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RECORD 1976/29

THE DEVONIAN ROCKS OF THE TOKO SYNCLINE, WESTERN QUEENSLAND

by

J.J. Draper

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SUMMARY

During 1975, field work was undertaken in an attempt to elucidate the relationships within the Devonian sequence of the Toko Syncline. Two Devonian rock units were recognized: the "thelodont-bearing rocks"; and the previously described Cravens Peak Beds.

The "thelodont-bearing rocks" consist of limestone, calcareous siltstone and siltstone, and contain thelodont scales (*Turinia pagei*), acanthodian spines, *Cryptophyllus*, and *ostracods*. The limestone, which is completely recrystallized, is known from one locality only and the calcareous siltstone and the siltstone are each recorded from one locality in the subsurface. The age, based on the presence of *Turinia pagei*, is Early Devonian (Dittonian). Marine or marginal marine conditions are indicated; and there was a possible connection with the Canning Basin.

The Cravens Peak Beds, a conglomerate and sandstone unit, contains no identifiable fossils in situ although fossil fish have been found in the vicinity of outcrops. The presence of *Wuttagoonaspis* sp. and *Phyllolepis* suggests a Middle to Late Devonian age. The unit was probably deposited in an alluvial fan-braided stream environment. Faunal similarities suggest a direct connection with southeastern Australia. The source of the conglomerate is the Adelaidean Field River Beds and therefore there must have been uplift of the Adelaidean Field River Beds prior to or during deposition of the Cravens Peak Beds. This uplift, the major deformation event in the area, is equated with the Alice Springs Orogeny which must be older than previously considered in this area.

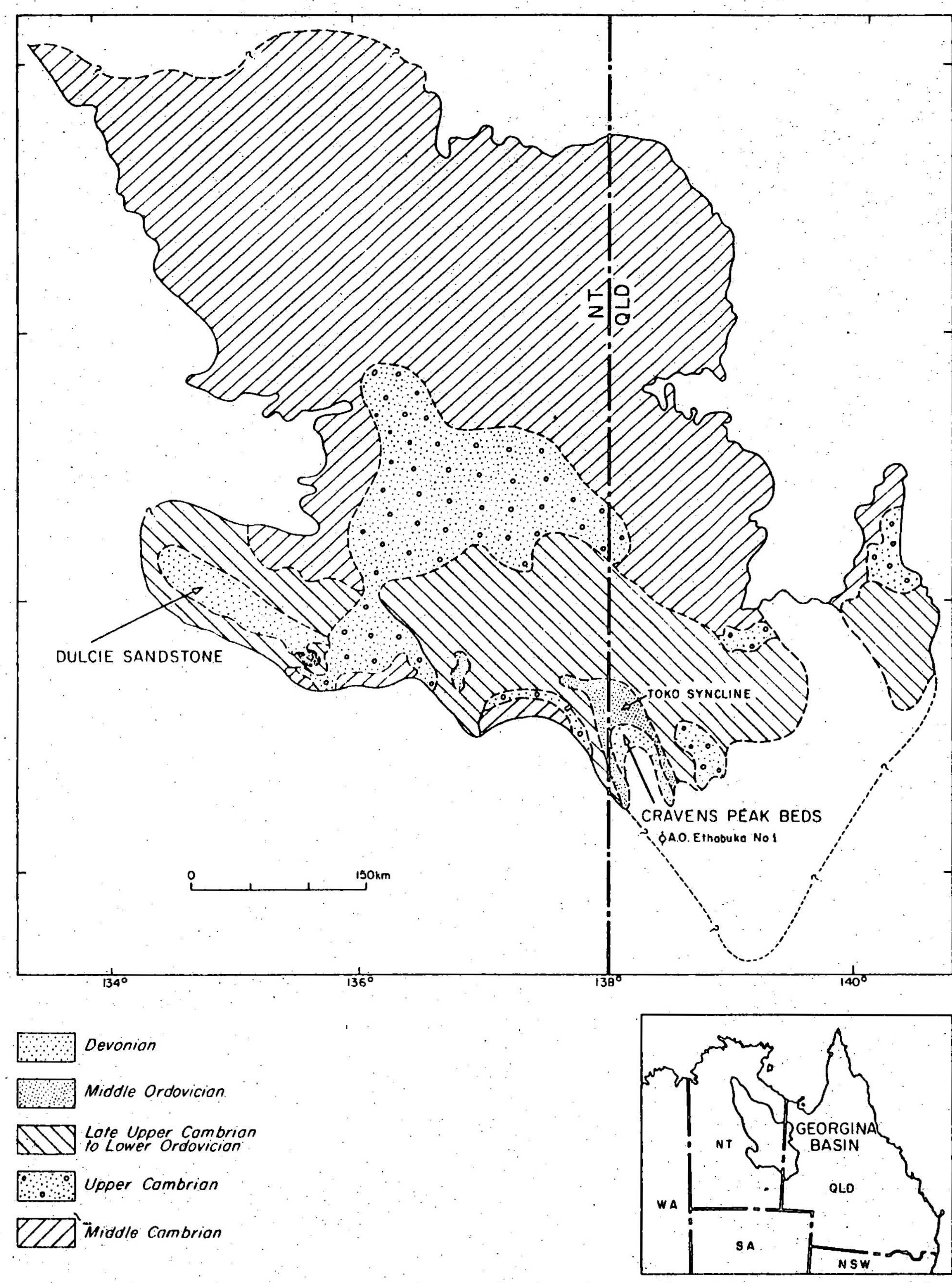

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Fig.1 Locality map and surface geology, Georgina Basin

INTRODUCTION

One of the aims of the Georgina Basin Project (Druce, 1974) is to investigate the Devonian Dulcie Sandstone and Cravens Peak Beds (Figure 1). During 1975, the Cravens Peaks Beds were examined in the field. The Dulcie Sandstone is being studied by G. Young.

Reynolds (1964; in Smith, 1965) defined the Cravens Peak Beds and included in the unit all sandstone and conglomerates of apparent Palaeozoic age overlying the Middle Ordovician Mithaka Formation. Included in the unit was Pritchard's (1960) unit Om-11 which overlies the Mithaka Formation with apparent conformity. Also included in the Cravens Peak Beds was an unnamed sandstone sequence overlying the Mithaka Formation in the Toomba Range with apparent conformity (Smith, Vine & Milligan, 1961).

Initially a Late Silurian to Early Devonian age was given to the Cravens Peak Beds on the basis of thelodont (jawless fish) scales recovered from seismic shothole cuttings (Jones in Reynolds & Pritchard, 1964). Jones (in Turner, 1973), has tentatively identified the thelodont scales as Turinia pagei, which in Britain is Early Devonian (Dittonian). However, the discovery of a Late Devonian (?Fammenian) arthrodian fauna (Gilbert-Tomlinson, 1968) and the identification of Wuttagoonaspis sp., a Middle Devonian arthrodian (Ritchie, 1973) indicates a Middle to Late Devonian age for part of the unit. Unfortunately the arthrodian fauna is not found in place and is associated with aboriginal artefacts. Smith (1972) gives the unit a Siluro-Devonian age. Gilbert-Tomlinson (1968) divided the Cravens Peak Beds into two biostratigraphic units: the "Lower Cravens Peak Beds" and "Upper Cravens Peak Beds".

The Cravens Peak Beds, as described and understood prior to this report, is a sandstone and conglomerate sequence of Early to Late Devonian age. In this report, two Devonian rock units will be described, and some of the sandstone and conglomerate previously included in the Cravens Peak Beds are shown to belong to other units. The environment of deposition and palaeogeography of the two Devonian rock units will also be discussed.

Acknowledgements

Dr P.J. Jones provided much helpful information on the Early Devonian fauna and its implications. Dr G.C. Young identified the fossil macrofauna. Miss J. Gilbert-Tomlinson and Dr M.R. Walter provided advice on particular aspects of the study. Mr K. Heighway carried out the thelodont extraction work. Dr E.C. Druce provided useful comments on the draft.

STRATIGRAPHY

In the Introduction, an outline of the study of the Devonian rocks to date was given; this is summarized in Figure 2. The Cravens Peak Beds as described and discussed in Smith (1965, 1972), and as shown on the Mount Whelan, (SF54/13), Glenormiston (SF54/9) and Hay River (F53/16) 1:250 000 geological maps have been divided into four separate units (Fig. 2): (1) an unnamed sandstone unit conformably overlying the Mithaka Formation of Middle Ordovician age; (2) a limestone and calcareous siltstone unit of Early Devonian (Dittonian) age, referred to in this report as "thelodont-bearing rocks"; (3) a conglomerate and sandstone unit of Middle to Late Devonian age for which the name Cravens Peak Beds is retained; and (4) a conglomerate unit of post-Devonian age. Units (1) and (4) will be discussed briefly, the "thelodont-bearing rocks" and Cravens Peak Beds in more detail.

Unit (1) ("unnamed sandstone unit" of Shergold, Druce, Radke & Draper, 1976) contains pelecypods and trilobite ichnofossils (Cruziana and others). The assemblage of sedimentary structures (flute marks) and ichnofossils is similar to that of the lower part of the Carlo Sandstone (Draper, in press), which underlies the Mithaka Formation. The Middle Ordovician age for unit (1) is based on superposition, and the fact that the unit can be correlated with a thick sandstone of Middle Ordovician age overlying the Mithaka Formation in Ethabuka No. 1 (Alliance Oil N.L., 1975). The extent of outcrop of this unit is shown in Figure 3. This unit, which is equivalent to unit Om-11 of Pritchard (1960), occupies the lower 35 m of the reference section of the Cravens Peak Beds (Reynolds, in Smith, 1965).

Unit (4) consists of pebbly sandstone and conglomerate. It is a relict valley-fill deposit unconformably overlying the Ordovician Mithaka Formation, Carlo Sandstone and Nora Formation, and cutting across the major structure in the area. The major tectonic event in the area is the Alice Springs Orogeny (Smith, 1972) which was considered to be of Early Carboniferous age although, as will be suggested later in this report, it may be older in this area. The distribution of Unit 4 is shown in Figure 3. Only the area of outcrop 3 km south of Mithaka Waterhole is shown on published maps.

"thelodont-bearing rocks"

Distribution: The "thelodont-bearing rocks" are known from two localities (Fig. 3). The northern occurrence is at the shothole localities of Jones (in Reynolds & Pritchard, 1964). The other is an outcrop at the base of the scarp at the south-eastern end of the Toomba Range; this outcrop has an area of about 5 m^2 along a spur fault of the Toomba Fault.

Lithology. The rocks obtained from the shot-holes were siltstones and calcareous siltstones (Jones, pers. comm.). The outcrop in the Toomba Range consists of recrystallized limestone.

Thickness. The thickness is unknown, but is probably less than 5 metres.

Contacts. The unit rests unconformably on the unnamed Middle Ordovician sandstone unit at the shot-hole locality, and

	Pritchard (1960)	Smith et al. (1961)	Smith (1965)	Gilbert-Tomlinson (1968)	Smith (1972)	This Record
POST-DEVONIAN						(4)
LATE DEVONIAN				'Upper Cravens		Cravens Peak
MIDDLE DEVONIAN				Peak Beds	Cravens Peak	Beds (3)
EARLY DEVONIAN			Cravens Peak Beds	? ? ? ? Lower Cravens Peak Beds	Beds	"thelodont (2) bearing rocks"
SILURIAN						
MIDDLE ORDOVICIAN	Om-11	unnamed				(1)

Figure 2. "Cravens Peak Beds": evolution of nomenclature.

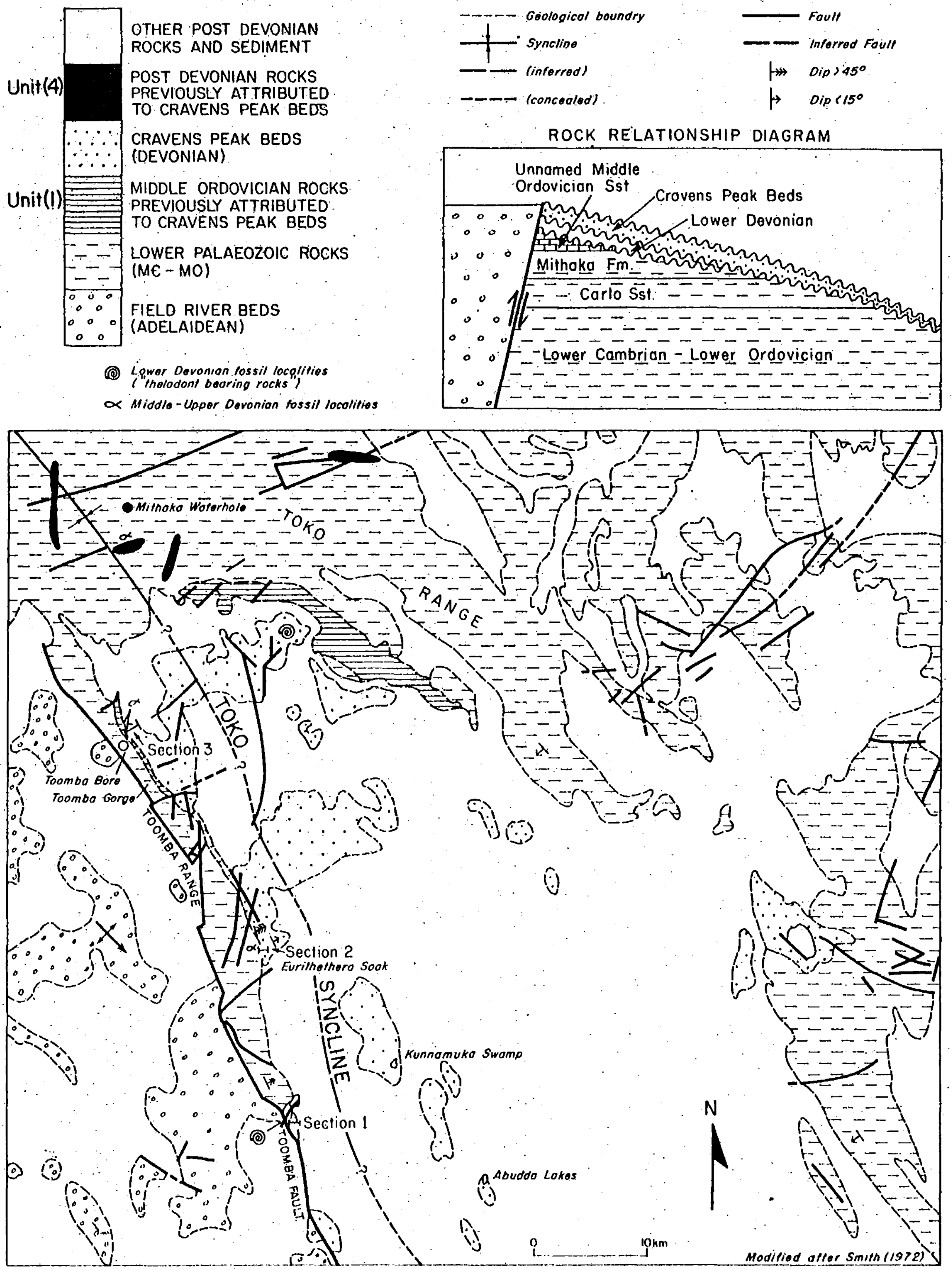

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Fig. 3 Generalized geology - Toko Syncline it is probably unconformable on the Mithaka Formation in the southern Toomba Range. The unit is unconformably overlain by sandstone and conglomerate of the Cravens Peak Beds.

Fossils. A similar fossil assemblage has been obtained from both localities: thelodont scales (Turinia pagei), acanthodian spines, Cryptophyllus, and undetermined ostracods (Jones, pers. comm.).

Stromatolite-like textures are present in the limestone. However no filaments were found, and recrystallization makes it difficult to assess the textures. They may be the result of primary or diagenetic inorganic processes rather than organic processes.

Age. Dittonian (Early Devonian). The age is based on the recognition of Turinia pagei, which in Britain is Dittonian (Turner, 1973). There is no corroborative evidence for this age as yet; the ostracods are undescribed, and Cryptophyllus has a long time-range (Jones, 1962).

Cravens Peak Beds

Derivation of name. The unit was nammed by Reynolds (in Smith, 1965) after Cravens Peak Holding (Queensland Lands Department map No. 68), which occupies an area between the Queensland/Northern Territory border and the Toko Range.

Distribution. Outcrops occur along the Toomba Range, and as isolated rubbly hills in the central area of the Toko Syncline (Figure 3). Ferruginized rubble on the eastern limb of the Toko Syncline was assigned to the unit (Smith, 1972), but there is little evidence to suggest that the rubble was derived from the Cravens Peak Beds.

Lithology. Rock types range from boulder conglomerate through finer conglomerate, mixed conglomerate-sandstone to

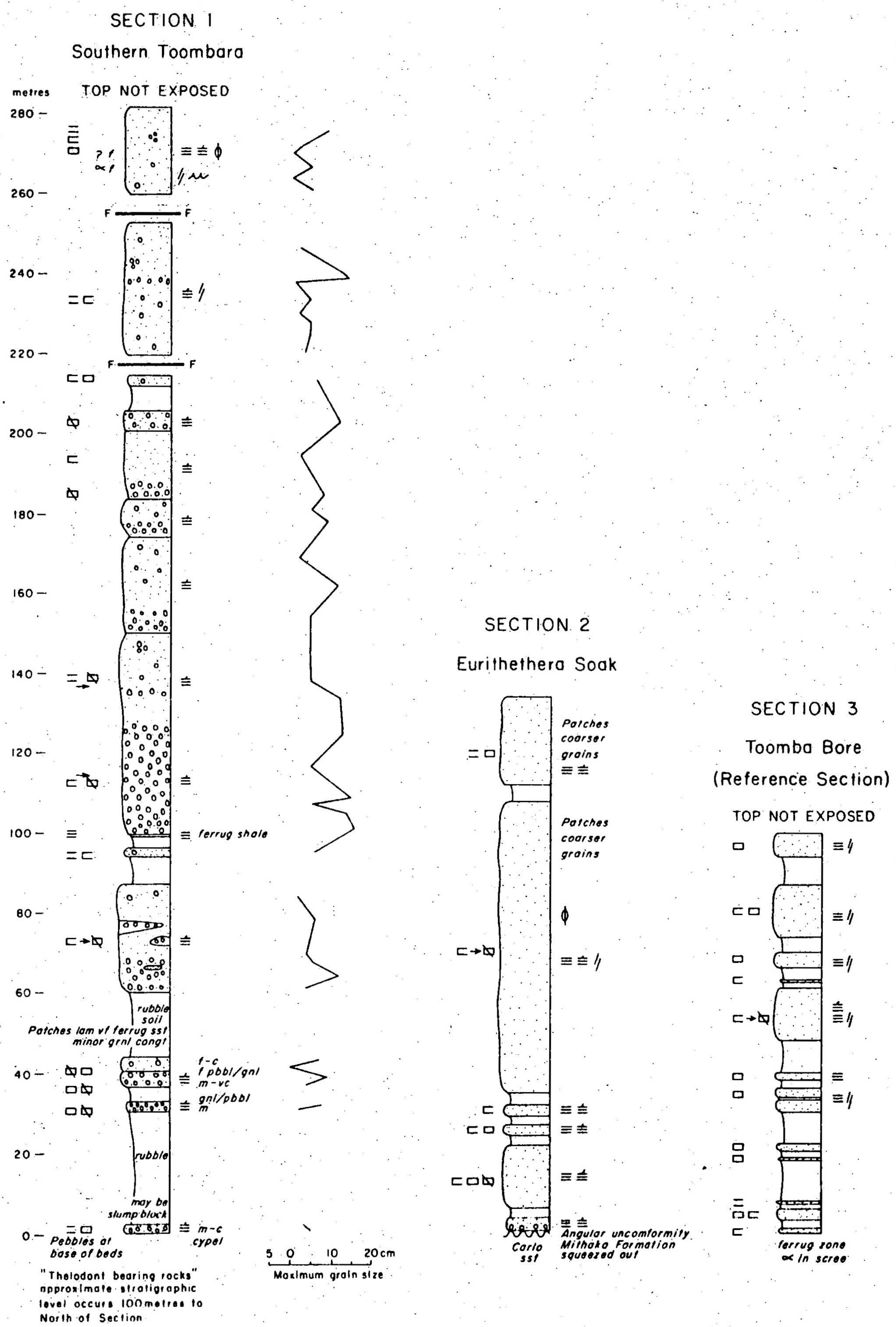

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Fig. 4 Stratigraphic Sections – Cravens Peak Beds quartz sandstone containing minor clay pellets (Figure 4), and minor amounts of shale.

Reference section. No type section has been proposed. The original reference section is 100 m east of Toomba Bore (see Smith, 1972 for section). The lower 35 m of sandstone outcrop in this section is Middle Ordovician; the Cravens Peak Beds start above a 10-m thick ferruginized zone separating the two units. This ferruginized zone may mask the presence of Early Devonian rocks in the area. The revised reference section is shown in Figure 4 (Section 3).

Thickness. Three sections ranging from 100 m to approximately 280 m, were measured in the Toomba Range (Figure 4). In no place is the top definitely exposed. Elsewhere, the unit is eroded and deeply weathered, outcrops rarely exceeding several metres in thickness. Although a considerable thickness of sandstone in Ethabuka No. 1 is attributed to the Cravens Peak Beds (Alliance, 1975), recent palaeontological evidence suggests little or no Devonian in Ethabuka No. 1.

Contacts. The unit unconformably overlies, in some localities, the "thelodont-bearing beds" (see section 1, Figure 4). It also unconformably overlies Middle and Lower Ordovician rocks (Figure 3). It is overlain unconformably by Mesozoic and Cainozoic rocks and sediments. Smith (1972) suggests that it may also be overlain by Permian rocks but the evidence for this is very tenuous and the boulder scree, previously thought as Permian, probably is a weathering product of the Cravens Peak Beds; the boulder beds of the Cravens Peak Beds occurring in the same locality as the supposed Permian rocks in the Toomba Range.

In the Toomba Range, the crust has been substantially affected by faulting. At Eurithethera Soak the Ordovician Carlo Sandstone and Cravens Peak Beds are separated by an angular unconformity of about 10^{o}, the less competent Mithaka Formation having been squeezed out. The sandstone unconformably overlying the Mithaka Formation elsewhere has apparently been eroded in the vicinity of the Toomba Range prior to deposition of the Cravens Peak Beds (Draper in Shergold, Druce, Radke and Draper, 1976). Further south, transverse movement has resulted in the abutment of the Cravens Peak Beds laterally against the Carlo Sandstone.

Fossils. No identifiable fossils have been found in situ in the Cravens Peak Beds. At the very top of Section 1 (Fig. 4), two fossils were collected in situ but were indeterminate; one was a possible arthropod impression (Gilbert Tomlinson, pers. comm.), the other, a faint impression of tuberculate ornament of a fish (Young, pers. comm.). Numerous sandstone samples were examined unsuccessfully for scales.

Three fossil localities are described in Gilbert-Tomlinson (1968) but unfortunately none of the specimens was found in place. Fossils from her locality (26), which were found associated with aboriginal artefacts, have since been examined by Ritchie (1973), who recognized *Wuttagoonaspis* sp., similar to but larger than *W. fletcheri* from the Middle Devonian Mulga Downs Formation of western New South Wales. Locality (26) is now assigned a post-Devonian age, and one can only conclude that the sample was carried there, although, as pointed out by Wilson (1963), the rock in which the fossils occur is heavy and unlikely to have been carried far.

A fossil fragment was collected by Dr C.J. Mulder of Shell Development (Aust.) Pty Ltd from a locality 1 km northeast of Toomba Bore; Locality (27) of Tomlinson (op. cit.). The fragment was not identifiable, but resembled *Coccosteus* and it may therefore be older than Late Devonian (Gilbert-Tomlinson, op. cit.). This locality is just north of the reference section.

The fauna at Gilbert Tomlinson's Locality (28), collected by Cooper (1960) contains fragmentary arthrodian plates, *Phyllolepis*, and an unidentified genus with pustulose ornament. A possible dipnoan fragment is present as well as poorly preserved lycopod bark impression (*?Protolepidodendron*). The locality, Eurithethera Soak, has numerous aboriginal carvings. Smith (in Gilbert Tomlinson, op. cit.) indicates that the nearest outcrop is 0.75 km away, but recent mapping has indicated that the sample was found within 100 m of Cravens Peak Beds. The presence of Phyllolepis suggests a Fammenian age (Gilbert-Tomlinson, op. cit.).

During the current project a fish impression was found in sandstone embedded in the ferruginized zone at the base of the reference section (Section 3, Figure 4). The sample was in ferruginized sandstone and apparently in situ. It has been identified as Wuttagoonsapis sp. (Young, pers. comm.), similar to samples collected at the base of the Dulcie Sandstone. Young suggests a Middle Devonian age.

Age. Circumstantial evidence outlined above indicates a Middle to Late Devonian age for the unit.

Description and comment. Three sections were measured in the Toomba Range (Figures 3, 4) and a number of localities visited. Section 1, measured at the southernmost extremity of the Toomba Range, contains 280 m of grey, brown and dark brown conglomerate and sandstone with a number of fining upwards cycles. The proportion of sand in the unit as a whole increases upwards, In the predominantly comglomeratic part of the sequence, cross-stratification and lensing of beds are common. Minor shale interbeds are present.

The sandier (fine to medium sand) top of the sequence is cross-stratified and laminated, with parting lineation, small-scale asymmetrical ripplemarks (wavelength 3.5 - 4.5 cm, amplitude approx. 0.4 cm) and possible interference ripplemarks. The cross-stratification varies from small-scale, very low-angle, to small to medium-scale, moderate angle trough cross-lamination. Clay pellets are present as isolated pellets, in patches, and along cross strata. Coarser sand also occurs in patches and along cross strata. Simple vertical and subvertical burrows are common in some beds, and in other beds they have a patchy distribution or are absent. The burrows vary in diameter from less than 0.5 cm to 1.6 cm and are up to 20 cm long. Short vertical burrows with raised rims are also present.

Section 2 (Figures 3, 4) was measured near Eurithethera Soak and consists of medium to very thick beds of fine to medium-grained, light grey to light brown sandstone with minor thin beds. A layer of quartzite pebbles marks the base of the section, and of the unit. Trough cross-stratification is common and parting lineation is present. In one bed simple vertical burrows (50 cm length, 1-2 cm diameter) are common. Towards the top of the section patches of coarse sand occur within the fine to medium-grained sandstone.

The reference section (Section 3, Figures 3, 4) 100 m east of Toomba Bore consists of medium to thick beds of fine to medium-grained, white to orange-brown sandstone. The exposed sandstone is laminated and parting lineation is common. Cross-stratification and scour and fill structures are present. Clay pellets are rare. The basal sandstone does not contain pebbles and none was observed in the scree. However, 3 km to the south, pebbles are present in the basal sandstone and they become larger and more persistent to the southeast.

Rubble at Abudda Lakes (Figure 3) attributed to the Cravens Peak Beds was observed to contain pebble conglomerate, and sandstone with vertical burrows. The unit crops out at Kunnamuka Swamp (Figure 3) where pebbles are present. Cross-stratification consists of cosets of medium-scale, moderate angle, trough cross-lamination. Lamination and parting lineation are common and undulose bedding is present. Patches of coarser sand grains are present in the fine-medium sandstone.

Well rounded quartzite gravel, with minor chert and quartz-gravel makes up the conglomerate component. Reynolds (1964) considered the Field River Beds to be the source of these boulders. Factors favouring this hypothesis are the proximity of the conglomerate to the Field River Beds (Figure 3), the lithology of the Field River Beds (quartzite boulder beds, siltstone, arkose, dolomite, quartz sandstone), and the lack of other suitable sources. Any Palaeozoic rocks would have contributed sandstone and perhaps limestone, but the Archaean sequence would have contributed granite and metamorphic clasts.

ENVIRONMENT OF DEPOSITION AND PALAEOGEOGRAPHY

"thelodont-bearing rocks"

A definitive determination of the environment of deposition cannot be made for these beds because of the paucity of data. Turner (1973) has indicated a fresh-water environment for *Turinia pagei* in European occurrences. However, the presence of *Turinia pagei* and the related *Turinia australiensis* (Gross, 1971) (Canning Basin) in Australia suggests the possibility of a marine influence in the life cycle of these fish. *Cryptophyllus* is considered indicative of marine conditions (Jones, 1968). The ostracods are smooth species and their environmental significance has yet to be elucidated (Jones, pers. comm.). The evidence suggests marine or marginal marine conditions. This evidence is strengthened by the fact that recrystallized limestone from the unit has a high strontium content (0.071 percent), which has been suggested (Odum, 1957) to be indicative of a marine origin.

The possibility of these rocks being of marine origin alters the palaeogeography of the Lower Devonian suggested by Johnstone et al. (1967) slightly; they show marine sediments in the Adavale and Canning Basins separated by a belt of terrigenous sediments. If these "thelodont-bearing rocks" are marine then a transgression occurred during Dittonian times. Gilbert-Tomlinson (1968) suggested the possibility of Lower Devonian marine incursions during deposition of the Mereenie Sandstone (Amadeus Basin), Dulcie Sandstone and Cravens Peak Beds (sensu Gilbert

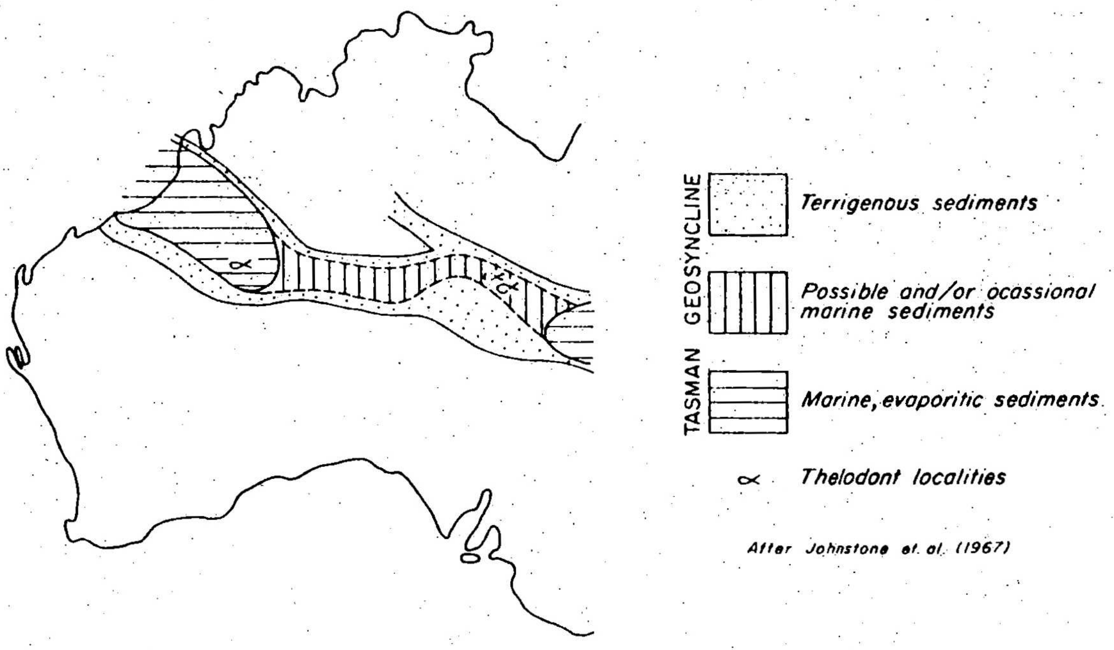

Fig. 5a Lower Devonian Palaeogeography, western and central Australia

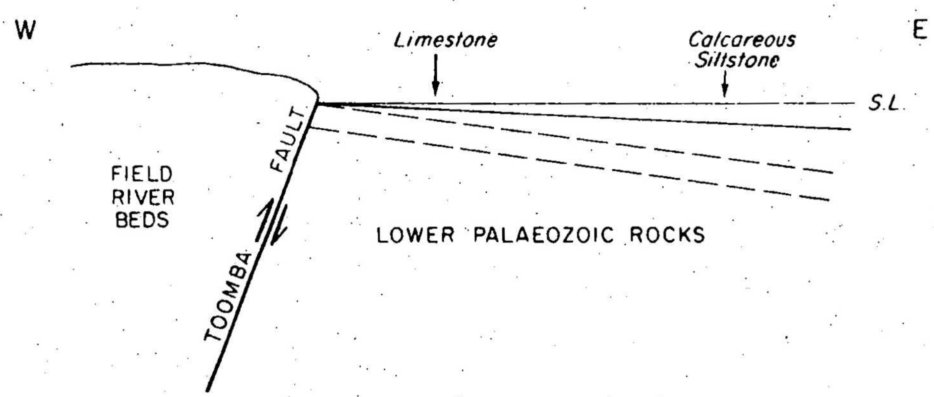

Fig. 5b Envisaged environment of deposition of the "thelodont-bearing rocks"

Tomlinson, 1968). In Mereenie Sandstone the sea appears to have transgressed eastwards (Wells et al., 1970), but in the case of the Cravens Peak Beds and Dulcie Sandstone the transgression could have been towards the west since no marine conditions are known in the eastern Amadeus Basin. However, the presence of thelodont scales and acanthodian spines in the Canning Basin (Gross, 1971) does suggest the possibility that there was a direct marine link between the Canning and Georgina Basins (Figure 5). If the Birdsville Track Ridge was emergent during the Devonian (Devine & Youngs, 1975) the sea can only have transgressed eastwards. The emergence of the Ridge is based on the marine transgressions in the Amadeus Basin being from the west and in the Adavale Basin from the east.

Cravens Peak Beds

The Cravens Peak Beds are visualized as having formed in an alluvial fan-braided stream environment (Figure 6). The basic models for such environments are described in Allen (1965).

Section 1 (Figures 3, 4) represents a section through the alluvial fan. It is adjacent to the Toomba Fault and the overthrust Field River Beds. The conglomerate is chaotic and lenticular bed forms are common. Upward-fining is evident for the whole section and for a number of cycles within the section. Observations at Kunnamuka Swamp, Abudda Lakes, and to the north-east up to Toomba Range suggests a relatively rapid decrease in gravel grainsize and content away from the general area of Section 2. This would be consistent with there being an alluvial fan in the vicinity of Section 1. Alluvial fans require intermittent stream action and a more or less sudden change in slope for their formation (Allen, 1965). The latter was provided by uplift of the Field River Beds along the Toomba Fault. Intermittent stream action occurs in arid areas or areas of spring thaw run-off. The red-brown colour typical of weathering; the association with braided stream deposits, and lack of fluvio-glacial features suggest an arid climate. The internal fining-upwards cycles would represent discrete depositional events while the

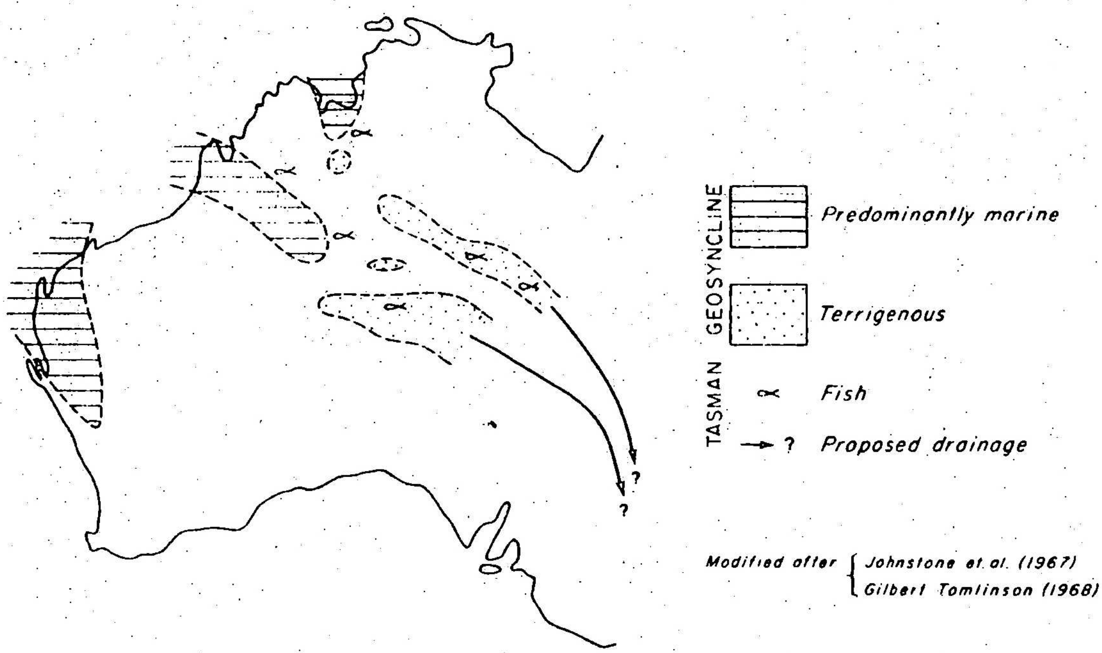

Fig. 6a Middle - Upper Devonian Palaeogeography, western and central Australia

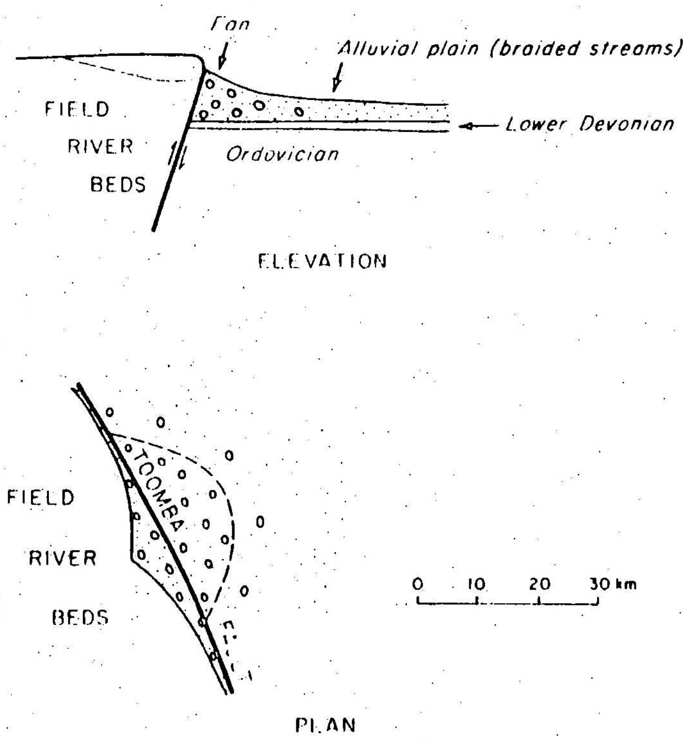

Fig. 6b Envisaged environment of deposition of the Cravens Peak Beds

overall fining upwards suggests a decrease in the rate and intensity of denudation. The burrowing and minor faunal traces in the sandstone also suggest more consistent conditions. The streams may have been more persistent at this later stage.

The sandstone (Sections 3, 4) was probably deposited under braided-stream conditions. The environment visualized is similar to that figured by Allen (1965, Figure 35B). Features in common with Allen's model are lack of argillaceous sediment, lenticular nature of the bedding, and the general lack of biologic activity. The only burrows observed are deep (50 cm), suggestive of dry conditions.

The Middle to Late Devonian palaeogeography of central and western Australia was summarized by Johnstone et al. (1967) who envisage predominantly marine conditions in western Australia, and terrigenous conditions in the centre. Gilbert-Tomlinson (1968) suggested the possibility of the central Australian sediments being part of a large river system flowing towards the sea in southeastern Australia; the suggestion being based on the apparent restriction of *Phyllolepis* to central and southeastern Australia. *Wuttagoonaspis*, though older, has a similar distribution to *Phyllolepis* and this supports this hypothesis (Figure 6) If this latter hypothesis is the case, either the Birdsville Track Ridge was not emergent or it was breached by the southeasterly flowing river system.

Major uplift along the Toomba Fault most have commenced before or during the Middle Devonian. If this faulting is associated with the Alice Springs Orogeny (Smith, 1972), it is apparent that uplift in the Toomba Range predates uplift in the Amadeus Basin which Playford et al. (1976) consider is of Late Devonian age.

CONCLUSIONS

The Devonian rocks in the Toko Syncline consist of the Lower Devonian (Dittonian) "thelodont-bearing rocks" and the Middle to Upper Devonian Cravens Peak Beds.

The "thelodont-bearing rocks" consist of limestone, calcareous siltstone and siltstone containing thelodont scales, acanthodian spines, Cryptophyllus and ostracods, and was deposited under probably marine to marginal marine conditions. A possible connection exists between these rocks and marine rocks of equivalent age in the Canning Basin.

Unconformably overlying this unit is the Cravens Peak Beds, a predominantly sandstone and conglomerate unit of alluvial fan-braided stream origin. No fauna has been found in situ, but fish impressions have been found in float adjacent to outcrops of the unit. The unit may have been part of a river system draining the the south or the southeast.

Faulting, probably associated with the Alice Springs Orogeny, appears to be of Middle to Late Devonian age in this area.

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