Ple)	900	About 3 km^2 along Eight Mile Creek, 12 km south of Warwick	450 m of acid volcanic rocks including agglomerate, breccia and crystal-lithic tuff, over conglomerate, pebbly sandstone, siltstone, and mudstone	Fauna 3A	Probably unconformable on Connolly Volcanics. Faulted against Rosenthal Creek Formation, unconformably overlain by Marburg Sandstone, and intruded by rhyolite and quartz-feldspar porphyry	Marine and possibly partly terrestrial
	Razorback Creek Mudstone (Pla)	300+	About 100 km^2 in Rivertree area	Olive-green mudstone		Base not exposed. Conformably overlain by Drake Volcanics	Probably marine
	Eurydesma and Wallaby Beds (Plr)	200+ and 150+	Stanthorpe Road Fault Blocks at Rokeby homestead, 15 km south of Warwick. About 1 km^2	*Eurydesma* Beds at base: conglomerate, lithic sandstone, siltstone and limestone. Wallaby Beds; Conglomerate, lithic sandstone, siltstone and ferruginous siltstone	Fauna 2	Down-faulted in Silverwood Group. Neither top nor bottom exposed. Probably slight unconformity between units	
	(P)	Up to 900	Five small areas; in west as outliers in Texas Beds; one northeast of Stanthorpe at Delmoak homestead	Conglomerate, pebbly sandstone, lithic sandstone, pebbly mudstone, siltstone; minor limestone and acid volcanics	Fauna 2: Some plant material	Unconformable on and faulted against Texas Beds. Intruded by granite northeast of Stanthorpe	Shallow marine
	Paddys Flat Formation (Plp)	2400+	North-northwest belt, 40 km long and 7 km wide, along Tabulam - Tooloom road	Well-bedded lithic sandstone and mudstone with beds of conglomerate and minor volcanics and limestone	Fauna 2	Top not exposed. Unconformable on Emu Creek Formation and unconformably overlain by Marburg Sandstone Intruded by granite	Shallow marine
UPPER CARBONIFEROUS	Mount Barney Beds (Cub)	2100+	Small areas around Mount Barney in northeast Warwick Sheet area	Calc-silicate rocks, lithic and feldspathic sandstone, conglomerate, bryozoan mudstone, carbonaceous siltstone; minor flow rocks and tuff	Marine macrofossils (Maxwell *in* Hill & Denmead, 1960, p. 167), and *Lepidodendron* (Stephenson, 1954)	Forced up through Mesozoic strata by Tertiary Mount Barney volcanic complex. Unconformably overlain by Marburg Sandstone	Shallow marine
	Emu Creek Formation (Cue)	1500+	North-northwest belt 35 km long and up to 5 km wide north-northeast of Drake	Interbedded fine-grained lithic sandstone and mudstone with beds of conglomerate	Fenestellids, trilobite, and rich shelly fauna characteristic of *Levipustula levis* Assemblage Zone	Base not exposed. Unconformably overlain by Paddys Flat Formation and Marburg Sandstone, faulted against Razorback Creek Mudstone and Drake Volcanics, intruded by granite	Marine
UPPER DEVONIAN(?) TO UPPER (?) CARBONIFEROUS	Texas Beds (Clt)	Unknown but great.	Large area west of New England Batholith	Regularly interbedded lithic sandstone and mudstone; intraformational conglomerate, slate, chert, jasper, intermediate volcanics, limestone	Mainly corals collected from limestone lenses	Probably unconformable on Silverwood Group. Unconformably overlain by Permian and Mesozoic. Intruded by granite	Shallow marine above and below wave base
SILURIAN(?) TO LOWER DEVONIAN — Silverwood Group	Rosenthal Creek Formation (Dlo)	1200	Small areas near Silverwood Siding, west of Rokeby homestead, and east of Dalveen	Volcanolithic sandstone mudstone, chert, conglomerate, limestone	Mainly corals collected from limestone lenses; Radiolaria	Top not exposed. Probably conformable on Connolly Volcanics, unconformably overlain by Permian and Marburg Sandstone. Intruded by granite and diorite	Marine
	Connolly Volcanics (Dlc)	1400	Small areas along Rosenthal Creek and west of Rokeby homestead	Coarse-grained pyroclastic rocks including agglomerate, breccia, and tuff, with minor volcanic sediments and limestone	Corals in limestone lenses	Probably conformable within Silverwood Group. Unconformably overlain by Permian and Marburg Sandstone. Intruded by granite and dioritic dykes	Marine and probably partly terrestrial
	Risdon Stud Formation (Dlr)	1800	Narrow north-trending belt from Dalveen to New England Highway south of Warwick	Andesitic crystal-lithic tuff, fine-grained volcanolithic sediments		Probably unconformably overlain by Lower Carboniferous Texas Beds, unconformably by Marburg Sandstone, intruded by granite and diorite dykes	Probably marine

APPENDIX 1

THE PERMIAN FAUNA FROM THE EIGHT MILE & TUNNEL BLOCKS SOUTH OF WARWICK, QUEENSLAND

by

J. M. Dickins

Summary

The fauna from the 'Eight Mile' and 'Tunnel' Blocks is regarded as representing a limited time span and for correlation is taken as a whole. It is closely related to the fauna from the Ulladulla Mudstone of the Sydney Basin, the *Fenestella* zone, and Fauna IIIA from the Gebbie Subgroup. Together these apparently form a horizon younger than Fauna II of eastern Australia and probably older than Fauna IIIB of the Bowen Basin. This conclusion seems to indicate that the sea was perceptibly cooler in the south than in the north during mid-Artinskian (Lower Permian).

Identifications

Eight Mile Block

TH 406 (3 km northeast of Silverwood siding)*

Pelecypods

Myonia sp. indet.
Stutchburia sp. indet.
Astartella sp. (as at 411)

Gastropods

Peruvispira cf. *elegans* (Fletcher, 1958). Occurs also in collection TH 198 from same beds. Seems to differ from species in Fauna II of Bowen Basin and in fauna from Farley Formation and possibly referable to *P. elegans*. Unfortunately the photographs of this species make it difficult to recognize.

Brachiopods

Terrakea sp. (as in Fauna III, Ulladulla Mudstone, etc.)
Ambikella† *cf. ingelarensis* (Campbell, 1961) (similar to specimens from KOE 3, Springsure area)
Ambikella profunda (Campbell, 1961) or *A. angulata* (Campbell, 1961)
Notospirifer cf. *extensus* (Campbell, 1961) (more like *N. extensus* than specimens from TH 198 although the beds are on strike).

TH 407 (3 km northeast of Silverwood siding)

Pelecypods

Nuculopsis (Nuculopsis) sp. indet.

Brachiopods

Strophalosia sp. indet.

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* For location of fossil collections, see Figure 17, p. 25.

† The usage suggested by Waterhouse (1965) is followed here and *Ingelarella* Campbell, 1959, is regarded as a synonym of *Ambikella* Sahni & Srivastava, 1956.

Anidanthus sp.
Neospirifer sp. indet.

TH 411 (3 km northeast of Silverwood siding)

Pelecypods
Megadesmus (Megadesmus) cf. *gryphoides* (de Koninck, 1877)
Myonia sp. indet.
Vacunella sp. indet.
Deltopecten limaeformis (Morris, 1845)
Deltopecten multicostatus (Fletcher, 1929)
Etheripecten cf. *tenuicollis* (Dana, 1847)
Etheripecten fittoni (Morris, 1845)
Stutchburia cf. *randsi* (Etheridge Jnr, 1892) (radial ribs present in middle part of shell)

Gastropods
Keeneia sp.

Brachiopods
Terrakea sp. (comparable to Fauna IIIA specimens at Homevale)
Ambikella ingelarensis (Campbell, 1961)
Ambikella cf. *mantuanensis* (Campbell, 1961) (adminicula as in specimens of *A. ingelarensis* but sulcus relatively flat)
Ambikella cf. *plana* (Campbell, 1961) or small *A. ingelarensis*
Notospirifer cf. *extensus tweedalei* (Campbell, 1961)

Fenestellid Bryozoans

TH 198 (4 km east-northeast of Silverwood siding)

Pelecypods
Myonia sp. nov.? (considerable variation in shape and development of carina shown by this group of shells. In shape there is some resemblance to *M. carinella* Runnegar, 1967).
Myonia cf. *corrugata* Fletcher, 1932 (these specimens seem closer to the holotype than those from Fauna IV from the Bowen Basin. The internal features seem to correspond to specimens from Fauna IIIA of the Bowen Basin — *Pachymyonia* sp. nov. of Dickins, 1966 and *Myonia* sp. nov.? of Runnegar, 1967).
Vacunella cf. *etheridgei* (de Koninck, 1877)
Pyramus? sp. indet.
Merismopteria sp.
Etheripecten cf. *tenuicollis* (Dana, 1847)
Stutchburia sp. (apparently no radial ribs)
Astartella sp.

Gastropods
Peruvispira cf. *elegans* (Fletcher, 1958)
Warthia sp.

Brachiopods
Terrakea sp. (as in TH 406 and TH 411)
Ambikella ingelarensis (Campbell, 1961) (specimens with deep sulcus seem best identified in this way, although the length of the adminicula in the brachial valve varies from that typical in *A. ovata* to that typical for *A. ingelarensis*. Forms with flattish sulcus are perhaps best identified as *A.* cf. *plana* Campbell, 1961).

Notospirifer sp. (somewhat similar to *N. extensis tweedalei,* also similar to forms in Fauna III such as in Ingelara Formation and Catherine Sandstone).

TH 199 (3 km north of Silverwood siding)

Brachiopods

Strophalosia sp. (somewhat raised muscle platform)
Ambikella sp. indet.
Neospirifer sp.

Bryozoans

Fenestellids
Stenoporoids

Tunnel Block

TH 171 (2.2 km north-northeast of Oaklands homestead)

Pelecypods

Myonia sp. nov.? (as at TH 198)
Astartella sp. (apparently as at Eight Mile Block)

Gastropods indet.

TH 201 (1.9 km north-northeast of Oaklands homestead)

Pelecypods

Etheripecten cf. *subquinquelineatus* (M'Coy, 1847)

Brachiopods

Terrakea sp. (as in Eight Mile Block localities)
Strophalosia sp. (seems close to species in *Fenestella* Zone of Branxton Formation. Considerable development of muscle platform but apparently distinct from *S. ovalis).*
Ambikella sp. indet.
Notospirifer sp. indet.
Rhynchonellid

Bryozoans

Fenestellids
Stenoporoids

TH 202 (1.4 km north-northeast of Oaklands homestead)

Pelecypods

Myonia sp. nov.? (apparently same as at TH 198)
Myonia cf. *corrugata* Fletcher, 1932
Pyramus? sp. indet.
Etheripecten tenuicollis (Dana, 1847)
Astartella sp.

Brachiopods

Strophalosia sp. indet.
cf. *Streptorhynchus*

TH 203 (1.2 km north-northeast of Oaklands homestead)

Pelecypods

Vacunella sp.?
Etheripecten cf. *subquinquelineatus* (M'Coy, 1847)

Brachiopods

Terrakea sp.

Strophalosia sp. (as at TH 199 and TH 201)

Notospirifer sp.

TH 414 (1.2 km south-southeast of Oaklands homestead)

Pelecypods

Myonia sp. nov.? (squashed but apparently same as in Eight Mile Block)

Stutchburia sp. (as at TH 195)

Relationships of the Fauna from the Eight Mile and Tunnel Blocks

With the possible exception of TH 407, much the same species are found at each locality and apparently they are of similar age. TH 407 underlies TH 408 a hundred metres or so stratigraphically and is the only locality in the two blocks from which *Anidanthus* was collected. Nothing indicates that the locality is substantially older than TH 408.

In the Eight Mile Block, productids are poorly represented except at a single locality, TH 199, where pelecypods and martiniopsids, plentiful at the other localities, are poorly represented. The same species, however, are represented together in the same beds in the Tunnel Block (TH 202 and TH 203), which indicates that the fauna represents a limited time span. For the purposes of correlation with other areas, the fauna is, therefore, taken as a whole.

It is most closely related to that from the Ulladulla Mudstone* of the southern part of the Sydney Basin, the *Fenestella* Zone of the Branxton Formation of the Hunter Valley, and Fauna IIIA from the basal part of the Gebbie Subgroup of the Bowen Basin. The relationship of the *Fenestella* Zone has been considered by Dickins (1968). Dickins, Gostin, & Runnegar (1969) suggested that the fauna from Ulladulla was mixed. Runnegar (1967) referred to it as the *Eurydesma-Myonia corrugata* fauna and (1969) as the Ulladulla fauna.

The characteristic feature of the Ulladulla fauna is that in addition to species recorded from Fauna II of the Bowen Basin, it contains species suggestive of a younger age — in particular a species referred to *Myonia corrugata* and *Ambikellas* with more advanced characters than found in Fauna II. The Ulladulla fauna also has terebratuloids with younger affinities. These features are repeated in the Eight Mile and Tunnel Blocks except for the terebratuloids, which are poorly represented. The fauna from the Eight Mile and Tunnel Blocks gives a clearer indication of an age younger than Fauna II than does the Ulladulla fauna, as it contains a few additional species found in Fauna IIIA. It contains also a few species not so far recorded from elsewhere. In the fault blocks a species of *Strophalosia* with a relatively high muscle platform and closely related to that in the *Fenestella* zone is found, whereas *Strophalosia* cf. *preovalis* has been recorded from Ulladulla Mudstone. Although *Eurydesma* has not so far been recorded, *Deltopecten limaeformis* and *Deltopecten multicostatus* parallel the occurrence in the Ulladulla Mudstone and a *Deltopecten* is found in the *Fenestella* Zone. Shells referred to *M. corrugata* are found at Ulladulla and in the fault blocks. From the examination of specimens from the fault blocks emerges the interesting conclusion that *Myonia* sp. nov.? (Runnegar, 1967, p. 56, pl. 4, figs 6-7) may represent an internal of *M. corrugata.* As in the Ulladulla Mudstone and the *Fenestella* Zone, the relationships of the *Ambikella* in the fault blocks are puzzling. *A. ingelarensis* is readily identifiable and confirms the conclusion that *A. ingelarensis* was already well established and widespread by the beginning of Fauna III time. Other *Ambikella* species present seem to show a mixture of morphological features found in specimens from Fauna II time and later, and perhaps a new specific name is required for the specimens from the fault blocks. Pending further information, however, on the characteristics of *A. undulosa,* this might be premature. Campbell (1961, p. 180) has recorded *A. undulosa* from the Eight Mile Block. There seems little doubt, however, of the

* Work which I have carried out subsequently shows that the fauna referred by Dickins, Gostin, & Runnegar (1969, p. 221) to the Wandrawandrian Siltstone is regarded more satisfactorily as from the Nowra Sandstone. The siltstone containing the fauna grades laterally into sandstone and the boundary of the main sandstone body is stratigraphically lower than the level from which the fossils came.

close relationship of these specimens in the Ulladulla Mudstone and the *Fenestella* Zone. Clearest relationship with Fauna III of the Bowen Basin seems to be given by *Vacunella* cf. *etheridgei* and *Notospirifer* cf. *extensus*. The significance of *Myonia* sp. nov.?, *Astartella* sp., and *Peruvispira* cf. *elegans* in the fault block in relation to the other areas is not clear.

Consideration of the evidence seems to justify the conclusion that the fauna of the Ulladulla Mudstone and the *Fenestella* Zone are similar in age to Fauna IIIA of the Bowen Basin and together form a horizon distinctive from Fauna II, which is found in underlying beds in all these areas. Although not altogether clearcut, this horizon seems older than Fauna IIIB, which contains a number of different species. Certainly it is readily distinguishable from Fauna IV. On this basis the concept of the mixed fauna (Dickins, Gostin, & Runnegar, 1969) is of doubtful merit and could lead to the glossing over of morphological differences that serve to distinguish the specimens in this level from those found in Fauna II and Fauna IV.

On the assumption of the time equivalence of these beds an explanation of the faunal change from south to north is warranted. A climatic or land barrier between the Bowen and Sydney Basin in Fauna III time has been postulated by Dickins (1968, p. 35). Runnegar's (1970) conclusions imply a land barrier in Fauna III time. From the fault blocks data it seems that the connexion between the two faunas was not closed until after Fauna IIIA time, and the faunal changes might reflect a change from cool to more temperate water conditions from south to north. This is suggested by the occurrence of *Deltopecten* and *Keeneia* in the fault blocks and the south but not in the Bowen Basin. The possibility of more persistent cool conditions in the Sydney Basin compared with the Bowen Basin has already been suggested by Dickins (1968) and this evidence seems to support this conclusion. Perhaps the occurrence of *Strophalosia* cf. *preovalis* in the Ulladulla Mudstone and *Stutchburia* cf. *randsi* in the Eight Mile Block is connected with this change in water conditions. Alternatively the distribution of species might be explained by the penetration of a marine tongue from the Sydney Basin into the fault blocks area, bringing species found in the Sydney Basin, but not in the Bowen Basin at this time. This would imply that those Fauna III species common to the Sydney and Bowen Basins were established in the two areas in late Fauna II time, evolved independently in the two areas, or migrated by an indirect route. These explanations do not seem as satisfying.

APPENDIX 2

REPORT ON COLLECTIONS OF CARBONIFEROUS CORALS FROM THE WARWICK, GOONDIWINDI, AND INVERELL SHEET AREAS, QUEENSLAND

by

D. L. Strusz

Collections were made from the limestone deposits of the region in September-October 1968. Those from the Lower Devonian at Silverwood are considered in Appendix 3, and one locality (476) that yielded bryozoans of Carboniferous or possibly Permian age in Appendix 4.

Three main regions of outcrop have yielded Carboniferous corals:

(1) Silver Spur/Limevale area, northeast of Texas (localities 468, 472).

(2) Glenlyon/Craigie/Riverton/Emu Park area, southeast of Texas (localities 474, 475, 477, 478, 479, 483, 485, 488, 1501).

(3) Cement Mills/Cooinoo/Pikedale/Sailor Jack area, west, northwest, and southwest of Stanthorpe (localities 97, 589, 592, 1507, 1508).

Most of the limestones in the first region have been extensively sheared and recrystallized; in few places were any macrofossils visible, and those collected are very poorly preserved. Preservation in the other regions varies from very poor to reasonable. The faunas are briefly described below in numerical order.

LOCALITY 97

Lithostrotion hallense Pickett, 1966 (F23537, 23528?, 23529, 23520?*)

A fasciculate form, with corallites 6.5-10 mm in diameter having 2 x (22-24) septa, of which the major are generally slightly withdrawn from the narrow columella. The minor septa reach to about half the radius, and may be a little discontinuous. Septal dilation is fusiform, moderate (major more than minor). The tabulae are mostly complete and steeply domed. There are 2 to 4 series of steeply inclined dissepiments, occasionally lonsdaleoid.

This form agrees well with Pickett's large-diameter variety.

Lithostrotion columnare Etheridge fil., 1900 (F23520)

This fragment of a cerioid form has corallites 3.5-5.0 mm in diameter, with 32 septa. The presence of lonsdaleoid dissepiments and the style of septal dilation make its identification certain. It corresponds to the small-diameter form found in the Riversleigh Limestone (Hill, 1934, Pl. X, figs 21-22).

Age: Visean, probably Upper.

LOCALITY 468

A scarcely recognizable rugosan.

LOCALITY 472

Large smooth slabs at this locality contained several corals, none of which could be collected. Acetate peels were taken from them in the field; although insufficient for precise identification these include forms probably referable to

* BMR fossil registration numbers.

Amygdalophyllum columellare Pickett, 1966 (F23540, 23541), and to either *A. conicum* Hill, 1934 or *Lithostrotion nitidum* Pickett, 1966 (F23538).

Age: Probably Visean, possibly Tournaisian.

LOCALITY 474

Specimens of crinoidal calcarenite contain fragments of a tabulate coral possibly referable to *Syringopora* (F23542).

Age: *Syringopora* is not definitely known above the Carboniferous, but there are similar forms in the Permian of which fragments could easily be mistaken for that genus.

LOCALITY 475

Merlewoodia? foliaceum (Hill, 1934) (F23543?, 23544, 23547, 23549)

A solitary non-columellate coral, readily distinguished from other species by the thin rejuvenescence rims and the septal dilatation.

Lithostrotion hallense Pickett, 1966 (F23545)

Fasciculate; corallite diameter 6.5-10 mm, 2 x (20-25?) septa. Columella variable, generally small, elongate; septa slightly withdrawn. Tabulae inversely conical; about 3 series of dissepiments. Septa dilated, fusiform.

Lithostrotion spp. indet. (F23552, 23553)

Fasciculate columellate corals whose structures are otherwise obliterated by recrystallization.

Amygdalophyllum sp. cf. *praecox* Pickett, 1966 (F23546)

A single poorly preserved transverse section; corallite diameter ca 14 mm, 58 septa. The strong columella is formed by the union of the axial ends of the radial major septa with the sides of the elongate counter septum. The septa are moderately dilated, in places peripherally lonsdaleoid; the minor septa are rather long.

This form agrees with *A. praecox* in the frequency of its lonsdaleoid dissepiments, but in style of septal dilatation and the structure of the columella it shows some resemblance to *A. columellare* Pickett.

Amygdalophyllum sp. cf. *conicum* Hill, 1934 (F23550)

Several fragments, up to 23 mm in diameter, in which the major septa join with the columella and the minor septa are long, have extremely dilated septa, and so are close to *A. conicum*. However, they lack the naotic modification of the septa which usually accompanies their strong dilatation in that species.

Amygdalophyllum? sp. indet. (F23548)

A single poorly preserved corallite about 28 mm in diameter with an elliptical columella is probably referable to this genus.

Age: *Amygdalophyllum praecox* is known from the Upper Tournaisian Rangari Limestone of N.S.W., but *A. columellare* comes from the Lower Visean. The other forms are known from various levels within the Visean, to which this locality should be referred.

LOCALITY 477

Merlewoodia? foliaceum (Hill, 1934) (F23556)

The size and septal characteristics, in particular the wide lonsdaleoid dissepimentarium, found in this specimen are characteristic of the species.

Age: Visean, probably Upper.

LOCALITY 478

?Merlewoodia sp. (F23558)

A single very poorly preserved non-columellate corallite is probably referable to this genus.

Age: Visean?

LOCALITY 479

Amygdalophyllum sp. cf. *conicum* Hill, 1934 or *columellare* Pickett, 1966 (F23559, 23560)

These two corallites of diameters 12 and 13.5 mm, with 76 and 70 septa respectively, have prominent columellas to which are joined thick tapering major septa. Preservation is too poor for accurate identification.

Age: Visean.

LOCALITY 483

?Amygdalophyllum sp. (F23561)

The axis is not preserved, so the presence of a columella is uncertain, but the size and septal dilatation suggest either *A. conicum* Hill or *A. columellare* Pickett.

Age: Visean?

LOCALITY 485

Rugosan indet. (F23563)

Age: Carboniferous?

LOCALITY 488

?Naoides rangariensis Pickett, 1966 (F23564)

This specimen comprises a single oblique transverse section through the calice of a corallite about 30 mm in diameter, with about 84 septa. There is a marginarium consisting of a septal stereozone 8 mm wide, from which the minor septa extend only a short distance towards the axis. The nearest form to which these characters could apply is *Naoides rangariensis* Pickett, from the Upper Tournaisian Rangari Limestone of N.S.W.

Age: Lower Carboniferous, possibly upper Tournaisian.

LOCALITY 589

Amygdalophyllum columellare breviseptatum Pickett, 1966? (F23532)

A solitary corallite with a diameter of 11 x 12.5 mm, and 46 septa. There is a strong columella consisting of the conjoined ends of the counter and cardinal septa, plus the detached ends of the other major septa. The withdrawal of the septa from the columella is characteristic of the subspecies.

Age: Lower to middle Visean.

LOCALITY 592

Lithostrotion hallense Pickett, 1966 (F23533)

Fasciculate corallites 4.5-8.2 mm in diameter, having 40-46 septa, a narrow columella more or less joined with the major septa, and several series of dissepiments, are referable to this species.

Amygdalophyllum conicum Hill, 1934 (F23535)

This is represented by a single corallite 13.8 mm across, with about 60 septa. The columella is small and narrow, and there is a very wide septal stereozone.

Age: Visean.

LOCALITY 592A

Amygdalophyllum? sp. (F23536)

This is a single very poorly preserved probable columellate corallite.

Age: Visean?

LOCALITY 1501

Lonsdaleia? sp. indet. (F23565-23567, 23570)

This coral is fasciculate, with corallites 5.5 to 9 mm in diameter (having tabularia 4.5 to 6 mm across), and 40 to 44 septa. The septa are conspicuously lonsdaleoid, short (the major seldom extend adaxially for more than half the radius), and thin or weakly dilated peripherally, tapering adaxially. There are 1 to 2 series generally wide lonsdaleoid dissepiments; in the wide tabularium the tabulae are flat or gently domed, marginally down-turned. In some sections a very small columella is visible.

The septal structure suggests a diphymorphic *Lithostrotion* (perhaps *L. hallense* or *L. stanvellense*), but the well developed lonsdaleoid dissepimentarium and the very poorly developed columella are more like those of *Lonsdaleia.*

Age: Carboniferous. Hill & Woods (1964) have reported another *Lonsdaleia* from the Visean? Baywulla Formation of Queensland.

LOCALITY 1507

?Merlewoodia sp. (F23571, 23573)

Both specimens are very poorly preserved large corallites with long thick septa. There is the suggestion of a columella in F23573, in which case it may be *Amygdalophyllum.*

Age: Visean?

LOCALITY 1508

Two very poorly preserved corals, one a *Lithostrotion* (F23574) and the other probably *Amygdalophyllum* (F23575) have been identified from etched surfaces. The material is too recrystallized for sectioning.

Age: Visean?

APPENDIX 3

REPORT ON COLLECTIONS OF LOWER DEVONIAN CORALS FROM SILVERWOOD, QUEENSLAND

by

D. L. Strusz

Preliminary identifications, mostly based on weathered or etched surfaces rather than thin sections, have been made on collections made in 1968 and 1969. In general, preservation is poor because of extensive recrystallization. The age of the Silverwood corals has been discussed previously by Strusz (1967) and the present identifications uphold the previously assigned probable Emsian or Pragian age.

CONNOLLY VOLCANICS

LOCALITY TH 150 (=WRW/8) (locality 8 of Richards & Bryan, 1924a)
Acanthophyllum? sp.
Favosites spp.

LOCALITY TH 167 (=WRW/11) (locality 5 of Richards & Bryan, 1924a)
rugosans indet.
Favosites sp.
Coenites? sp.

LOCALITY TH 174 (=WRW/13)
Favosites spp.

LOCALITY TH 451 (=palaeontological locality WRW/1)
?Chlamydophyllum expansum Hill, 1942
?Fasciphyllum sp. aff. *conglomeratum* (Schlüter), Hill, 1940
Favosites? spp.
Thamnopora sp. or *Coenites* sp.
Syringopora sp.

LOCALITY TH 455 (=WRW/5) (locality 2 of Richards & Bryan, 1924a)
Favosites sp.
Coenites? sp.

LOCALITY TH 456 (=WRW/6)
Acanthophyllum (Neostringophyllum) implicatum Strusz, 1966
Acanthophyllum sp. or *Lyrielasma* sp.
Xystriphyllum insigne Hill, 1940
Pseudamplexus sp. cf. *princeps* (Etheridge, 1907)
?Chlamydophyllum expansum Hill, 1942
?Fasciphyllum sp. aff. *conglomeratum* (Schlüter), Hill, 1940
Spongophyllum halysitoides minor Hill, 1940
Tryplasma sp. cf. *columnare* Etheridge, 1907
Tryplasma? sp.
Plasmophyllum sp.
Favosites spp.
Pachyfavosites? sp.
Thamnopora? sp.

Coenites? sp.
Scoliopora? sp.
Alveolites? sp.
Syringopora sp.
Heliolites sp.
stromatoporoids, including *Amphipora*
algae

LOCALITY TH 457 (=WRW/7)
?Xystriphyllum insigne Hill, 1940
Favosites? sp.
Coenites? sp.
stromatoporoids

ROSENTHAL CREEK FORMATION

LOCALITY TH 160 (=WRW/9)
?Xystriphyllum dunstani (Etheridge, 1911)
Acanthophyllum? sp.
Favosites sp.
Coenites? sp.

LOCALITY TH 161 (=WRW/10)
Acanthophyllum sp.
rugosan indet.

LOCALITY TH 172 (=WRW/12)
Acanthophyllum? sp.
rugosan indet.
Favosites spp.
Coenites? sp.

LOCALITY TH 452 (=WRW/2)
Acanthophyllum? sp.
Favosites spp.
Thamnopora sp. or *Coenites* sp.
Heliolites sp.

LOCALITY TH 453 (=WRW/3)
Acanthophyllum sp.
Pseudochonophyllum pseudohelianthoides (Sherzer), Strusz, 1966
Spongophyllum halysitoides or *Xystriphyllum insigne*
Cyathophyllum? sp.
Phillipsastraeidae, indet.
Favosites spp.
Thamnopora? sp.
Heliolites sp.

LOCALITY TH 454 (=WRW/4) (locality 7 of Richards & Bryan, 1924a)
?Chlamydophyllum expansum Hill, 1942
?Pseudochonophyllum pseudohelianthoides (Sherzer), Strusz, 1966
Favosites spp.
Coenites? sp.
Syringopora sp.
stromatoporoids

APPENDIX 4

REPORT ON BRYOZOA FROM THE WARWICK AND INVERELL 1:250 000 SHEETS

by

Robin E. Wass*

Specimens from Locality 476, 1.5 km north of Emu Park homestead along the Glenlyon-Bonshaw road, Inverell 1:250 000 Sheet area (439405) and Locality 228, 2.5 km east of Mount Barney, Warwick 1:250 000 Sheet area (584492), were examined to determine if they are from Carboniferous strata.

Limestone from Locality 476 revealed numerous specimens of *Fistulamina* sp. in thin sections, together with stenoporids, fenestellid fragments, and a rhabdomesid. From this the locality is assigned a Carboniferous age. *Fistulamina* sp. was first described by Crockford (1947) from the Lower Carboniferous of New South Wales and Queensland; subsequent workers have added to Carboniferous records of it. Crockford (1957) records it from the Permian of Western Australia together with many other cyclostomes. Records of cyclostomes in the Permian of eastern Australia have been made only by Wass (1968a, 1968b), who recorded *Goniocladia immensa* and *Fistulipora* sp. from the Bowen Basin.

The fauna from Locality 228 is composed entirely of fenestellids. The most common species is *Polypora neerkolensis* Crockford. With some measurements, e.g. fenestrules per 10 mm and zooecial apertures per 5 mm, there is a larger range than listed by Crockford (1948). From her measurements of distance between centres of zooecial apertures it is feasible to have from 9 to 14 zooecial apertures per 5 mm and this range is found in specimens from Locality 228. Some poorly preserved specimens can be referred to *Fenestella* cf. *osbornei* (Crockford) and *F.* cf. *loganensis* Wass. Measurements made on two specimens of *Fenestella* show them to be unrecorded from Australia. The first specimen has a meshwork formula of 8-9/5-6//16-17/? and is similar to species described by Shulga-Nesterenko (1952) from the Lower Permian of the Urals. The most closely related species is *Fenestella kuzminensis* Shulga-Nesterenko. The second specimen has a meshwork formula of 17/14//19-21/? and is similar to species described from the Carboniferous of Russia (Shulga-Nesterenko, 1951; Trizna, 1958). This specimen is characterized by very narrow dissepiments which are peculiar to other species of *Fenestella* from the Carboniferous. From the fauna identified, I would say that the locality is probably in strata correlative with the Neerkol Formation, which is Middle to Upper Carboniferous in age.

* University of Sydney.

APPENDIX 5

REPORT ON UPPER PALAEOZOIC FOSSILS FROM TERRICA STATION, WARWICK SHEET AREA, QUEENSLAND

by

M. G. Fleming*

Locality: Erosion gully 3 km east of Terrica homestead, 38 km west-northwest of Stanthorpe (BMR locality TH 417).

Determinations: *Streblopteria* sp.
impunctate orthoid brachiopod
Fenestella cincta?
F. loganensis
F. osbornei?
Fenestella spp.

Age: ?Upper Carboniferous.

Remarks: The age can be assigned only very tentatively on the basis of the presence of *F. loganensis* and the doubtful presence of *F. cincta.* Only two of the *Fenestellas* have the apertural face well preserved: *F. loganensis,* and a species with a strong, blunt carina and large, hollow modes which I have not previously seen. The doubtful identification of *F. cincta* is based on some specimens which are about the usual size of the species and have similar apertures. *F. osbornei, F. malchi,* and *F. micropora* may be present, but an age could not be based on their possible presence.

* Geological Survey of Queensland.

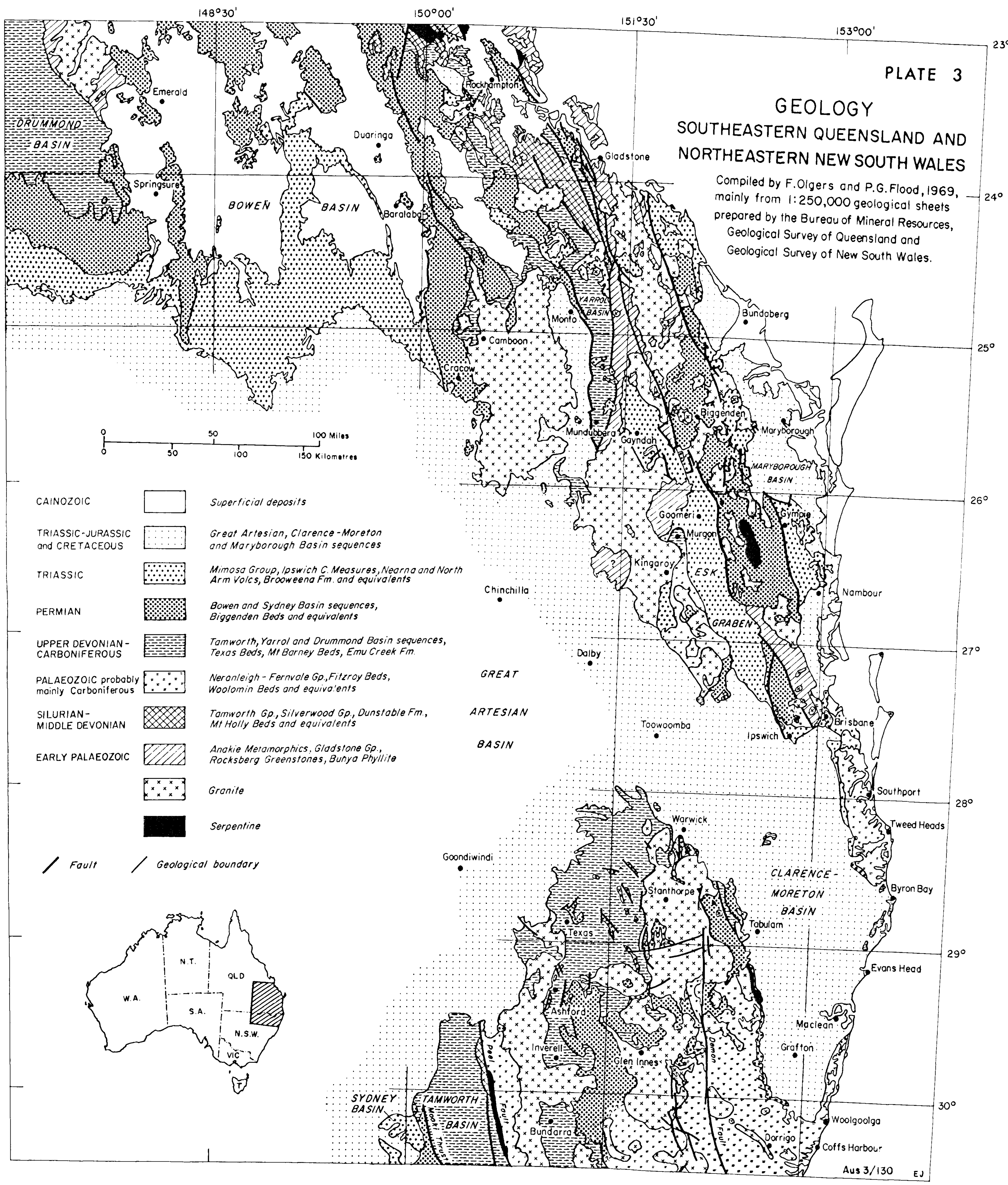


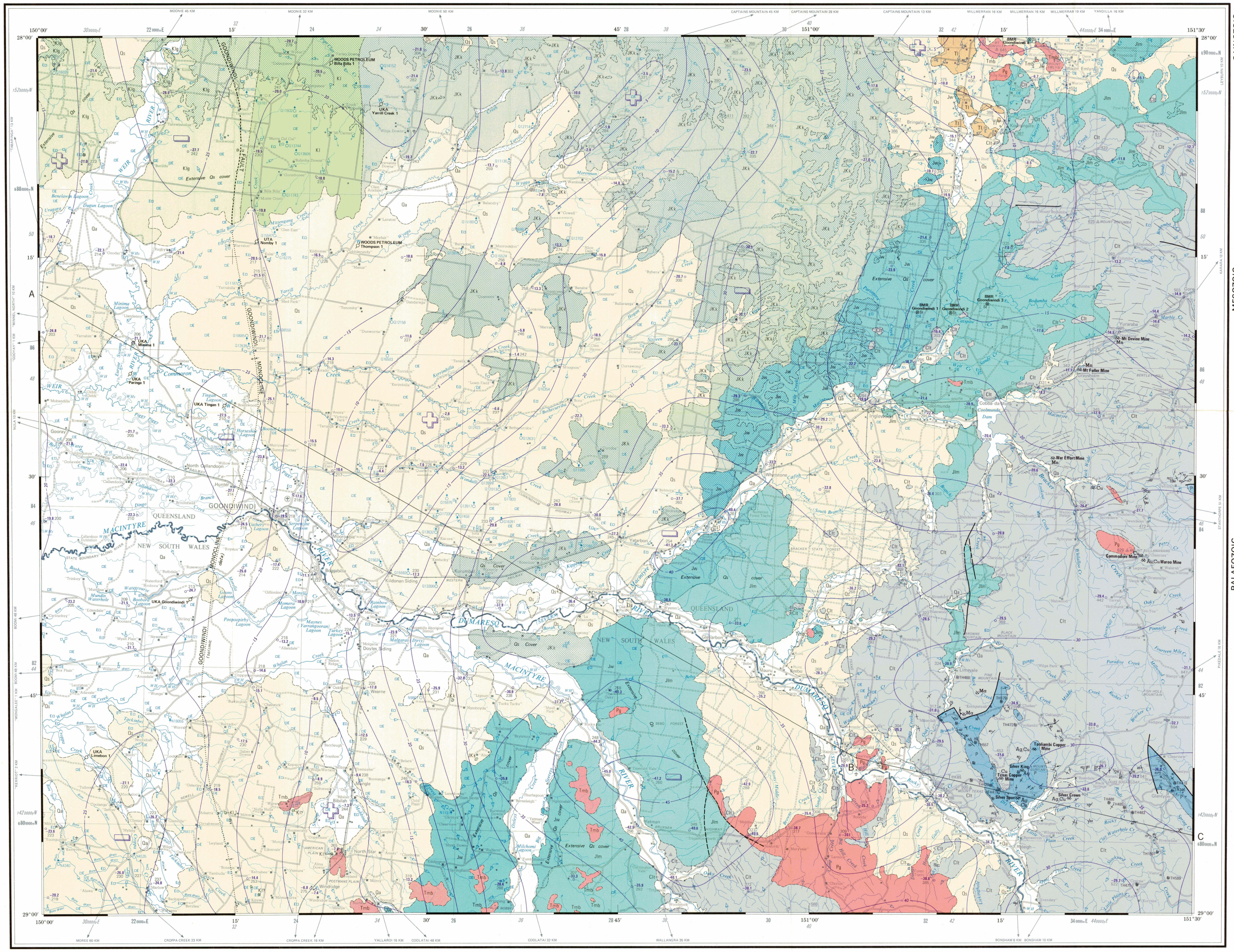
PLATE 3
GEOLOGY
SOUTHEASTERN QUEENSLAND AND NORTHEASTERN NEW SOUTH WALES
Compiled by F. Olgers and P.G. Flood, 1969, mainly from 1:250,000 geological sheets prepared by the Bureau of Mineral Resources, Geological Survey of Queensland and Geological Survey of New South Wales.
148°30'
150°00'
151°30'
153°00'
23°
24°
25°
26°
27°
28°
29°
30°
CAINOZOIC
Superficial deposits
TRIASSIC-JURASSIC and CRETACEOUS
Great Artesian, Clarence-Moreton and Maryborough Basin sequences
TRIASSIC
Mimosa Group, Ipswich C. Measures, Nearna and North Arm Volcs, Brooweena Fm. and equivalents
PERMIAN
Bowen and Sydney Basin sequences, Biggenden Beds and equivalents
UPPER DEVONIAN-CARBONIFEROUS
Tamworth, Yarrol and Drummond Basin sequences, Texas Beds, Mt Barney Beds, Emu Creek Fm.
PALAEOZOIC probably mainly Carboniferous
Neranleigh - Fernvale Gp, Fitzroy Beds, Woolomin Beds and equivalents
SILURIAN-MIDDLE DEVONIAN
Tamworth Gp., Silverwood Gp., Dunstable Fm., Mt Holly Beds and equivalents
EARLY PALAEOZOIC
Anakie Metamorphics, Gladstone Gp., Rocksberg Greenstones, Bunya Phyllite
Granite
Serpentine
Fault
Geological boundary
0
50
100 Miles
0
50
100
150 Kilometres
DRUMMOND BASIN
BOWEN BASIN
YARROL BASIN
MARYBOROUGH BASIN
ESK GRABEN
GREAT ARTESIAN BASIN
CLARENCE-MORETON BASIN
SYDNEY BASIN
TAMWORTH BASIN
Peel Fault
Demon Fault
Emerald
Duaringa
Rockhampton
Gladstone
Springsure
Baralaba
Monto
Bundaberg
Camboon
Cracow
Mundubbera
Gayndah
Biggenden
Maryborough
Goomeri
Gympie
Murgon
Kingaroy
Nambour
Chinchilla
Dalby
Toowoomba
Ipswich
Brisbane
Southport
Tweed Heads
Warwick
Goondiwindi
Stanthorpe
Byron Bay
Tabulam
Texas
Evans Head
Ashford
Maclean
Inverell
Glen Innes
Grafton
Woolgoolga
Bundarra
Dorrigo
Coffs Harbour
N.T.
QLD
W.A.
S.A.
N.S.W.
VIC
Aus 3/130
EJ

AUSTRALIA 1:250,000 GEOLOGICAL SERIES

GOONDIWINDI

QUEENSLAND AND NEW SOUTH WALES

SHEET SH 56-1



Reference

CAINOZOIC	QUATERNARY			Qa	Alluvium	
				Qs	Sand, soil	
	TERTIARY	UPPER OLIGOCENE TO LOWER MIOCENE		Tmb	Basalt, tuff, agglomerate	
				Tl	Quartzose sandstone and conglomerate, silicified	
					Deeply weathered sediments (kaolinized, in part silicified and ferruginized)	
MESOZOIC	LOWER CRETACEOUS	Rolling Downs Group	Griman Creek Formation	Klg	Lithic sandstone and siltstone, commonly glauconitic and calcareous	
			Surat Siltstone and Wallumbilla Formation	Kl	Siltstone, mudstone, lithic sandstone, glauconitic and calcareous in part	
			Surat Siltstone	Kls	Carbonaceous mudstone and siltstone, commonly glauconitic and calcareous, minor sandstone	section only
			Wallumbilla Formation Coreena Member	Klc	Siltstone and mudstone, minor labile sandstone; commonly carbonaceous; glauconitic and calcareous in part	section only
			Doncaster Member	Kld	Carbonaceous mudstone, minor siltstone and sandstone; glauconitic and calcareous in part	section only
			Bungil Formation	Kly	Siltstone, mudstone, carbonaceous sandstone; glauconitic and calcareous in part	section only
			Mooga Sandstone	Klm	Clayey lithic sublabile to lithic sandstone interbedded with siltstone and mudstone; coal	section only
	MIDDLE JURASSIC TO LOWER CRETACEOUS		Kumbarilla Beds	JKk	Sandstone, siltstone, mudstone; some conglomerate	
	UPPER JURASSIC		Orallo Formation	Juo	Siltstone, lithic to very lithic sandstone and mudstone, carbonaceous, clayey, calcareous in part	section only
			Gubberamunda Sandstone	Jug	Clayey lithic sublabile to lithic sandstone, interbedded with siltstone and mudstone; slightly carbonaceous	section only
	MIDDLE TO UPPER JURASSIC		Springbok Sandstone	Js	Clayey lithic sublabile to very lithic sandstone; calcareous in part; interbedded with carbonaceous mudstone and siltstone	
			Walloon Coal Measures	Jw	Very labile to sublabile sandstone, calcareous in places, minor mudstone and siltstone	
	LOWER JURASSIC		Marburg Sandstone	Jlm	Labile to quartzose sandstone, some siltstone, mudstone, conglomerate and breccia	
			Hutton Sandstone	Jlh	Quartzose sandstone; minor conglomerate, siltstone, mudstone	section only
			Evergreen Formation	Jle	Siltstone and mudstone, lesser sandstone; minor coal	section only
			Precipice Sandstone	Jlp	Quartzose sandstone, conglomeratic in places; minor siltstone, mudstone	section only
	MIDDLE TO UPPER TRIASSIC		Moolayember Formation	Ꝛm	Sublabile to labile sandstone, siltstone, mudstone; tuffaceous	section only
			Clematis Sandstone	Ꝛc	Conglomeratic quartzose to sublabile sandstone, mudstone, sandstone, siltstone, calcareous	section only
?	PERMIAN OR TRIASSIC			Pg	Granite	
PALAEOZOIC	UPPER PERMIAN		Blackwater Group	Puw	Tuff, shale, sandstone, conglomerate, coal seams; micaceous in part	section only
	LOWER TO UPPER PERMIAN		Back Creek Group	Pb	Tuffaceous shale, siltstone, sandstone, calcareous in upper part; coal	section only
	LOWER PERMIAN			P	Fossiliferous mudstone, pebbly mudstone, conglomerate, lithic sandstone; minor limestone	
	UPPER DEVONIAN ? TO UPPER ? CARBONIFEROUS		Kuttung Formation	C	Tuff, andesite, dacite, siltstone, sandstone, conglomerate, shale (section only)	
			Texas Beds	Clt	Interbedded lithic sandstone and mudstone, shale; minor chert, jasper, fossiliferous limestone, andesite, intraformational conglomerate	

Geological boundary

Fault (D, U indicate relative movement down, up)

Monocline

Where location of boundaries and faults is approximate, line is broken; where inferred, queried; where concealed, boundaries and folds are dotted, faults are shown by short dashes

Strike and dip of strata

Unmeasured strike and dip of strata

Vertical strata

Dip < 15°

Trend lines } air-photo interpretation

Joint pattern } air-photo interpretation

Unmeasured strike and dip of foliation

TH179 Macrofossil locality with collection number

Dyke; b - basic

Mine, not worked

Open cut, quarry

Ag Silver

Au Gold

Cu Copper

Ma Marble

Mn Manganese

W Well - dry, abandoned (W - indicates completion as water well)

St Stratigraphic hole

Q2822 Artesian bore, flowing } deeper than 1000 feet, with registered number of the Queensland Irrigation and Water Supply Commission (Q) and Water Conservation and Irrigation Commission of New South Wales (N)

N1246 Sub-artesian bore

E Earth tank or dam

Dam on stream

WH Waterhole on stream

Windpump

Highway

Road

Vehicle track

Railway with station and siding

Airport

Landing ground

"Brentwood" Homestead

Building

Trigonometrical station

500 Elevation in metres, accurate

445 Elevation in metres, approximate

Gravity station

−23.9 Bouguer anomaly (milligals)

−30 Isogal

Gravity anomaly-relative high

Gravity anomaly-relative low

Bouguer anomalies are based on the May 1965 observed gravity value at Isogal gravity base stations in and near the area

For the calculation of Bouguer anomalies 2.2 g/cm^3 has been adopted as an average rock density

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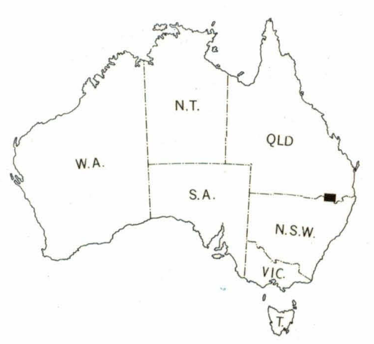

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Showing magnetic declination 1970

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9°E 9°30'E 10°E 10°30'E 11°E 11°30'E

ANNUAL CHANGE 1'30"E

Scale 1:250,000

5 0 5 10 15 20 25 KILOMETRES

5 0 5 10 MILES

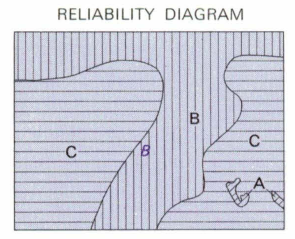
GREY NUMBERED LINES ARE 20,000 METRE INTERVALS OF THE AUSTRALIAN MAP GRID, ZONE 56
GREY TICKS WITH ITALIC NUMBERS INDICATE THE 20,000 YARD GRID, ZONE 8 (AUSTRALIA SERIES)
TRANSVERSE MERCATOR PROJECTION

Section

Cainozoic sediments omitted

Scale: $\frac{V}{H} = 4$

RELIABILITY DIAGRAM



Geology A Detailed mapping
B Detailed reconnaissance: numerous traverses and air-photo interpretation
C General reconnaissance: some traverses and air-photo interpretation
Gravity *B* Reconnaissance

Mesozoic geology, 1968, by A. Mond and D. Burger (BMR), P. Rasmus (GSNSW)
Palaeozoic geology, 1968, by F. Olgers, P. G. Flood and W. J. Perry (BMR), P. Rasmus (GSNSW)
Compiled, 1968, by A. Mond, F. Olgers and P. G. Flood
Gravimetry 1960 and 1968, by Geophysical Branch, BMR
Cartography by Geological Branch, BMR
Drawn by Mercury-Walch, Pty Ltd, Hobart, Australia
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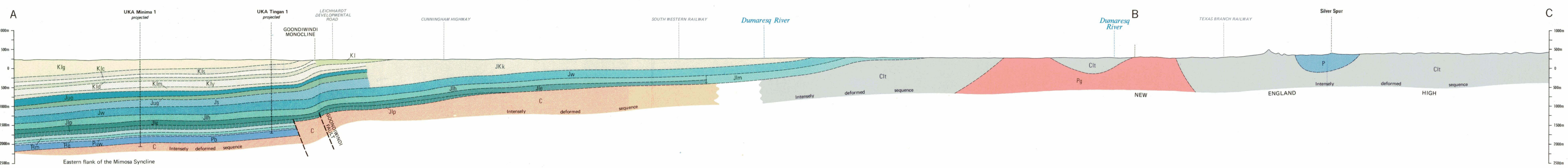

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GOONDIWINDI

SHEET SH 56-1

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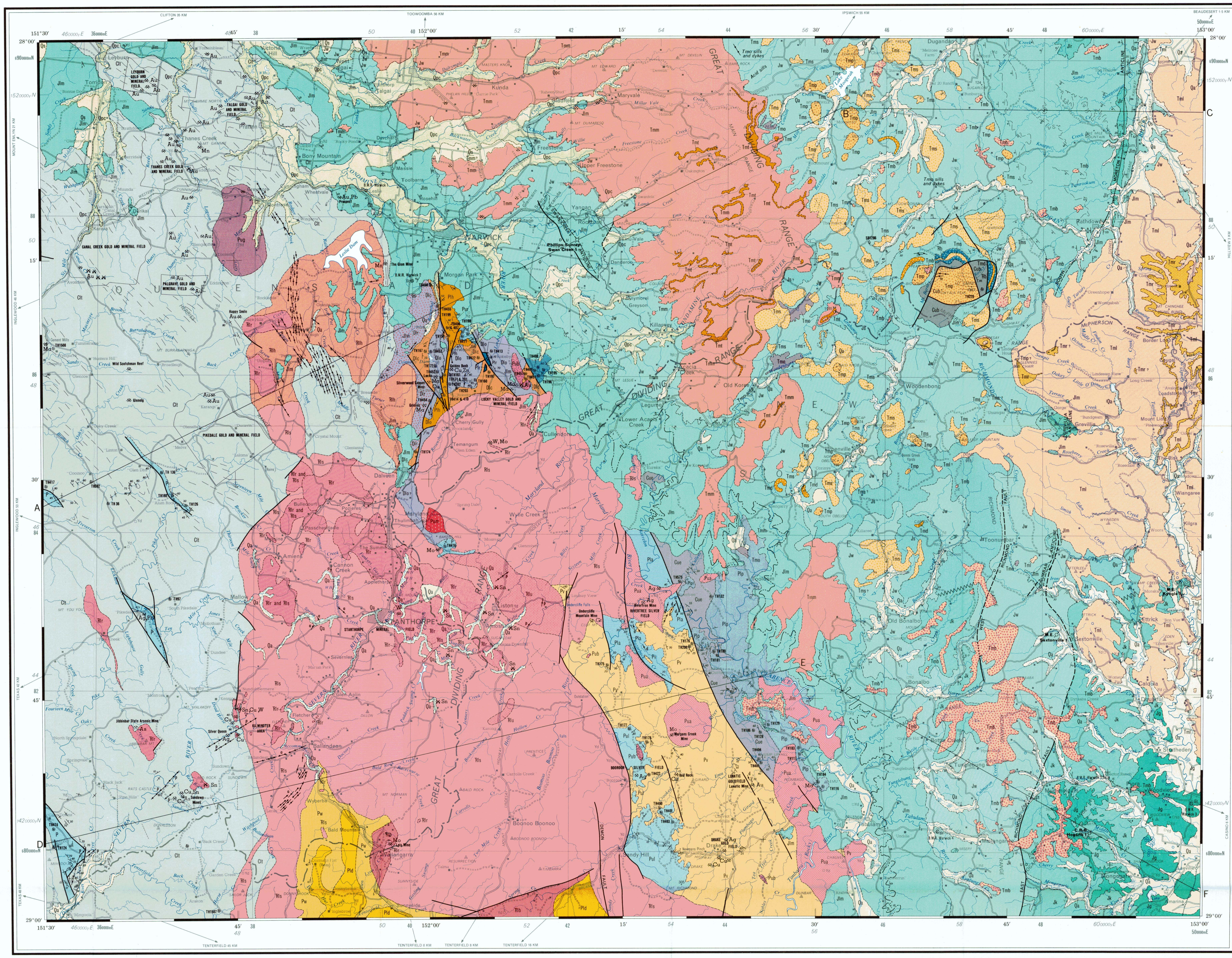
AUSTRALIA 1:250,000 GEOLOGICAL SERIES

WARWICK

QUEENSLAND AND NEW SOUTH WALES

SHEET SH 56-2



Reference

- Geological boundary
- Facies boundary
- Anticline
- Plunge of minor anticline
- Fault (D,U indicate relative movement down, up)

Where location of boundaries, folds and faults is approximate, line is broken; where inferred, queried; where concealed, boundaries, folds are dotted, faults are shown by short dashes

- Strike and dip of strata
- Prevailing strike and dip of strata
- Vertical strata
- Horizontal strata
- Overturned strata
- Dip < 5° (air-photo interpretation)
- Dip 5°—15° (air-photo interpretation)
- Dip 15°—45° (air-photo interpretation)
- Dip > 45° (air-photo interpretation)
- Trend lines (air-photo interpretation)
- Joint pattern (air-photo interpretation)
- Fossil locality—general
- TH 124 Macrofossil locality and field collection number
- SB 1286 Plant fossil locality and field collection number
- Fossil wood locality
- Fossil wood horizon
- Dyke or vein; a - aplite, d -diorite, p-porphyry, tr -trachyte
- Boundary of gold or mineral field
- Prospect
- Mine
- Mine not worked
- Quarry
- Quarry not worked
- Alluvial working not worked
- Ag Silver
- As Arsenic
- Au Gold
- C Coal
- Cu Copper
- Gt Graphite
- Ma Marble
- Mn Manganese
- Mo Molybdenite
- Pb Lead
- Sn Tin
- W Wolfram
- Zn Zinc
- Oil well, dry hole, abandoned
- St Stratigraphic hole
- Shallow water bore
- Dam on stream
- WH Waterhole
- Swamp
- Highway
- Road
- Vehicle track
- Railway with station and siding
- Telephone line
- Built up area
- "Montrosa" Homestead
- Building, hut or outstation
- Landing ground
- Yd Yard
- State boundary
- 204 Elevation in metres
- Trigonometrical station

Reference

CAINOZOIC	QUATERNARY		Qs	Sand
			Qa	Alluvium: sand, silt, mud, gravel
	PLEISTOCENE		Qpc	Sandy alluvium of Condamine River, vertebrate fossils
	TERTIARY (MIOCENE)	Main Range Volcanics	Tmm	Alkali—olivine basalt, minor tuff, sandstone, mudstone
			Tmt	Trachyte
			Tmd	Dolerite sills and dykes
		Lamington Volcanics	Tml	Sub-alkali basalt, minor tuff and agglomerate
			Tmr	Agglomerate, rhyolite, mudstone conglomerate
			Tmb	Basalt
			Tmp, Tms, Tmd	Rhyolite, trachyte, granophyre; minor diorite and andesite. Tmp—plug; Tms—sill; Tmd—dyke
MESOZOIC	UPPER JURASSIC	Grafton Formation	Jg	Lithic sandstone, siltstone, mudstone
		Kangaroo Creek Sandstone	Jk	Quartzose to feldspathic sublabile sandstone
		Woodenbong Beds	Jo	Medium feldspathic to feldspathic sublabile sandstone, siltstone
	MIDDLE TO UPPER JURASSIC	Walloon Coal Measures	Jw	Fine labile sandstone, siltstone, mudstone, coal; calcareous in part. Plant fossils
	LOWER JURASSIC	Bundamba Group	Ӿ-Jb	Sandstone, lesser siltstone, mudstone, conglomerate. Section only
		Marburg Sandstone	Jlm	Feldspathic to feldspathic sublabile sandstone, pebbly in part; lesser siltstone, mudstone. Basal pebbly arkose in west
	UPPER TRIASSIC	Ripley Road Sandstone	Jlr	Feldspathic to quartzose sandstone with massive cross-beds
		Raceview Formation and Aberdare Conglomerate	Ӿb	Feldspathic to quartzose sandstone and siltstone with massive conglomerate near base
	MIDDLE TO UPPER TRIASSIC	Ipswich Coal Measures	Ӿi	Shale, siltstone, sandstone, conglomerate, coal (section only)
			Ӿv	Basalt, andesite, trachyte
				Conglomerate, basic lava and tuff, quartzose sandstone, carbonaceous shale
	LOWER TRIASSIC	Ruby Creek Granite	Ӿr	Granite
		Herries Adamellite	Ӿh	Adamellite
		Stanthorpe Adamellite	Ӿs	Adamellite
		Undercliffe Falls Adamellite	Ӿu	Adamellite
		Bungulla Adamellite	Ӿb	Adamellite
	UPPER PERMIAN OR TRIASSIC		Pus	Adamellite, granite, diorite, granodiorite
		Maryland Granite	Pum	Granite
		Greymare Granodiorite	Pug	Granodiorite
			Pub	Diorite
			Pur	Spherulitic rhyolite, quartz-feldspar porphyry
PALAEOZOIC	UPPER PERMIAN	Gilgurry Mudstone	Pul	Mudstone; minor feldspathic sandstone
	LOWER TO UPPER PERMIAN	Condamine Beds	Puc	Mudstone, poorly sorted sandstone, conglomerate; minor tuff
			Pu	Rhyolite, rhyodacite, tuff
		Drake Volcanics	Pr	Agglomerate, crystal and crystal lithic tuff; minor flows and interbedded sediments
	LOWER PERMIAN	Dundee Adamellite Porphyrite	Pld	Adamellite porphyrite
		Rhyolite Range Beds	Plr	Spherulitic rhyolite, dacite, andesite, agglomerate, tuff; minor conglomerate, sandstone and mudstone at base
		Eight Mile Creek Beds	Ple	Conglomerate, sandstone, mudstone; minor agglomerate and tuff at top
		Razorback Creek Mudstone	Plz	Mudstone
		Eurydesma and Wallaby Beds	Plw	Conglomerate, sandstone, mudstone, pebbly mudstone, minor limestone
			P	Conglomerate, sandstone, mudstone, pebbly sandstone and mudstone, minor limestone and tuff
		Paddys Flat Formation	Plp	Sandstone, mudstone, conglomerate; minor volcanics and limestone
	UPPER CARBONIFEROUS	Mount Barney Beds	Cub	Lithic and feldspathic sandstone, conglomerate, mudstone; minor acid volcanics
		Emu Creek Formation	Cue	Lithic sandstone and mudstone; minor conglomerate
	UPPER DEVONIAN ? TO UPPER ? CARBONIFEROUS	Texas Beds	Ct	Lithic sandstone and mudstone, intraformational conglomerate, slate, chert, jasper, andesite, limestone
	SILURIAN ? TO LOWER DEVONIAN (Silverwood Group)	Rosenthal Creek Formation	Dlo	Sandstone and mudstone; chert, intraformational conglomerate, limestone
		Connolly Volcanics	Dlc	Coarse andesitic pyroclastics and flows; minor lithic sandstone; limestone lenses near top
		Risdon Stud Formation	Dlr	Silicified fine andesitic tuff; silicified siltstone and mudstone
	LOWER PALAEOZOIC		Pz	Undivided Devonian, Carboniferous and Permian strata. Section only

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Palaeozoic geology 1968-69 by F. Olgers, P. G. Flood, W. J. Perry, J. M. Dickins (BMR); A. C. Offenburg, J. Cramsie (GSNSW)
Mesozoic and Tertiary geology mainly 1968 by N. F. Exon, A. Medvecky (BMR); R. F. Reiser, D. J. Casey, A. D. Robertson (GSQ) C. T. McElroy, R. L. Brunker (GSNSW); N. C. Stevens, P. J. Stephenson (UQ)
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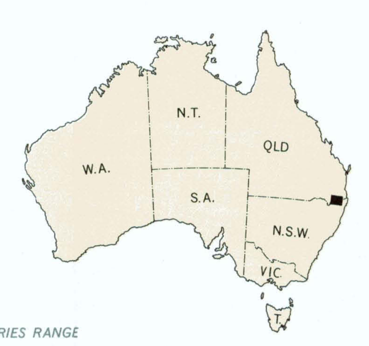

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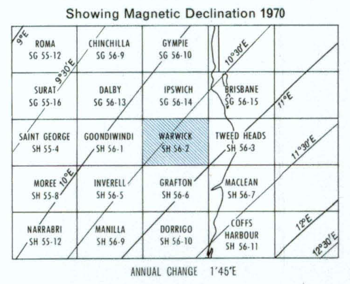

Scale 1:250,000

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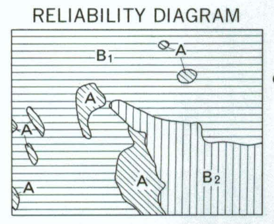
RELIABILITY DIAGRAM

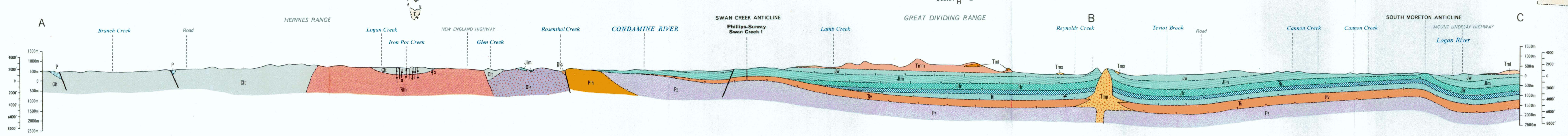


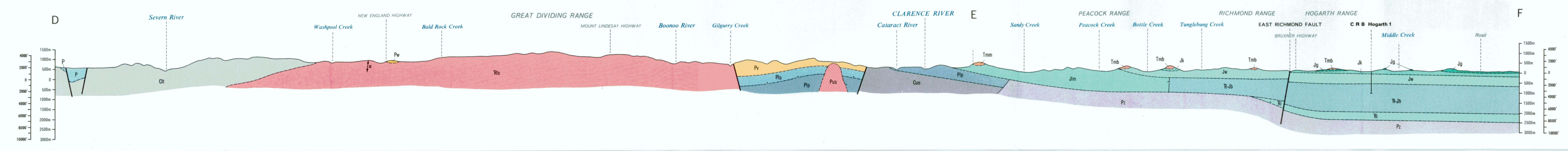
Geology
A Detailed mapping
B_1 Detailed reconnaissance: numerous traverses and air-photo interpretation
B_2 General reconnaissance: compilation of previous work and air-photo interpretation

Sections

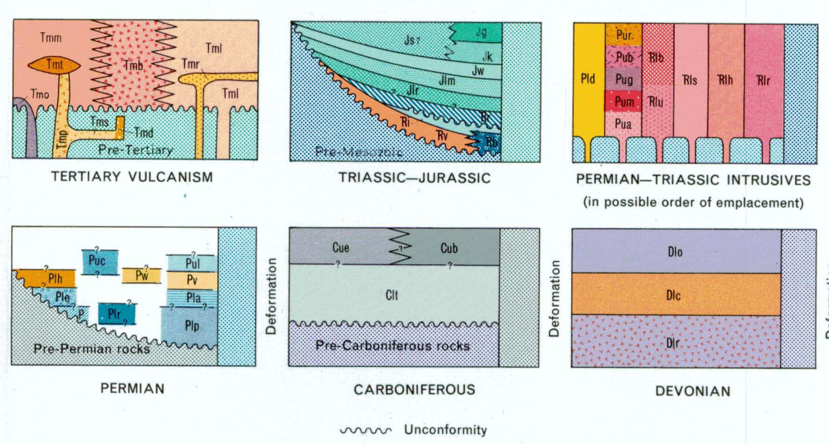
Cainozoic sediments omitted

Scale $\frac{V}{H} = 2$





DIAGRAMMATIC ROCK RELATIONSHIPS AND GEOLOGICAL HISTORY



TERTIARY VULCANISM — TRIASSIC—JURASSIC — PERMIAN—TRIASSIC INTRUSIVES (in possible order of emplacement) — PERMIAN — CARBONIFEROUS — DEVONIAN

Unconformity

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WARWICK

SHEET SH 56 -2

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