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Floral Evidence for a Middle Triassic Age of the Gunnee Beds and Gragin Conglomerate, near Delungra, New South Wales

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ABSTRACT. The Gunnee Beds, near Delungra, northern New South Wales, are a sequence of arkose, conglomerate, prominent sublabile sandstones, carbonaceous shale, and coal, unconformably overlying Late Palaeozoic rocks of the New England Fold Belt, and overlain by the Gragin Conglomerate with cobbles of quartz-feldspar porphyry and acid volcanics. Megafossil and microfossil floras obtained from the Gunnee Beds and Gragin Conglomerate indicate a Middle Triassic age. These are the only Triassic strata which crop out in the Warialda Trough on the west of the Woolomin-Texas Block of the New England Fold Belt. Deposition and preservation of Middle Triassic terrestrial sediments both east and west of the New England region, indicate that the major unroofing of the New England Batholith had probably been completed by this time.

INTRODUCTION

In 1954, Rade (1954a) reported a Triassic megafossil flora from carbonaceous shales exposed in the bank of Warialda Creek, north-west of Delungra, N.S.W. Five species of the flora were subsequently identified by Dr. A.B. Walkom (in Rade, 1954b) and the containing strata, designated the Gunnee Beds, were correlated with the Ipswich Coal Measures of Queensland on the basis of the identified plant megafossils (Rade, 1954b). This was of interest as the Gunnee Beds were the only known Triassic strata outcropping at the base of the Surat Basin on the north-western margin of the Palaeozoic New England Tablelands region. Rade (1954b) correlated the overlying Gragin Conglomerate with the Bundamba Group of Queensland and considered it to be of Jurassic age. Since then, however, these units have been shown on maps in part as Permian granite and Tertiary sediments by Chesnut and Cameron (1971) and Pogson and Hitchins (1974).

During recent mapping in the area (Bourke, 1974), D.J.B. relocated Rade's site in the Gunnee Beds (Figure 1); this led R.E.G. and G.J.R. to collect further specimens, including palaeopalynological samples, and to re-examine Rade's material housed in the Australian Museum. Palaeopalynological samples were also collected from a shale and siltstone lense in the Gragin Conglomerate, and a collection of plant megafossils from this unit examined. The palaeopalynological samples were investigated by R.M. and R.H.

No attempt has been made here at major taxonomic description, the fossils merely being identified by comparison with known forms. Plant megafossils from the Gunnee Beds are housed in the Australian Museum (prefixed AMF) and the Geology Department, University of New England (prefixed UNEF); those from the Gragin Conglomerate and all figured microfossils in the Geological and Mining Museum of the Geological Survey of New South Wales (prefixed MMF and MMMC). Stage co-ordinates refer to the rotary stage of the Geological and Mining Museum's Zeiss Photomicroscope No. 67500. Unfigured palaeopalynological material is lodged in the palynology collection of the Geological and Mining Museum, catalogue number 2319 (Gunnee Beds), and 2545, 2737, 2738 (Gragin Conglomerate).

STRATIGRAPHY

In the Warialda-Delungra district, Mesozoic sediments nonconformably overlie the New England Fold Belt (Scheibner, 1973; Leitch 1974; Rod, 1975) which in this area consists of highly deformed Palaeozoic cherts, slates, basic volcanics and tuffs (possibly the Woolomin Beds) intruded by granitic rocks of probable Late Carboniferous age. The basal Mesozoic unit of the sequence is the Triassic Gunnee Beds (Rade, 1954b); these may be a marginal equivalent to the Wandoan Formation of the Permo-Triassic Sydney-Bowen Basin. The Gunnee Beds are in turn overlain by the Triassic Gragin Conglomerate. Both the Gragin Conglomerate and the Gunnee Beds are restricted, in outcrop, to a small structural depression east of Warialda, named the Warialda Trough (Bourke, 1974). Sediments of the Surat Basin overlie the Gragin Conglomerate.

In the area shown on Figure 1, the Gunnee Beds consist of coarse-grained to granular sublabile sandstone and arkose, interbedded with medium- to fine-grained labile sandstone and minor siltstone, carbonaceous shale and mudstone, and coal. The fossil plant horizons are interbedded with and overlain by prominent coarse-grained and granular sandstones. The sequence in this area is considered to represent the finer-grained, upper part of the Gunnee Beds. South and west of Figure 1, where the unit is topographically and probably stratigraphically lower than this sequence, the Gunnee Beds are composed of very coarse-grained to granular arkose, poorly-sorted paraconglomerate and coarse- to very coarse-grained sublabile sandstone. The unit ranges in thickness from 2 m to over 30 m.

The Gunnee Beds appear to have been deposited under terrestrial conditions. It is evident from the immaturity of much of the Gunnee Beds that the sediment was transported only a short distance, and in many outcrops the arkose lies directly on the parent granitic rock. Restriction of the Gunnee Beds to the Warialda Trough and the

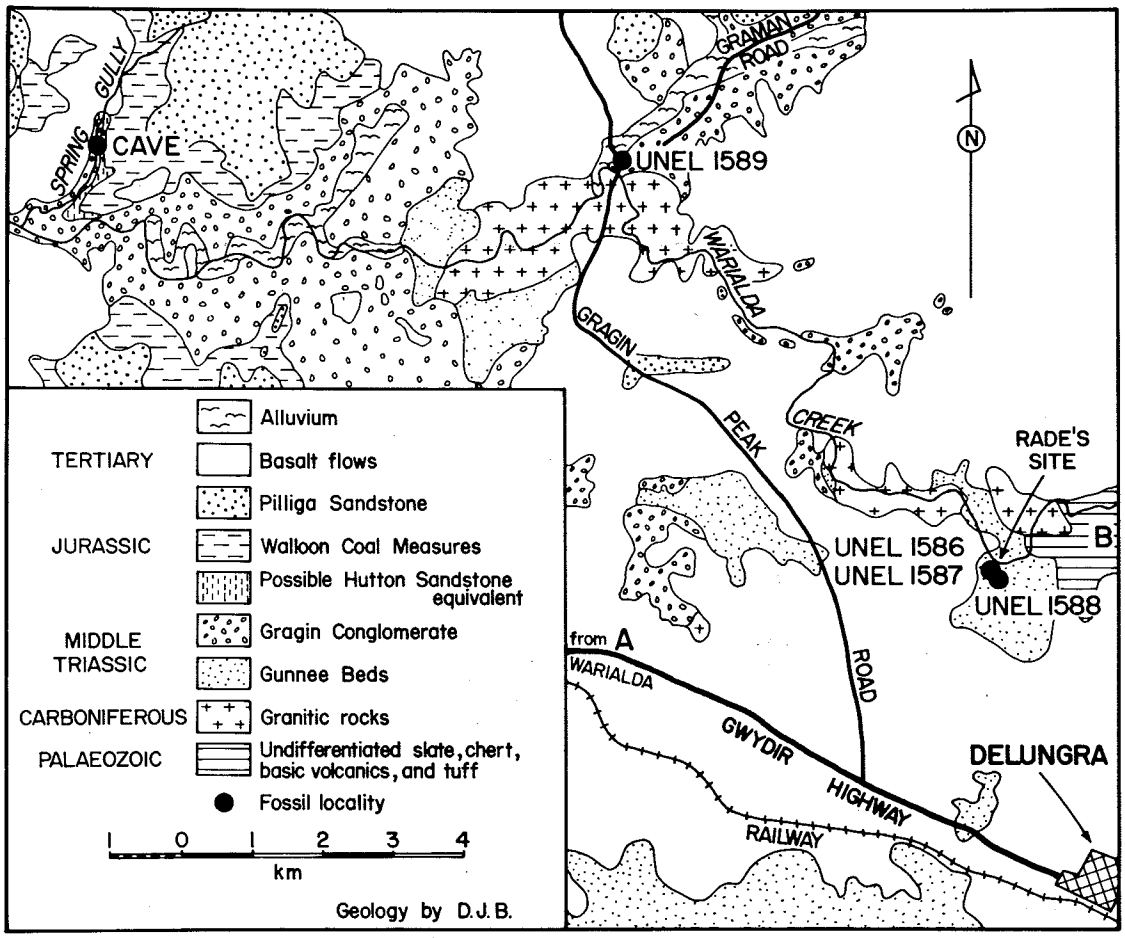

Fig. 1. Geological map of the Delungra area

lithology suggest that the unit may have been deposited in a river valley system with some development of swamps and lakes.

The Gragin Conglomerate is composed dominantly of cobbles (with some pebbles) of quartz-feldspar porphyry and acid volcanics; clasts of granite, chert, and siliceous metamorphosed sediments such as mudstone, sandstone, and pebble conglomerate, are less abundant. The cobbles are about 120 mm in diameter, well-sorted and well-rounded. They are set in a matrix of medium- to coarse-grained sublabile sandstone. There are some lenses of laminar-bedded sublabile sandstone which are infrequently capped by lamellae of siltstone and carbonaceous shale. The conglomerate is exposed as spectacular cliff faces up to 50 m high along Warialda Creek. The Gragin Conglomerate is essentially conformable on the Gunnee Beds but shows an erosive basal contact.

Sediments of the Surat Basin onlap across the Gragin Conglomerate, with the Hutton Sandstone overlying the unit on the western side of the Warialda Trough. Further east towards the margin of the Surat Basin, the Walloon Coal Measures and the Pilliga Sandstone (= Warialda Sandstone of Rade, 1954b) directly overlie the conglomerate. Some erosion of the Surat Basin sediments occurred prior to the area being covered by flood basalts in the Tertiary (Figure 2).

Today the Gunnee Beds and Gragin Conglomerate are exposed in creek banks and other places where they have been exhumed from under the basalt or Surat Basin sediments. The sandstone and the conglomerate of the Gunnee Beds are extensively silicified (a silcrete, cf. Taylor and Smith, 1975) especially where they are overlain by basalt.

MEGAFOSSIL FLORA: GUNNEE BEDS

The flora was collected from three localities (UNEL1586-1588) at GR 883221 on the Bingara

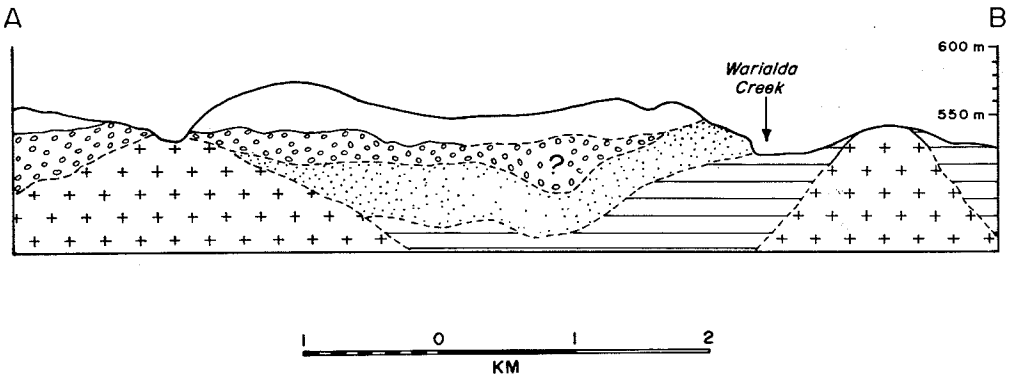

Fig. 2. Geological cross section of the Delungra area.

1:100,000 sheet 9038, approximately 4.75 km NNW of Delungra (Figure 1). The flora is dominated by species of the corystosperm *Dicroidium* and closely related genera typical of the Triassic of Gondwanaland.

Locality UNEL1586 is in a black carbonaceous shale exposed on the southern bank of Warialda Creek. The shale grades upwards into the very fine sandstone and siltstone of UNEL1587. The fossil leaves are commonly oxidised with an oxidation corona developed into the dark matrix, but sometimes carbonised compression material does remain. *Johnstonia coriacea* is the most common of the fossils, which include:

Dicroidium sp. cf. *D. australe* Jacob and Jacob 1950. [AMF45718-9]

D. dubium (Feistmantel) Gothan 1912. [AMF51140]

D. lancifolium (Morris) Gothan 1912. [AMF45735]

D. odontopteroides (Morris) Gothan 1912. [Figure 3.7]

D. zuberi (Szajnocha) Archangelsky 1968; including various small and large fronds. [Figure 3.8]

Dicroidium sp.; like *D. zuberi*, but with pinnules coalescing in the apical part of the pinna and semicircular, wider than long in the basal portion. [AMF51141]

'*Dicroidiopsis*' sp. *sensu* Gould 1967. [Figure 3.12]

Johnstonia coriacea (Johnston) Walkom 1925 *s.s.*; with narrow lamina and entire margins. [Figure 3.5,6]

J. stelzneriana (Geinitz) Frenguelli 1943; includes *D. dentatum* (Walkom) Anderson and Anderson 1970. [Figure 3.10]

Johnstonia sp.; weakly lobed forms intermediate between *J. stelzneriana* and *J. coriacea*, including *Dicroidium* (intermediate sp. A) Anderson and Anderson 1970. [Figure 3.9]

Xylopteris elongata (Carruthers) Frenguelli 1943. [Figure 3.11]

Pteruchus sp. cf. *P. simmondsii* (Shirley) Thomas 1933, *sensu* Townrow 1962; macroscopically intermediate between *P. johnstonii* (Feistmantel) Townrow 1962 and *P. simmondsii*. [UNEF15081-2]

Pilophorosperma sp. cf. *P. burnerense* Thomas 1933. [UNEF15079; UNEF15080 is a similar specimen but about half the size]

Isolated corystosperm seed; similar to that figured by Thomas (1933, fig. 33e) but rather more elongate. [UNEF15083]

Rissikia media (Tenison-Woods) Townrow 1967. [Figure 3.14]

Locality UNEL1587 is in a leached siltstone and very fine sandstone immediately underlying the bluff-forming sandstone and granule conglomerate on the southern bank of Warialda Creek; the locality is about 1 m above UNEL1586. The plant remains, which are all fragmentary and naturally macerated to varying degrees, include:

Cladophlebis lobifolia (Phillips) Seward 1900, *sensu* Walkom 1924. [Figure 3.1]

Cladophlebis sp. cf. *oblonga* Halle 1914; similar specimen illustrated by Frenguelli (1947, pl. 5, fig. 7). [Figure 3.2]

Asterotheca menendezii de la Sota and Archangelsky 1962; probably includes fertile *Cladophlebis australis* of Walkom (1917). [Figure 3.3]

Dicroidium lancifolium (Morris) Gothan 1912; most like '*Thinnfeldia*' *acuta* Walkom 1917. [Figure 3.4]

Pteruchus johnstonii (Feistmantel) Townrow 1962. [AMF51132]

Ginkgoites moltenensis (Seward) Du Toit 1927; includes *G. digitata sensu* Walkom 1917. [AMF51142]

Rissikia sp. cf. *R. apiculata* Townrow 1967. [Figure 3.13]

Locality UNEL1588 is a grey shale underlying a thin coal seam in a small north-flowing tributary gully of Warialda Creek, about 70 m southeast of UNEL1586 and UNEL1587. This locality is probably a few metres stratigraphically lower than UNEL1586. Fossils collected:

Dicroidium odontopteroides (Morris) Gothan 1912. [UNEF15084]


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Pilophorosperma sp. cf. *P. Burnerense* Thomas 1933. [UNEF15085-6]

Many of the forms present, e.g. *D. odontopteroides, D. dubium, J. coriacea, J. stelzneriana, X. elongata,* and *P. johnstonii*, are commonly given Middle to Late Triassic ranges (Stipanicic and Bonetti, 1969; Banks, Cosgriff, and Townrow, 1967; Anderson and Anderson, 1970). However local comparisons suggest a Middle Triassic (Anisian to Ladinian) age for the Gunnee Beds. *Cladophlebis lobifolia sensu* Walkom (1924) is only known from the Middle Triassic Esk and Neara Beds of Queensland and the Middle Triassic Nymboida Coal Measures of New South Wales (Flint and Gould, 1975); a basalt flow in the Nymboida Coal Measures has yielded a Middle Triassic radiometric date of 211 ± 5 x 10^6 years (Retallack, Gould, and Runnegar, in press). *Johnstonia coriacea* (*s.s.* with entire margins) is much more frequent in the Esk Beds than in the Late Triassic Ipswich Coal Measures (Jones and de Jersey, 1947, p. 19; de Jersey, 1972), and also occurs at one horizon in the Basin Creek Formation of the Nymboida Coal Measures (UNEF14718 from UNEL1489). *Xylopteris elongata* is common in the Ipswich Coal Measures, but is also found in the early Middle Triassic Hawkesbury Sandstone at Brookvale, N.S.W. (AMF18581); only one specimen has been found in the Gunnee Beds. The flora from the overlying Gragin Conglomerate is also of Middle Triassic age and so restricts the youngest age assignable to the Gunnee Beds.

This Middle Triassic age determination was independently substantiated by palaeopalynological evidence.

MICROFOSSIL FLORA: GUNNEE BEDS

A palaeopalynological sample from the black carbonaceous shale at the plant megafossil locality UNEL1586 on Warialda Creek, was processed and examined by R.M. and R.H. The microfossil flora is dominated by *Falcisporites australis* (de Jersey) Balme 1970 [Figure 3.18] and includes the following additional important forms:

Aratrisporites parvispinosus sensu Helby 1973. [Figure 3.16, 17]
Aratrisporites tenuispinosus sensu Helby 1973.
Baculatisporites comaumensis (Cookson) Potonié 1956.
Cycadopites follicularis Wilson and Webster 1946. [Figure 3.15]
'Guthoerlisporites' cancellosus Playford and Dettmann 1965.
Indospora clara Bharadwaj 1962.
'Nevesisporites' limatulus Playford 1965.
Polypodiisporites mutabilis Balme 1970.
Protohaploxypinus samoilovichii (Jansonius) Hart 1964.
Protohaploxypinus sp. cf. *P. jacobii* (Jansonius) Hart 1964.
'Retusotriletes' radiatus (Kara-Murza).
Uvaesporites sp. cf. *U. verrucosus* (de Jersey) Helby ex de Jersey 1971.
Verrucosisporites sp. cf. *V. carnarvonensis* de Jersey and Hamilton 1967.

The microflora recovered from the Gunnee Beds exhibits restricted diversity, but the mutual occurrence of *A. parvispinosus, P. samoilovichii, U.* sp. cf. *U. verrucosus*, and *V.* sp. cf. *V. carnarvonensis* suggest a close comparison with the *A. parvispinosus* Assemblage Zone of Helby (1973) which is of Middle Triassic age. The apparent absence of *Annulispora* spp. and *Crateriporites rotundus* de Jersey 1970 from the Gunnee Beds association may differentiate it from the *C. rotundus* Zone which characterises the Late Triassic Ipswich Coal Measures (de Jersey, 1975). This is substantiated by the occurrence in the Gunnee Beds of *P.* sp. cf. *P. jacobii* and *V.* sp. cf. *V. carnarvonensis* which do not appear to range into strata younger than mid-Ladinian (R.H.). An Anisian/Ladinian age is thus suggested.

Helby (1973) indicated that the *A. parvispinosus* Assemblage Zone also occurred in the Wandoan Formation, the Clematis Sandstone and the Moolayember Formation in the Bowen Basin of Queensland. Although the Gunnee Beds microfossil flora is clearly similar to the assemblages reported from the Wandoan Formation (de Jersey and Hamilton, 1969), the Clematis Sandstone (de Jersey, 1968), and the Moolayember Formation (de Jersey and Hamilton, 1967), none of the species regarded as diagnostic of the *Duplexisporites problematicus* Microflora by de Jersey (1975) were encountered. The apparent absence of these species and the restricted diversity of the Gunnee Beds assemblage may possibly be explained by the extreme proximal position of the Gunnee Beds in the Wandoan/Moolayember drainage system.

Fig. 3. 1, *Cladophlebis lobifolia* (Phillips) Seward *sensu* Walkom; portion of pinna showing characteristic pinnules. AMF51128, X 1.5. 2, *Cladophlebis* sp. cf. *C. oblonga* Halle. AMF51129, X 1.8. 3, Portion of fertile pinna of *Asterotheca menendezii* de la Sota and Archangelsky. AMF51130, X 1.5. 4, *Dicroidium lancifolium* (Morris) Gothan. AMF 51131, X 1.5. 5, 6, *Johnstonia coriacea* (Johnston) Walkom *s.s.* 5, AMF51133, X 0.9. 6, AMF51134, X 1. 7, *Dicroidium odontopteroides* (Morris) Gothan. AMF51135, X 1.1. 8, *Dicroidium zuberi* (Szajnocha) Archangelsky. AMF51136, X 0.75. 9, *Johnstonia* sp. AMF51137, X 0.6. 10, *Johnstonia stelzneriana* (Geinitz) Frenguelli. AMF51138, X 1. 11, *Xylopteris elongata* (Carruthers) Frenguelli. AMF45745, X 1.35. 12, *'Dicroidiopsis'* sp. *sensu* Gould. AMF45710, X 0.8. 13, *Rissikia* sp. cf. *R. apiculata* Townrow. AMF51143, X 1.3. 14, *Rissikia media* (Tenison-Woods) Townrow. AMF45693, X 1.6. 15, *Cycadopites follicularis* Wilson and Webster. MMMC2010, 028/0886, X 800. 16, 17, *Aratrisporites parvispinosus* Leschik *sensu* Helby. 16, distal focus. 17, proximal focus. MMMC2011, 042/1102, X 800. 18, *Falcisporites australis* (de Jersey) Balme. MMMC2011, 050/1070, X 800.

MEGAFOSSIL FLORA: GRAGIN CONGLOMERATE

A collection of plant megafossils was obtained by D. Probert from small, khaki shale and siltstone lenses interbedded with the conglomerate at UNEL1589. The locality is in a gravel pit near the junction of the Graman and Gragin Peak Roads at GR 831281 on the Bingara 1:100,000 sheet 9038. Determinations include:

Dicroidium sp. cf. *D. eskense* (Walkom) Jacob and Jacob 1950; poorly preserved, with some transverse creasing of the pinnae. [MMF 17080, MMF17084]

D. odontopteroides (Morris) Gothan 1912. [MMF 17085-6]

D. zuberi (Szajnocha) Archangelsky 1968; small fronds like the one figured from the Gunnee Beds. [MMF17081-3]

Lepidopteris madagascariensis Carpentier 1935. [MMF17090]

Presence of *Dicroidium* spp. indicates a Triassic age for the flora. *Lepidopteris madagascariensis* ranges from Early to Middle Triassic (Townrow, 1966) while *D. odontopteroides* ranges from Middle to Late Triassic (Townrow, 1967), so a Middle Triassic age for the Gragin Conglomerate is most likely. This is substantiated by the presence of a frond comparable to *D. eskense* which is restricted to Middle Triassic floras of eastern Australia (see Flint and Gould, 1975).

MICROFOSSIL FLORA: GRAGIN CONGLOMERATE

Several samples collected from siltstone and carbonaceous shale horizons at the top of a small sandstone lense of the Gragin Conglomerate in a cave on the eastern bank of Spring Gully (Bingara 1:100,000 sheet 9038, GR 759284) were subjected to palaeopalynological investigation. Spores and pollen recovered from the Gragin Conglomerate samples were even more restricted than those from the Gunnee Beds. Palynomorphs identified include:

Converrucosisporites cameronii (de Jersey) Playford and Dettmann 1965.

Cycadopites follicularis Wilson and Webster 1946.

Dictyophyllidites mortonii (de Jersey) Playford and Dettmann 1965.

Falcisporites spp., including *F. australis* (de Jersey) Balme 1970.

Guttatisporites visscheri de Jersey 1968.

Neoraistrickia taylori Playford and Dettmann 1965.

Osmundacidites wellmanii Couper 1953.

Polypodiisporites ipsviciensis (de Jersey) Playford and Dettmann 1965.

Punctatisporites spp.

Punctatosporites walkomii de Jersey 1962.

Rugulatisporites sp.

Tuberculatosporites spp.

Uvaesporites sp. cf. *U. verrucatus* (de Jersey) Helby ex de Jersey 1971.

Vitreisporites pallidus (Reissinger) Nilsson 1958.

Circulisporites parvus (de Jersey) Norris 1965 - acritarch.

Falcisporites and *Polypodiisporites* were the most prominent genera in the samples. The microfossil association is clearly Triassic in age but the apparent absence of diagnostic species (discussed above in relation to the Gunnee Beds microfossil flora) precludes more definitive age assignment beyond suggesting that they are no older than Middle Triassic.

DISCUSSION

The Middle Triassic age assigned to the Gunnee Beds and Gragin Conglomerate is thus based on both plant megafossil and microfossil data. Fossil plant-bearing sediments of a similar age occur to the north in the Bowen Basin (de Jersey and Hamilton, 1967, 1969) and the Esk Trough of southern Queensland (de Jersey, 1972; Figure 4), to the east at Nymboida in the southern Clarence-Moreton Basin (Flint and Gould, 1975), far to the south in the Sydney Basin (Helby, 1973), and possibly to the south-west in the Gunnedah Basin as well (Hind and Helby, 1969; Bembrick, Herbert, Scheibner, and Stunz, 1973).

The Delungra and Nymboida Middle Triassic sediments impose some constraints on interpretations of the New England region. The granitic rocks of the New England Batholith which intrude the Palaeozoic basement have been assigned Late Carboniferous to Early Triassic radiometric ages (Wilkinson, 1974), and the deposition and preservation of Middle Triassic coal measures on erosion surfaces of this complex probably means that most of the unroofing of the New England Batholith was completed by the Middle Triassic. The Gunnee Beds near Delungra have been deposited on granitic rocks of the batholith and contain much quartzose and arkosic sediment. The clasts of the overlying Gragin Conglomerate are mostly of quartz-feldspar porphyry with some granitic rocks. The Nymboida Coal Measures, unconformably overlying the Late? Palaeozoic sediments of the Coffs Harbour Beds (Korsch, 1971), contain the Bardool Conglomerate (McElroy, 1963). The majority of clasts in the Bardool Conglomerate are rhyolitic and/or ignimbritic; clasts of greywacke, siltstone, and chert from the underlying Palaeozoic sediments are also present. So it seems the source for much of the sediment in these Middle Triassic units was from erosion of the granitic rocks of New England and their volcanic and sub-volcanic equivalents. The granitic rocks underlying the Gunnee Beds are probably among the earliest intrusives of the batholith, but even so they had already been exposed and eroded by the Middle Triassic. The later intrusives of the batholith show characters of high level emplacement (Wilkinson, 1974) which is not inconsistent with a relatively rapid erosion of the intruded country rocks.

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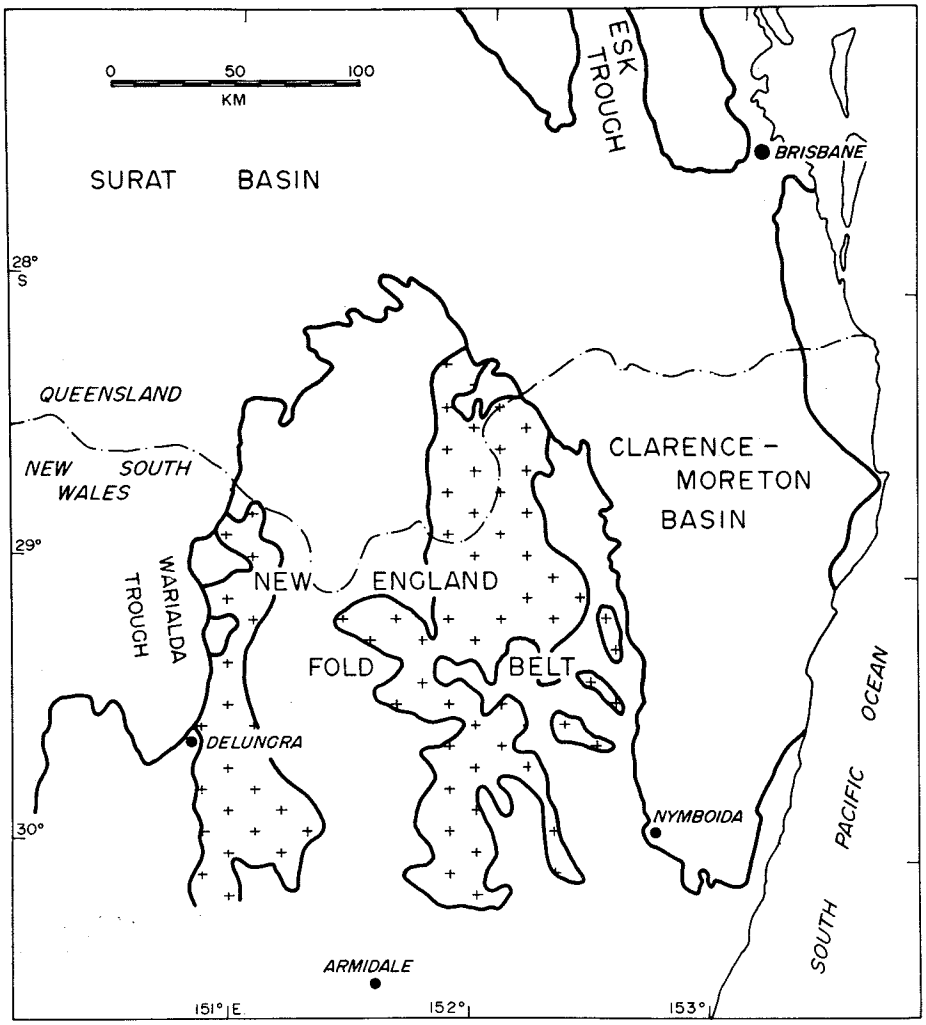

Fig. 4. Location map.

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